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Thesis by Simon Josias Graf

Building Formal Ontologies for Theology and Systems of belief

This thesis develops and discusses representations of theology and a system of belief by formal ontology and semantic information architectures and it evaluates the usefulness of such information architecture.

Master Thesis at Aalborg University

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Abstract

"Ontology" may be one of the complicated terms in information architecture due to its substantial history in philosophy and its various connotations within computer science. No less intricate is the notion "systems of beliefs" associated with different religions and long traditions of thought. Nonetheless, this study clarifies the history of ontology from its ancient roots, through its early modern invention to its present use in information science. After the introduction of ontology, the thesis develops and represents a theological system and a system of beliefs in formal ontologies designed with the ontology software, Protégé. The thesis takes heed to present ontology carefully giving a thorough description of the development process and a discussion of the ontologies for theology (the TheOn) and for Calvinism (CalvOn). While the former ontology is developed with insights from analyses of ontologies for philosophy, the latter ontology is constructed with reference to the categorization in A. N. Prior's paper *The Logic of Calvinism*. The information architectures of these ontologies comprise semantically enriched knowledge structures capable of presenting theological information and confessional beliefs in a machine-readable language and enabling logical inferences throughout the categorizations. The resulting formal ontologies will be described, illustrated, and discussed in detail throughout the thesis before the thesis provides an assessment of the ontologies' usefulness, a brief examination of their practical potential applications, and some suggested ways forward.

1. Introduction

Neutral information designs do not exist for there are inevitably some ethical, philosophical, or ideological assumptions involved in an information architecture. Whether explicit or implicit, premeditated or unintended, there is at all times an underlying set of values, assumptions, and beliefs embedded in an information architecture. While the presence of such presumed beliefs in information systems is uncontested, the problem of whether it is possible and good to present systems of beliefs as information architecture is more contentious. This, however, is what the thesis endeavors to examine in developing information architectures presenting theology and a system of beliefs. In doing this, the study aims at answering the thesis statement:

How can a system of beliefs such as Calvinism be presented as an information architecture and what is the usefulness and value of such an information architecture?

The phrase "system of belief" is ambiguous. Here, it connotes a set of ideas that are held by one or more cognitive agents to be good, right, and true. Calvinism exemplifies one such system of beliefs. The thesis will treat systems of beliefs with Calvinism as its case study due to the tradition's rigid line of thought, its thought-provoking nature, and its thorough treatment in history. It will develop an information architecture for Calvinism through categorization analysis and formal ontology for various possible applications by websites, online learning environments, and artificial intelligence.

After observing how an inclusive information architecture can be developed for theology in general, the thesis takes its point of departure for the case study of Calvinism in the paper *"The Logic of Calvinism"* by the philosopher A. N. Prior, which was written around 1943-1945, but which was not published until the project of developing the Prior's Nachlass was taken up in recent years. Prior's paper analyses the *Westminster Confession* (1646) and offers a formal categorization which the thesis will use to develop a formal ontology for Calvinism.

After providing context for the study in the introduction, the thesis undertakes its treatment of the problem in four main sections. First, an introduction to formal ontology is offered. This is followed by the development and presentation of a general ontology of theology. The third part provides an introduction and discussion of Calvinism and presents a specific formal ontology for Calvinism. The final section consists of a discussion of the purpose, applications, usefulness, and the ways forward of the formal ontology information architectures for theology and systems of beliefs.

1.1. The meaning of "systems of beliefs as information architecture"

From the above, the distinction between system of beliefs embedded or presumed *in* information architecture and system of beliefs *as* information architecture deserves some clarification. In all information systems, subjective ideas and values are inevitably assumed. Hence, one could refer to many examples of information systems assuming beliefs of commercial, cultural, philosophical, political, religious, or social nature.[1]

Although studies on such systems would be important, these information architectures are not the focus for this thesis. The present concern is not systems of beliefs expressed in information architecture. Rather, the thesis focuses on information architectures designed for the purpose of presenting systems of beliefs; information architectures that aim at outlining and structuring belief systems with clarity to make the belief systems' information findable, understandable, and usable. For this aim, the thesis will use knowledge representation and the discipline of formal ontology.

At the heart of the field of information architecture lie the challenges of structuring, organizing, labelling, and categorizing information. The art of systematizing information is not foreign to the domain of beliefs – at least not to the traditional monotheistic beliefs with longstanding traditions of thoughts. This is evident from the highly structured representations of beliefs in early Christian creeds (like the Apostles' Creed or the Nicene Creed), in magnus opuses of historic theologians (like Thomas Aquinas' *Summa Theologica* or John Calvin's *Institutes*) and in more contemporary ones (like Karl Barth's *Church Dogmatics* or Wayne Grudem's *Systematic Theology*).

Systematizing beliefs through information technologies, however, is a rather uninvestigated task. Fields in information technology (e.g. information architecture, knowledge representation and formal ontology) offer much potential to be explored in this regard. Arp, Smith, and Spear (2015, pp. 187-188) and Ong, et al. (2017) show that the vast majority of existing formal ontologies represent the medical field and generally the natural sciences. In addition, the semantic web has also been applied to commercial purposes for instance in the tourist industry (Busse, et al., 2015, p. 31). In comparison, the humanistic sciences (including theology) have only been a minor subject for knowledge representation in formal ontology and to the knowledge of the author there has not been developed a formal ontology for theology yet although there exist a few for philosophy.

[1] One example is the American App, "2ndVote" advising conservatives about where to be a costumer, based on a rating of businesses related to their support of liberal or conservative values, causes and issues (https://www.2ndvote.com/).

Busse et al. explain that the standardization of the description language *Web Ontology Language (OWL)* by the World Wide Web Consortium led domain experts worldwide to start formalizing information in ontologies (Busse, et al., 2015, p. 31). By means of ontology, the Semantic Web can categorize domains and provide to classes definitions and specification of relations. This enables information technologies to make logical deductions and searches with reasoners understanding not only the syntax but even the semantics of information in a knowledge base (ibid. pp. 29-32). Applied to systems of beliefs and theology, such information architecture might enable and increase understanding of the semantics in the domain of faith and theology.

The attempt in the thesis to systematize beliefs as information architecture means to clarify and emphasize the structure and logic in the system of beliefs. In breaking new ground by using formal ontology to represent a system of beliefs, the thesis will attempt to present information of theology and a system of beliefs by formal ontologies comprising defined classes, properties, and individuals. It will explore whether formal ontology offers a means of presenting systems of thoughts as information architectures that might be useful for genuine needs.

1.2. Reasons for systematizing beliefs as information architecture

After this elaboration of the terms, one might question the purpose and validity of systematizing beliefs as information architecture. Thus, some considerations regarding this question is offered here commenting on skepticism towards the endeavor along with benefits of it.

As noted above, the attempt of systematizing belief is neither new nor insignificant. Many thinkers and great volumes have been devoted to precisely this task of systematizing belief for clarity and practical purposes. Several fields and traditions have contributed to the systematization of Christian belief including analytic theology, systematic theology, and scholastic theology.

Nevertheless, a controversial tone in the phrase "*systematizing beliefs*" seems to be found. Indeed, there seems to be a skepticism towards thorough systems of thought expressing itself in intolerance of exclusivist beliefs. Inclusion in regard to beliefs is generally considered a virtue and religious particularism tends to be thought of as "arrogant and immoral" for its frank belief that people who disagree are wrong (Moreland & Craig, 2003, p. 617). Systemizing and formalizing beliefs as with for instance Calvinism tend to exclude and might thence be considered unpopular.

In his comprehensive work of the concept "*worldview*", Naugle explains a reactionary postmodern attitude towards the premodern attempt of describing an exhaustive worldview:

> *"The result has been what Jean-Francois Lyotard has famously called an "incredulity toward meta-narratives,"*[56] *or to paraphrase, a disbelief that any worldview or large-scale interpretation of reality is true and ought to be believed and promulgated. What remains for the postmodern denizen is a plethora of socially and linguistically constructed meaning systems, each unprivileged, nonhegemenous, and thoroughly tolerated."* (Naugle, 2002, p. 174).

In view of this, it is not surprising that Christian belief as a worldview often is considered outdated, irrational, or unjustified 'wishful thinking'. Part of this view of Christian belief is likely shaped by significant thinkers like Sigmund Freud, Karl Marx and Bertrand Russell who criticized Christian theism as false, deficient, and irreconcilable with reality. But perhaps it was also shaped by a perceived contrast between faith and reason. Millard Erickson observes that modernity gave rise to a "epistemological dualism" between reason and faith, in which God cannot be object of "pure reason" for lack of any sensory perception of him (Erickson, 2013, p. 25). And according to Packer, "We are told that "God-talk," as Christians have historically practiced it, is a refined sort of nonsense, and knowledge about God is strictly a nonentity." (Packer, 1993, p. 19) Nevertheless, it has been convincingly argued by, for instance, the distinguished philosopher, Alvin Plantinga, that it is still possible to have warranted belief in God which need neither be justified by any evidences of God's existence nor disproven by the most common defeaters such as the problem of evil (Plantinga, 2015). Since belief in God need not to be irrational or nonsense, the thesis will proceed assuming that its treatment of Christian beliefs might be an appropriate domain for ontology.

Still, even among theologians there are controversy on whether it is meaningful to systematize belief, so it might be necessary to validate further the attempts of categorizing and formalizing belief. In Erickson's view of theology, these endeavors are related to the discipline of Systematic Theology which being part of Doctrinal Studies is differentiated from Biblical Studies, Historical Studies, and Practical Studies (Erickson, 2013, p. 10). Erickson argues that the discipline is necessary due to the importance of correct doctrinal belief between the believer and God, the wide-ranging consequences for our lives of doctrines, and due to the discrepancies between Christian orthodoxy and alternative viewpoints from various other religions, ideologies, or contemporary winds of thought (ibid. pp. 14-16). Thus, the thesis contents with Erickson that the Church must engage in systematization of theology asking itself what doctrines it believes and why it favors

those against others (ibid. p. 44). The means of ontology and information architectures might be used by the Church to develop and mediate doctrinal belief.

On a positive note, it is natural for the believer to ponder on what she believes and to reflect on who God is. Indeed, when a believer finds God worthy of worship, the natural reaction is generally a desire to know more about God. One of the benefits of systematizing beliefs is that it provides a common language by which belief can be mediated. Since categorization is a fundamental cognitive necessity for sense making of the world, conceptualizations of the categories of belief are indispensable for the formation of Christian faith. The conventional categorizations in systematic theology are used to decipher the wide spectrum of traditional beliefs. Categorizing a system of belief, thus, offers the personal and spiritual value for believers seeking understanding.

When a system of belief is presented in an understandable manner, it is also made object of meaningful conversation and reasonable discussion of its structure and content. Hence, the systematization of belief offers a shared conceptualization that enables research and further study of that which is believed. This pedagogical and research value are extended when considering systematizing belief by information architectures. Education and learning is in various ways mediated by information architecture and information architecture can assist students and researchers in their acquiring, discussion and sharing of knowledge.

Besides the spiritual value and the educational value, there is the commercial value of applications which could be built with the information architectures for systems of beliefs. For instance, Semantic Web applications of formal ontology could today empower a knowledge base, a search engine, a reasoning tool, and even a weak artificial intelligence in mediating systematized beliefs or vast amounts of formalized theological knowledge. For instance, categorizations of beliefs and theology could be programmed into Siri, Watson, or other personal digital assistant, so that they would be able to relate information in the domains of belief, religion, and theology. In addition to the spiritual, the educational, and the commercial value, the endeavor of the thesis is also motivated by the innovative value in the fact that systematization of belief and theology by formal ontology has not (to the knowledge of the author) been attempted previously.

Based on the preliminary thoughts introduced in the above, the thesis embarks on its pursuit of presenting an information architecture for a system of beliefs and discussing its usefulness. The thesis will begin this by introducing the history of ontology and its use in information architecture.

2. The making of formal ontology

This section introduces the history of ontology and the discipline of formal ontology, before section 3 and 4 employ formal ontology to develop information architectures for theology and Calvinism.

2.1. A historical introduction to ontology

Ontology; the compound word of the Greek "*to on*" (lit. "the being") and "*logia*" (the study of), was not coined until 1606, when Jacob Lorhard introduced the term in his eight-volume textbook *Ogdoas Scholastica* (Kenny, 2007, p. 160), (Øhrstrøm, Schärfe, & Uckelman, 2008, p. 74). Nevertheless, it represents a discourse that can be dated back to the antiquity, for ontology; the study of the basic categories of being, is very closely related to its relative, *metaphysics*, introduced with Aristotle. It was, in fact, originally synonymous to *metaphysica generalis* describing the "most general categories of being" (Smith, Ontology, 2009). Kenny even states "The central topic of metaphysics is ontology: the study of Being" (Kenny, 2007, p. 160).

As the discussion of being as such, the history of ontology might be traced back to the pre-Socratic philosophy of Parmenides of Elea (c. 515-440 BC) who wrote about "the attributes of "What is" (*to eon*) and "true reality" (*alêthia*)" pondering on the nature of "What is" and stating that "it cannot not be" (Palmer, 2016) (Curd, 2016). More than stating the law of non-contradiction, it seems that Parmenides considered it possible to have genuine knowledge of what is (Curd, 2016). While the term, ontology, has been attributed to Lorhard who coined it and Christian Wolff who popularized it, Kenny argues that Parmenides was the actual founder of ontology (Kenny, 2007, pp. 160-161).

While Parmenides argued that the true Being is utterly unchanging, another pre-Socratic philosopher, Heraclitus (535-475 B.C.) argued that the reality is in total flux (ibid. pp. 163-165). These conflicting points of view represent a major controversy in antique philosophy. Plato (c. 425-347 B.C.) tried to solve the controversy by dividing Parmenides' Being in the realm of the ideas and Heraclites' fluctuating entities in the empirical realm, and while he demonstrated that Being comprehends both the unchanging and the changing (ibid. pp. 164-173), the empirical entities ultimately depended on their unchanging Form or Idea (Hancock, 2018).

This led Aristotle (384–322 B.C), who was greatly influenced by Plato but skeptical about his Theory of Ideas, to describe Being in the categories of "substances (things, or bodies) and accidents (qualities, events, processes)" (Smith, 2001) (Kenny, 2007, pp. 63, 172). He regarded the study of

substances as the metaphysical study of "*being qua being*", the study of being through being (Cohen, 2016) (para. 1). In this study, Aristotle examined the nature of being by discussing the "causes and principles of substances" (ibid.). And he perceived the discussion of immaterial and unchangeable things, which he called "theology", as part of this metaphysical study (ibid).[2]

In the monumental work, *Categories*, Aristotle listed ten categories constituting a basic and comprehensive account of being, where substance was the first and privileged category on which the other nine categories (accidents/properties) depended (ibid.) (para. 2). Aristotle's categories are presented in the table below (Busse, et al., 2015, p. 34):

Denomination	**Greek**	**Question**	**Example**
Substance	ουσία (ousia)	What is something?	Man, horse
Quantity	ποσον (poson)	How much/big is something?	Two inches long
Qualities	ποιον (poion)	What are the features?	White, able to read
Relation	προσ τι (pros ti)	In what relationship is something (to something)?	double, half, bigger, daughter of, was born in
Location	που (pou)	Where is something?	On the table, in the swimming pool
Time	ποτέ (pote)	When is something?	Yesterday, in the future
Position/ orientation	κειστηαι (keisthai)	What orientation does something have?	standing, sitting
Having	ἔχηειν (echein)	What does something have?	Has shoos on his feet, is armed
Doing	ποιείν (poiein)	What does something do?	Cut, burn
Experience	πάσχηειν (paschein)	What experiences something?	Being cut, being burned

Table 1: Representation of Aristotle's Categories by Busse et. al.

Aristotle further quantified with universals and particulars to define types of many or of particular entities (Cohen, 2016, para. 2). Hierarchies of such types could then be represented as upside-down trees branching from general to specific items (ibid. para. 2). Thus, already from Aristotle, we begin to observe resemblance to our contemporary formal ontologies. Two examples of such hierarchies; the well-known Tree of Porphyry presented in the 3rd Century AD as part of an introduction to Aristotle (Arp, Smith, & Spear, 2015, p. 28), and the Tree of Brentano arranging Aristotle's categories which John Sowa refers to as "Aristotle's Ontology" (Sowa, 2001), are presented below.

[2] Regarding the problem of the thesis, some might argue that knowledge of God is in fact, a nonentity; not fulfilling the Parmenides' definition of being; "it cannot not be". But in contrast knowledge of God might regarded with Aristotle as metaphysical knowledge suitable for the study of being and representation through formal ontology.

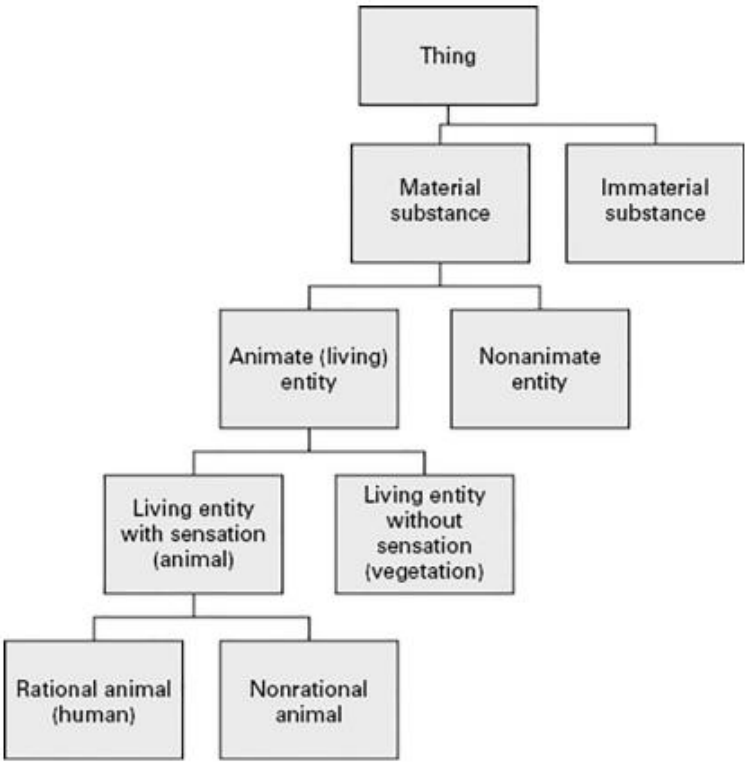

Figure 1: The Porphyrian Tree (Arp, Smith, Spear, 2015, p. 28)

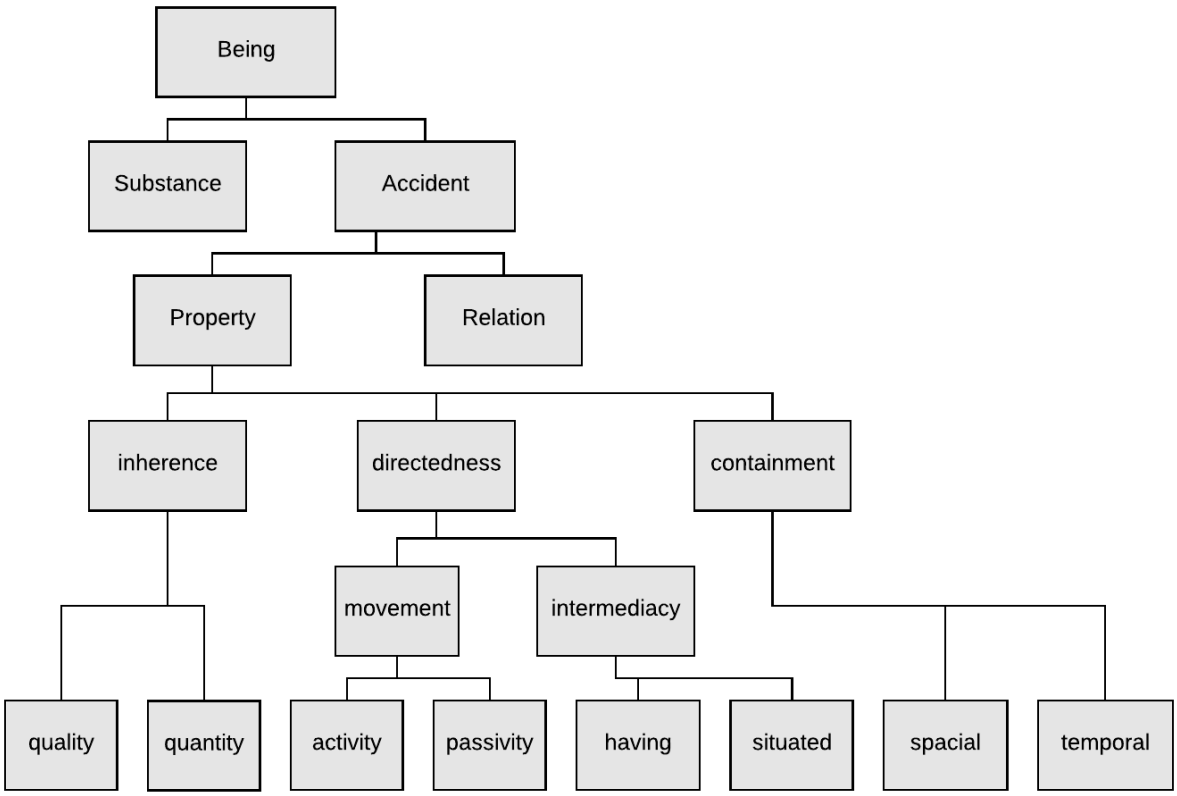

Figure 2: Brentoni's Tree of Aristotle's categories (Sowa, 2001)

During the centuries following Aristotle, comparatively little was added to the study of Being. The major philosophical groups in Greece were no longer the schools founded by Plato and Aristotle, but rather they represented the Epicureans, the Stoics, and the Skeptics, who were generally more concerned with epistemology and ethics than with metaphysics (Kenny, 2007, pp. 77-86, 181-182).

The first-century Jesus of Nazareth impacted the study of Being indirectly as the study was carried forward until modern time largely by Christian thinkers. Christian thought in the Patristic period (c. 100-451 AD) consisted early on mainly of apologetics, the defense of faith, in face of persecutions and clarification of right beliefs in opposition to heresies (McGrath A. E., 2013, pp. 17-35). But near the end of the patristic period came Augustine of Hippo (354-430 AD).

Augustine was perhaps the greatest Christian philosopher of all time and Kenny states that of all ancient philosophers "only Aristotle had greater influence on human thought" (Kenny, 2007, p. 94). As a Christian Neoplatonist owing to Plotinus (205-270 AD.), Augustine wrote against the Greek Skeptics and offered his own theory of ideas in which ideas exist eternally and unchangeably in the mind of God (ibid. pp. 92-93). Augustine's Neoplatonic ontology, which involved a dualism between the sensible (physical) and the intelligible (spiritual), was instrumental in the development of Augustine's influential account of evil, for he reasoned that the human condition should be explained from the intelligible of *original sin*; a sinful condition universally inherited from the fall of Adam, along with a eudemonism in God, who for Augustine was the ultimate source of Being, Goodness, and Truth (Mendelson, 2016).

From the sixth- to the twelfth-century, Augustinian thought was the principal philosophical tradition, which in developing upon Augustine's theory of ideas, struggled with the issue raised by Porphyry; the problem of universals, that is, the questions of "what universals really are" and of whether universals exists apart from human thought and apart from particulars (Leinfellner, Kraemer, & Schank, 1982) (Hancock, 2018).

Besides the Augustinian tradition was the distinguished Muslim philosopher, Avicenna (980-1037), who is described as "the greatest metaphysician of the first millennium AD." (Kenny, 2007, p. 401). Avicenna's ontology involved a central distinction between existence and essence. On the one hand, a thing's existence corresponded with *that it is* in the comprehensive sense of the phrase where everything that "is" can be contributed to exists. On the other hand, a thing's essence connoted *what it is* (its essence, quiddity, thingness, and mode of existence) (Lizzini, 2016, p. section 3). This

distinction between existence and essence allowed Avicenna to include in his ontology the modalities of necessity and potentiality (ibid., section 4).

The prominent Christian thinker, Thomas Aquinas (1225-1274), followed the Augustinian tradition and Avicenna, but adopted and developed Aristotelian metaphysics to explain the notions of "essence and existence, necessary and contingent existence, and particular and universals" (Hancock, 2018). For Aquinas, contingent beings exist due to God, the First Cause, who is a self-existent necessary Being (ibid.). Part of Aquinas' legacy are detailed commentaries of Aristotle's *Nicomachean Ethics* and *Metaphysics*. So, Aquinas is known for his Aristotelian Christianity (Kenny, 2007, pp. 315-316). For instance, he used Aristotle's categories of substances and accidents to develop the doctrine of transubstantiation which the Catholic Church still confesses (ibid. p. 407). In this doctrine the bread in the Eucharist receives the substance of Christ while the visible accidents of the bread remain.

Until this point the major traditions of thought has been favoring some type of realism. While Plato offered a realism by his Theory of Ideas presenting universals as ideas independent of particulars, Aristotle held to a realism in which universals exist only when instantiated by some particular. In the fourteenth-century, however, William of Ockham (c. 1285-1349) presented the view that our ideas do not exist in themselves, but they correlate indifferently to individuals from our experience (Hancock, 2018) (Øhrstrøm, Andersen, & Schärfe, 2005, p. 427). Therefore, Ockham is often called a nominalist; one who thinks that universals does not exist and that we merely use name for collections of particulars when we refer to species, kinds or categories (Arp, Smith, & Spear, 2015, p. 14). Followers of Ockham elaborated his ideas further in a manner which anticipated Hume's empiricism and the logical positivism in the twentieth-century (Hancock, 2018).

By the early modern period and the rise of modern science, many subjects traditionally attributed to physics were transferred to metaphysics which consequently began to cover a wide range of topics. Van Inwagen and Sullivan explain that "It was at about that time that the word 'ontology' was invented—to be a name for the science of being as such, an office that the word 'metaphysics' could no longer fill." (Van Inwagen & Sullivan, 2018).

When Jacob Lorhard (1561-1609) presented the notion of ontology in his *Ogdoas Scholastica*, he was influenced by the distinguished Catholic metaphysician Suarez (1548-1617), but even more than that by the protestants Petrus Ramus (1515-1572) and Clemens Timpler (1563-1624) (Øhrstrøm, Schärfe, & Uckelman, 2008, pp. 75-76). From the scholastic metaphysician Suarez,

Lorhard received a detailed history of ontology and a high regard for the study of being. Through Timpler, Lorhard also received Suarez' dichotomy of *entis reale* and *entis rationale*. According to Øhrstrøm, et. al., the basic term of the intelligible and the categorizations in Lorhard's ontology were adopted virtually directly from Timpler's *Metaphysicae* (ibid. p. 76). The influence of Petrus Ramus is primarily observed in the hierarchal categorization (ibid. pp. 83-86). This kind of hierarchy structured in dichotomies, also called a Ramism, was a significant means of the post-reformation project of presenting the new Protestant ontology and theology. Section 4 on Calvinism elaborates how Petrus Ramus became influential in the confession of the protestant central Europe.

Uckelman's English translation of Lorhard's ontology in the eighth volume of *Ogdoas scholastica* shows us that while Lorhard's ontology involves deep theological content such as God's eternal and temporal works and the nature of angels, it is tied to a full upper-level ontology that gives account of Lorhard's most basic intelligibles (Uckelman, 2018, pp. 44, 46). At the top level, Lorhard divides the world of intelligibles into universals and particulars, and further down the hierarchy, he involves distinctions between essence and being, between real (mind-independent) and rational (or mind-dependent), between different modalities and between substantial and accidental beings (ibid. pp. 1-13). Thus, in its comprehensiveness Lorhard's ontology involves both a top-level ontology and entities which would normally be classified to a theological domain ontology.

Christian Wolff (1679-1754) who popularized the notion of ontology by distinguishing between 'general metaphysics', which he called ontology, and the different topics of 'special metaphysics' that comprise the conventional outline of a modern textbook on metaphysics (Van Inwagen & Sullivan, 2018). According to Etienne Gilson, Wolff perceived the subject-matter of the study of being as that which can exists; whether actual, possible, or imaginary, it is the entity for which existence is not repugnant (Gilson, 1952, pp. 114-116).

Peter Simons clarifies the development of ontology after the time of Wolff's division of ontology and special metaphysics until Husserl's and Ingarden's formal ontology (Simons, 2009, p. 312). Simons describes how metaphysics was divided in the three categories; "rational theology, rational psychology, and rational cosmology", before it was classified by Kant as ontology divided in the transcendent categories; theology and cosmology, and in the immanent categories; psychology and physics (ibid. p. 312). On the ontologies of Husserl and Ingarden, Simons writes:

> "*Husserl gave the discipline of being the name of ontology, but divided it into formal ontology and several material or regional ontologies.* (…) *Husserl's student Ingarden divided ontology*

into existential, formal and material. Existential ontology is concerned with what he called moments of existence, like forms of dependence, modality and temporality, which are combined into modes of being. Formal ontology studies different objects according to their form (thing, property, event, process, relation, state of affairs, system), material ontology according to their kind (spatio-temporal, psychological, divine). For Ingarden 'metaphysics' denotes among all possible ontologies the one that is actual." (Simons, 2009).

Today, metaphysics is generally perceived in the two categories introduced by Wolff. In the discussion of ontology, it discusses the most general categories of being and treats issues such as the problem of universals, possible worlds, and the nature of numbers. Meanwhile, the special metaphysics investigates matters like identity, change, mind/body, and determinism/freedom.

The major contributions to ontology and the distinct views of the study of being that were introduced in this section are relevant to the formal ontology for systems of beliefs, because the different philosophical views on ontology bears on the perception of the purpose of formal ontology. If a non-realist ontological theory, like nominalism, is held, then formal ontology might be reduced to conceptual analysis for functionality, but if an ontological realism is held, then the task of formal ontology is to present reality truthfully. It was shown that there has been many different philosophical perceptions of what ontology really involves and describes.

At present, then, the term, ontology, is still somewhat ambiguous. While, it refers to the study of general metaphysics in philosophy, computer science has introduced new senses of the word. So, having observed the historical development and different views of ontology as well as some related controversies, the thesis will now attempt to provide clarification to the term, "ontology", and notions associated with or belonging to ontology in information science.

2.2. Introduction to Ontology in Information Science

Ontology is used as a term in common language, in philosophy, psychology, social studies and more. But it also has a specific meaning in information science. Busse et al. explain that information science borrows the term from philosophy and uses it as a metaphor, so that whereas it in philosophy implies "the study of being as such", the

Philosophy	Computer Science
Substance	Class, entity, concept
Accidents	Attribute, property
Facts	Fact, statement, proposition, relation
Ontology	Base-ontology, foundational ontology

Table 2: Correspondences between disciplines retrieved from (Busse et al., p. 39)

analogous use of the term in information science connotes formal definition of concepts and their relations within a chosen scope to share information (Busse, et al., 2015, p. 29). Table 2 by Busse et al. portrays how ontological terms in philosophy and information science correspond.

Even within information science alone there are various definitions of ontology (Poli, 1999). Head of the ontologist team for iPhone's Siri App, T. Gruber, suggests the simple definition "An *ontology* is an explicit specification of a conceptualization." (Gruber, 1993, p. 199). Arp, Smith and Spear offer the extended definition of ontology as "a representational artifact, comprising a taxonomy as proper part, whose representations are intended to designate some combination of universals, defined classes, and certain relations between them." (Arp, Smith, & Spear, 2015, p. 1). A third definition says, "Formal Ontology is the science that is concerned with the systematic development of axiomatic theories describing forms, modes, and views of being at different levels of abstraction and granularity." (Busse, et al., 2015, p. 30) and a fourth one regards ontologies as "the structural frameworks for organizing information on the semantic Web and within semantic enterprises." (Bergman, 2010).

2.2.1. Semantics and ontology

The definitions above seem to comprise a variety of understandings similar to the varying philosophical views on ontology (e.g. conceptualism and realism), for while Gruber finds the shared conceptualization essential to ontology, Smith et. al. embraces a realism involving representation of universals (Arp, Smith, & Spear, 2015, pp. 8-10). What the definitions have in common is that they regard ontologies as formal representations of defined entities with specified relations. Formal in this context connotes having "well-defined syntax and semantics that can be processed by computer programs." (ibid. p. 31). The formal ontologies define entities in simple RDF triplets of subjects, predicates, and objects to conceptualize relations between entities in a given area. Accordingly, formal ontologies are used to facilitate clear categorization of information (ibid. p. 39).

The distinction between the Syntactic Web and the Semantic Web provides clarification to the endeavor of knowledge engineering by formal ontologies. While, syntax signifies the form and symbols by which content is represented on the Web, semantics implies the meaning of that content. Information technologies have already been far outrunning the human ability to manipulate syntax and process data quickly, but by the means of semantics the technologies are also in a sense able to reason with the data or at least imitate understanding of it.

Whenever, the semantics are incorporated to information systems, Busse et al. argue, ontology is somehow used (ibid. p. 30). Busse and others provide the example of a search engine for people looking at hotels for their travels. In the example, the search engine manipulated the syntax of the search "child-friendly hotel at the beach in Northern Germany". It then matched the search with a beach hotel in Durbai, because it had a review written by a guest from Germany who had "Children: None" written in his profile (ibid. p. 30). Although good syntax is a vital part of our Web, such a search is obviously very limited without semantics. In using ontology to classify entities for the search engine, semantics can provide linguistic analysis, controlled vocabulary, reasoning, and meaningful matching in an information system such as the hotel search engine (ibid. pp. 30-31).

Besides this distinction between syntax and semantics, it is useful to distinguish between informal ontologies and formal ontologies (as illustrated in the Figure below). Ontologies can be employed by in different manners and with different degrees of formality and rigidness. In an informal manner, ontologies can be employed by means of Use Case Diagrams, UML Class Diagrams, Activity Diagram and Sequence Diagram (Sánchez, Cavero, & Martínez, 2007, p. 11). Part of my past work with such information architectures has been a chat bot presented in UML diagrams (shown in Appendix 1). In that system, one can discern an informal ontology with entities like types of content and actors (chat bot, user, creator), with annotations such as names, titles, and with different relations as "isOffered" and "isSend" between content and chat bot.

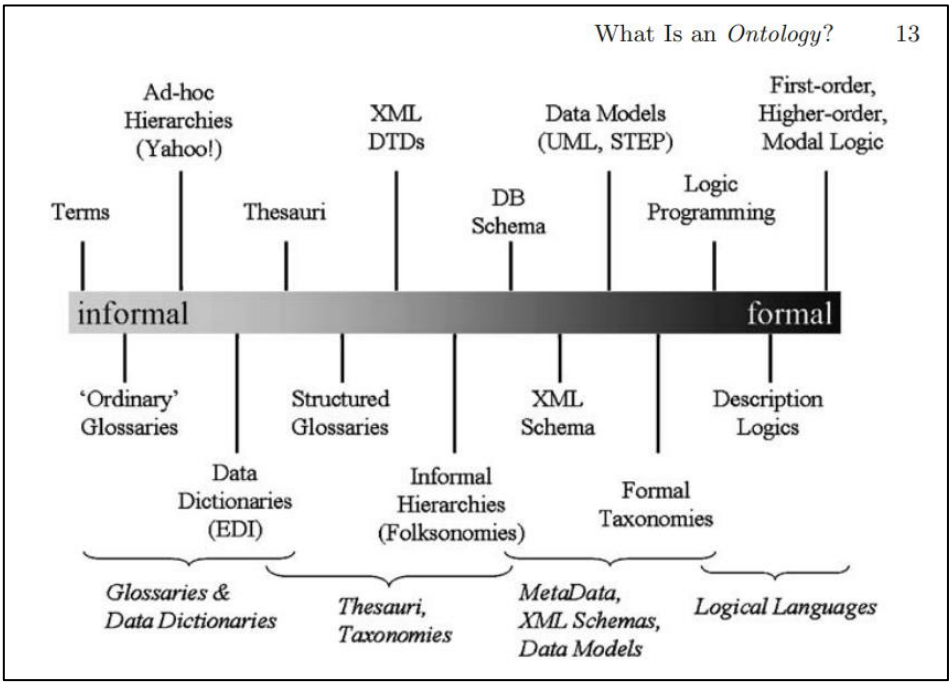

Figure 3: Portrayal of informal and formal ontological means retrieved from: N. Guarino et al., 2009, p. 13.

Another means by which informal ontologies might be used is the semantic tool of controlled vocabulary. An exemplification of this from Logos Bible Software will be described in greater detail below in section 3.1. The example shows the utility of adding semantic enrichment through controlled vocabulary to a knowledge base. Such semantic enrichment might be amplified by categorizing the controlled vocabulary. In the example, this was done by incorporating an informal ontological structure in their Bible software with the five types; thing, person, place, event, and text. These types were tagged as metadata to the biblical entities represented in the software.

Thus, metadata can be used to categorize content in information systems and to engineer informal ontologies. In the Prior Project, metadata is for instance used to tag characteristics to sources in the Virtual Lab for Prior Studies. The Virtual Lab, which produces the Prior Nachlass and facilitates research on the life and work of the philosopher, A. N. Prior, stores 328 Prior papers and 1195 Prior letters to which "conventional metadata of title, date, and author, as well as unconventional domain metadata e.g. different logical systems." is tagged (Graf, 2017, p. 7). For more on this, see Appendix 2 analyzing the Virtual Lab and Prior Nachlass developed by the Prior Project.

Sometimes the semantics of informal ontologies will be sufficient for the use of an information system. L. Obrst, et al argue that "For simple applications, controlled vocabularies, terminologies, and classificational systems, usually structured in topic taxonomy or thesauri, are sufficient. For more complex applications that require precise semantics, more expressive models, i.e. ontologies, are required." (Obrst, Janssen, & Ceusters, 2013, p. 215).

2.2.2. Formal Ontology, OWL, and Ontology-Editors

The formal ontologies are more rigid in their definitions and hierarchical structure than the informal ones. In the early 2000s, the World Wide Web Consortium (W3C) developed the language; Web Ontology Language (OWL 1), which was republished in 2012 as OWL 2 (Group, 2012). The language is a standardization of other languages like the Resource Description Framework (RDF) and the Xtensible Markup Language (XML). In W3C's words, OWL is "a computational logic-based language such that knowledge expressed in OWL can be exploited by computer programs, e.g., to verify the consistency of that knowledge or to make implicit knowledge explicit." ((W3C), 2013). As mentioned in section 1.1., the making of the semantic descriptive language, OWL, stirred domain specialists to formalize their knowledge as web ontologies (Busse, et al., 2015, p. 31).

Today, many programs are designed to work with semantics by formal ontology in OWL. One type of such semantic software is the ontology-editor. Different ontology-editors have specific advantages and comparison of these editors are done by various criteria examining different functions (Alatrish, 2013). One of most widespread editors is the software, Protégé, which is provided by Stanford University. In the formal ontologies of sections 3 and 4, Protégé will be used due to its high usability and its clear composition.

Along with ontology-editing software, ontology communities have also offered collections of formal ontologies, as OWL files, in several ontology libraries. One such file, which is avaliable online via http://philosophome.org/, is the PhilOntology (or PhilO) made by Pierre Grenon and Barry Smith., which will be examined in section 3.2. as inspiration in the development of an ontology for theology (Grenon & Smith, 2011).

2.2.3. Types of Ontologies

Within ontology in computer science, there are different types of ontologies. Arp et al. distinguish along with Husserl between formal and material ontologies; formal ontologies describing classes in terms like “object” and “process” that are domain neutral and material ontologies describing classes in domain-specific terms such as for “cell” and “carburetor” in a medical ontology (Arp, Smith, & Spear, 2015, p. 31). In this sense, which should not to be confused with formalization as described above, the formal ontologies are “formal” because they represent general categories (like those of Aristotle) whose universals are instantiated in all domains of reality and hence shared by various ontologies (ibid. p. 31). The material ontologies are “material” because they represent non-formal entities belonging to a specific domain and hence not shared by ontologies of other domains (ibid. p. 31). For other classifications of ontologies see (Sánchez, Cavero, & Martínez, 2007, pp. 9-10).

As material ontologies (also known as domain ontologies) are edited, shared, and combined with other ontologies, one issue is becoming increasingly problematic. This is the problem called the “Tower of Babel problem” (ibid. p. xviii). Due to the success of domain ontologies, many domain ontologies now involve incompatible compositions and identical terms with different meanings making the ontologies somehow “inaccessible”, “non-sharable”, and “nonoptimal” (ibid. p. 37). Top-level ontologies serve to clarify this confusion of tongues. The top-level ontologies (also called upper-, base-, or foundation ontologies) are formal ontologies designed to be the common reference unto which domain ontologies can be built in a compatible manner.

An issue with the top-level ontologies is that there is disagreement between ontologists on which top-level ontology represents reality best. As shown in the historical introduction, the distinction between universals and particulars was generally accepted from Aristotle throughout the Medieval Period. However, since the existence of universals began to be seriously doubted and since the theories of nominalism and conceptualism have become influential, the distinction of the "abstract and concrete" has been adopted by many contemporary ontologists instead of the classical distinction between "universal and particular" which was originally employed by Lorhard (Øhrstrøm, Schärfe, & Uckelman, 2008, p. 77). Computer scientists and ontology developers, Øhrstrøm, Andersen and Schärfe argue, need to be aware of and ready to defend their ontological commitments embedded in the ontology they select, because ontology more than merely being a tool for knowledge engineering, is meant to be a representation of reality (Øhrstrøm, Andersen, & Schärfe, 2005, pp. 436-437).

In the table below, an introductory comparison between some selected top-level ontologies is offered (the selected top-ontologies can be viewed by illustrations in Appendix 3. For additional comparison see (Jansen, 2008), (Semy, Obrst, & Pulvermacher, 2004)):

	Website:	**Fundamental distinctions:**
SUMO	http://www.adampease.org/OP/	Physical/abstract; object/process
BFO	http://basic-formal-ontology.org/	Continuant/occurrent; independent continuant/ dependent continuant; material entity/immaterial entity
Sowa	http://www.jfsowa.com/ontology /toplevel.htm	Independent/Relative/Structure; Physical/Abstract; Continuant/Occurrent
Lorhard	http://www.illc.uva.nl/Research/ Publications/Reports/X-2008-04.text.pdf	Universal/Particular; Substantial/Accidental; Created/Uncreated; Essence/Being; Real/Rational

Table 3: Comparison and introduction of different top-ontologies

2.2.4. Terms in Computational Ontology

Having observed the general background of computational ontology and different types of ontologies, the paper will now introduce different components involved in formal ontology.

Some of the most basic terms in formal ontology are entity, class, and taxonomy. An entity might be defined as “anything that exists, including objects, processes, and qualities” and including also beliefs, sayings etc. (Arp, Smith, & Spear, 2015, pp. 1-2). This definition depends on one’s ontological commitments of what exists. The term, class, is synonymous with type and is a collection of thing(s) having a common denominator (ibid. p. 18). Taxonomy can be defined as a hierarchy of types related through subtypes (ibid. p. 1).

Other basic terms in an ontology include individuals, relations, and properties. Individuals are the individual entities which a class instantiates so that for the class, Human, there is an individual called Simon Graf who is writing this thesis, which may be categorized as an instance of an academic thesis. Relations can be had between classes, a class and an individual, or between individuals. The most common relation in the ontology is the is_a relation relating classes in a taxonomy as subclasses and superclasses. For instance, the tree of Porphyry (see p. 9 above) has the is_a relation between “rational animal (human)” and “living entity with sensation (animal)” so that the human is a living entity with sensation. Another relation is the parthood relation, part_of, which relates a class to another and which might denote transitive inheritance of the properties from the part to the whole (ibid. p. 35). This relation could be exemplified as the relation between body-parts and the body. By means of categorization with these and more components, the formal ontology enables annotation and semantical enrichment of data.

2.4. Formal ontology as information architecture

The notion information architecture constitutes part of the theoretical backdrop of the thesis. Morville and Rosenfeld offers several definitions for this term that in sum describe that information architecture is the discipline of presenting, shaping, and structuring information environments, products, and services to increase usability and findability (Morville & Rosenfeld, 2006, p. 4).

An essential task of information architecture is the process of boiling down the information to present it as clear and usable as possible. As a means for solving these tasks, formal ontology comprises a handy information architectural tool. As mentioned in the introduction, formal ontology is at the very heart of information architecture. The categorization, classification, labeling, and annotation in formal ontology can advance information systems from mere syntactical data structures to semantically enriched systems. This enrichment can increase both the findability and

usability of information in an information system. For the above-mentioned reasons, it is fair to conclude that formal ontology constitutes a powerful information architectural tool which is relevant as a subject in an information architectural study like the present.

3. An Ontology of Theology

At this point, we are now ready to explore the development of the information architecture of an ontology for theology. The thesis first offers an examination of the more general ontologies for theology before considering a more specific ontology for Calvinism in section 4.

The examination of an ontology of theology here imports learnings of the similar developments and studies; Sean Boisen's semantic structures for Biblical Studies from Logos Bible Software (Boisen, 2014), the ontology for philosophy (the PhilO) (Grenon & Smith, 2011), and the ontology for philosophy from Indiana University (InPhO) (Buckner, Niepert, & Allen, 2011).

The two ontologies that the thesis will seek to develop (respectively for theology and for Calvinism) have generally two different purposes. Whereas, the ontology of Calvinism aims at representing the system of belief in depth, reflecting its specific perception of reality, the ontology of theology aims at representing entities related to Christian belief with neutrality to increase functionality and shareabiltiy. These endeavors raise special issues that will be discussed in greater depths in the following sections.

3.1. Semantic structures for Biblical Studies with Logos

Developed over the past twenty-six years, Logos Bible Software is a highly usable application for personal, pastoral, and scholarly Biblical Studies (Wikipedia, 2018). Besides its advanced functions enabling different Bible studies, the software contains a library platform of more than 41.000 books related to Biblical Studies (Boisen, 2014). It is safe to say that Logos is an ingenious library technology and the world leading Bible Study Software (see more on www.logos.com/7).

Generally, Logos Bible Software employs two semantic arrangements. One relates to lexical, grammatical, and linguistic categories of words in the Greek and Hebrew Bible manuscripts. The other semantic organization relates to the things referred to by the words in the Bible as exposed

through secondary literature (Bible commentaries, Bible dictionaries, monographs, etc.) in the library platform (an instance of such a thing could be the place “Bethlehem”).

In observing Logos’ ontological and semantic structures before attempting to develop the formal ontologies for theology and for Calvinism, the thesis will take a closer look at the semantic organization for entities referred to in the Bible. In doing this, the thesis will first observe the early developments of a knowledgebase and a controlled vocabulary, before looking at the more recent development of the systematic theology function in the software.

Sean Boisen, director of content innovation at Logos, describes the semantic organization in Logos as the task of “organizing the world’s Biblical information” (Boisen, 2011). Developed from the ontology for New Testament Names (NTN) graphically represented in Figure 4 below (Boisen, 2006) (Boisen, 2005)), the Logos Controlled Vocabulary (LCV) and the Bible Knowledgebase (BK) of entities in the Bible were launched in 2009 (Boisen, 2011).

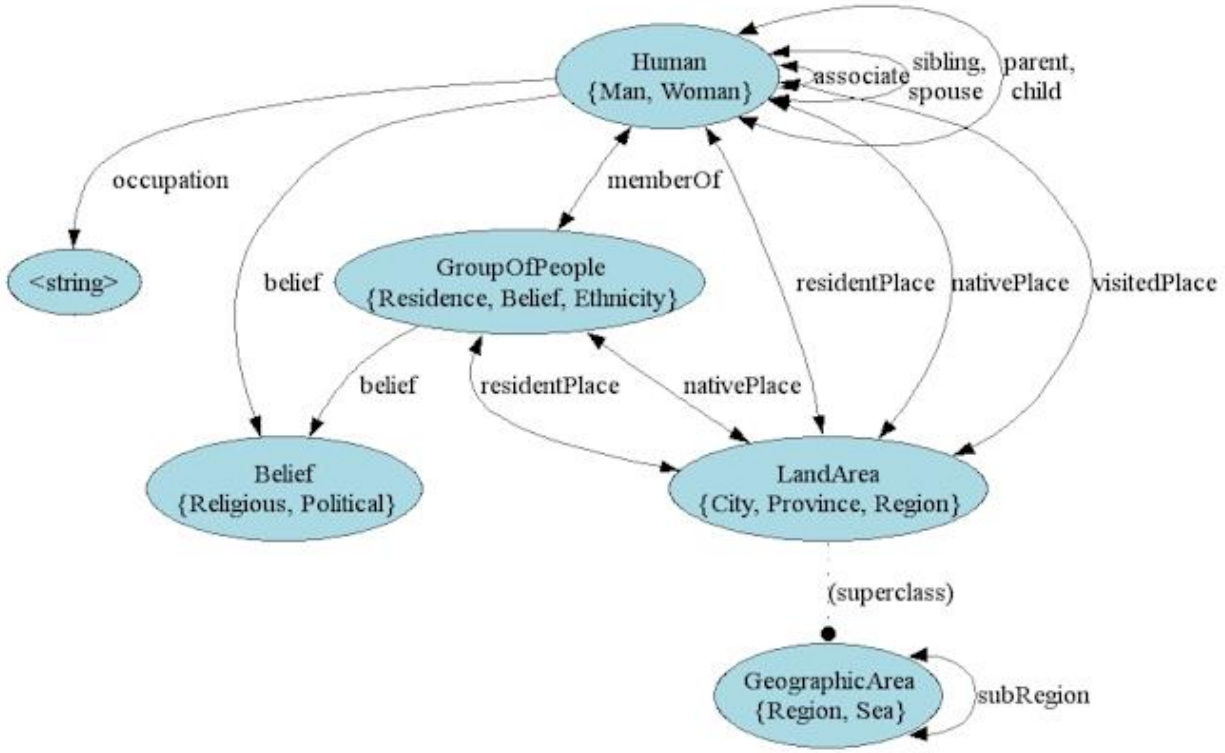

Figure 4: Representation of the New Testament Names ontology retrieved from https://web.archive.org/web/20060131232834/http://www.semanticbible.com:80/ntn/ntn-overview.html

Figure 5, below, illustrate the entities in the Bible knowledgebase and it portrays their classification in the software involving their identifiers, preferred labels and their types shown in the diamond.

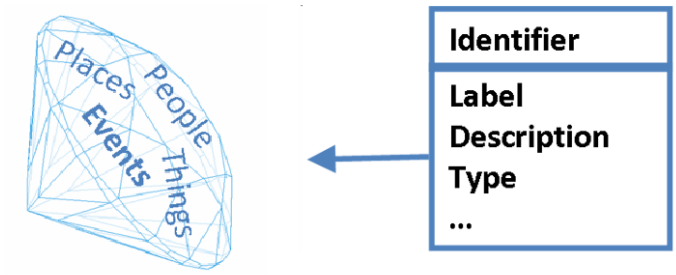

Figure 5: Diamond of the BK entities, their classification and identification (retrieved from: (Boisen, 2011)).

In the semantic organization of the BK there are four types; “people”, “places”, “events”, and “things”. While the NTN constituted a formalized domain ontology which could be connected to the SUMO ontology, the categorization of entities in the BK comprises a more informal ontology. The organization of the BK seeks to address the identities, utilities, and relationships of its entities by using labels, descriptions, and by classifying the entities in the types mentioned above.

This data organization was developed with reference to Tim Berners-Lee’s four rules for linked data that Boisen sums up as the rules of providing identity (URI), utility (useful description), and relationship (links to other URI’s) to the entities in the database, and with reference to Metcalfe's Law for digital libraries; that the “value of a network is proportional to the square of the number of connections” (Boisen, 2011), (Berners-Lee, 2009).

Rather than applying this organization by the means of the traditional hyperlinks that are unidirectional links merely providing one destination with very limited preview, Logos applied more advanced textual links. Through the linking of data in Logos, one is offered numerous suggested actions and related data with a right-click on a word in the Bible.

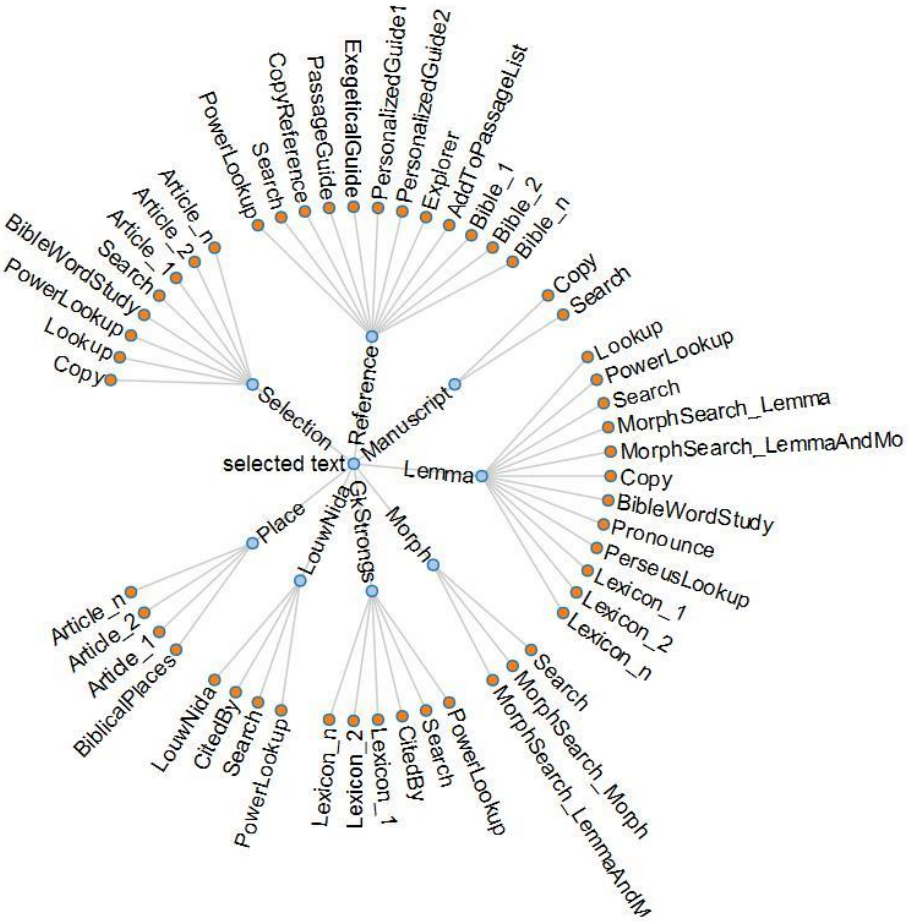

Figure 6: The advanced linking of data in Logos Bible Software version 4 (retrieved from (Boisen, 2011)).

In the figure above, illustrating the various links provided by this right-click action, the “Selection” category contains links related to the selected word, while the “Reference” category links to various actions associated with the Bible reference (for instance John 3:16) in which the selected word occurs. The categories “Manuscript”, “Lemma”, “Morph”, “GkStrongs” and “LouwNida” all provide links to lexical, grammatical, and linguistic actions and entities.

The last category “Place” corresponds to the ontological type in the BK to which the selected word belongs. This category provides links to various dictionary entries and to the biblical places tool which offering identification, relevant information on the entity, and links to related places, persons, events, and things (note this category would be represented as either “Person”, “Thing” or “Event” if the selected word belonged to one of those categories). In the latest two versions of the Logos Bible Software (Logos 6 and 7), this last category links to the “Factbook” guide regardless of the

type of the selected word. The Factbook empowered by the semantic organization provides rich background information related to the selected entity (to see more (Logos Pro: Factbook, 2018)).

The subjects of the Factbook, the BK and the LCV were initially derived from several Bible dictionaries including *Anchor Yale Bible Dictionary*, *New Bible Dictionary*, and *Tyndale Bible Dictionary*. Together these dictionaries gave 44.000 terms, which were automatically reduced to 23.000 and manually boiled down to 11.000 terms (Boisen, 2016). The semantic organization sought to provide identity, utility and relationship to these terms as illustrated in Figure 7.

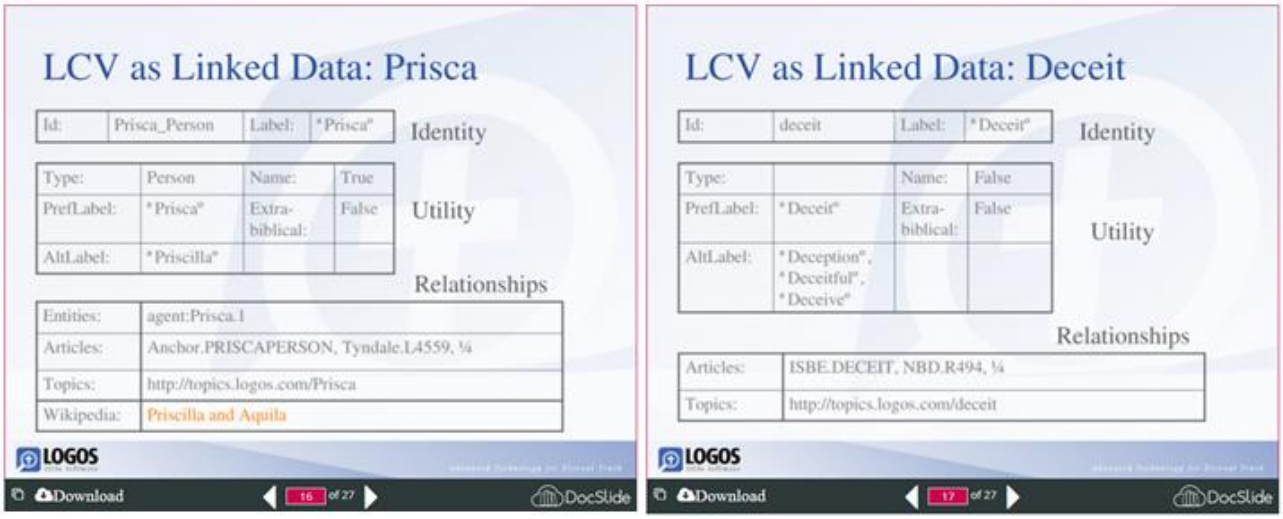

Figure 7: Slides from Sean Boisen's talk at SemTech 2010 retrieved from https://docslide.com.br/documents/using-a-controlled-vocabulary-for-managing-a-digital-library-platform-sean.html

This semantic organization comprise high utility for the use-cases of a) topical search that is improved by the controlled vocabulary, b) information browsing (through interrelated concepts and references), and c) text mining; indexing biblical references related to a concept in comparing dictionary entries' use of scriptures for a concept (Boisen, 2016).

More recently the innovators at Logos added a categorization of theology to their passage guide which divides content to the conventional systematic theology subdisciplines of Theology Proper, Christology, Soteriology, Ecclesiology and more. For each of these categories, the passage guide offers further categorization of theological subdiscipline according to denominational groups as Lutheran, Methodist/Wesleyan, Modern Catholic, Pentecostal/Charismatic, Presbyterian, and Reformed. Thus, the software provides content based on a specific subdiscipline of systematic theology and based on a particular denominational group.

In sum, the semantic structures of Logos that are most relevant for purposes of this paper consists of on the one hand, an informal ontology of the biblical entities of the types person, place, event, thing, and cultural concept and on the other hand a categorization of systematic theological disciplines and related to denominational groups. While, the latter of these somewhat the resembles the ontology of theology offered below in section 3.2., the simplicity and utility of the categorizations in the BK is worth keeping in mind when developing the ontology for theology.

3.2. Formal Ontologies for Theology Inspired by Ontologies of Philosophy

As stated above in the introduction to section 3, the ontology for theology will be developed with reference to the existing ontologies for philosophy; Grenon and Smith's *PhilO* and Indiana University's *InPhO*, as well as the *Wittgenstein Ontology* (Pichler & Zöllner-Weber, 2013). In this regard, the thesis will not seek to invent the wheel anew, but rather it will adopt the basic classification and methodology utilized in the abovementioned ontologies.

3.2.1. Introducing Ontologies for Philosophy

Whereas table 4 below introduces the main classes, the central object properties, and the basic use case of the three ontologies, Appendix 4 consists of various screenshots portraying the ontologies and their uses. The Wittgenstein Ontology organizes Wittgenstein literature by relations between its 64.373 instances of the 23 classes comprising a vast knowledgebase of 521.002 axioms. In a smaller scale, the InPhO ontology contains 282 classes with 3547 instances and the PhilO ontology 852 classes encompassing 337 instances.

The Wittgenstein ontology instantiates entities of persons and texts that are involved in the Wittgenstein Nachlass and Wittgenstein scholarship. In being based on the Nachlass, the ontology has the strength that its entities are comparatively unambiguous and very relevant for the domain. Also, it provides the strength of modelling different point of views in a consistent manner through the class "Perspective" whose instances relate by way of different properties like "isContra" or "isPro" to instances of "Point" declaring specific assertions.

Unlike the individuals in the Wittgenstein ontology, the InPhO ontology, being based partly on automated collection of data, include instantiations that seem to be completely unrelated to the

domain of the philosophy. For example, the class “Profession” contains instances such as “Executive”, “Executor”, and “Exotic_dancer”. In contrast, the PhilO ontology contains more intuitive and domain specific classes of philosopher, philosophical concept, and philosophical field.

Comparison of Philosophical Ontologies			
	Wittgenstein Ontology	**PhilO** (Grenon & Smith, Buffalo University)	**InPhO** (Indiana University)
Main Types / Classes	1. Person 2. Source 2.1. Primary Source 2.2. Secondary Source 3. Subject 3.1. Date 3.2. Field 3.3. Issue 3.4. Perspective 3.5. Place 3.6. Point	1. Philosopher 1.1. Philosopher by field 1.2. … by geography 1.3. … by time 2. Philosophical concept 2.1. … by geography 2.2. … by time 2.3. … by field 3. Philosophical field	1. Agent 2. Idea 2.1. Epistemology 2.2. Continental philosophy 2.3. Asian philosophy 3. Nationality 4. Publication 5. Profession
Central Object Properties	discusses hasAuthor hasDate isArguedForIn isArguedAgainstIn isContra isPro isDicussedIn refersTo isReferredToIn	activeInField conceptInField conceptToPhilosopher philosopherToConcept subconceptOf subfields superfields	commitsTo attackedView dicusses criticized hasInfluenced studiedAt wrote
Use-Case	Knowledgebase for the Wittgenstein Nachlass	“to aid navigation through philosophical literature” (p.185)	Ontology for philosophy developed by automated approach guided with expert feedback

Table 4: Comparison of the philosophical ontologies

The domain of theology is to a fair extend related to and similar with the domain of philosophy. Both philosophy and theology are ordinarily regarded as part of the humanistic sciences and both of their ontologies intuitively involve persons, concepts, theories, and writings. Moreover, there are often overlapping categories and entities like the person “St. Augustine”, the fields of study

“Philosophical Theology” or “Philosophy of Religion”. Hence, it seems that the ontological structure in the philosophical ontologies above can be adapted to the domain of theology.

3.2.2. Engineering the Ontology for Theology (TheOn)

The needs for the ontology for theology resemble the needs of the philosophical ontologies. By this ontology, the theological domain can be described in a computer readable language through which the computer can perform queries and make sense of the semantic relationships between entities of theology. The thesis seeks to develop an ontology representing a semantic knowledgebase offering beneficial and useful possible applications in websites, applications, and artificial intelligences.

With the different strengths and weaknesses of the philosophical ontologies in our minds, it seems ideal to construct an ontology with the basic classes of “Theologian”, “Subject”, and “Source” inspired by the Wittgenstein Ontology’s main categories of “Person”, “Subject”, and “Source” while distributing these in categorizations like “Theologian_by_field” or “Source_by_time” and staying close to the specific domain as done by Grenon and Smith in their PhilO.

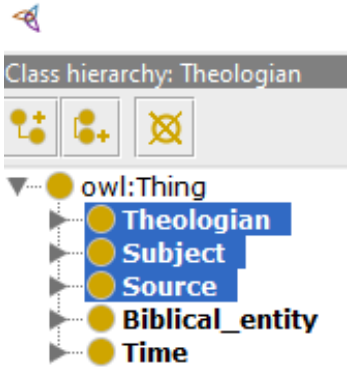

Figure 8: Top-classes in the TheOn

In addition, the superclasses of “Time” and “Biblical_entity” were added. Time was included because it enables the ontology to describe theology in relation to time connecting theologians and sources to specific times, so the theological entities from a certain period can be portrayed representing a specific domain of historical theology. “Biblical_entity” was added because the fundamental subject of Christian theology is the Bible. The categories of Biblical_entities reflect the entities of the Bible Knowledgebase from Logos Bible Software (person, place, event, and thing), so that the data of the Bible Knowledgebase could be merged into the ontology for theology.

Accordingly, the ontology for theology (the TheOn) encompasses the categories that are shown in the in figures 8 and 9. The categories depicted in Figure 9 enable classification of the instances that can be placed into the ontology. At this stage, the TheOn simply constitutes a database in which data of theology is grouped into different categories.

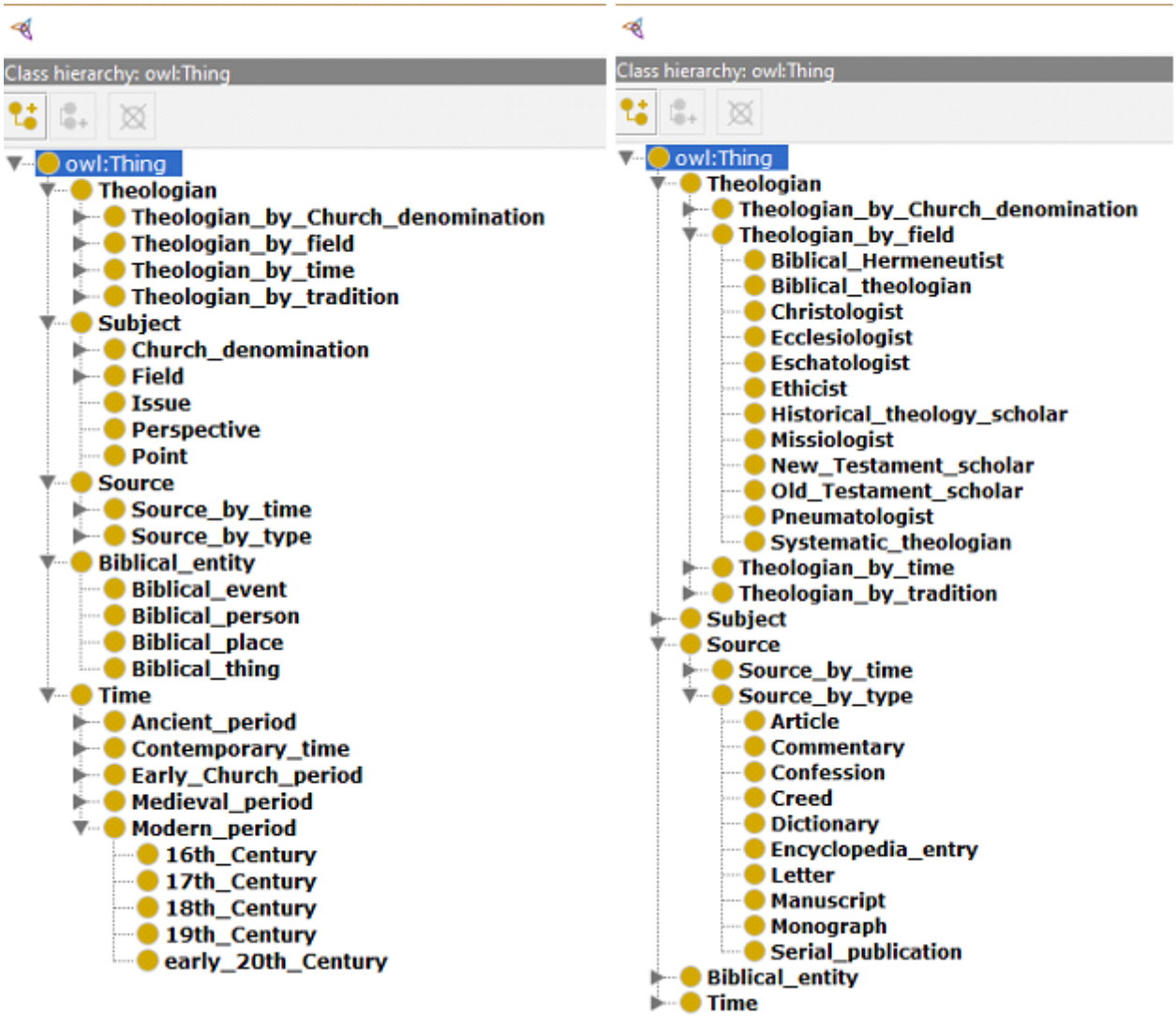

Figure 9: The TheOn class hierarchy with subclasses such as "Theologian_by_field" and "Source_by_type"

The most foundational categories of TheOn are the classes “Source” and “Theologian” which is divided into subclasses as “by type”, “by field”, and “by time”. In addition to the classes providing specification for sources and theologians, the TheOn includes subclasses for “Subject” such as “Issue”, “Point”, and “Perspective”. This categorization is imported from the Wittgenstein Ontology, which models scholarly disagreement by facilitating mutually inconsistent points of view in the class “Perspective”. Just as the Wittgenstein domain contains conflicting perspectives, so also the domain of theology contains some disagreements that would be great to represent in the TheOn. To do this, the TheOn not only uses classes of “Point” and “Perspective”, but it also models antagonistic object properties such as “affirms”, “denies”, “arguesFor”, and “arguesAgainst” as is shown in Figure 10 below.

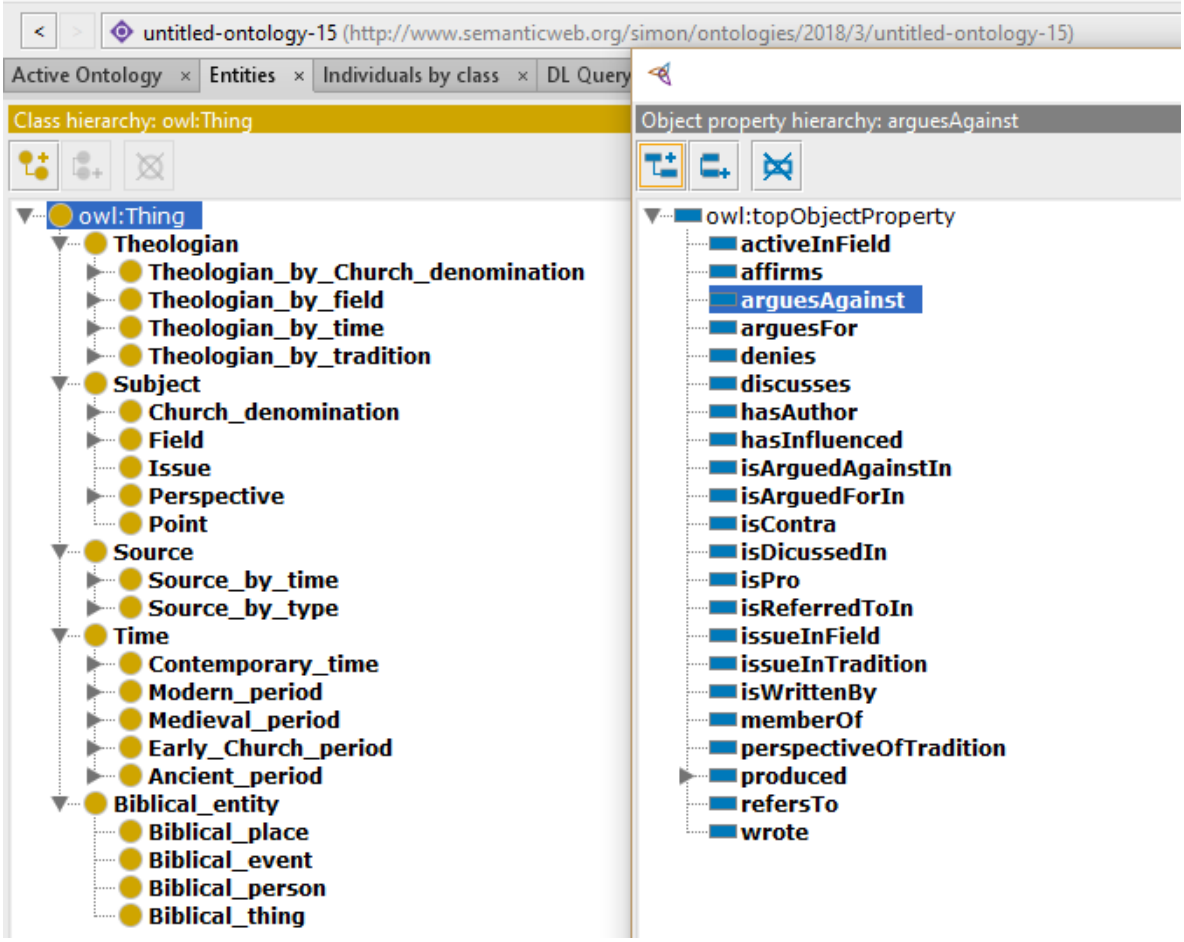

Figure 10: Screenshot of TheOn's classes and object properties from Protégé

The object properties, that are shown in the right site of Figure 10, provide some semantic enrichment to the knowledgebase when they are related to the classes and instances. This is illustrated in the figure below, portraying the classes and object properties by which the article “The Logic of Calvinism” is categorized.

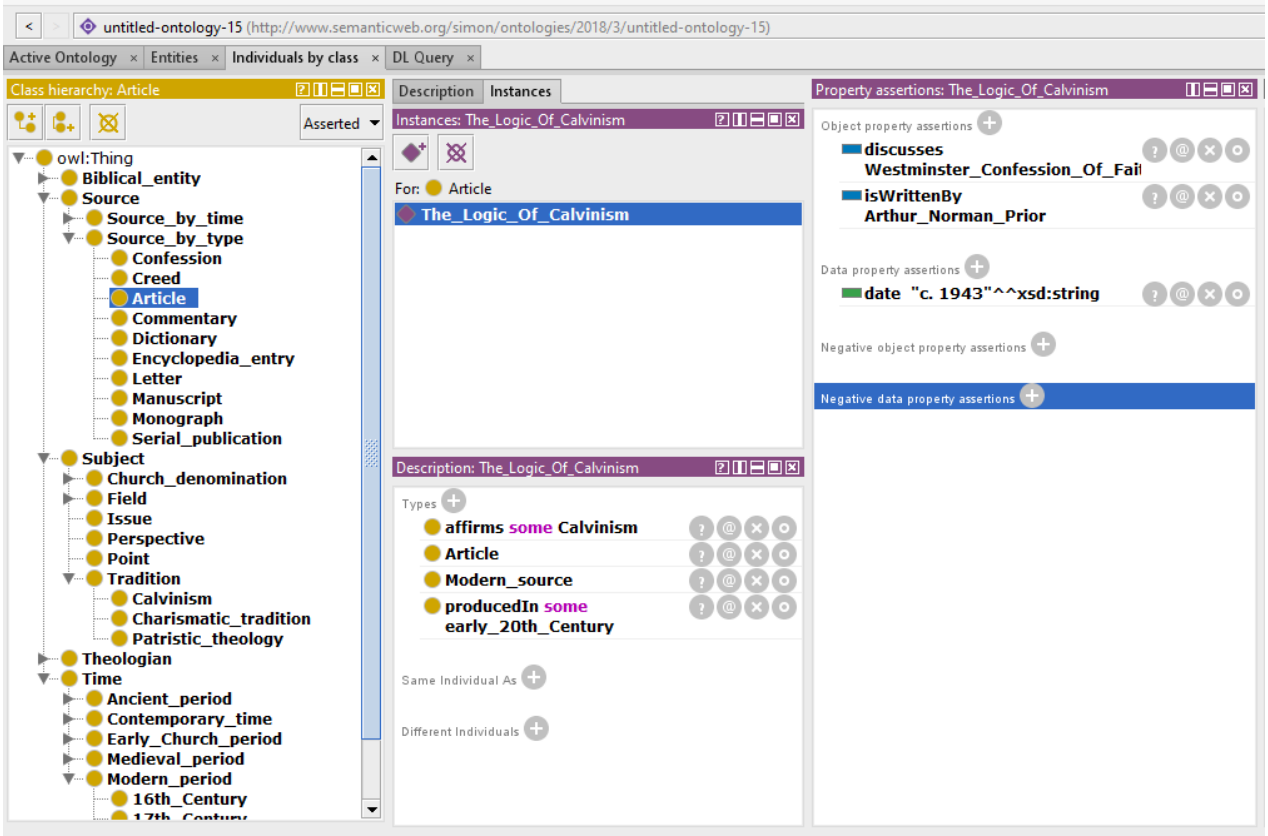

Figure 11: TheOn's classification of A.N. Prior's article "The Logic of Calvinism"

Note that the classification of the instance above merely asserts that The Logic of Calvinism "affirms some Calvinism". A way to further develop the ontology making it more precise would be to specify different types of the "Perspective" subclass "Calvinism". It might for instance be helpful to distinguish between different variants of Calvinism such as moderate Calvinism, High Calvinism, and Hyper Calvinism.

Two graphical representations of some relations in TheOn are offered below. Figure 12, portraying the relations between the yellow classes and the purple instances, shows that the Logic of Calvinism discusses the Westminster Confession. The relations "isWrittenBy" and "wrote" between the Logic of Calvinism and A. N. Prior are defined as inverse of each other. Figure 13 portrays relations of the Anglican New Testament Scholar, N. T. Wright, three of his books "Paul: Fresh Perspectives", "Scripture and the Authority of God" and "Who was Jesus?", and related issues and perspectives.

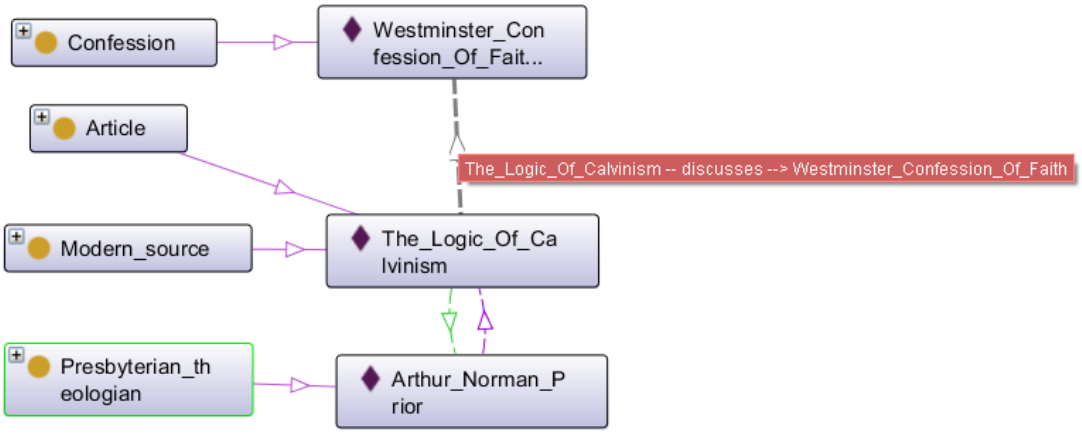

Figure 12: Relations to instances for the Westminster Confession, the Logic of Calvinism, and A. N. Prior.

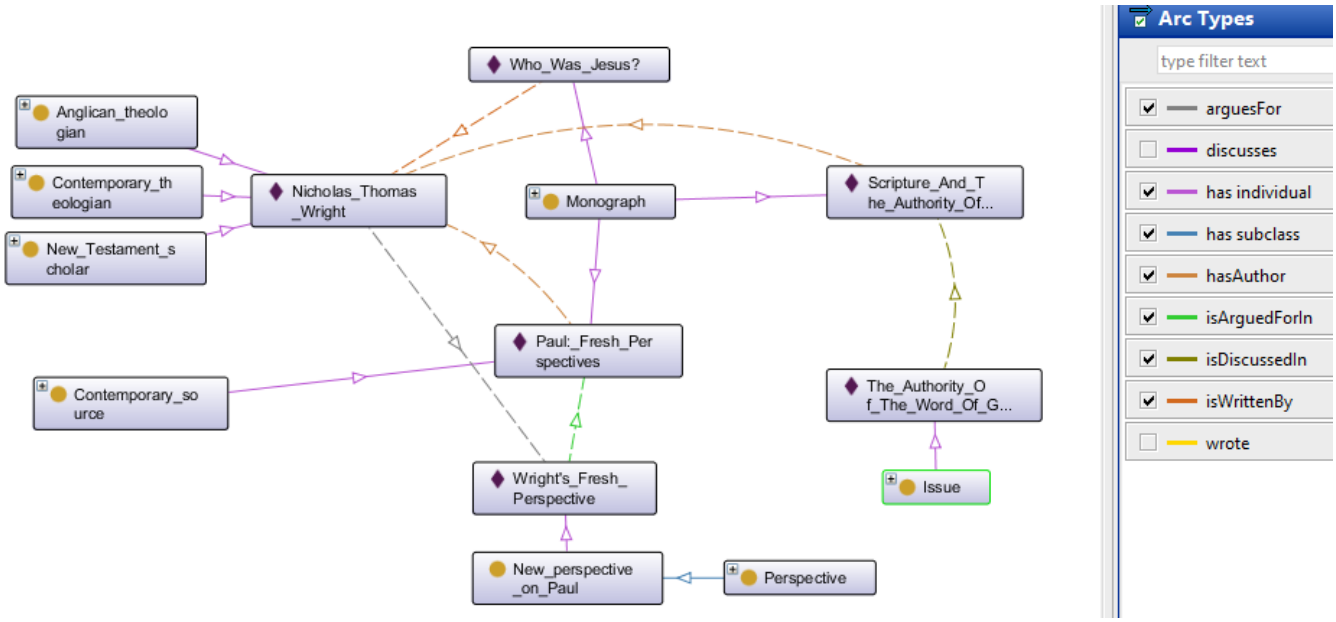

Figure 13: Relations of N.T. Wright and his books in the Protégé plugin OntoGraf.

With its RDF triplets (classes, properties, and individuals), the TheOn constitutes a useful model for a theological knowledgebase of theologians and theological writings. It clarifies how these relate to biblical entities, periods of time, theological traditions, perspectives, points and more. It embodies categories that organize theologians and sources according to their place in history, their place in systematic theology, and their place in the different fields of theology. Thus, the data is classified in useful categories for historical and systematic studies as well as for more specific domains like the field “New Testament Studies” which could be developed further to involve the subclasses Johannine studies, Pauline studies, etc.

As shown above, the graphical representations of specific entities in TheOn enables one to easily acquire understanding of relations between complex matters such as the New Perspective on Paul and one quickly gets understanding of the contexts of individual entities. And, as shown below, the TheOn enables theological queries of the database, so that one can find all the instances or subclasses relating in a particular way to a class.

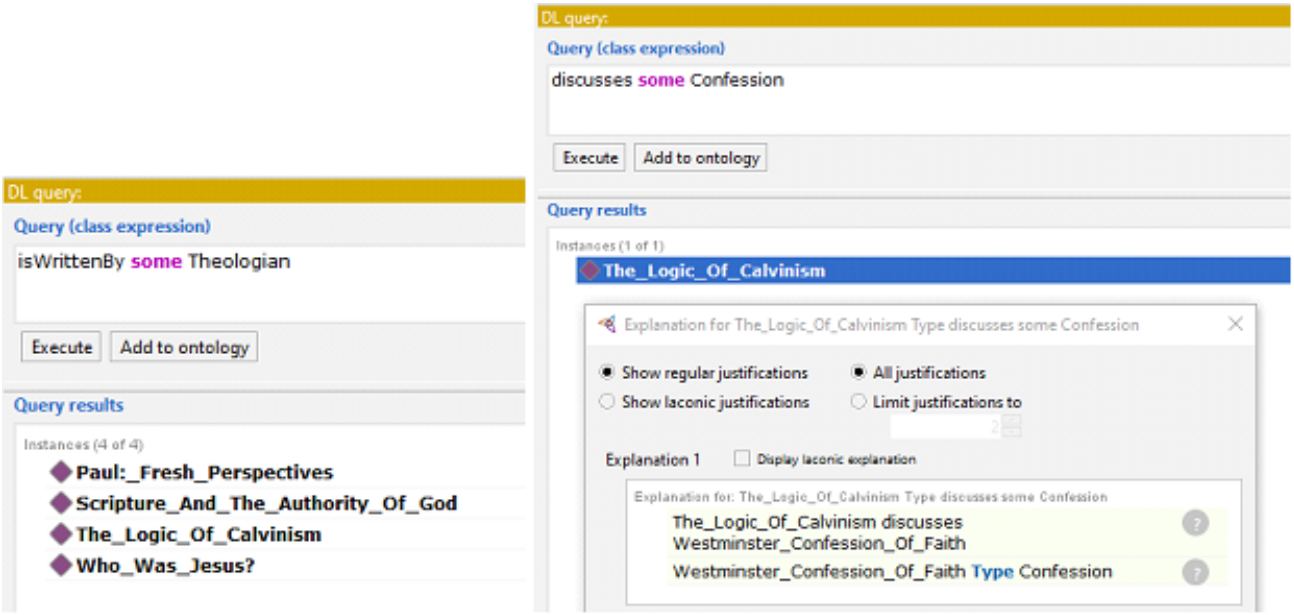

Figure 14: Two separate queries in TheOn from the DL query in Protégé.

In the left side of the figure above, a query is made which searches sources written by theologians. Despite what one might expect from the TheOn, this query with the rudimentary property "isWrittenBy" which relate sources to theologians only finds four individuals. If the TheOn would be developed to a satisfying degree for applications, then this query would need to find countless of individuals, since the domain of theology is comprised by innumerable writings by theologians. However, this query is so basic that it is not very meaningful. It would be more useful to make such a query with a certain subclass of theologian. For instance, it might be interesting to make a search for the sources written by a New Testament scholar.

The other query depicted in the figure above reasons that TheOn entities discussing some confession include "The Logic of Calvinism" since it discusses the Westminster Confession which is of the type "Confession". This could be a relevant search for a historical inquiry about the development and content of creeds and confessions.

Presently, the queries enabled by TheOn depend greatly on the asserted axioms of the ontology. This means that the queries tend to find only what has been manually specified in an instance or subclass relation or as a relation between instances. However, the queries do find some inferred axioms by for example the object relations that are inverted between instances so that a Source which "isWrittenBy" a Theologian who "wrote" the source. Consequently, the TheOn 'knows' that when a source is written by a theologian, then it follows that the theologian wrote that source.

Nevertheless, TheOn could be developed further by relating classes to each other as inferred subclasses or relating some object properties as sub-properties to other properties. This would make the queries more effective, since it would depend less on the manual work of specifying assertions for each instance. A way to develop inferred relations would be to relate fields to issues or perspectives. For instance, it would seem appropriate to relate "Biblical_Hermeneutist" to "Biblical_Hermenutics" by the relation "activeIn" and such relations would increase the number of inferred axioms of the ontology which would in effect become increasingly semantically enriched.

As mentioned above, another way to develop TheOn further, would be to deepen the ontology by discerning between different types of the perspective "Calvinism". But with a more significant development, the TheOn could be expanded to cover theology in relation to geography. Unlike the PhilO, TheOn does not at the moment contain classes such as theologian_by_geography. While this categorization might not seem as significant as theologian by denomination, time or field, the geographical classification does in fact provide theologically relevant information since the theological substance is very dependent on geography. There is for instance most likely greater theological distance between a Pentecostal in Denmark and one in Nigeria, than there is between a Pentecostal theologian and a Baptist theologian both from Denmark.

Although the TheOn is modelled after Smith and Grenon's PhilOnto which aims at neutrality by its simple and unambiguous categories, the TheOn cannot be said to be fundamentally neutral. A problem with neutrality is how one classifies individuals. For instance, N. T. Wight is categorized as a New Testament Scholar. While this classification is fairly uncontroversial, there might be some disagreement as to whether he is not also a systematic theologian, an ecclesiologist, or a biblical hermeneutist. He certainly is active in those fields in some of his writings comprising over seventy books and many articles.

A more fundamental issue regarding the neutrality of the TheOn is the definition and the selection of classes. For instance, in seeking to stay close to its domain, the ontology only includes persons in

the class “Theologian” or “Biblical_person”, but not all relevant individuals relevant for the ontology seem to fall into these categories. At this point, valid criticism might be raised and for further development, this issue must be solved by for example including a more general superclass to “Theologian” called person with additional relevant subclasses.

Presently, the TheOn includes two instances of “Theologian” that probably ought to be classified differently. One is the person “A. N. Prior” who is said to be a Presbyterian Theologian. Although he was an elder in a Presbyterian church around 1950 and although he identified himself as a theologian around the time of his writing “The Logic of Calvinism” during the 40’s, he had a crisis of faith and eventually abandoned his Christian faith and the Church while becoming a distinguished philosopher and the inventor of the field of temporal logic (Kenny, 1970). While, he experienced a philosophical breakthrough during the 50’s, he never received great attention as a theologian although he wrote some keen articles about the Christian faith. Therefore, he is known today as a philosopher and not as a theologian. While, it would be more appropriate to classify Prior as a philosopher, Prior’s theological stand could too be classified more appropriately as of the instance of a tradition “Barthian Calvinist” rather than instance of “Presbyterian theologian”.

The other instance of “Theologian” which currently comprises some discrepancy in the TheOn, is “The Apostle Paul” who is classified as a “Early_Church_theologian” and as a “Biblical_person”. The categorization as an Early Church theologian can be questioned as it involves a few assumptions and issues. One issue is whether Paul can be called a theologian at all. As an Apostle and a writer of the New Testament, many Christian theologians would argue that he is in an entirely different class from other theologians.

Just as many would agree that the class “Theologian” seems to be too small for Jesus, who is perceived as the Son of God, so too, many theologians believe that Paul as an apostle should belong to a different class than “theologian”. For those holding a traditionalist view of the authority of the scriptures, Paul is someone that should not be the range of object properties such as “denies”, “disagreesWith” and “arguesAgainst”. To be precise, Paul is in this view someone whom a theologian, with reverence to the authority of scripture, could not deny. Thus, the aforementioned object properties could only in very special cases be attributed to a person such as in the case admittedly involving heresy or in the case involving controversy in the Bible (e.g. Paul and Barnabas in Acts 15:36–41). In the normal use of the antagonistic object properties, Paul or Jesus would not be appropriate ranges. In addition to the problem of defining Paul as a theologian, it is

also a controversial matter to define the class “Early_Church_theologian” with the annotation “a theologian of the first four Centuries AD”. This definition seems too simplistic and it might be fair to object to the association of Paul with the established Early Church. It might be said, that the ordinary association of an “Early_Church_theologian” involves the Church Fathers and Christian writers of the 2nd-5th Century rather than to the Biblical authors of the 1st Century.

As shown in the above, there are clearly issues with neutrality in the TheOn. Figure 14 below shows provides a crude example of how much the ontology could misrepresent reality. While it is clear that persons with Biblical authority should not be defined as opposing theological perspectives, the TheOn might easily misrepresent contemporary theologians with classifications that the theologians themselves might disagree with. At times, a theologian might be misunderstood as belonging to a certain category and at other times, the person’s relation to a subject might have changed over time.

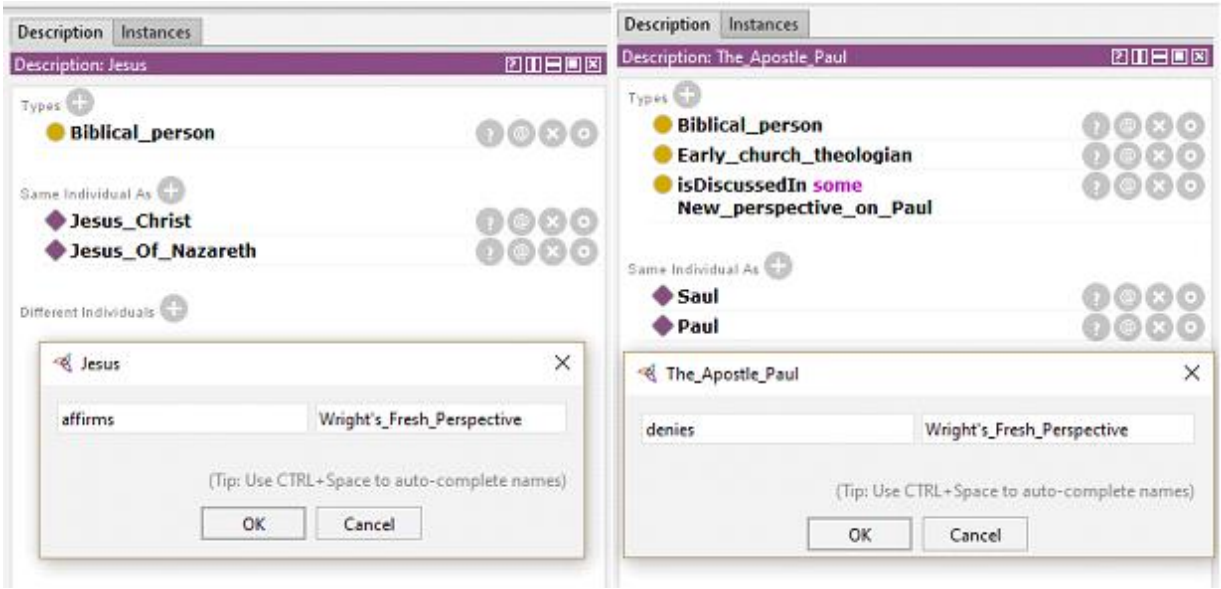

Figure 15: Example of how the ontology designer can define relation in a preposterous manner

One of the challenges in working with owl is that the syntax has to be clear and simple. RDFS and OWL sentences are always expressed in the manner of subject - predicate - object which comprises some limitation. It was for instance not possible for the developer to programme the inference that an author is discussing an issue when that author has written a source which discusses the issue. The challenge seems to be that the owl language expresses binary relations and not relations between three entities (such as author, source, and issue). One way to solve this challenge, is to include one of the entities in the object properties such that OWL could express that an author discussesTheAuthorityOfGodsWordIn some source. However, this relation just multiplies the

challenges. For one thing, the syntax of the relation is unable to represent and link to the entity "The_Authority_Of_The_Word_Of_God" which is an instance of the class "Issue", so this entity is not involved in the queries and graphs with that object property. Another problem with this type of relation is that an object property would need to be developed for every single issue, not to mention perspectives, points, or other types that TheOn would like to involve in the "discusses…In" property. The challenge of solving this problem comprises another issue for further research.

In sum, TheOn constitutes ontology with the important classes like "Theological", "Sources" or "Subject". The TheOn has a great strength in presenting various points of views under subjects and perspectives. It is, however, the theologians and theological sources that enable the TheOn in being a genuinely great knowledgebase that is semantically enriched. The ontology also has ability in performing various queries showing interconnectings with the linked data in the Bible school. Through the object properties, the categorization of the theological information has great expressive power.

4. An Information Architecture of Calvinism

Here in chapter 4, the thesis will focus on developing an ontology for Calvinism and observe the possibility of representing an actual system of belief in a detailed manner by formal ontology. It will do so for Calvinism by first introducing its historical and geographical expressions. Then, a brief critique of Calvinism will be offered noting the most controversial points in the belief. Having, thus, observed Calvinism, the thesis will develop an ontology based on A. N. Prior's paper "The Logic of Calvinism" and finally the thesis offers an evaluation of the formal ontology for Calvinism noticing its strengths and weaknesses.

4.1. Calvinism in history

The term Calvinism derives from the reformer John Calvin (1509-1564) born in the northern France and ministering in the southwestern Swiss town, Geneva, bordering France. Unlike Lutheranism, the term does not belong to a church denomination, but it refers to a teaching which is adopted by Reformed churches and Presbyterian churches. The teaching is also adopted by some Baptist churches, Anglican churches, and other conservative churches across denominations.

Defining the term is not simple, for as noted in the TheOn, there exist different versions of the perspective. 16th century Calvinism in Switzerland is associated with both the ecclesiastically oriented Zwingli and Bullinger in Zürich and the system minded Calvin and Beza in Geneva. Whereas, Bullinger drew up the first Swiss Reformed confessions; *The Helvetic Confessions*, Calvin produced his momentous work; *Institutes of Christian Religion.* As Calvinism spread through Germany into Northern Europe, which was dominated by Lutheranism, it became increasingly relevant to distinguish between doctrinal differences. Hence, further detailed confessions and articles of faith were formalized in the period 1559-1622, known as "the period of orthodoxy", expressing Protestant scholasticism (McGrath A. , 2011, pp. 50-51).

A significant dispute arose in the early 17th century, Netherlands, between the Remonstrants, following Jacobus Arminius (1560-1609), and stricter reformed dutchmen. Subsequent to Arminius' death, forty-four ministers issued a formal Remonstrance against Calvinism. The Remonstrance affirmed the teachings of conditional election[3], unlimited atonement[4], and the resistibility of grace[5] (Benedict, 2002, p. 307). Their central emphasis was, thus, on human freedom over divine sovereignty. In reaction, the National Synod of Dort (1618-1619) produced *The Canons of Dort*, reclaiming the points denied by the Remonstants. In the recent movement, *New Calvinism*, these points have become famously known as "The Five Points of Calvinism" signified by the acronym TULIP; 1) total depravity, 2) unconditional election, 3) limited atonement, 4) irresistible grace, and 5) perseverance of the saints (McGrath A. , 2011, p. 368). Calvinism experienced renewal when Abraham Kuyper, theologian and Prime Minister of the Netherlands in 1901-1905, sparked the movement, *Neo-Calvinism*, perceiving Calvinism as an exhaustive worldview. Despite its relatively large social, political, and religious influence, in the Netherlands and abroad, D. G. Hart argues that the Neo-Calvinist "project of cultural renewal and ecclesiastical reform" collapsed after a few decades due to circumstantial problems and the tumult of the early 20th century (Hart, 2013, p. 247).

Reformed theology and Calvinism was introduced in Britain by founder of the Presbyterian Church in Scotland, John Knox. Although Arminianism generally prevailed over Calvinism in English theology of Anglicanism and Methodism, the Westminster Assembly, summoned by the English

[3] God elects those who believe and persevere in faith based on (God's foreknowledge of) their faith.
[4] The redemption is offered to all human beings, Jesus died for all, not only limited to the elect, and atonement is available for everyone, yet only made effective by those who believe.
[5] It is possible to resist God's grace and humans have a free will enabling them to resist the Holy Spirit.

Parliament in the 1640's, articulated the Westminster Confession (1646) which became a standard statement of Calvinism (Manschreck, 1986). The confession affirms covenantal theology (ch. 7) and a strong doctrine of God's eternal decree (ch. 3).[6] Puritanism and covenantal theology emigrated from England to North America where revivals broke out in the 18th century from a Presbyterian church led by the minister Jonathan Edwards who was characterized by his Calvinist understanding of the Bible, his revivalist preaching, and his philosophical theology (Kuklick, 2003).

In the 20th century, Calvinism took new forms. Besides Kuyper's Neo-Calvinism described above, an inventive theology arose from central Europe. During 1920-1935 in Germany, the Swiss theologian Karl Barth lectured on Reformed doctrine presenting original neo-orthodox theology. When he was banned from his classroom and public speaking by Nazi officials, he took up a professorship in Basel, Switzerland, where he could continue his work (Hart, 2013, p. 286). The result; Barthian Calvinism; a dialectic theology understanding God as the "wholly other" whose transcendental Word is the sole basis for knowledge of God and whose Kingdom stands in utter contrast to any earthly regime, comprises an unconventional Calvinism where Christ, the God-man, is both seen as the elector and the elected one.

A more recent development in contemporary time is New Calvinism. The movement originates from America and it is also known as the "Young, Restless, Reformed". It joins classic Calvinism with postmodern pop-culture in internet blogs/websites[7], pop music[8], and conferences[9]. The movement is associated with John Piper, Albert Mohler, Timothy Keller and other passionate reformed ministers and teachers who has turned to Calvinism as presented in The Canons of Dort, the Westminster Confession, or Jonathan Edwards' revivalist Calvinism. Despite criticism from traditional Presbyterians and other evangelicals, the movement has proven relevant and significant with many young people turning to Calvinism for a sovereign and supreme God who is not just gentle and good, but also all-powerful and awe-inspiring in saving man from total depravity and wholesale condemnation.

[6] As explored further in section 4.3., the confession comprises a highly structured Calvinist system of belief using Ramism to categorize its content in dichotomies.
[7] Examples include https://www.desiringgod.org, https://www.thegospelcoalition.org/, and https://www.challies.com/
[8] Although not directly proclaimed Calvinists, artists as Lecrae and Kings Kaleidoscope have been celebrated by the "Young, Restless, Reformed".
[9] Popular Christian conferences that has strengthened New Calvinism include the Passion Conference and for instance the Together for the Gospel (T4G).

In sum, Calvinism has taken different forms throughout its five-hundred years lifetime. Calvin organized his teaching in the *Institutes* according to the four-fold structure of the early creeds, for instance *The Nicene Creed*; (1) God, the creator, (2) the Lord Jesus Christ, (3) the Holy Spirit, and (4) the Church. Later Calvinist system of beliefs were organized in Ramist dichotomies (e.g. Westminster Confession) or in five stringent points (e.g. the Canons of Dort). More recently, Calvinism was introduced by Kuyper as an all-encompassing view of the world and by Barth as an other-worldly dialectic theology. Finally, moderate Calvinist like Millard Erickson and J. I. Packer moderately emphasize God's sovereignty over the human freedom, whereas New Calvinists tend to affirm the strict five points represented the acronym T.U.L.I.P.

4.2. A Critique of Calvinism

In general terms, Calvinism is a system of belief and a unified interpretation of the Bible with distinct views on the fallen nature and the predestined fate of man. Occasionally, the term connotes the whole of reformed theology or even a complete worldview. Other times, it merely refers to an understanding of the doctrine of election and predestination where God unconditionally ordains the eternal fate of individuals.

The heart of Calvinism is a reverence for the sovereignty of God, who alone, without reference to any effort of man, is to be trusted for salvation. Tracing the Calvinistic system back to Augustine and Calvin, Schaff and Schaff grasp the attitude of the two fathers with the words "To them God was everything: man a mere shadow." (Schaff & Schaff, 1910, p. 539). The mind of Calvinism is characterized by logical rigorousness and confidence in the authority and sufficiency of God's revelation in the Bible. The teaching is based on a thorough reading of the Bible with reference to passages such as Romans ch. 9 and Ephesians ch. 1. Calvin advised his followers to keep a "learned ignorance" choosing to confess without seeking to explain and speculate how exactly God ordained the fall of Man without being morally responsible for it, that is, without being the author of sin. Thus, Schaff and Schaff argue that the Calvinist, in the end, must turn to the incomprehensibility and mystery of the divine decree to avoid fatalism and moral absurdity (ibid. p. 555).

Calvin knew that the perplexing doctrine of election and predestination raised many difficult questions and he was aware of the controversial nature of the idea that God unconditionally predestined some to election and others to reprobation. Though he referred to the doctrine of

predestination as “perilous to human curiosity” and as “an inextricable labyrinth” for those who seeks to apprehend rather than adore the “sublime eternal wisdom” and “the secrets of his[God’s] will”, Calvin perceived the doctrine as “useful, necessary, and most sweet.” and he declared: “Ignorance of it impairs the glory of God, plucks up humility by the roots, begets and fosters pride. The doctrine establishes the certainty of salvation, peace of conscience, and the true origin of the Church.” (Calvin, Institutes, book III, ch. XXI, p. 1).

Among the most resolute oppositions against Calvinism has been John Wesley with his Arminian perspective. Schaff and Schaff present Wesley’s perception of the doctrine of predestination citing from Wesley’s frontal attack on the doctrine in the sermon *Free Grace* preached in Bristol:

> “He goes so far as to call it “a doctrine full of blasphemy,” because “it represents our blessed Lord as a hypocrite, a deceiver of the people, a man void of common sincerity, as mocking his helpless creatures by offering what he never intends to give, by saying one thing and meaning another.” It destroys “all the attributes of God, his justice, mercy, and truth, yea, it represents the most holy God as worse than the devil, as both more false, more cruel, and more unjust.” (Schaff & Schaff, 1910, p. 566).

Schaff and Schaff raises a number of objections against Calvinism. In sum they argue that the Calvinist system defects by undermining Man’s moral responsibility and God’s divine attributes (e.g. justice and mercy) and by leading to a dilemma between morality or logical consistency (ibid. pp. 538-555). In addition, they claim that Calvinism is “constructed on the ruins of the fallen race, instead of the rock of the redeemed race”, that it is based on the Augustinian doctrines of original sin and total depravity rather than the accomplished fact of redemption (ibid. pp. 543-544).

Now needless say, the Calvinism has been a highly controversial subject. Two primary objections claim respectively that Calvinism leads to fatalism and that it is incompatible with God’s attributes of justice and love. With respect to the first, it is argued that the Calvinistic idea of unconditional predestination; that God’s eternal decree ordaining some for election to salvation and others for reprobation, leaves people without any chance of salvation. For opponents of Calvinism, it seems utterly absurd that some people could never have any real possibility of being saved because they are not chosen. This leads to the second criticism about the character of God in relation to predestination. Since, not all believe, God’s will and unconditional decree seem arbitrary. God’s perfect attributes of justice, mercy, and love does not seem to correspond with an understanding that some are created without choice and opportunity besides eternal condemnation.

Since the wave of New Calvinism moved through the western world's Protestant churches, Calvinism has been subject to both 'hype' and taboo, and it is generally either loved or hated. Meanwhile, I am of the impression that the growing Protestant church in Asia, Africa and Latin America is largely unaware of the historic Arminianism/Calvinism debate although the dispute has been essential in shaping the soteriology of the church.[10] If there should be nothing of theological worth to learn from Calvinism, then the system of belief still constitute an interesting study of information architecture and knowledge representation due to its logically precise and rigid formulation of belief.

4.3. The Logic of Calvinism

Having introduced Calvinism in history with a critical comment, the thesis will now seek to propose an information architecture and formal ontology of Calvinism based on A. N. Prior's analysis of the Westminster Confession in his paper *The Logic of Calvinism*.

4.3.1. A. N. Prior's treatment of the Westminster Confession

The paper likely written around 1942 was never published by Prior, but it has been edited and published in the Prior Nachlass by David Jakobsen. The paper contains a categorization and historical investigation of the "inward order and pattern" of the Westminster Confession (Prior & Jakobsen, 2014). Prior's handwritten paper, which has been transcribed for the Nachlass, is located in Box 7 of the Prior Archive Bodleian Library in Oxford. In a comment in The Virtual Lab for Prior Studies on the content of Box 7, Per Hasle explains from suggestions by the late Mary Prior that the theological papers including *the Logic of Calvinism* were likely "meant to be included as (or reworked for) parts of ANP's project of writing a History of Scottish theology", a project which were never completed due to two fires in Prior's house during the 40's (Kenny, 1970, pp. 329-330) (Hasle P. F., The problem of predestination: as a prelude to A. N. Prior's tense logic, 2012, p. 341). The present publication of *the Logic of Calvinism* is somewhat misleading, since it appears in the

[10] This suggestion rests upon assumptions that are beyond the scope of the paper to prove. The central assumptions are that the non-western Protestant growing Church is largely influenced by the Charismatic Movement and Pentecostalism which in turn is influenced by Methodist and Wesleyan *Arminian* soteriology. One could also assume that although such soteriology might not be stated or even considered, it might be inherited through and expressed in the practice and beliefs of churches and individuals.

manuscript as the first twelve pages of a twenty-six-page document. The article in its present form is thus followed by the still unpublished texts “Natural and Revealed” (pp. 13-16), “Echo of Islam” (pp. 17-21), and “The Church and the Believers” (pp. 22-26). Together these articles not only introduce the Westminster Confession Calvinism systematically and historically, but they also offer an evaluation of the Westminster Confession informed by the Amyraldism and Barthian Calvinism that Prior was sympathetic with. It is my interpretation that Prior refers to unlimited atonement, common grace, and the public offices of the Church when he concludes “These are things which the structure of the Confession is so ill adapted to saying.” (Unpublished paper *The Church and the Believers*, p. 26, in Box 7 at the Prior Achieve in the Bodleian Library, Oxford). Prior was in fact working on a revision of the Confession. In the unpublished *Notes on the Westminster Confession and the proposed revision*, possibly written in 1940 and also located in Box 7, Prior expresses his skepticism:

> “*There would be almost universal agreement that the original Calvinist doctrine of predestination requires revision... The cue to the revision that is necessary is already given in the original confession itself, when it takes over the Biblical description of the Church as "the fulness of him that filleth all in all." The Calvinist doctrine of predestination should be criticised in the light of what is here cited as its own proof-text, Ephesians 1*.” [p. 1]

4.3.2. The Formalization of the Westminster Confession with Ramism

The inward order or logic of the Calvinist system which Prior exposed from the Westminster Confession is not accidental. Prior detects a “*Polanus - Wollebiuss - Ames - Milton method of dividing up the subject-matter of theology (...) in the arrangement of the Confession*” influenced by the Protestant convert, educator and logician, Petrus Ramus, who became an early Protestant martyr (Prior & Jakobsen, 2014, p. 4). For Ramus, the primary educational task was to present knowledge already acquired, so he developed the pedagogical tool of Ramism categorizing and visualizing knowledge in branching dichotomies. Explaining Ramus’ way of presenting knowledge, Igor Ryabov writes:

> “*On Ramus’ model, in seeking to define anything, one may go up and/or down the appropriate classificatory hierarchy to find the higher or lower (i.e., more basic or more general) “forms”. Moving from the general before the specific (...), Ramus worked as a cataloguist by reorganizing complex philosophical concepts of his time into detailed tables and tree diagrams.*

This was a real revolution in method signified the adoption of the language of mathematics as a way to describe previously obscure philosophical entities." (Ryabov, 2012, p. 22)

According to Prior, Polanus was very interested in the work of Ramus (Prior & Jakobsen, 2014, p. 4) and Ames were also strongly influenced by Ramus' approach which he adopted to his theological work. That Polanus and Ames were in debt to Ramus was already noted by Prior in the 40's, but it was first made evident by Letham, who in 1990 wrote:

> *"Polanus' Ramism is immediately evident. The Partitiones is preceded by no fewer than fifty-five pages of Ramist charts that provide a comprehensive breakdown of the entire field of theology. Dichotomous subdivision is present at all stages. The book itself is divided into two major categories: faith and good works. This was the division of theology favored by Ramus himself, (and adopted by the Ramist Puritan William Ames in his magnum opus)."* (Letham, 1990, p. 465).

It was not only Presbyterian theologians who adopted Ramism in their categorization of knowledge or belief for as already noted in the historical introduction of ontology, Lorhard who coined the term ontology was also indebted to Ramus. The similarities between the ontology in Lorhard's *Ogdoas scholastica* and the theology in Polanus' *Partitiones* and Ames' *The Marrow of Theology* are evident when comparing the screenshots in Appendix 5 showing the Ramistic arrangements of the systems. They all utilize brackets to divide and visualize the content in dichotomies. Although the Ramist logic has been criticized in modern scholarship for being simplistic, unoriginal, and unable to show important interconnections in a system of knowledge, Ramism has the great advantage of enabling clear visualization by its diagrammatical representation of knowledge (Letham, 1990) (Ong W. J., 1961).

The ramist categorization of the Westminster Confession is highlighted by A. N. Prior with a numerical system in *The Logic of Calvinism.* Whereas the formalization in the original manuscript can be viewed in Appendix 5, the equal formalization in transcribed and published Nachlass paper is cited here below:

"**The Logic of Calvinism**

1. The Authority of the Word of God.
2. The Contents of the Word of God. ("God and His Works").

2.1. Of God.
2.1.1. Of God's general attributes.
2.1.2. Of God as the Holy Trinity.
2.2. Of God's Works.
2.2.1. Of God's Works in Eternity – His Decree.
2.2.1.1. Of God's General Decree.
2.2.1.2. Of God's Special Predestination of Men and Angles.
2.2.2. Of the Execution of God's Decree in Time.
2.2.2.1. Of Creation.
2.2.2.1.1. The Creation of the World.
2.2.2.1.2. The Creation of Man
2.2.2.2. Of God's Providence.
2.2.2.2.1. God's General Providence.
2.2.2.2.2. God's Providence in Relation to Sin.
2.2.2.2.2.1. The Covenant of Works and its Breaking.
2.2.2.2.2.2. The Covenant of Grace.
2.2.2.2.2.2.1. The Purchase of the Covenant of Grace.
2.2.2.2.2.2.2. The Application of the Covenant of Grace.
2.2.2.2.2.2.2.1. The Inward Work of Grace.
2.2.2.2.2.2.2.2. The Outward Means of Grace.
2.2.2.2.2.2.2.3. The Fruition of Grace in Glory."

The information structure above takes its departure from the Word of God, the Bible, because the teaching of Calvinism and Westminster Confession correspond to a particular interpretation of scripture. In fact, the articles in the Westminster Confession are all associated with texts from the Bible that the authors of the confession perceived as justification for the belief formulated in the articles. The formalization moves by the ramist dichotomies from the most basic and general to the more specific. Tracing the categorization back to the confession, the table below shows the relation between Prior's classes and the articles of the confession:

The Logic of Calvinism	**The Westminster Confession**[11]
1. The Authority of the Word of God	Chapter I
2. The Content of the Word of God	Chapter II-XXXIII
2.1. Of God 2.1.1. Of God's general attributes. 2.1.2. Of God as the Holy Trinity	Chapter II Chapter II, articles I-II Chapter II, article III

[11] For a well-designed interactive version of the Westminster Confession, see http://www.freepresbyterian.org/wcf-7/

2.2. Of God's Work	Chapter III-XXXIII
2.2.1. Of God's Works in Eternity – His Decree. 2.2.1.1. Of God's General Decree 2.2.1.2. Of God's Special Predestination of Men and Angles.	Chapter III Chapter III, article I Chapter III, articles I-VII
2.2.2. Of the Execution of God's Decree in Time.	Chapter IV-XXXIII
2.2.2.1. Of Creaton 2.2.2.1.1. The Creation of the World 2.2.2.1.2. The Creation of Man	Chapter IV Chapter IV, article I Chapter IV, article II
2.2.2.2. Of God's Providence 2.2.2.2.1. God's General Providence 2.2.2.2.2. God's Providence in Relation to Sin	Chapter V-XXXIII Chapter V, articles I-III Chapter V, articles IV-VII
[Of the Fall and Sin. This fundamental article is not represented by a distinct category in Prior's Logic]	Chapter VI
2.2.2.2.2.1. The Covenant of Works and its Breaking 2.2.2.2.2.2. The Covenant of Grace	Chapter VII, article II Chapter VII, article III-VI [and possibly the remaining chapters[12]]
2.2.2.2.2.2.1. The Purchase of the Covenant of Grace	Chapter VIII
2.2.2.2.2.2.2. The Application of the Covenant of Grace 2.2.2.2.2.2.2.1. The Inward Work of Grace 2.2.2.2.2.2.2.2. The Outward Means of Grace 2.2.2.2.2.2.2.3. The Fruition of Grace in Glory	Chapter IX-XXXIII Chapter IX-XVIII Chapter XIX- XXXI Chapter XXXII-XXXIII

Table 5: The Correspondence between Prior's "The Logic of Calvinism" and the Westminster Confession

In the presentation above, it should be apparent that the Westminster falls into a categorization of Ramist dichotomies, which Prior perceived as an "inward order and pattern" (Prior & Jakobsen, 2014, p. 1). This categorization can be portrayed using bracketing division, as in the Ramist categorizations included in Appendix 4, or numerical visualization, as in the above, or by using a branching structure, as in standard graphical visualizations of formal ontologies. By means of Ramism, the formalization and visualization of the Westminster Confession permit straightforward understanding of the Calvinist system of belief. The categorization also allows for an innovative study with ontology for systems of belief.

[12] A. N. Prior is a bit ambiguous here. While, his comments on p. 2 indicate that the category only corresponds with the last half of chapter VII, the numerical categorization indicates that the category includes the remaining chapters.

4.4.3. Developing an Ontology for the Logic of Calvinism (CalvOn)

So far, the work with ontology has provided an ontology for the domain of theology (TheOn). This ontology constituted a semantically enriched knowledge base capable of containing an exhaustive number of declared axioms for theology and able to perform simple types of inferred axioms.

Now the thesis puts forward a more distinct ontology for the domain of Calvinist theology. Whereas, the scope of the TheOn is broad seeking to represent theology in general, the ontology for Calvinism has a narrower and deeper scope for as shown above Calvinism represents a thorough interpretation of scripture and human history. In many versions of Calvinism, the system constitutes a detailed outline and proclamation of relatively abstract doctrines. Hence, the ontology that is offered in this section is more specific and more conceptual than the TheOn.

The ontology of Calvinism could be perceived as a deepening of TheOn class; “Calvinism”, which is a subclass of “Perspective”. Thus, the ontology for Calvinism comprises a higher level of granularity than TheOn. While, TheOn merely concerns different theological systems in the forms of “Perspective”, “Issue” and “Point”, the ontology for Calvinism concerns itself with the parts of a perspective. It lays out the components of which the Calvinist system is built. In doing this, the ontology describes Calvinism in the wide sense of the term as apparent in the Logic of Calvinism where Calvinism is perceived as a system of belief, an overarching interpretation of the Bible, or as an understanding of the salvific history as revealed in the Bible and in history.

By direct import of Prior’s formalization to an ontology, the Logic of Calvinism is presented in Figure 15, below. In this ontology, the superclass “Thing” immediately divides in the dichotomies; “The_Authority_of_the_Word_of_God” and “The_Content_of_the_Word_of_God”. This fundamental categorization is inherited from the Protestant doctrine of Sola Scriptura, where scripture is the highest authority for doctrine, and from the universal belief that God has revealed himself in his Word as mediated by the prophets, the apostles, and the God incarnated; Jesus. In safe and strict keeping with this inheritance, the Logic of Calvinism then divides in subsequent categories that all constitute part of the “The_Content_of_the_Word_of_God”. This categorization is strict by being completely dependent on thorough analysis and interpretation of the Word of God. Due to of this strictness, the Westminster Calvinism might be considered essentially analytical and rationalistic. With a more positive wording, one might say that the confession is safe-guarded by depending on an accessible and common basis, namely, the Scriptures.

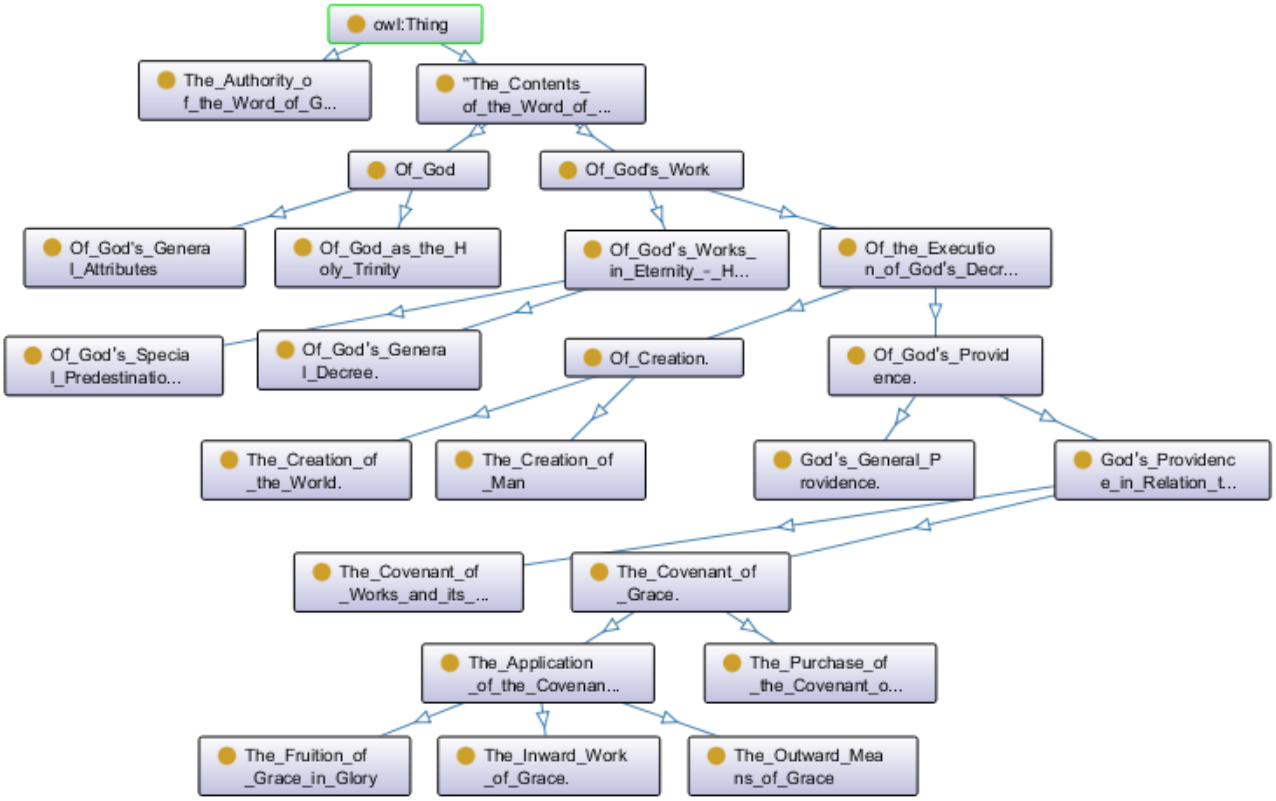

Figure 16: Direct import of the "Logic of Calvinism" to OWL in the Ontology Editor, Protégé.

Not only does the graphical representation in Figure 16 show that all classes follow from "The Content of the Word of God" (with exception of "The Authority of the Word of God"), it also depicts two other dichotomies between content "Of_God" and "Of_God's_Work" and between his work in eternity and his execution of his decree; his work in time.

With this direct import, one immediately runs into problems with the ontology. Firstly, there is a problem of syntax when only some classes contain the ambiguous "Of_"-prefix. This prefix seems to imply "Content_of…" in Prior's Logic of Calvinism, but in the Westminster the "Of_"-prefix occurring in the chapter titles seem denote "Confession of…". Without the implicit "content of …", the syntax with the "Of_"-prefix is nonsensical, for it is meaningless to assert that "Of_God's_General_Attributes" is_a "Of_God".

Secondly, the complicated syntax with Prior's "Of_"-prefix ought perhaps to be simplified to describe doctrinal statements, rather than interpretation of the content of scripture. It is desirable to translate the syntax in the classes, so that the Calvinist ontology could be described as a statement of faith, answering the conventional question of confessions; "What do we believe?", instead of the abstracted question about the understanding of scripture. It seems that the upper half of the ontology

with the “Of_...”-prefix describe Calvinism in terms of an interpretation of the content scripture, while the lower half of the ontology describes Calvinism in terms of doctrines.

Thirdly, the directly imported categorization may be improved by adding contextualizing top classes to the ontology. If done to merge the ontology with TheOn, it might be appropriate to add the superclass “Westminster_Calvinism” to the ontology as a subtype of the TheOn class “Calvinism” which is a subtype of “Perspective”. As a separate ontology, it might be helpful to define this Westminster Calvinism as a system of belief.

Thus, in seeking solution to these three difficulties, the ontology might be developed according the graphical representation in Figure 17, in the page below. In this representation, the ontology is defined with the super classes in relation to the super classes “WestminsterTheology” which is a subclass of “SystemOfBelief” and the ontology is also defined in relation to the instantiations “WestminsterConfessionOfFaith” and “TheLogicOfCalvinism”. Differences from the direct import above, also include annotations such as those referring to the original wording of the classes in Prior’s *Logic of Calvinism* as well as the object relations “part_of”.

The study of parthood; mereology, comprises a distinct study part of the study of ontology, and although the parthood relation is not a built-in relation in OWL, the language is capable of presenting this relation with defined object relations (Rector & Welty, 2005). Without commenting on concepts and theories in mereology, it is relevant to note that parthood relations are transitive, so that if C is part of B which is part of A, then C is both part of B and A. In Protégé, it is possible to define a relation “partOf” as transitive and it is also possible to define the relation “hasPart” as an inverse relation of “partOf” so that whenever B is part of A, then A has part B. For the ontology of Calvinism, this means that the Application of the Covenant of Grace is both part of God’s Providence and God’s Work in Time.

This part_of relation corresponds well with Ong’s description of the Ramist logic used in The Logic of Calvinism:

> “Ramist analysis forces the pupil to process all his mental possessions through some art or curriculum subject before he puts them to use. If an apothegm or a proverb or an aphorism should by any chance come to mind, before one uses it one had best write it down and analyze it – grammatically, rhetorically, logically, mathematically, or "physically." What it "contains" is what comes out of the analysis, not what it actually says before it is analyzed.” (Ong W. J., 1961, p. 47)

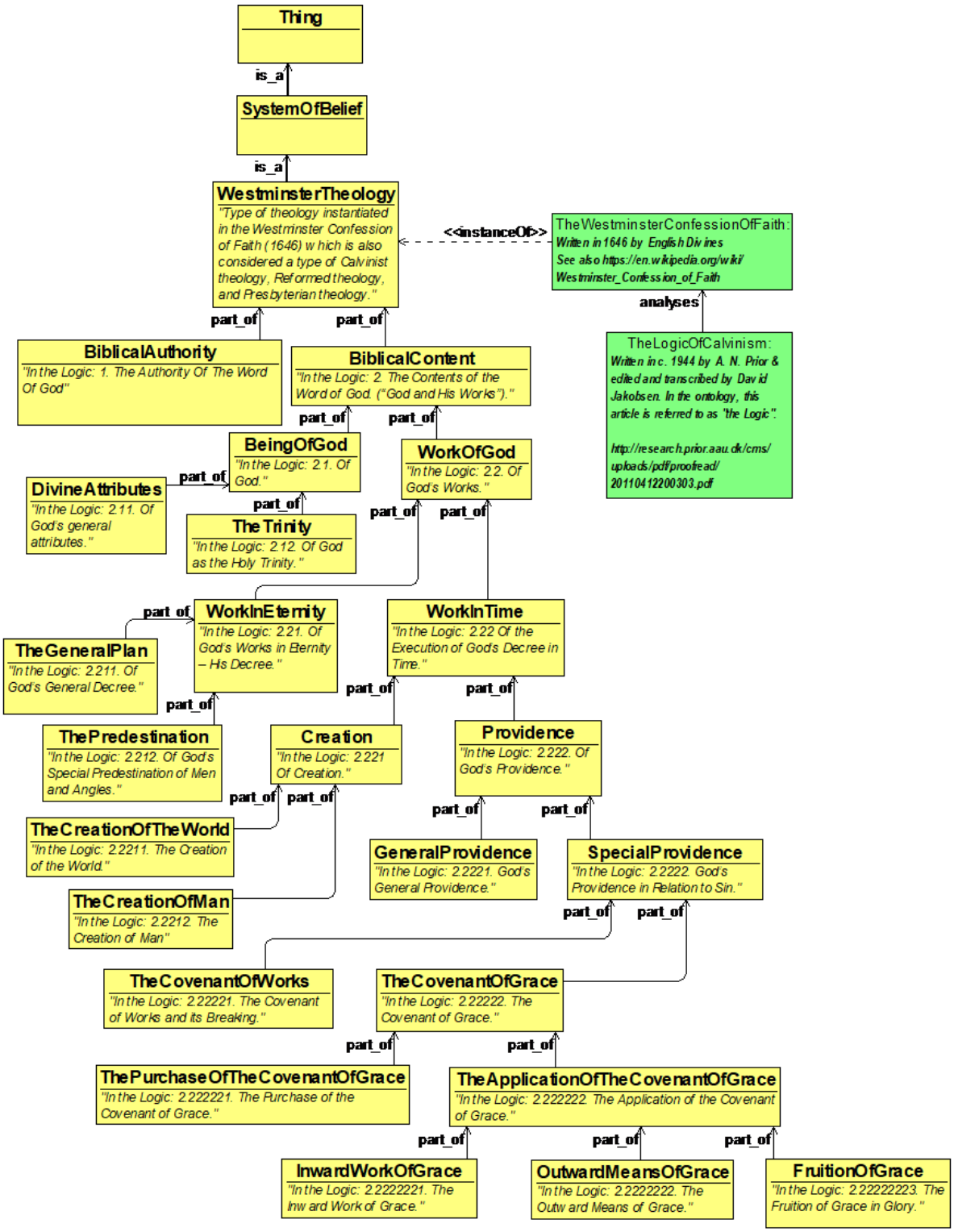

Figure 17: Representation of the ontology of WestminsterTheology referencing the Westminster Confession and the Logic of Calvinism as instances related to the classes of doctrines interrelated by parthood.

But challenges also arise in this categorization. Whereas the transitive part_of relation describes the interrelation between most of the theological categories well, the terminology is quite imprecise. The entities in *The Logic of Calvinism* refer to doctrines or in Prior's words they refer to parts of the "summary of the teachings of scripture" (Prior & Jakobsen, 2014, p. 1). This ambiguity is clarified by annotations defining the terms.

However, it is crucial to use conventional terms in building ontologies to limit ambiguity and unclarity (Arp, Smith, & Spear, 2015, p. 61). To increase clarity, the thesis put forward an ontology for Calvinism defining the doctrines as subclasses of "Topic" and interrelating them by the object property of "concerns" and its specifying subproperties such as "concernsGod". The three figures, below, portray among other things the topics, object properties and inferred subclass hierarchy (showing interrelated topics) of the ontology for Calvinism which may be called the CalvOn.

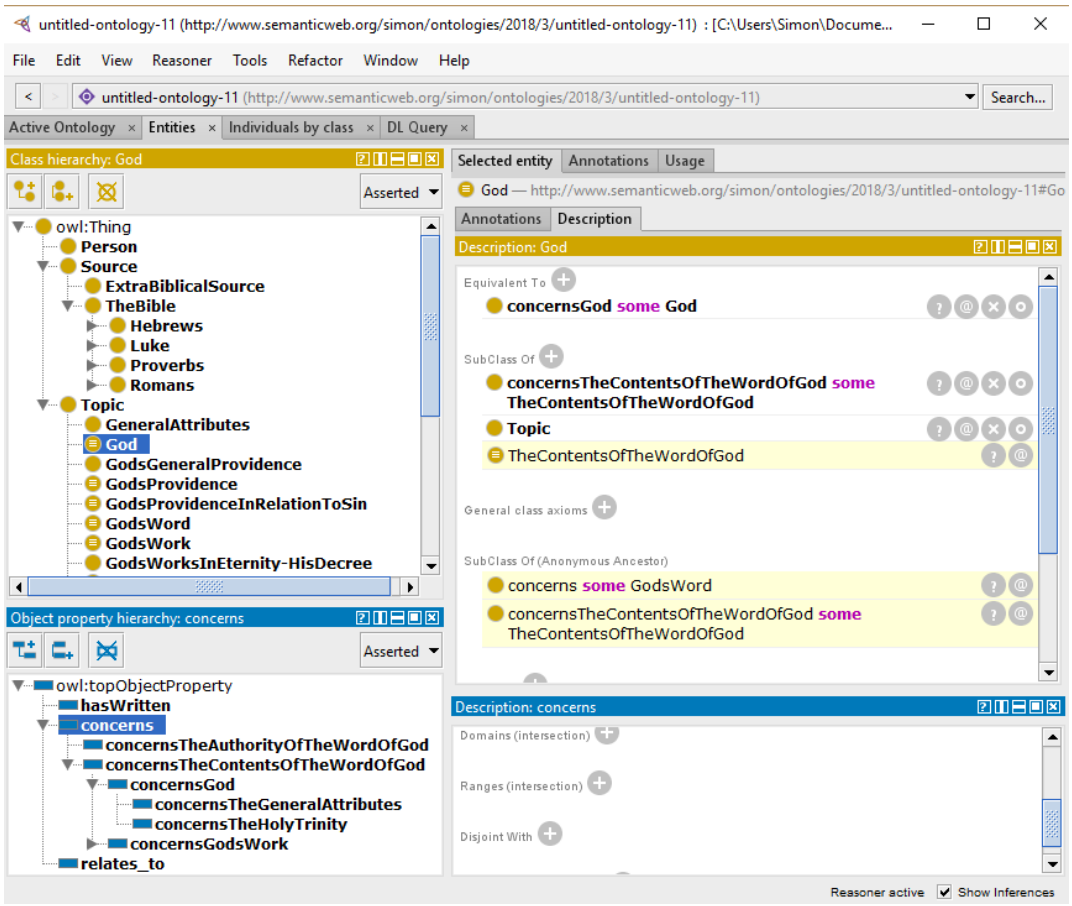

Figure 18: "The Logic of Calvinism" categorized as subclasses of "Topic" interrelated object property.

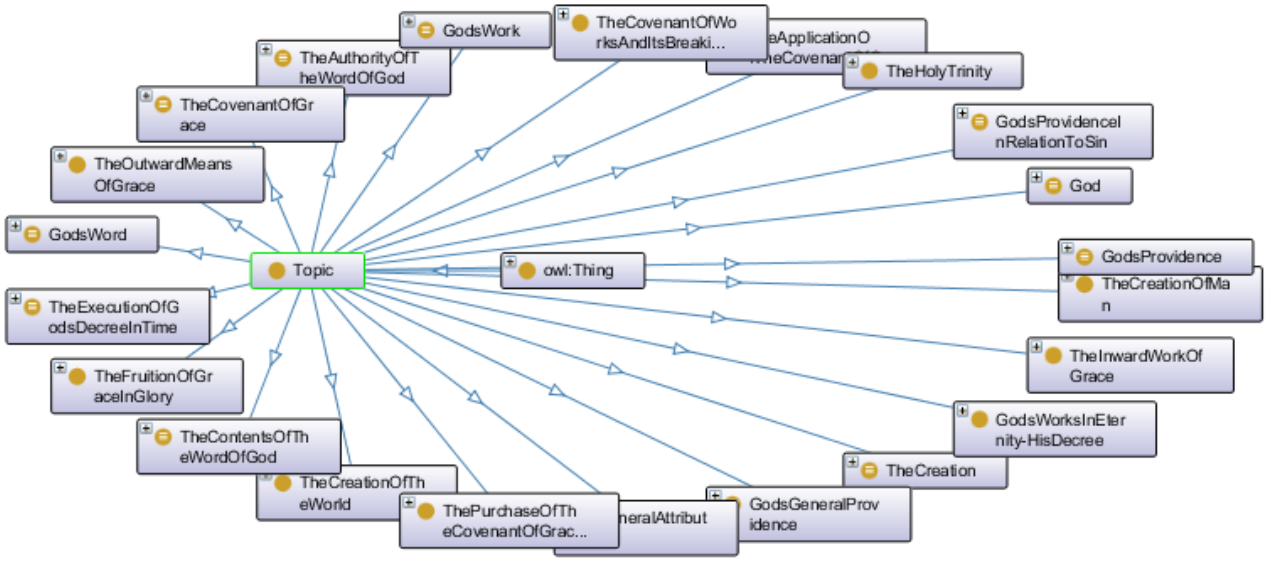

Figure 19: Graphical representation of the classes related to the class "Topic" in the CalvOn.

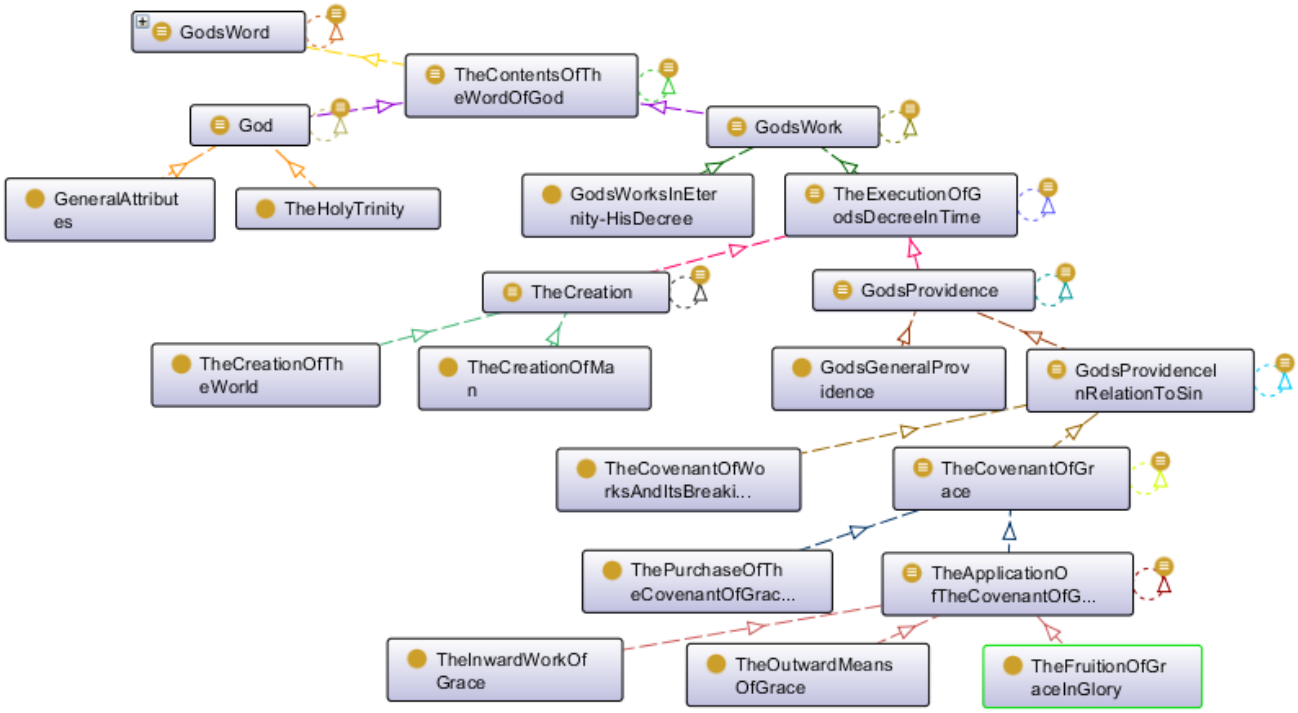

Figure 20: Graphical representation of the inferred class relations in the ontology for Calvinism.

The three figures above are all retrieved from the program, Protégé. As they show us, the CalvOn represents Prior's ramist formalization of the Westminster Confession as topics divided in subtopics

that concern their respective more general topic. Thus, the heart of the ontology is expressed in the definitions that tells us what topics concern what topics. Since this relation of *concerning* is defined as transitive, it is possible to depict the hierarchical structure of topics concerning other topics, as done in Figure 20. The hierarchy shows the inferred class structure of CalvOn. Since the "concerns" relation is transitive, it is not declared, but rather it is inferred, that "TheFuitionOfGraceInGlory", for instance, concerns "TheExecutionOfGod'sDecreeInTime". The description in Figure 18 of the class, "God", as "Equivalent To "concernsGod some God"" seems to state the obvious, but such equivalent definitions are necessary for the computer to understand the transitive relations in the inferred class hierarchy.

Whereas all the "concerns" object properties describe the relations between topics, two other object properties are involved in the CalvOn; the "relates_to" property and the "hasWritten" property. The "relates_to" property connects the subclasses of "Source" and "TheBible" comprising specific Bible texts to the topics that they correspond to as they are used for basis of the articles in the Westminster Confession.[13] For instance, the Bible verse, Hebrews 1:1 ("Hb1,1"[14]) relates to the authority of the Word of God since it is used as scriptural proof in the first article of the chapter in the Westminster Confession, "Of the Holy Scripture", in footnote six.[15] This categorization of0 scriptural basis for the doctrines is crucial in representing the Calvinist ontology which is essentially an interpretation of scripture. The "hasWritten" property is used with the domain "Person" and the range "Source" to associate a person and the extrabiblical source which the person authored such as in the example of the instantiation ArthurNormanPrior who hasWritten TheLogicOfCalvinism.

The ontology of Calvinism, the CalvOn, represented above, is a representation of the Calvinist belief system in its own right and not only insofar as it is referring to Prior's formalization of the Westminster Confession. It is a conceptualization of Calvinism because it gives articulation of and high priority to God's work in eternity and the predestination of humans. In addition, the CalvOn focuses solely on God's work without any human actions described in the ontology. These characteristics of the ontology resemble the analysis of Calvinism in section 4.1. and section 4.2. where Calvinism is shown to emphasize divine sovereignty over human freedom.

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[13] On this point, see the footnotes "Scripture Proofs" of the Westminster Confession in http://www.freepresbyterian.org/wcf-1/. That the Confession is based on scripture is illustrated by this fact that all the propositions in the articles of faith refer to the scriptures from which the articles are derived.

[14] Although, "Heb." is used sometimes, "Hb" is a relatively conventional abbreviation of the New Testament letter, The Epistle to the Hebrews.

[15] The Confession is available in the website; http://www.freepresbyterian.org/wcf-1/ (Collective, 2014).

Finally, it might appear curious that God is an inferred subtopic of God's Word. It might seem peculiar and circular, if not heretical or idolatrous, that God's Word is perceived as more basic or general than God himself. However, for some Calvinists God's Word might be regarded appropriately as more general than God, since it is the only adequate source of true knowledge of God, through which God has chosen to reveal himself in a special way.[16] Hence, it would be fair to say that God, or more precisely; our knowledge (doctrine, confession, etc.) of God, is subject of his own word.

In conclusion of this development of the ontology for Calvinism, Figure 21 below presents a final graphical representation of CalvOn depicting the inferred "concerning" and "is_a" relations between topics. See Appendix 7 for a more comprehensive graphical representation of the ontology.

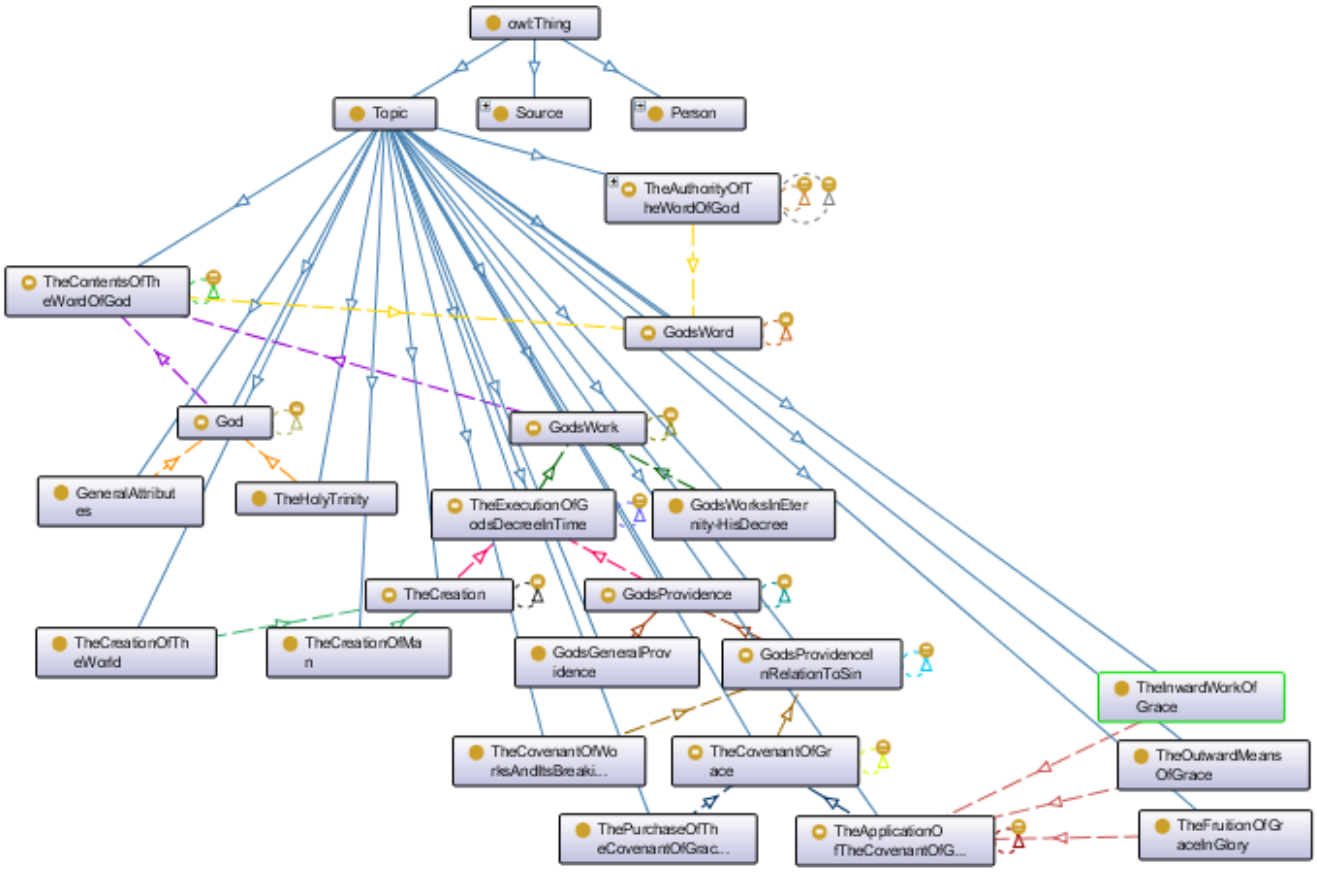


Figure 21: A graphical representation of the topics in the CalvOn and their interrelations.

[16] Although traditional Calvinists do have a theology of a natural theology following Calvin's "*Sensus divinitatis*" which has been strongly defended by Alvin Plantinga (Plantinga, 2015, pp. 30-35), there is, generally, a clear emphasis on the dependency on scripture for knowledge of God.

Queries and inferences in the CalvOn

The information architecture in the CalvOn enable queries and inferences about Calvinism as it is presented. By the transitivity relation “concerns”, the CalvOn can infer all the subclasses of a certain topic. This is illustrated in Figure 22 which depict a query on the subclasses that concern the topic the execution of God’s decree in time. This query shows there are fourteen entities that concern this execution of God’s plan in time. Included in these classes are for instance God’s providence, the creation of man, and the covenant of grace.

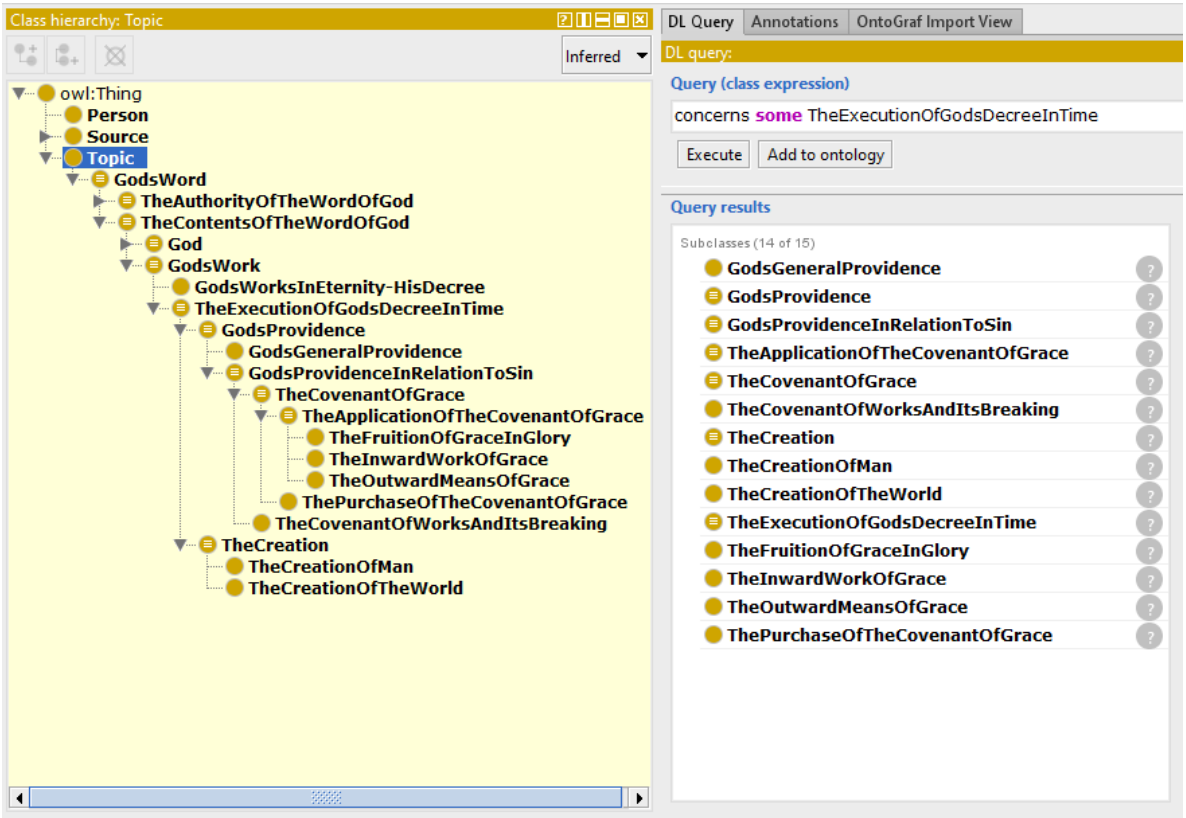


Figure 22: Part of the inferred class hierarchy (to the right) and a DL query on what concerns The Execution of God's Decree, that is, his work in time (to the left).

When clicking on the question mark bubbles to the right of the query results, the query offers its logical explanation or evidence for the query result to the left of the question mark. Figure 23 provides one of the different explanations for the query result that the covenant of grace concerns the execution of God’s decree in time shown in Figure 22. The explanation shows that from the declared axiom, “TheCovenantOfGrace is SubClassOf concernsGodsProvidenceInRelationToSin some GodsProvidence”, CalvOn deduces that the covenant of grace does concern the execution of God’s decree in time, since “concernsGodsProvidenceInRelationToSin” is a derived SubPropertyOf

of “concerns” and since “GodsProvidence” indirectly has “TheExecutionOfGodsDecreeInTime” as superclass through the concern relation.

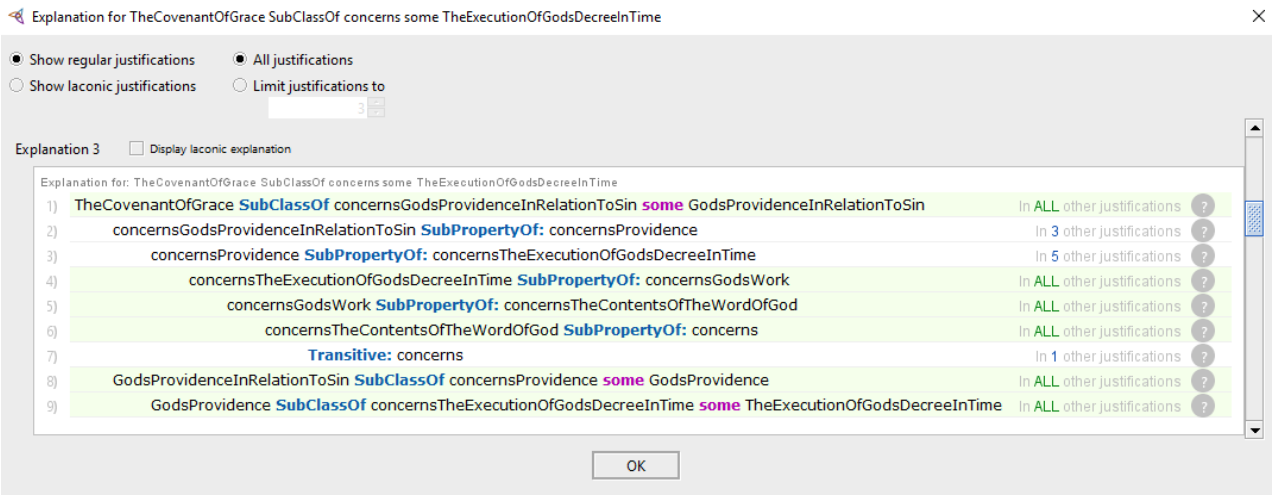


Figure 23: An example of an explanation of a query result from the Protégé plugin; DL query.

The query about what topics concern the execution of God’s decree in time is an example of a query filtering results from the ontology. A similar query for entities concerning the Covenant of Grace, would offer the results; the purchase of the covenant of grace, the application of the covenant of grace, the inward work of grace, the outward means of grace, the fruition of grace in glory and a reference to the covenant of grace which is defined, like all the other topics, as concerning itself. These examples show that the ontology facilitates a clear understanding of what topics are involved under the different topics.

Another kind of query that the ontology enables is the query for scriptures relating to the topics. These scriptures are the Biblical texts used as basis for the articles of the confession. As mentioned, the confession is in essence an interpretation of the Bible and the scriptures referred to in the confession are understood as leading to this interpretation. Thus, the Bible texts that are included in the footnotes of the confession are called “Scriptural Proofs” (Collective, 2014).

An example of such a query for scriptures related as basis to a certain topic is offered in Figure 24 below. It shows that the articles in the doctrine of “The Authority of the Word of God” are based at least primarily on the five Biblical texts; Hebrews 1:1, Luke 3:3-4, Proverbs 22:19-21, and Romans 2:14-15 and 15:4. Figure 25 and 26 provide three other examples of queries for the so-called “Scriptural Proofs” related to three topics of the CalvOn. These examples show the scriptural basis for the topics; the trinity, God’s general attributes and God himself. While, Figure 25 presents

queries revealing that there are ten scriptures related to the doctrine of the trinity and forty-six scriptures related to the doctrine of God's general attributes, Figure 26 displays that fifty-six scriptures relate to the topic "God". The scriptures related to the topic of God have an inferred connection and they are the sum of scriptures inherited from the topics "TheHolyTrinity" and "GeneralAttributes" that concern the topic of "God".

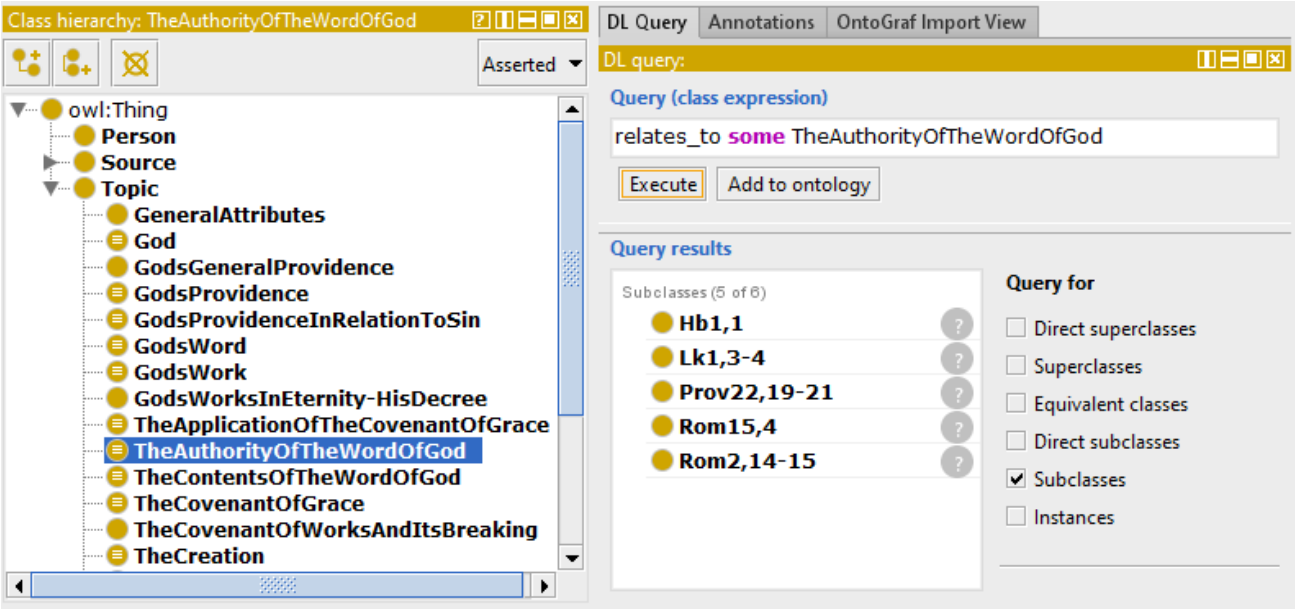


Figure 24: Query for scriptures, under "Source", that relate to the topic "TheAuthorityOfTheWordOfGod"

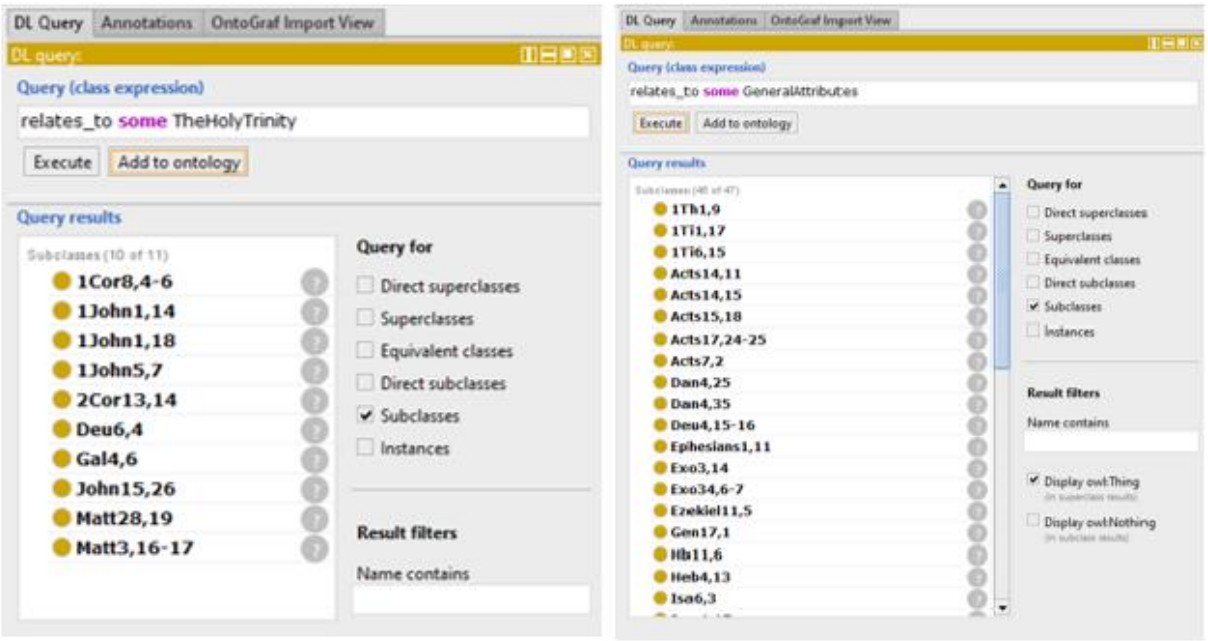
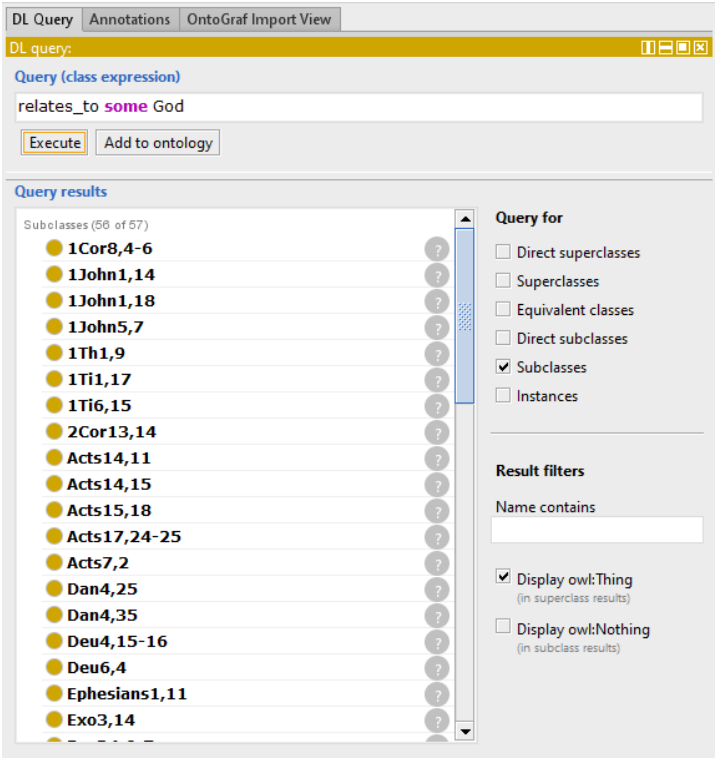


Figure 25: Two queries respectively displaying scriptures relating to the trinity and to the attributes of God



By facilitating this categorization and conceptualization of scriptures relating to topics and providing basis for doctrines, the CalvOn is able to represent the backbone of the Calvinism formalized in the Westminster Confession. Hence, not only does the ontology comprehend the "inward order" of topics in Calvinism, but it also relate the scriptures that the topics are derived from. It is granted that the ontology presents massive interpretation with little discussion. But, in doing so, it demonstrates the very core motivations and deductions of Westminster Calvinism.

Figure 26: Query on scriptures relating to the topic "God"

Before proceeding to evaluating the CalvOn and suggesting possibilities for further studies and improvements on the CalvOn, a concluding figure with a graphical representation of the topics related to scriptures will be presented below. See also Appendix 7 for a graphical representation and an overview of the most fundamental categories in the CalvOn.

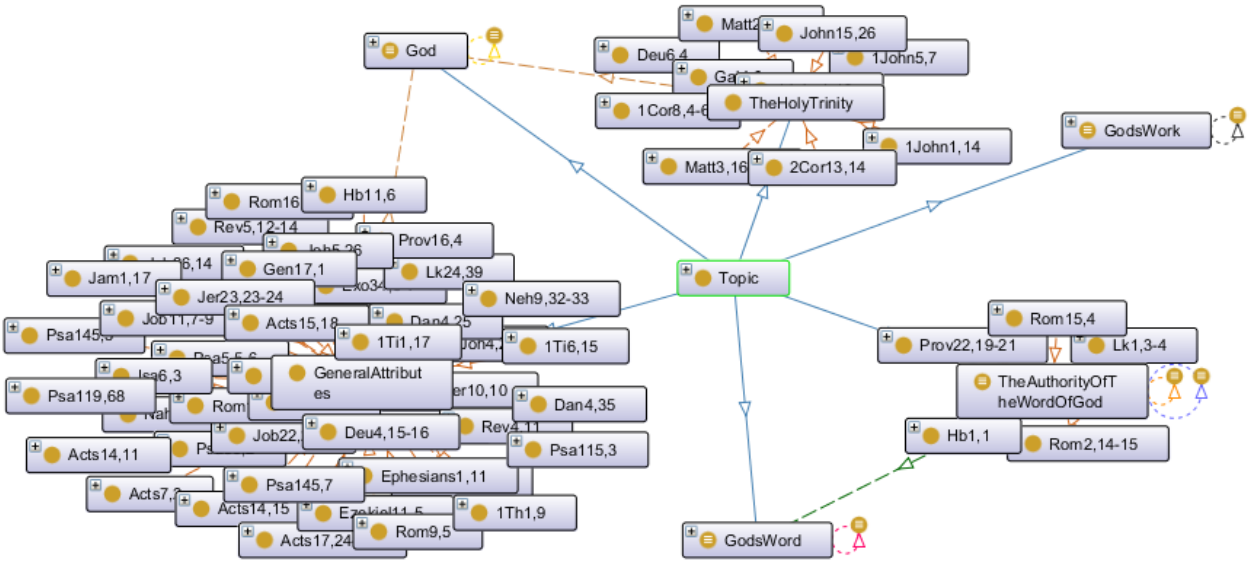


Figure 27: Graphical representation of selected topics and the scriptures related to some of these topics.

4.4. An Assessment of the Ontology for Calvinism

The ontology for Calvinism has now been presented. At this stage the CalvOn presents an early and innovative example of about how systems of beliefs can be presented as information architecture by formal ontology. Before the next section in which the thesis examines the purpose, the various use-cases and applications of this information architecture, the thesis will offer an assessment on the ontology of Calvinism. First, CalvOn's main strengths are noted, then some significant weaknesses will be observed, and lastly some ways of further development of CalvOn will be suggested.

Among the most significant strengths of the CalvOn are the categorization of interrelated topics and the inferred relations that are contained in the ontology. As seen above, these characteristics facilitate demonstrative queries.

The first major advantage of the CalvOn; the unambiguous categorization of topics, is crucial since Calvinism is an abstract and conceptual domain. The structure of topics concerning each other is coherent and explicit by avoiding the in-built "is_a" relation between the topics, which is somewhat unclear, and by having a clearly defined syntax without the "Of_..." prefix used in the Westminster Confession and in Prior's Logic of Calvinism. By defining the chapters in the confession as subclasses of "Topic", the conceptual nature of the classes is evident. As an independent ontology, the CalvOn is consistent and orderly. If CalvOn should be merged with another ontology such as the TheOn then the topics would need to be defined more clearly.[17]

A second major strength of the ontology is the classification of justification for the topics the biblical sources. This is at the heart of Calvinism as a system of belief built on an understanding of scripture. Together with these scriptural references the Ramist dichotomies facilitate a way of sharing abstract and detailed understanding of Calvinism in a simple and understandable manner. The pedagogy of the Ramism which is used in the ontology, thus, also provides strength of clear knowledge representation to the ontology. Through the graphical representations in for instance Figure 20 or in Appendix 7, the domain of Calvinism is presented with clarity and simplicity and

[17] An example of a clearer definition in view of other ontologies would define the classes not as topics but as "Doctrine" with the words "Doctrine of" as part of the IRI, so that the topic "God" would become "DoctrineOfGod" and the topic "TheExecutionOfGodsDecreeInTime" would become "DoctrineOfTheExecutionOfGodsDecreeInTime" but as an independent ontology, this clarification might not be essential. This will be discussed further below when suggestions of improvements of CalvOn are offered as part of the present assessment.

through the scriptural references made evident in the queries, the reasons used as justification for the topics are also provided.

A third strength of the ontology is the theological unity of the system. Today, such unity of beliefs can be difficult to find. In contemporary theology, there is a tendency to affirming inconsistency in biblical theology[18] and there is a tendency of separating doctrines without very clear emphasis and explanation of their unity in systematic theology[19]. However, in CalvOn, the system of belief is clearly unified structure divided in subclasses derived from a perception of the Word of God as the source of revelation. While, this consistency and unity in the ontology might be regarded as too strict[20], excluding, and perhaps even arrogant (recalling Craig & Moreland on systematizing belief from the introduction, p. 4), the unity and consistency of CalvOn might represent a sensible alternative to some postmodern beliefs that at times seem thoroughly subjective, relative to the changing emotions, experiences, and preferences of individuals, and that on occasions seem admittedly illogical or evidently incoherent.[21] That the CalvOn has a clear unity in its beliefs enables simple representation of it and it avoid self-contradiction in the information system.

The most significant weaknesses of the CalvOn involve failure to present more than a summary of titles for the contents of the articles in the confession as well as incapability of presenting disagreements with the categorization of the ontology.

The failure to present the very content on the confession is a weakness that ought to be improved in the CalvOn. The mere titles serve to illustrate the categorization and they provide a simply overview of a complex system in an easy manner. However, they are full of multifaceted terms that

[18] In this field of study, it is widely accepted that the biblical narrative is at times self-contradictory (e.g. in the classic comparison between Paul and James' views on faith and works).

[19] Here, the system of belief is often divided in several major parts (e.g. Bibliology, theology proper, Christology, ecclesiology) with many chapters pertaining to a certain issue (e.g. the trinity, the attributes of God). Although the order of the parts and chapters represent priority and order, there is often an independent treatment of the individual doctrines. One issue with the disunity of systematic theology is a unclarity about the starting point: is the starting point of systematic theology a bibliology, a doctrine of God, or perhaps even a sociological defense and treatment of religion?

[20] On a personal note, giving balance to the criticism of postmodern belief in paragraph, I think that it is, in fact, right that the Westminster Calvinism of the CalvOn is too strict. I would follow A. N. Prior, Millard Erickson, J. I. Packer and others in affirming a more moderate form of Calvinism giving higher priority to God's work of Salvation and offering more explicit account of the moral responsibility of man and man's role in sanctification which is absent in CalvOn. And on the topic of predestination, I find strict Calvinism deeply unsatisfying and as an alternative I perceive Molinism to be helpful.

[21] For instance, postmodern popular pluralism tends to accept all beliefs as equally valid, but this constitutes a real problem regarding the belief that does not perceive all beliefs as equally valid; is it equally valid that all beliefs are equally valid and that they are not equally valid?

is not defined clearly unless the very content of the confession which they refer to is being related. As we have seen in the sections introducing Calvinism (ss. 4.1. and 4.2.), predestination is a complicated and controversial topic which has been subject of various tensions and treatments throughout history of Christian thought. In the current version of CalvOn, the doctrine of predestination is merely mentioned in a title of a topic concerning other topics and related to some scriptures. The CalvOn fails to provide confession or formulation of that doctrine. Having identified this weakness, the thesis will offer, further below in this section, suggestion for this aspect of the ontology might be improved.

Secondly, one might a weakness in CalvOn's current categorization which does not facilitate other view point than the Calvinism formalized in A. N. Prior's analysis of the Westminster Confession. CalvOn, thus, merely provides one system of belief without supplying criticism of it or presentation of alternative view point. A criticism of Ramism might add that CalvOn imposes a certain scriptural interpretation or theological view and fails to give account of interrelations between classes that are not related by sibling- or subclass. On the weakness of Ramism, Letham argues:

> "*However, the major drawback consists in an arbitrary structure being imposed on theological content. Interconnections between levels other than those made patent by the model are thereby lost; we are left with no option but to see theology as Polanus' Ramism sees it. The model itself is unquestioned, but as a way of allowing the object of inquiry to disclose itself we must adjudge it a failure. The methodology gets in the way of the content.*" (Robert Letham, p. 465)

Letham is right in his point that interconnections are lost; for example, CalvOn fails to show the how the attributes of God have a relation to the work of God. This question is not at all inessential because the relation between God's attributes and his work is exactly what has been subject of the criticism towards Calvinism raising the question whether the doctrine of predestination is compatible with God's attributes of justice and love. However, the claim that it imposes a view which leaves out alternatives and hinders inquiry seems unconvincing. In contrast, one might argue that the categorization by Ramism enables detailed analysis and discussion. It is fitting to raise questions regarding the labelling, relations, and prioritization of categories. One might for instance, like A. N. Prior[22], suggest that the alternative topic, "The Redemption", ought to be categorized as a

[22] In his still unpublished paper succeeding "The Logic of Calvinism"; "Natural and Revealed Theology", A. N. Prior talks of "the Confession's failure to consider redemption as a distinct activity of God on level with creation" and he argues that the categorization of God's work in time divided by the dichotomies "creation" and "providence" confuses the trinitarian confession of Calvin and the Apostle's Creed. He writes: *"God's "work in time" are not divided into those of creation and redemption, or, as in Barth, those of creation, reconciliation and redemption; but into those of*

central and an essential topic on level with and independent of God's work of providence and creation. So, it is possible to compare alternative categorizations with the Ramistic structure of CalvOn and discussion of CalvOn's system of belief is also not impossible.

In attempt to improve on this weakness, CalvOn could be developed to include a category for alternative topics and object relations representing evaluation of the Westminster categorization. Such attempt is portrayed, below, but it seems more appropriate to limit the scope of the ontology to representing a Calvinist system of belief and without giving account for the criticism that there is of it. Nevertheless, in merging with TheOn, CalvOn could be categorized as one of other perspectives that can be affirmed or denied and argued for or argued against. Also, by exporting CalvOn to a webpage for presentation, discussion, use of the confession for individuals and for churches, it might be desirable to have a class "Evaluation" under which users of the website could add comments on definitions and categorizations of topics in the CalvOn.

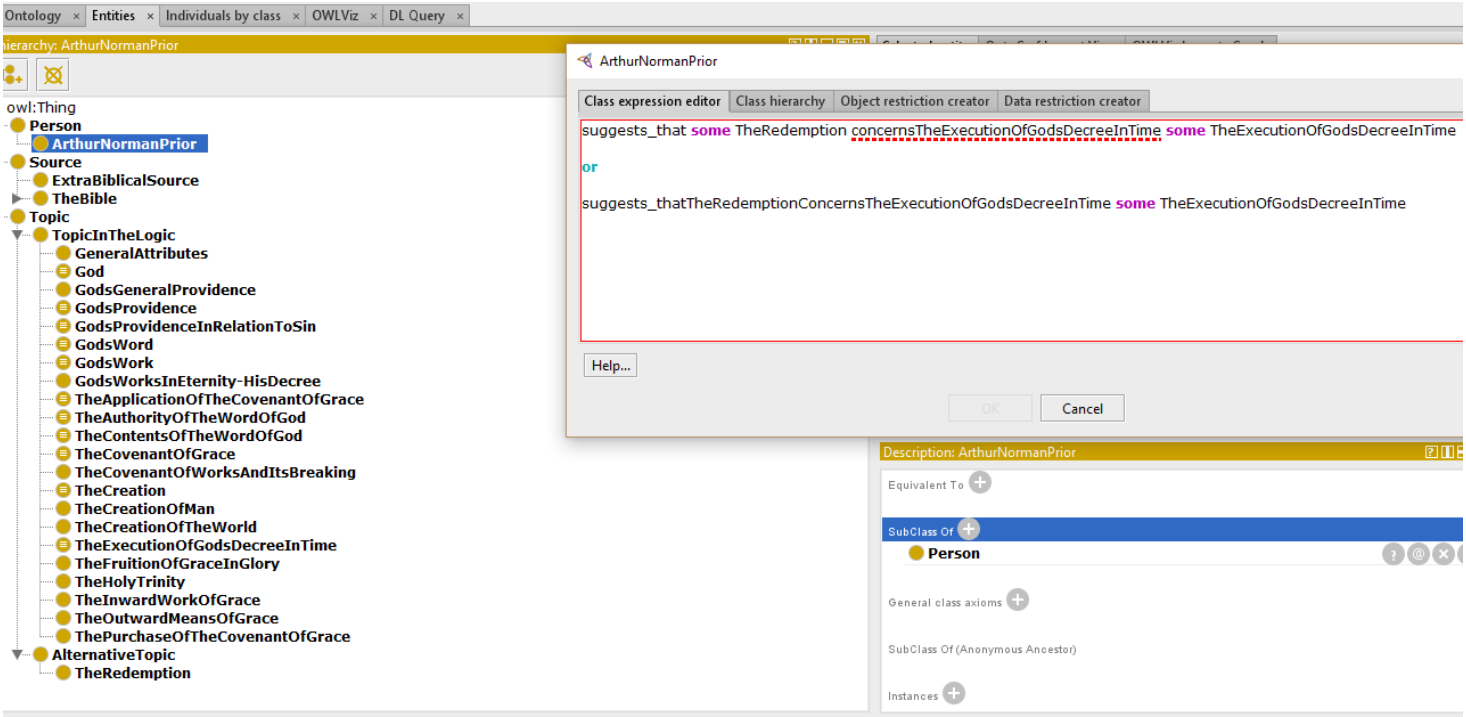


Figure 28: Alternate categorization of CalvOn with alternative topics
(the problematic syntax, in the class ArthurNormanPrior is meant to illustrate intention and not be applied).

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creation and providence. The whole plan of redemption is simply God's "special" providence. The outlines of the Apostle's Creed, still clear in Calvin, are not invisible in the Westminster Confession either, but they have become somewhat blurred. The "balance" of the Creed has been lost, and all the later sections of it have become appendages to the one article, "I believe in God the Father Almighty, Maker of Heaven and Earth." It is not surprising that Presbyterians in England and America has sometimes slipped in Unitarianism." (A. N. Prior, *Natural and Revealed Theology*. Unpublished paper from the 1940's. Retrieved from the Virtual Lab for Prior Studies: http://research.prior.aau.dk/login_user.php)

Having examined the primary advantages and disadvantages with the categorization of the CalvOn, the thesis will now offer two ways forward for further improvements of the ontology. First, it seems, as mentioned, necessary to categorizing more of the content of the topics used. The second opportunity for improvement involves better design of the ontology, so that it can support merges with other ontologies such as the TheOn.

Concerning the first suggestion, there seem to be two ways of classifying the content of the topics. First, it might be possible to classify the propositions in the articles of the confession as of the class "Points" (which is used in TheOn) and thus relate the points to the topics. In doing this it might even be possible to create a knowledge base of defined theological concepts used in the system. While such categorization constitutes good possibilities of improvements, it entails a great amount of reclassification and, thus, it remains for further study. There is a simpler way to add the content to the ontology. The confessional propositions of the confession could be inserted as annotations to classes for the corresponding confessional articles. Then those articles could be related to the topics according to the analysis in Prior's paper, *The Logic of Calvinism*, which provides the correlation shown in Table 5 (pp. 44-45). This categorization is represented in the two figures below that give an impression of how CalvOn could be further developed in this respect.

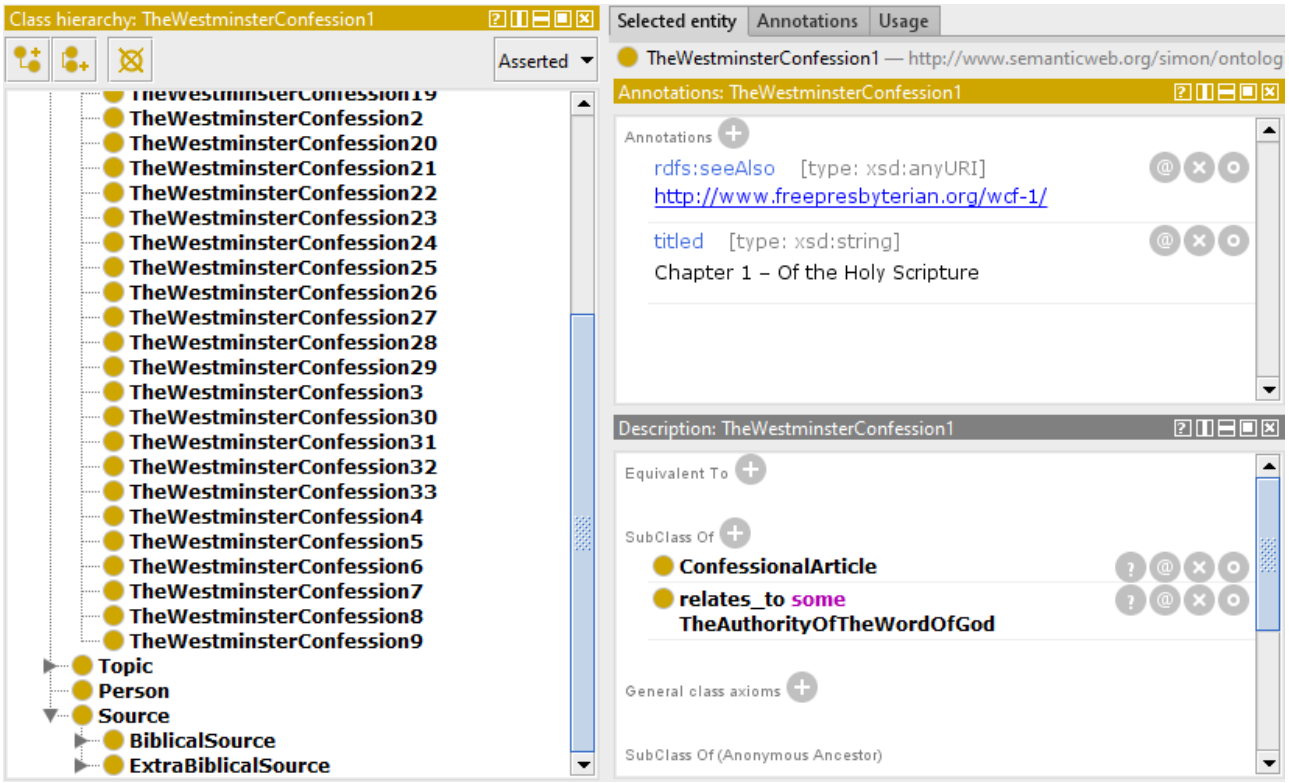

Figure 29: Categorization of chapters and articles of the Westminster Confession in CalvOn

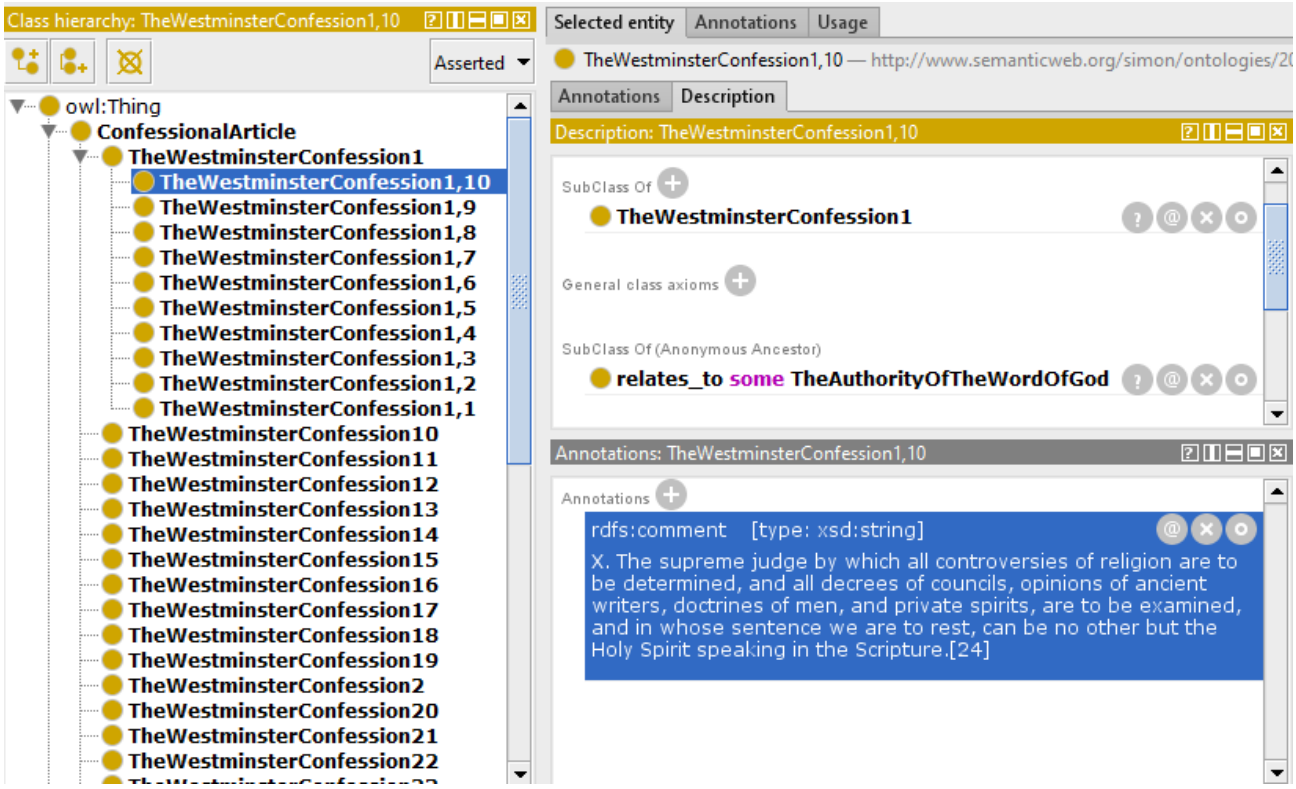

Figure 30: Categorization of chapters and articles of the Westminster Confession in CalvOn

Figure 28 shows that the class "TheWestminsterConfession1"; chapter one of the confession, has annotations attributing the headline; "Chapter 1 - Of the Holy Scriptures", and linking the class to a webpage providing the chapter and the rest of the confession in a usable format. The figure also shows that the chapter "relates_to" the authority of the Word of God. In addition, Figure 29, shows that the article "TheWestminsterConfession1,10" inherits the relation to the authority of the Word of God from its chapter and the text itself is provided as a rdfs comment.

Besides these annotations, comments and references could be added to the topics to provide definition to abstract, complex and theologically rich terms like "Predestination", "Providence", or "TheCovenantOfGrace" that most people might not be familiar with. In doing so it would be possible to limit confusion of terms for people not acquainted with the theology.

The second suggestion of improvement for CalvOn concerns the design of the ontology in relation to other ontologies that it might be merged with. In view of future information architecture of systems of belief developed with formal ontology, it might be desirable to design the ontologies in such a way that possible applications of them would draw on a number of ontologies representing various systems of belief. For conservative protestant theology alone, there are numerous traditional systems of belief that differentiates from each other. It might be relevant to develop ontologies for

these theologies that are represented in different church denominations and Christian movements. But for theological studies in general, it might too be desirable to develop information systems with applications like knowledge bases, online encyclopedia, and artificial intelligence that could represent different systematic paradigms and theological traditions without mischaracterization. This might be achieved with an extended ontology categorized in such a way that it could facilitate deep account of a variety of theological systems, but it also necessitates that the different systems of beliefs would be designed without using common phrases and classes with different meanings. In theological debate it is most often this problem of different interpretations or meanings of common words that is source of miscommunication and confusion. It should be clear from the treatment of Calvinism above that terms such as "predestination", "election" and even the "attribute of love" has quite different usages, denotation, and implications in different theological perspectives.

The primary problem in this regard in relation to CalvOn is that its doctrines are classified as topics and then related to each other in a hierarchy that is uniquely Calvinistic. If those topics would be used in different relation to each other within other systems of beliefs, then the queries on those topics would offer confused and meaningless results. To give a hypothetical example, imagine a paper "*The Logic of Arminianism*" categorizing God's providence apart from the execution of God's decree. Now, suppose that an ontology "ArmOn" based on the categorization of the paper would be merged with CalvOn. In this case the categories used with different meanings in the ontologies would be confused and meaningless.

Hence, it seems necessary to specify that the topics of the CalvOn as topics according to a type of Calvinism, if the ontology is to be successfully merged with other ontologies and categorizations for systems of beliefs. However, in this concern, OWL's syntax has a limited expression power, since it only supports statements in the form of a subject-predicate-object syntax (Busse, et al., 2015, p. 33). It is not satisfying to define for instance the topic, predestination, as being conditional (as perceived by Arminianists) and as being unconditional (as perceived by Calvinists). In this case a query would suggest the contradiction that predestination is conditional and unconditional; that is, that it is not conditional. And although the author of the thesis might wrong, the impression has been that it is impossible to express a conditional statement like "Calvinism suggests_that GodsSpecialPredestinationOfMenAndAngels concerns GodsWorksInEternity-HisDecree". If one could specify such statements in OWL then the topics could be related to each other through qualifications according to persectives and then CalvOn could more easily be merged with different ontologies of alternative systems of belief.

What could be done in improvement of this issue, would be to specify the topics as topics according to the perspective. Such specification could for instance be definition of the CalvOn topics as subclasses of the general topics. Thus, in specifying God's providence in relation to Westminster Confession Calvinism, the topic might be labelled "GodsProvidenceInWCC" and classified as subclass to the subclass of "Topic"; "GodsProvidence". In making these categorizations even more clear, one might find it helpful to redefine all topics as classes of the type "Doctrine", since it might be more conventional to talk about doctrines of different perspectives, than topics of different perspectives. However, these considerations merely and modestly suggest a way forward in improving CalvOn which, in some regards, is still in its early stages. It would comprise a study of a larger scope to treat these difficult challenges effectively and optimize them to excellence.

In sum, it was noted that CalvOn has the advantage of its clearly defined relations of abstract topics and it has the strength of its classification of biblical data providing basis for the Calvinistic categorization of topics as well as the benefit of its strong unity of the system shaped by the Ramistic dichotomies that provide clear structure to the complex domain. Besides these advantages of the system, it was seen that CalvOn also has current shortcomings like the failure to present the material content of the articles in the Westminster Confession. While it was shown as a suggested way forward, that CalvOn could offer a simple categorization of chapters and articles of the confession as classes, with annotations presenting the propositions of the confession in comments, to relate these to the topics of the CalvOn, it became evident that the modelling of disagreements and different perspectives in merges between CalvOn and other ontologies is a more substantial challenge. Although some possible solutions were suggested, it was clear that further studies could be undertaken to design ontology with optimized comprehensiveness and consistency in presenting different systems of beliefs. While, TheOn was consistent in modelling various perspectives, CalvOn has the advantage of comprehensiveness on its domain by offering a profound categorization of the inner order of its system of belief. Thus, it is evidently a challenge to employ both comprehensiveness and consistency in modelling different systems of beliefs.

It has been argued that the ontology of Lorhard, which in some regards resembles[23] the Westminster Confession, anticipates implementation in the information architecture using hypertextual categorization (Øhrstrøm, Schärfe, & Uckelman, 2008). However, in comparison with this type of

[23] Lorhard's ontology is just 38 prior to the Confession and both works are influenced by the seventeenth-century Protestant scholasticism and shaped by Ramism.

system, the CalvOn, with its formal ontology, has the great advantages of being capable of involving various annotations, multidirectional links, and more advanced relations through specified object relations, whereas the traditional hypertextual categorization only supports simple bidirectional links. While, the hypertextual architecture is very fitting for the Ramist formalization, the use of formal ontologies provides increased expressive power enabling the system to describe a diversity of relations and characteristics. Therefore, the categorization in CalvOn constitutes a rich and significant information architecture for representation of its system of belief. In the final major chapter of the study, the thesis will proceed from here to discover the purpose, usefulness and future perspectives for formal ontologies representing systems of beliefs.

5. The purpose, utility, and vision of ontologies for system of beliefs

Now, three aspects of the use of formal ontology to represent systems of belief will be examined. First, the thesis investigates issues pertaining to the purposes of ontologies for belief systems. Secondly, it examines several possible applications of the formal ontology for systems of belief commenting on the usefulness of formal ontology for such applications. Thirdly, it offers a vision of the future for the representation of systems of beliefs by formal ontology.

5.1. The purpose of formal ontology for systems of beliefs

The purpose of ontologies for systems of beliefs is naturally related to their intended practice and specific use. While the potential uses and the usefulness of TheOn and CalvOn will be further discussed in section 5.2., some issues regarding the general purpose and validity of developing of ontologies for systems of belief will be observed here.

There is a tendency to emphasize or perceive ontology as either formal representation of reality or as formalized conceptualization for mere information practice (Arp, Smith, & Spear, 2015, p. 7). These two basic views of the purpose of ontology; correspondence with reality or functionality in practice, correspond with two philosophical views related to ontology; realism and conceptualism. Arp, Sharp and Smith argue:

> *"The goal of ontology for the realist is not to describe the concepts in people's heads. Rather, ontology is an instrument of science, and the ontologist, like the scientist, is interested in terms or labels or codes – all of which are seen as linguistic entities –only insofar as they represent entities in reality. The goal of ontology is to describe and adequately represent those structures of reality that correspond to the general terms used by scientists."* (ibid. p. 7)

Øhrstrøm et. al also explain, "If ontology is seen as an information practice, ontologies may refer to multiple, possibly fragmented domain descriptions relative to some selected perspectives rather than to monolithic systems" (Øhrstrøm, Andersen, & Schärfe, 2005, p. 435). While historic ontologies of Lorhard, Wolff and Kraft were meant to categorize reality comprehensively in monolithic systems, the modern information science ontologies have departed significantly from the classical view of ontology and now they tend to be much more "subjective and changeable" than they used to be (Øhrstrøm, Andersen, & Schärfe, 2005, pp. 434-435). According to Sánchez et. al, "Computer Science does not give an answer about what is the essence (it is not its goal). It assumes that everything that can be represented is "real"." (Sánchez, Cavero, & Martínez, 2007, p. 7). This last assumption stands in stark contrast with Arp, Sharp and Smith's realist perception of ontology and the ontologies developed in the seventeenth and eighteenth centuries.

Regardless of whether the ontologies for systems of beliefs present beliefs that correspond with reality, systems of beliefs do certainly exist as conceptual beliefs in writings, in confessions etc. that are believed by people. It is possible to represent conceptualization of such entities in doxastic or epistemic modalities such as "it is believed that …" relative to different perspectives. This is what is done with TheOn and what is suggested in its potential merge with CalvOn, where the formalism of Calvinism would be presented as a "perspective".

However, abstracted and simplified "model theory" has been criticized in relation to biomedical formal ontologies by Obrst et al who state that "it has become clear that the whole detour via semantic models is in fact superfluous: the job of ontology is not the construction of simplified models; rather, a biomedical ontology should directly correspond to reality itself in a manner that maximizes descriptive adequacy within the constraints of formal rigour and computational usefulness." (Obrst, Janssen, & Ceusters, 2013, p. 218). In their view, "ontologies are based on common understanding of the real world, and try to avoid conceptualist pitfalls (…) and epistemological, belief-based, or evidential (…) observational knowledge." (ibid. p. 220).

If ontology must not be mere model theory and if it ought to represent reality in the way advocated by Obrst et al, then it is contentious whether it can describe specific religious beliefs as corresponding with reality. While ontologies for systems of beliefs might conceptualize valid religious knowledge, it would be an overstatement to call that knowledge factual, scientific, or common knowledge. Yet in the view of Obrst et al, this seems to be the kind of knowledge that is appropriate for ontology. But this perception of the purpose of ontology as representing common knowledge facts is very narrow. In contrast, others have perceived ontology as "a description of a world view", that is, a particular way of looking at a domain (Bergman, 2010) or as a formalized and shared "abstract, simplified view of the world that we wish to represent for some purpose." (Guarino, Oberle, & Staab, 2009, p. 3). In such perception of ontology as representing world views, there seems to be much room for systems of beliefs to be presented. In relation to Obrst's view of epistemological or belief-based knowledge as inappropriate subjects for ontology, Roberto Poli's contrasting remark seems informing:

> *"The fact that there is a mutual or bilateral form of dependence between ontology and epistemology does not oblige us to conclude that we cannot represent their specific properties and characteristics separately. On the contrary, we should specify both what ontology can say about epistemology (a belief is a kind of object, it has parts and properties, etc.), and what epistemology can say about ontology (knowledge of the structure of objects is a kind of knowledge)."* (Poli, 1999).

Although it is not in the intention of the ontologies developed in this thesis, it will be controversial when ontologies are designed to represent one system of belief deliberately as the actual true ones.[24] This was, however, exactly what was done in the historic ontologies by Lorhard and Kraft. From this realist point of view on the purpose and use of ontology, it has been suggested that ontology might improve society in relation to religious misunderstandings:

> *"(...) according to Kraft, as for the whole Wolffian tradition, ontology is not just a technique, but rather a framework of a number of true statements regarding the fundamental structure of reality. (...) to Jens Kraft and the ontologists of the 18th century, the understanding of reality is*

[24] While artificial intelligences such as Siri, Watson and others are designed with a neutrality in mind related to spiritual or religious questions, one could imagine future AIs designed to share the Christian gospel and fundamental doctrines or other religious messages. While such imaginations could be explicit and perhaps offensive to some in their presentation of worldview sensitive issues, present societies - online and offline - are full of messages, notifications, symbols, and persuasive triggers that are value biased presenting ethics, philosophies, or beliefs. There might even be a subtle tendency to promote a pluralism treating all religious ideas as subjective realities that are equally valid.

> *also important when it comes to ethical and religious questions. They believed that dealing properly with ontology may help mankind to make a better society. According to Jens Kraft, many misunderstandings concerning social and religious improvements may in fact be avoided, if "the ontological truths" are taken properly into account."* (Øhrstrøm, Andersen, & Schärfe, 2005, p. 432)

To Kraft, ontology was "a useful foundation for any kind of scientific activity" and consequently useful for ethics and religious (ibid. p. 432). Øhrstrøm et. al affirms both purposes of ontology as unified descriptions of reality and as conceptualization for information practice and they explain that "this is not a dichotomy: in reality, these positions form a continuum, and specific efforts in ontology research may occur at any point between the extremes." (ibid. p. 436).

Hence, the two perceptions of ontology can be understood together. Both purposes seem significant for the values of formal ontologies representing theology and system of beliefs. The benefits of these ontologies, certainly, relate to the degrees to which they are functional, and to which correspond to reality. A system that represents the religious and spiritual reality will be more beneficial than one representing belief that do not correspond to reality.

In discerning and including beliefs in ontologies it is helpful to refer to ontological commitment. This notion comes from the twentieth-century philosopher W. V. Quine (Ding, Kolari, Ding, & Avancha, 2007, p. 79). The ontological commitments represent the commitment to the entities that one regard as real. Such commitments are inevitable in the developments of formal ontologies, but the commitments might not all be equally valid, so ontology developers should be ready to defend their ontological commitments that that involved in the information systems. "It is an obvious obligation on the developer of an ontology to discuss and defend his choice of theory and the ontological commitments to which it gives rise." (Øhrstrøm, Andersen, & Schärfe, 2005, p. 437).

5.2. Applications and utility of formal ontology

Ontologies are commonly designed with use-cases in mind. This is entirely appropriate. They should be designed to enable users achieve specific tasks effectively. For systems such as Logos Bible Software, the online Wittgenstein Nachlass and Siri, ontologies are designed to are developed to aid the users of the system in various ways. Likewise, the purpose for building ontologies

representing theology and systems of beliefs, such as TheOn and CalvOn, is related to their application and use.

In general, there are different field of information science in which formal ontologies are developed and used effectively. Among the subdisciplines of information science using ontologies is information architecture. It has been argued that "Database Systems, Software Engineering and Artificial Intelligence are the three most important fields where ontologies have been used to construct solutions to satisfy their needs." (Sánchez, Cavero, & Martínez, 2007, p. 14).

More specifically the formal ontologies for systems of beliefs have different possible uses. In observing the potential utility of TheOn and CalvOn, three aspects of the usefulness of ontologies for faith and theology will be observed.

Firstly, the ontologies presented in the paper are useful for the education, pedagogy, and research in studies of humanities such as theology, history of thought and literary science. The humanistic fields of studies have not been a significant subject of ontology development compared to other areas where ontologies have been developed to a far greater extend. As seen in the ontologies for philosophy, for archiving, and for theology, formal ontology comprises a great potential for categorization and structuring information in humanities and for making that information accessible and usable. The value of the ontologies for the education, thus, comprise partly in the fact that there has not been developed formal ontologies for the domain of theology yet. Another part of this educational value is in the analytical presentation systems of belief by Ramist formalization and doxastic modalities. The developments in this thesis introduce further challenges and issues that would be appropriate topics for further studies. It might for instance be a fascinating undertaking to use the Ramist categorization in presenting a greater variety of systems of belief in a linked database clarifying ontological commitments in different traditions of thoughts.

Secondly, the ontologies related to system of beliefs and theology provide usefulness for knowledge sharing and semantic enrichment of content in the concrete information systems and applications in which they can be used. The ontologies provide useful interconnections between contents and is a powerful tool for linking data in information systems for theology and systems of belief. It has been argued and showed that the categorization formal ontology offers more complex liking and semantics than the traditional binary hyperlink structures. The semantic structures can increase the quality of user experience in web applications such as the Wittgenstein Nachlass and in desktop applications such as Logos Bible Software.

There are multiple specific application opportunities of ontologies for systems of beliefs. Here, the thesis will observe a few possible applications. These opportunities might include websites similar to the Wittgenstein Nachlass into which the ontology can be imported and used through software like SwickyNotes and Philospace (see http://www.discovery-project.eu/technologies.html). By such means the ontologies could be made available and visualized online for browsing, studying, commenting, discussing, etc. In this way, one could imagine a website for theological research and shared data on the writings about Calvinism. Another website use-case could be a theological encyclopedia similar to www.plato.stanford.edu structured around the ontologies for theology. Applications could also include a chat bot which can relate a specific system of belief through ontology such as the Calvinism in CalvOn. This would be easy to do with a small scope developing a chat bot that could explain the basic categories of Calvinism by the means of free chatbot software like www.chatfuel.com, but with a fuller formal ontology and other more advanced software like voice recognition system, one could imagine a personal assistant artificial intelligence like SIRI for knowledge representation of systematic theology and biblical studies. Such a project could have immense theological significance and be an incredible pedagogical tool for mediation of theology, since there is so much written data, hundred-thousands of writings, and a vast amount of information in the domain of theology. Even as a knowledge base representing theological writings an ontology like TheOn could be an incredibly usable information system for theologians and students of theology. The ontologies, TheOn and CalvOn, could also be applied in existing software like Logos Bible Software providing deepened and semantically enriched categorization for its representation systematic theology.

Thirdly, the ontologies offer the usefulness in relation to the individual believer who might observe the information system in different applications. The introduction suggested some personal/spiritual value, some educational/research value, some commercial value, and some innovational value of the undertaking developing formal ontologies of theologies and systems of beliefs. These values are of course only extended to the believer when she uses the ontological structure of information in some application. A possible application for the use of the believer could be an app of linked data designed to explore, comment, and meditate on one’s belief or the belief confessed in one’s church.

In sum, the ontologies presented in this thesis comprise usefulness for innovative humanistic studies, for practical uses in possible applications from websites, to AI, and to databases, and finally the ontologies and their applications comprise usefulness for individual believers who might find

conceptualization of their belief beneficial in contemplation, personal studies, or in spiritual growth with faith seeking understanding.

5.3. Perspectives and possibilities for further studies

The issue of knowledge representation of beliefs may be developed much further in the next decades as information science, theological technologies and artificial intelligence likely continue its growth.

Suggestions for further studies and possibilities for improving the ontologies have already been noted throughout the thesis. In bringing the comments together there seem to be two major paths going forward one concerning the improvements of the ontologies and the other concerning the development of specific applications for the ontologies. Regarding the internal improvements of the ontologies developed here, it was suggested that it would be beneficial to have future effort in conceptualizing the very text of the Westminster Confession through classes of its articles. A more substantial improvement consists in merging TheOn and CalvOn and in making them compatible with each other without compromising on the capability of the TheOn to present different perspectives and without limiting the comprehensiveness of the Calvinist categorization in CalvOn. Regarding the specific applications the ontologies, further studies could be made in development of semantically enriched information systems such as an online scholarly encyclopedia for theology, confessional applications for individual believers or faith communities, or perhaps even artificial intelligence understanding the semantics of faith.

However, there is also the future work beyond the scope of the thesis of describing and presenting other systems of beliefs and religious confessions in formal ontology and the semantic web. Other systems would include various other traditions within Christian theology, but also religious systems foreign to Christianity. It would be interesting to see ontologies developed describing the important persons, doctrines, events, places, and arguments for and against the various systems of belief.

6. Conclusion

Ontology, the study of “being qua being”, has had a formidable history. The term first was coined by Jacob Lorhard (1561-1609), but being almost synonymous with general metaphysics, it can be traced back to ancient philosophy. In the past decades, the term has been adopted by computer science where it refers to formalized conceptualization of specified relationships between defined entities. Here, it has proven to be a significant means of annotating, categorizing, linking, querying, and sharing semantically enriched data.

The thesis demonstrated these benefits of ontology by developing ontologies for theology and for the system of belief, Calvinism. The ontologies, TheOn and CalvOn, conceptualized the domains of general theology and Calvinism. TheOn categorized general theological entities like “Theologian”, “Subject” and “Source” and it could be used in a theological knowledge base due to its capacity of coherently presenting large amounts of interlinked theological data including contradicting points of views in theology. CalvOn conceptualized the Calvinism in A. N. Prior’s *The Logic of Calvinism.* In this information architecture, topics (doctrines) were defined as concerning each other with transitive relations, so that the fundamental topics inherited the contents of their subtopics. The topics were also related to the biblical texts used as basis for the original doctrinal categorization and content for the system of belief. For both ontologies insightful queries were demonstrated.

On the purpose, usefulness, and the future of the ontologies, the thesis introduced general issues related to the purpose, key aspects of the usefulness and concrete application possibilities of the ontologies, as well as a few suggestions for further studies. The relatively unique study of the thesis comprises an innovative investigation of the use of ontologies to present theology and systems of beliefs, but further studies on this issue are anticipated as the fields of information science, knowledge representation and artificial intelligence are expected to continue their expansion and further their applications into new domains.

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Appendices

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Appendix 1: Designing an Intelligent Robot to Assist the Pastor

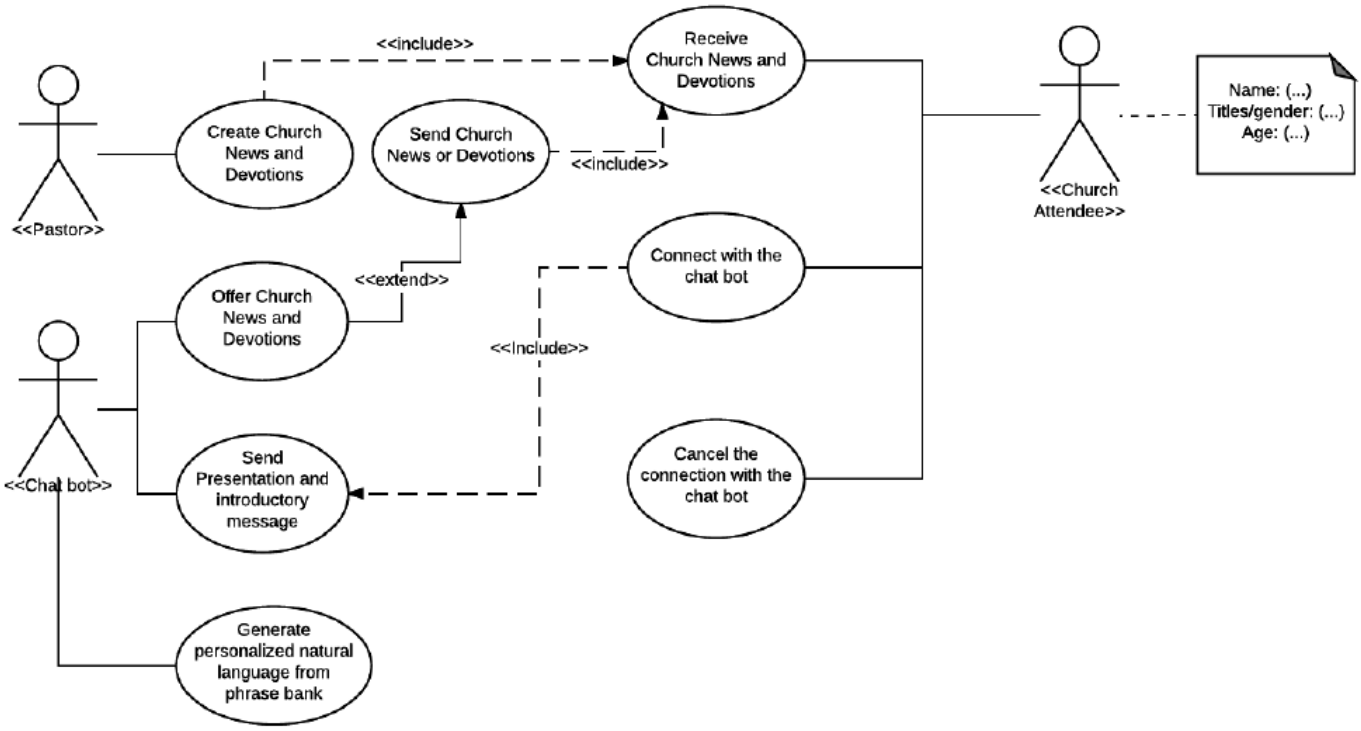


Figure 31: Use Case Diagram of necessary functions in the chat bot and basic entities of a related informal ontology

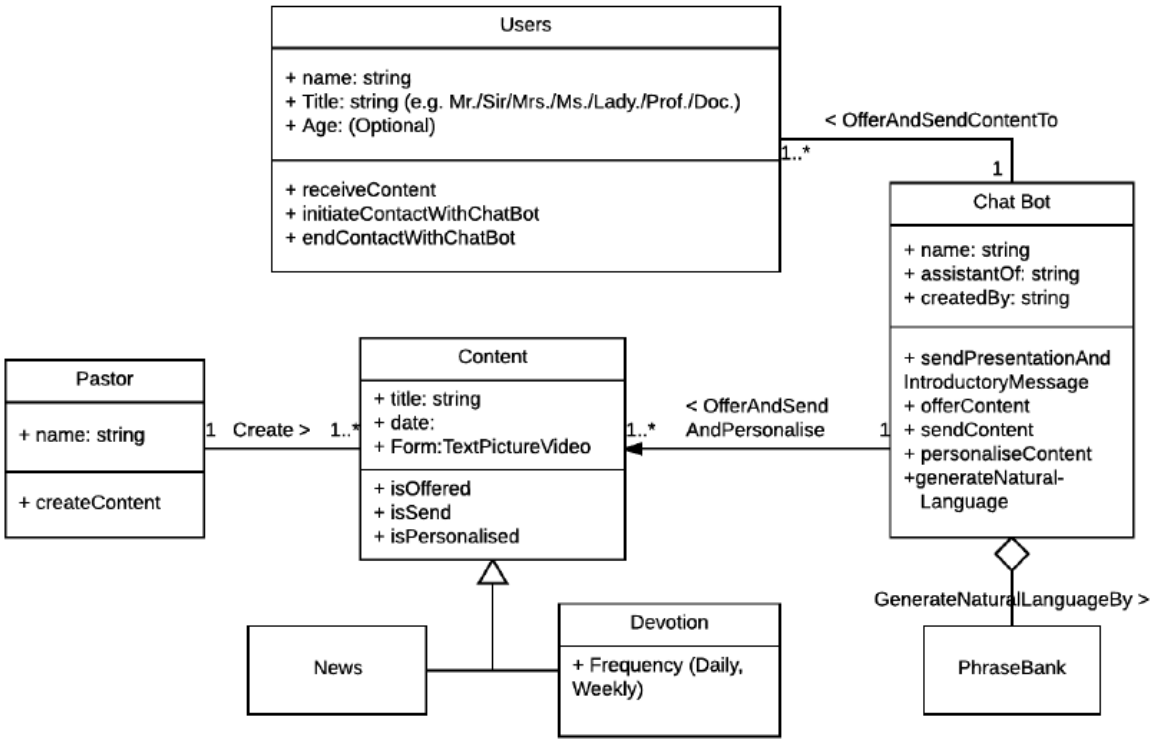


Figure 32: UML Class Diagram of classes in the chat bot and basic entities of a related informal ontology

Appendix 2: Excerpt of the Prior Project Internship Report

1. The Prior Project internship

In the 9th semester's internship of the master's programme in information architecture and persuasive design, I was delighted and privileged to work for the Prior Research Project alongside professors and academics interested in the life and work of the philosopher A. N. Prior. The internship offered challenges and opportunities that I had never encountered before, and the work offered new learnings and achievements.

Prior was born in 1914 in New Zealand where he grew up, studied, and became a lecturer before moving to England for professorship where he would live until his death in 1969. His covers a wide variety of subjects from theology, ethics, logic, and metaphysics. He is best known today for his invention and development of tense logic.

The Prior Research Project is a joint project between the Department of Information Studies at Copenhagen University and Department of Communication and Psychology at Aalborg University. Its primary information systems are the online Prior Nachlass and the Virtual Lab for Prior Studies. The Virtual Lab is an internal and password protected online system designed for a group of people transcribing, commenting, and publishing the unpublished papers and letters of A. N. Prior in the Nachlass. The Prior Project is thus a collaboration with the Bodleian Library in Oxford which holds the physical Prior Nachlass. The Prior Project openly invites researchers interested in Prior studies to join the project, but to become a project member and a user of the virtual lab one must be approved by Per Hasle and Peter Øhrstrøm who oversee the project (Hasle & Øhrstrøm, 2013). The group of people working in the project comprises a network of researchers from at least five Danish universities as well as researchers from other countries e.g. New Zealand (Øhrstrøm, About the Project: The Primacy of Tense, 2017).

Through the internship, I was exposed to different experiences and tasks. Among the primary responsibilities that I took was transcribing and editing two papers; *Racialism* and *Law and Order* and one letter (*Letter to Hugh* (30/6/38)) written by Prior as well as providing an introductory comment on the papers. This was done with Martin Prior, A. N. Prior's son, under supervision from Peter Øhrstrøm and David Jakobsen. Another big task was to comment and analyze Prior's early theological writings to offer an introductory presentation and analysis of Prior's early theology which has been largely overlooked (Hasle P. F., The problem of predestination: as a prelude to A. N. Prior's tense logic, 2012) (Grimshaw, 2002) and possibly to assist David Jakobsen in publishing a commented and edited volume of Prior's theological writings. These theological tasks of the internship remain unfinished for the moment and should be completed within January 2018. In addition to these tasks, two workshops were attended; one in Aalborg with four other people focusing on transcription and one in Copenhagen with 20-30 people of whom most submitted and presented papers on themes from Prior in relation to Logic and the philosophy of time. These experiences and productions of the internship can be seen in the Internship Portfolio in Appendix 1.

This project report offers an analysis of the primary information architectures of the Prior Research Project. It evaluates the current state of the project and offers some ways forward for an improved

information architecture. But the internship report also discusses the challenges and purposes of the specific assignments that I was exposed to through the internship and how these tasks relate to information architecture. In addition, the report provides a critical and reflective evaluation of the work that I did in the internship and describes the learnings of the work.

2. The information architecture of the Prior Project

2.1. Introduction

As noted above, the two primary information architectures of the project are the online Prior Nachlass and the Virtual Lab for Prior Studies which produces the content of the Nachlass. A full introduction of these information architectures is offered by Albretsen, Hasle and Øhrstrøm (2016). This section offers a brief introduction to the users, the structure, and the content of the information systems presenting first the Virtual Lab and then the Nachlass.

The users of the Virtual Lab are the people working within the Prior Project. As mentioned the system is password protected and as of September 1st, 2016 there were 48 users with login to the system (Albretsen, Hasle, & Øhrstrøm, 2016, p. 4). These are primarily researchers and academics from the fields of logic, philosophy of time, metaphysics, but the list of disciplines continues and there are people with other backgrounds than these working in the virtual lab. The people in the Virtual Lab work with files located in the Bodleian Library in Oxford but scanned and made accessible in the Virtual Lab. Although many users of the Virtual Lab are from different parts of Denmark, there are people from different places on the globe working in the Lab. In effect, there is a need for the researchers to work beyond the physical limits of the achieve boxes in Oxford, England. Other basic needs in all substantial archives and information architectures are that information are not only made accessible but also made findable and made easy to manage.

For users of the virtual lab this means that the contents; the 328 Prior papers and 1195 Prior letters, are made findable and usable (Morville & Rosenfeld, 2006, p. 4). The virtual lab makes the content accessible online as scanned documents and it makes the content findability and usable by a search engine and categorization system classifying the content on the highest level between “Prior papers” and “Prior letters” (see Appendix 2, Screenshot 2). When a user enters the link “Prior papers” the Virtual Lab limits the search zone and provides a search engine empowering a semi-advanced search. This search function enables the user to search for papers form a specified date and to search for words occurring in either titles, contents, or comments by editors and other users (see Appendix 2, Screenshot 3). If the user searches without any specifications the search offers a list in which all the 328 Prior papers in the database appears (see Appendix 2, Screenshot 3). The listing displays the number of the paper in the database, its author, title, status of content, data, and comments by users. The titles are color-coded with red for not transcribed yet, yellow for has been transcribed but not proofread and published yet, and green for transcribed, proofread, and published on the Nachlass (see Appendix 2, Screenshot 4). A specified search for the word “theology” in the title of the papers can be seen in the fifth screenshot in Appendix 2.

The contents that the users in the Virtual Lab transcribes and proofreads are then sent to be published on the Prior Nachlass which comprises the other information architecture of primary

significance in the Prior Project. The Prior Nachlass is an information architecture that is not password protected and can be used by anyone. Hence, the users of this information system can vary from people who are interested in the life and work of Prior to people of different backgrounds who are more interested in specific issues which Prior worked with or touched upon. However, the majority of users of the Nachlass are likely researchers and students involved in academic studies.

The Nachlass currently consists of 49 Prior papers and 12 Prior letters listed in alphabetical order as PDF documents free to be downloaded (The Nachlass of A. N. Prior, 2017). More of Prior's works and letters are in the process of being published through the Nachlass. This information architecture furthers research and mediation of Prior's works by comprising an online achieve that is very accessible and rather easy to use.

2.2. Analysis

As shown above, the information architecture of the Prior Project consists primarily of the two information systems; the Virtual Lab and the Nachlass. These two systems are however actually one one website; priorstudies.org separated as two independent interfaces with two different kinds of users (Volkmar Engerer, 2017, p. 55). As illustrated below in *Figure 1*, the Nachlass is a flat information architecture having a simple navigation bar in the left side with links referring to various other websites and having only five pages in all and just two categories of contents.

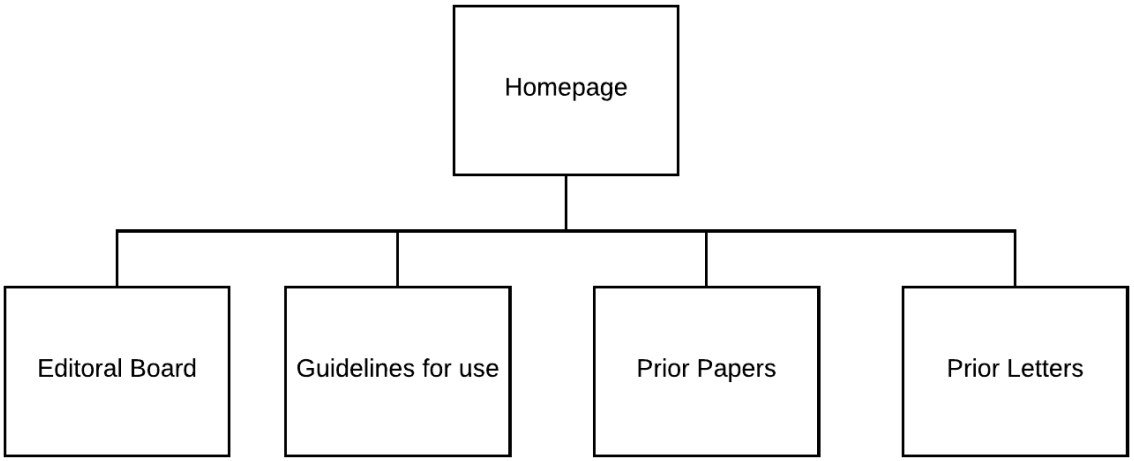


Figure 1: Taxonomy of the pages in the Prior Nachlass Website

In contrast to the Nachlass, the Virtual Lab is a fairly deep information system with a lot of pages, many functions, and thousands of scanned files for the users. For each of the 328 papers and 1195 letters there is a folder with the scanned files from the Bodleian achieve in Oxford. The folders holding the scanned documents also constitutes a working room where users can upload the transcription, comment, and pose questions to the background of the text. A taxonomy comparable to *Figure 1* portrays below in *Figure 2* the Virtual Lab as a significantly deeper system than the Nachlass.

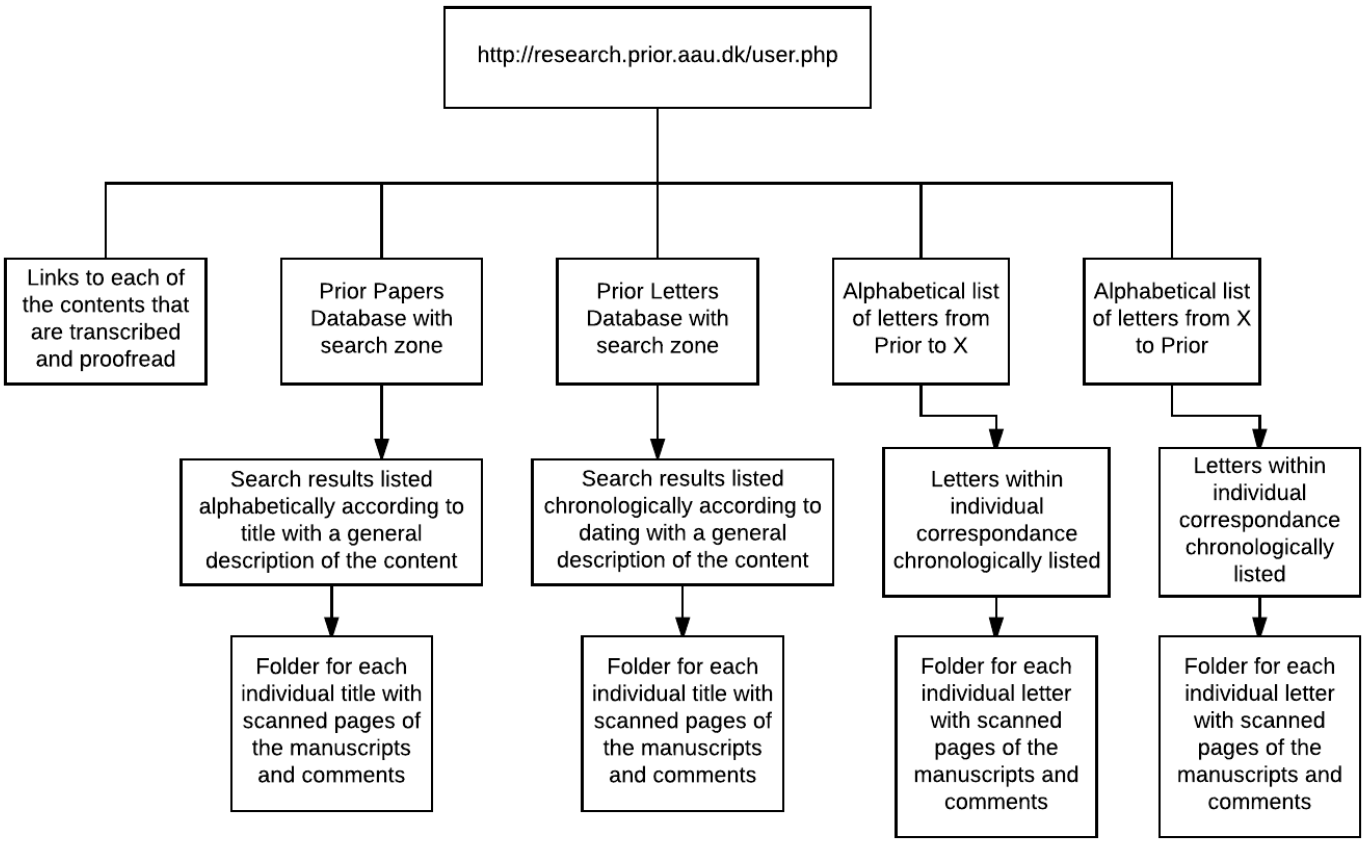


Figure 2: Taxonomy for the pages in the Virtual Lab

What the taxonomy above does not show about the Virtual Lab is that its information architecture makes use of tagging connecting each Prior text with the box number from the Bodleian library. Hence, the Virtual Lab can present the texts according to its kind; Paper or letter, according to the box in which it is placed, or according to results from its search engine. The results of the search engine can group the texts around the search word which could perhaps be the name of a person whom Prior corresponded with or wrote about or it could be an idea, an issue, or a field of study which Prior wrote about (see Appendix 2, Screenshot 5).

But Virtual Lab is not only a deeper information architecture than the Nachlass, it is also much more interactive. While the Nachlass users can download the works by Prior made available, the users of the Virtual Lab can download the same file and many more, comment on them, comment on comments by other users, and upload transcriptions of the works. Hence, while the Nachlass merely offers a content to support research, the Virtual Lab enables the work of the closed research community transcribing and researching the Prior works. In the terms of Fogg's functional triad, the Nachlass functions as a simple tool providing content and the Virtual Lab functions as a more complex tool enabling research work and a medium for simple interaction between researchers (Fogg, 2003, p. 25).

In this brief analysis of the information architecture of the Prior project it is also relevant to comment on Morville and Rosenfeld's three circles of information architecture; content, context,

and users (Morville & Rosenfeld, 2006, p. 25). The Nachlass presents the contents in a relative simple, findable, and usable manner. For the purposes of the Nachlass the key need of the Nachlass users is certainly to find and retrieve the relevant Prior work. On the one hand, due to the simplicity of the system, there is a high degree of usability and functionality. On the other hand, the users might be distracted by the visual design of the webpage with various text formats, colors, and text alignments. Seeing the screenshots in Appendix 3, it is safe to say that the design of the webpage is disorganized and not very intuitive. While this detail is irrelevant to the functionality of the system, the distractions in the visual design might be an issue reducing the findability and usability of the system and weakening its user-experience. For the users, being primarily researchers with need of specific content, and for the context of the Prior research community the functionality of the system is much more essential than the visual design of the system.

Although the Virtual Lab presents much more content in a more complex manner than the Nachlass, it does provide a findability and usability of the system using simple categorizations, intuitive listing, and conventional metadata of title, date, and author, as well as unconventional domain metadata e.g. different logical systems (Volkmar Engerer, 2017, p. 55). Engerer states that this unconventional metadata necessitating domain knowledge is exactly what the users in the research group needs in order to research and understand the patterns and overall developments of Prior's works (ibid. p. 55). Nevertheless, the observations about the visual design of the Nachlass could also be mentioned for the Virtual Lab with reference to screenshots in Appendix 2. However, especially since the users of this system is a closed research group, the system's functionality is much more significant than its aesthetics.

The persuasive aim of the systems might be identified following Miller as behavior reinforcing which seeks to empower research on the Prior works (Miller, 2002). The purpose of the design would not be to change behavior or to shape a new behavior as much as it would be to reinforce and enable the research work, but the persuasion of the Prior project's information architecture is subtle, and it is driven primarily by researchers' need of content. However, Engerer and others point out that the whole of the information architecture is "not neutral" and it is a kind of "theory" or "statement" about Prior's work (Volkmar Engerer, 2017). Concerning the visual design of the systems, Wendel's model "Create Action Funnel" in Appendix 4 illustrates the significance of limiting distractions for achieving intended action (Wendel, 2013, p. 40). Although all the five stages in Wendel's funnel might not apply equally well to all the users of the systems, the model's emphasis on distractions might illuminate opportunity of improvement for the information architecture.

2.3. Ways forward

In evaluation of the general information architecture presented thus for a few ways forward based on the analysis above will be offered. This section also provides insights from other literature evaluating the Prior Project's information systems.

It was shown above that despite the simplicity of the Nachlass information system, portrayed in Figure 1, the navigation bar and the header of the webpage makes the visualization of the system rather confusing. While this does not hinder the users from using the systems, the user experience

would be improved if the user interface were better designed. Whitenton (2013) advices that usability can be improved by minimizing “the cognitive load” on a webpage and she explains that one way this can be done is by “avoiding visual clutter”. On the Nachlass in general and the Virtual Lab, specifically, its opening page, the visual clutter could be decreased by aligning and formatting texts in a consistent manner. Moreover, the visual clutter on Nachlass could be decreased by removing the screenshots and compressing the inessential sidebar in order to emphasize the significant two subsides; Prior Papers and Prior Letters. Similarly, one could lessen the cognitive load by removing or decreasing the inessential features filling the right and left columns in the login page to the Virtual Lab (Virtual Lab for Prior Studies, 2017). The inessential features or links of the project’s websites could also be compressed into subcategories, so that the websites would be deeper and tidier with fewer distracting elements. When the inessential features would be toned down and the essential purposes emphasized the persuasive design would also be increased.

After such a critical comment, the information architecture of the Virtual Lab deserves a positive note for its functionality and usefulness in mediating content and providing a tool enabling research work. Especially, the information architecture of the virtual lab embodies intelligent categorizations and classifications. The lab comprises a deep information architecture full of contents and information. Its search engine makes the thousands of files highly findable and the search system is very usable. Perhaps, it could be improved even further by making the tagging of each title to its box hyperlinks so that researchers quickly could find related titles that are sorted in the same archive box. Another information architectural opportunity is to classify the titles further and deepen the ontology of the Nachlass and the Virtual Lab from “papers” and “letters” to topics like “theology”, “ethics”, “philosophy”, and “logic” (or different logical systems e.g. propositional logic, tense logic, and hybrid logic) in which the Prior works could be grouped. In doing so, it would be important to acknowledge that these categories overlap and that many titles would be fitting in more than one category. It is also important to note that such an information architecture would assume what was described above as a “statement” or “theory” on the overall architecture of Prior’s works (Volkmar Engerer, 2017, p. 56).

A further possible improvement of the Virtual Lab, as an alternative to or standing alongside the elaboration of the ontology, could be the more systematic and consistent categorization through metadata in the comments of each Prior work. This metadata would group the works in specific groups relevant for the research community. It is already a function of the information architecture, but it has not been applied by most users and it seems that Engerer and the people behind the Virtual Lab sees the value of separating the user interface and the metadata so that the users would not be the ones creating the classifying metadata in the comments (ibid. p. 55).

Additional steps ahead involve a systematic analysis of the user behavior from the people behind the Virtual Lab (ibid. p. 55), “a new interface” (ibid. p. 55) and “a more elaborate it-system” for the Virtual Lab (Albretsen, Hasle, & Øhrstrøm, 2016, p. 12), as well as further research on the notion of a “Virtual Closed Collaborative Community” (Volkmar Engerer, 2017, p. 56) (Albretsen, Hasle, & Øhrstrøm, 2016, p. 5).

The segment of the Prior Community which I was mostly involved with through the internship focuses on Prior’s early theology and its relation to the other work. As the report will show below there are also important research with this focus waiting to be done in the Prior community.

Appendix 3: Graph representations of selected top-ontologies from section 2.2.3.

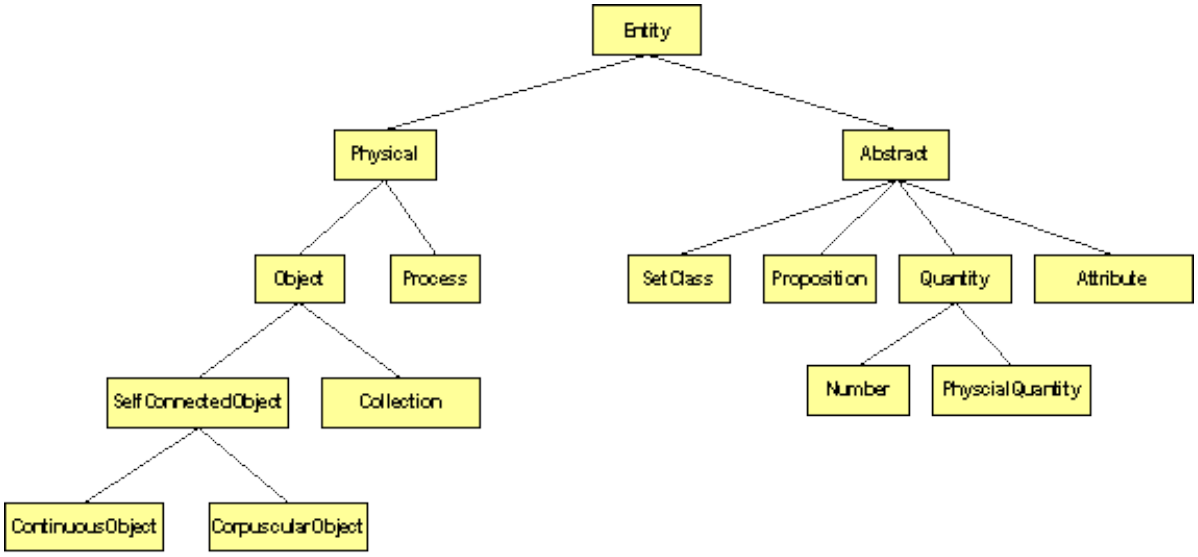


Figure 33: A subset of top level categories in SUMO" in http://ontology.ihmc.us/coi/Resources/UpperOntologyUseLong.html

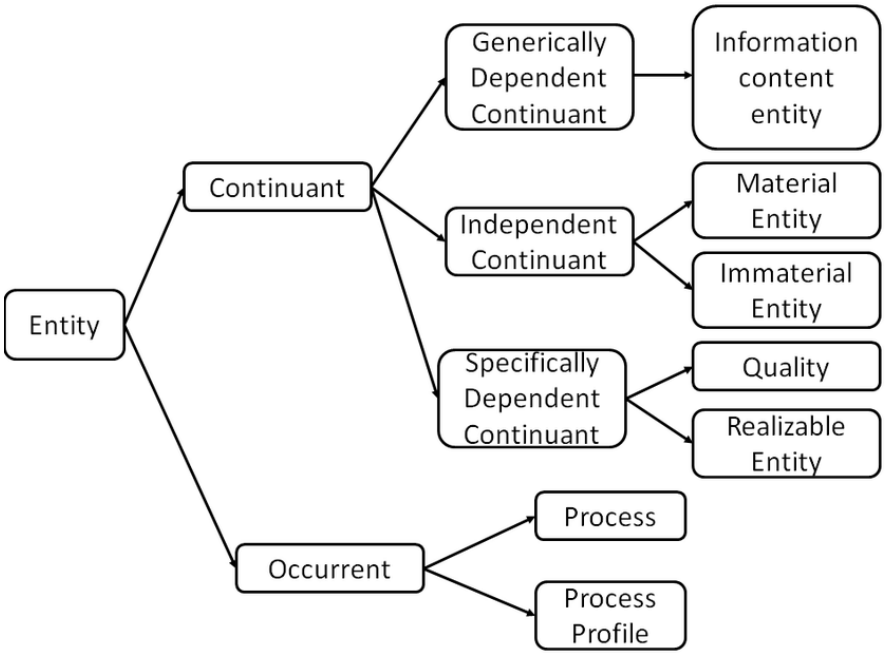


Figure 34: Furini, Francesco & Rai, Rahul & Smith, Barry & Colombo, Giorgio & Krovi, Venkat. (2016). Development of a Manufacturing Ontology for Functionally Graded Materials. 10.1115/DETC2016-59964.

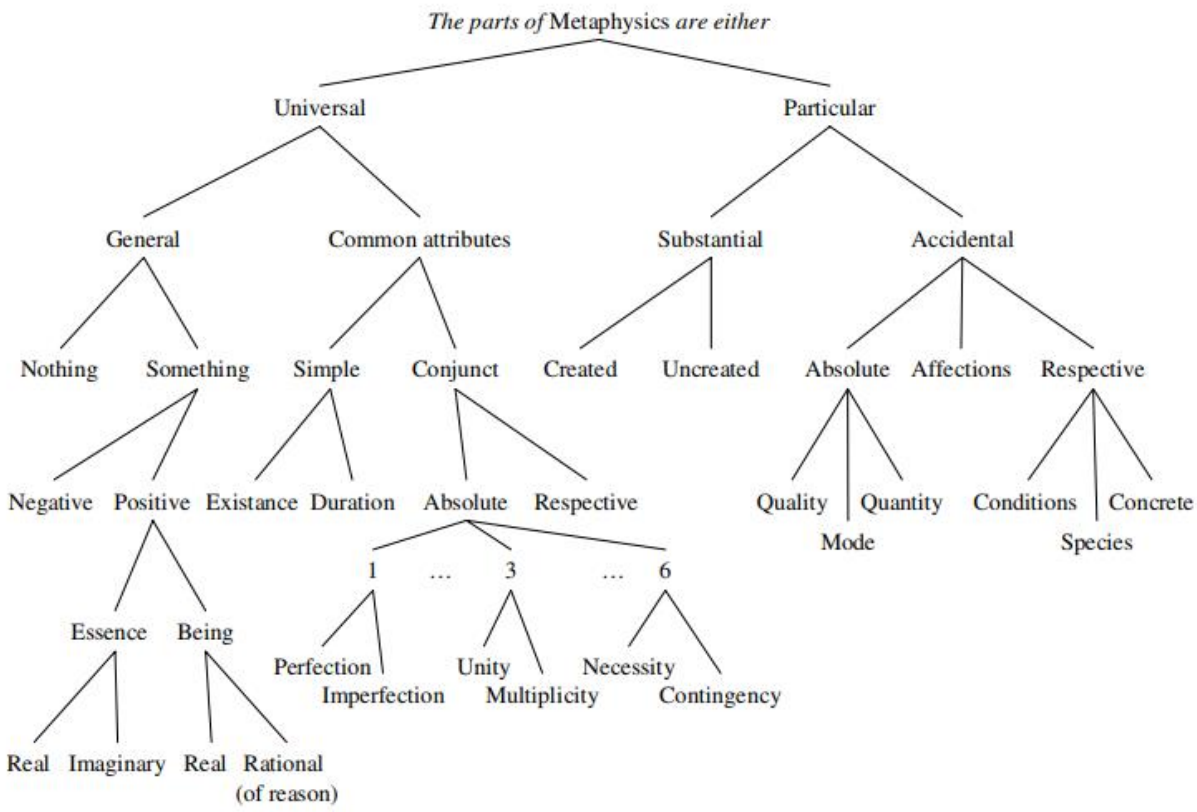


Figure 35: Lorhard's ontology represented in (Øhrstrøm, Uckelman, & Schärfe, 2007, p. 383)

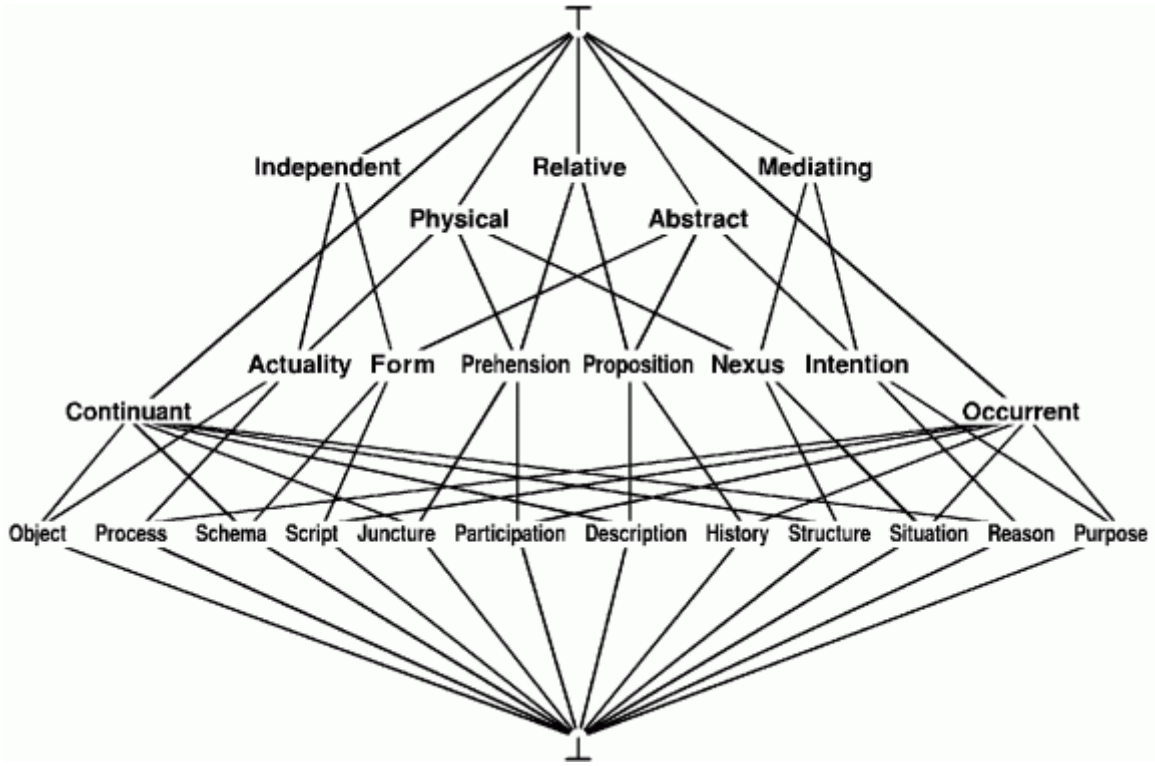


Figure 36: John F. Sowa's top-level categories retrieved from http://www.jfsowa.com/ontology/toplevel.htm

Appendix 4: Graphical representation of the ontologies for philosophy

Screenshots retrived from the references:

- Buckner, C., Niepert, M., & Allen, C. (2011). From encyclopedia to ontology: toward dynamic representation of the discipline of philosophy. Synthese, 205–233.
- Grenon, P., & Smith, B. (2011). Foundations of an ontology of philosophy. Synthese, 185–204.
- Pichler, A., & Zöllner-Weber, A. (2013). Sharing and debating Wittgensteinby using an ontology. Literary and Linguistic Computing, 700-707.

In the below I have collected some visaulisations of ontologies made for philosophy. One could imagine similar categorisations applied to theology.

Ontology for the Wittgenstein's Nachlass

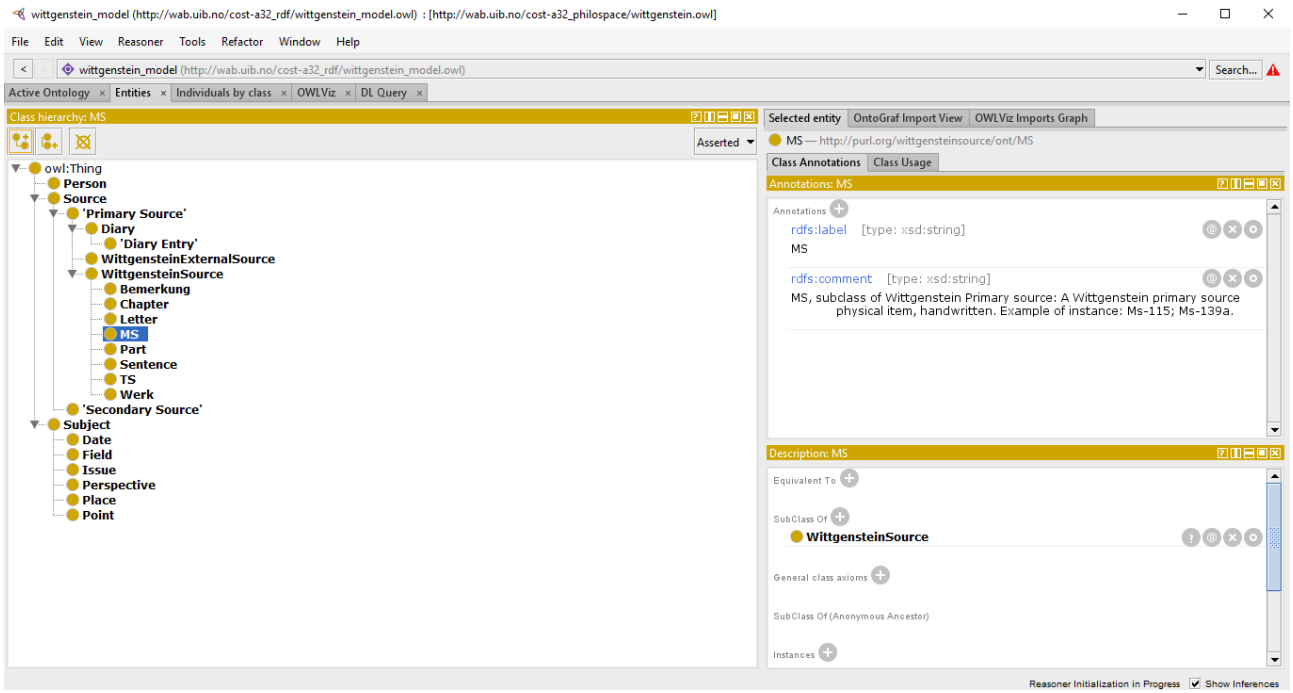


Figure 37: Screenshot from the Wittgenstein Ontology depicting its classes

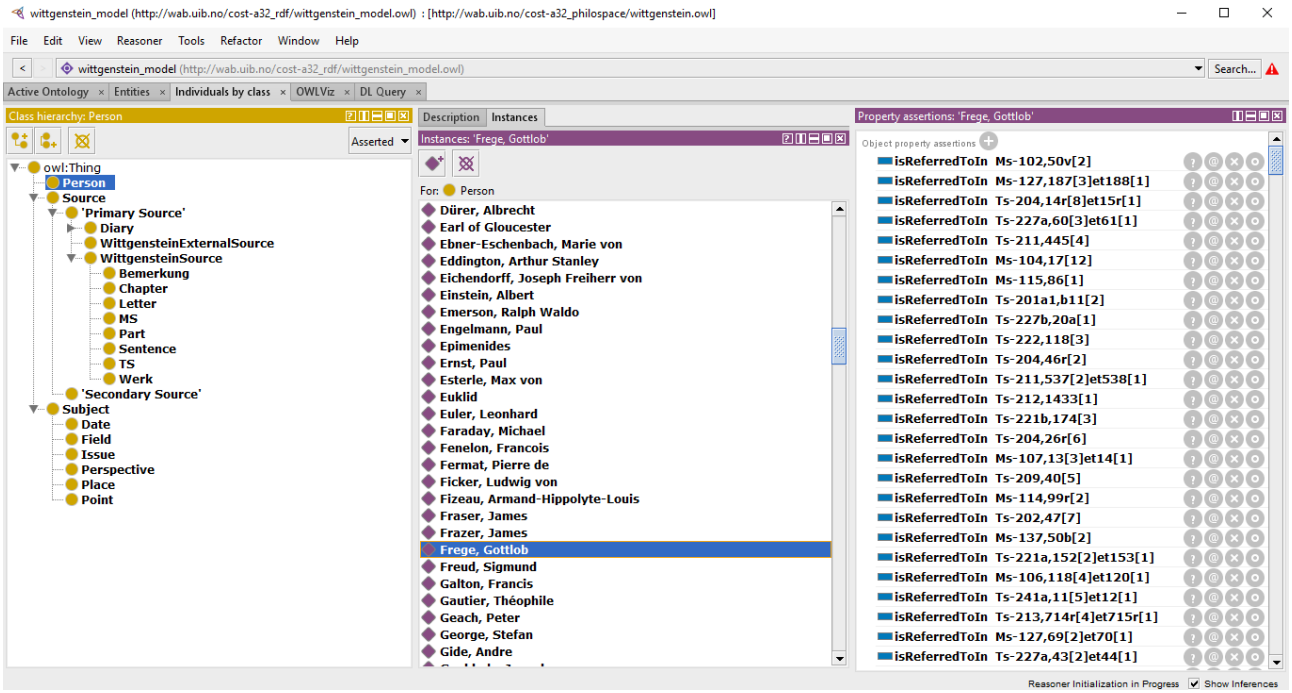


Figure 38: Screenshot from the Wittgenstein Ontology depicting the instances of the class „person“ and the property annotation to the instance „Frege, Gottlob“

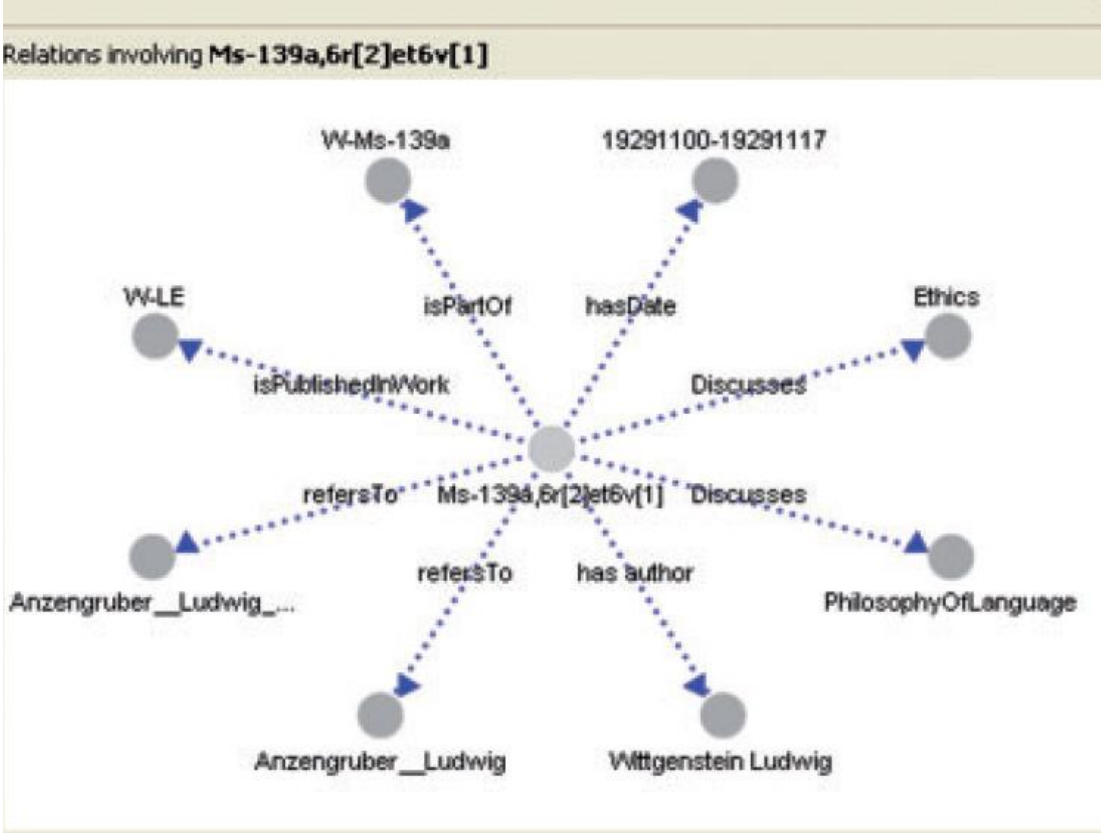


Figure 39: Relations between text, person, disciplines of philosophy retrieved from (Pichler & Zöllner-Weber, 2013, p. 705)

Ontology for Philosophy (from the InPhO project**)**

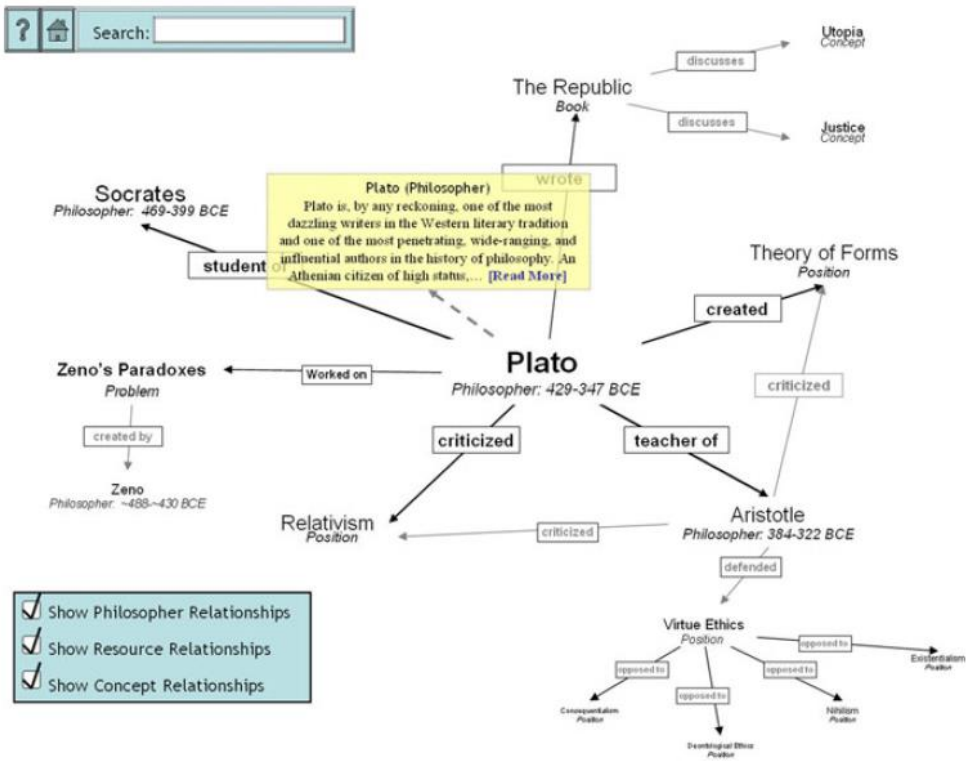
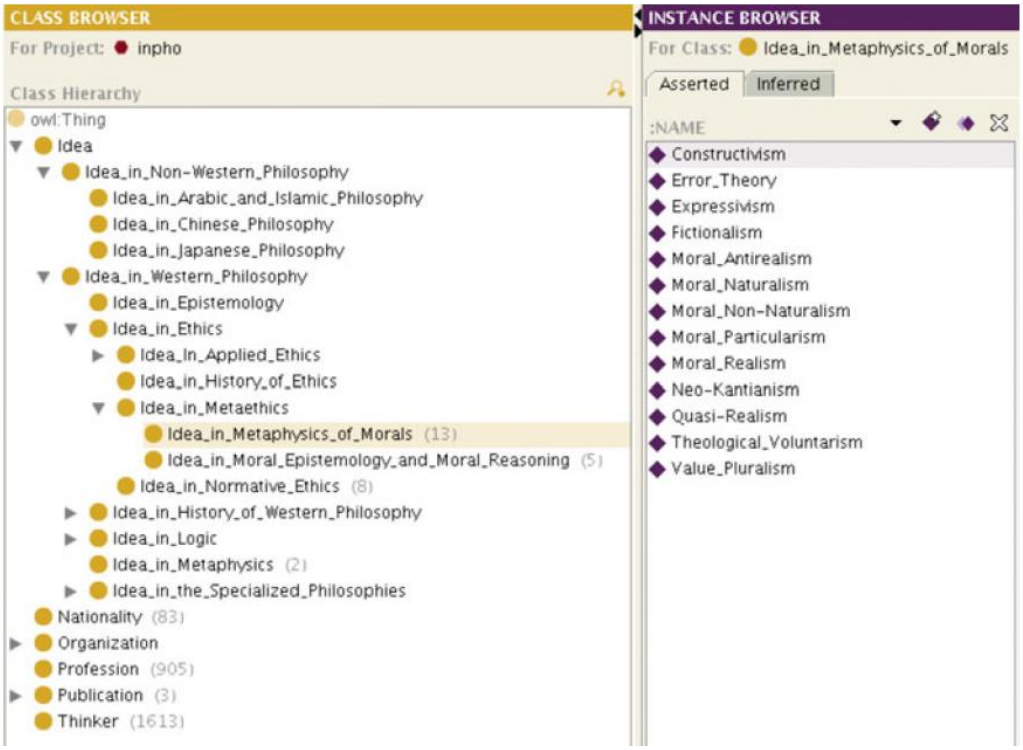


Figure 40: Diagrammic representation of the instance „Plato“ (Buckner, Niepert, & Allen, 2011, p. 226)



Protégé screen shot showing InPhO categories with sample instances retrieved from (Buckner, Niepert, & Allen, 2011, p. 211)

Ontology for Philosophy (Barry Smith and Pierre Grenon's PhilO project)

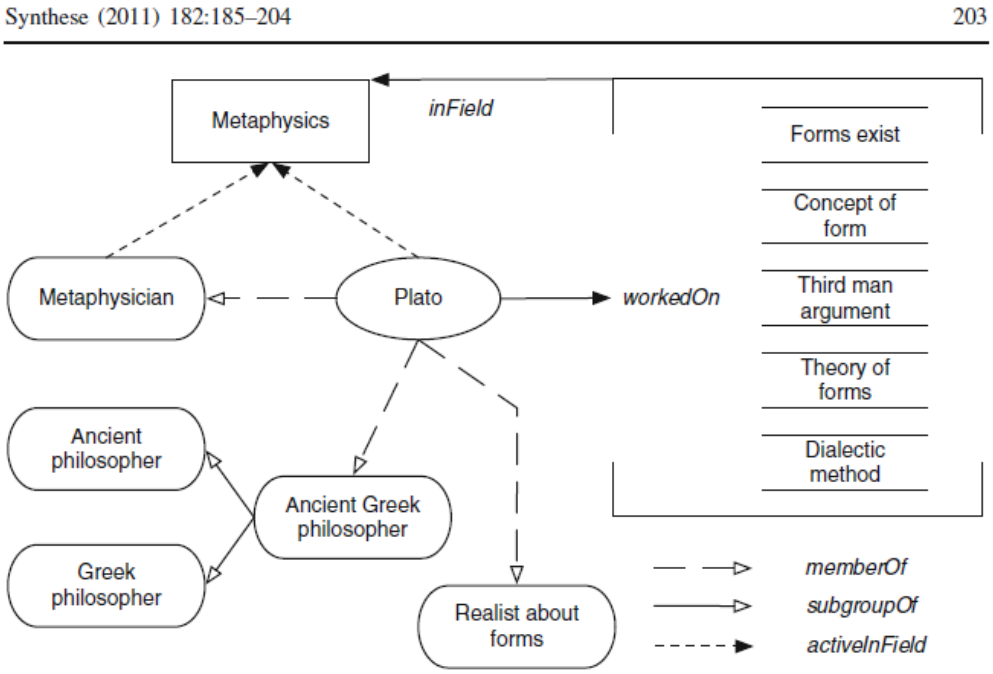


Figure 41: "Plato and some of the entities surrounding him in the domain of philosophy" retrieved from (Grenon & Smith, 2011, p. 203)

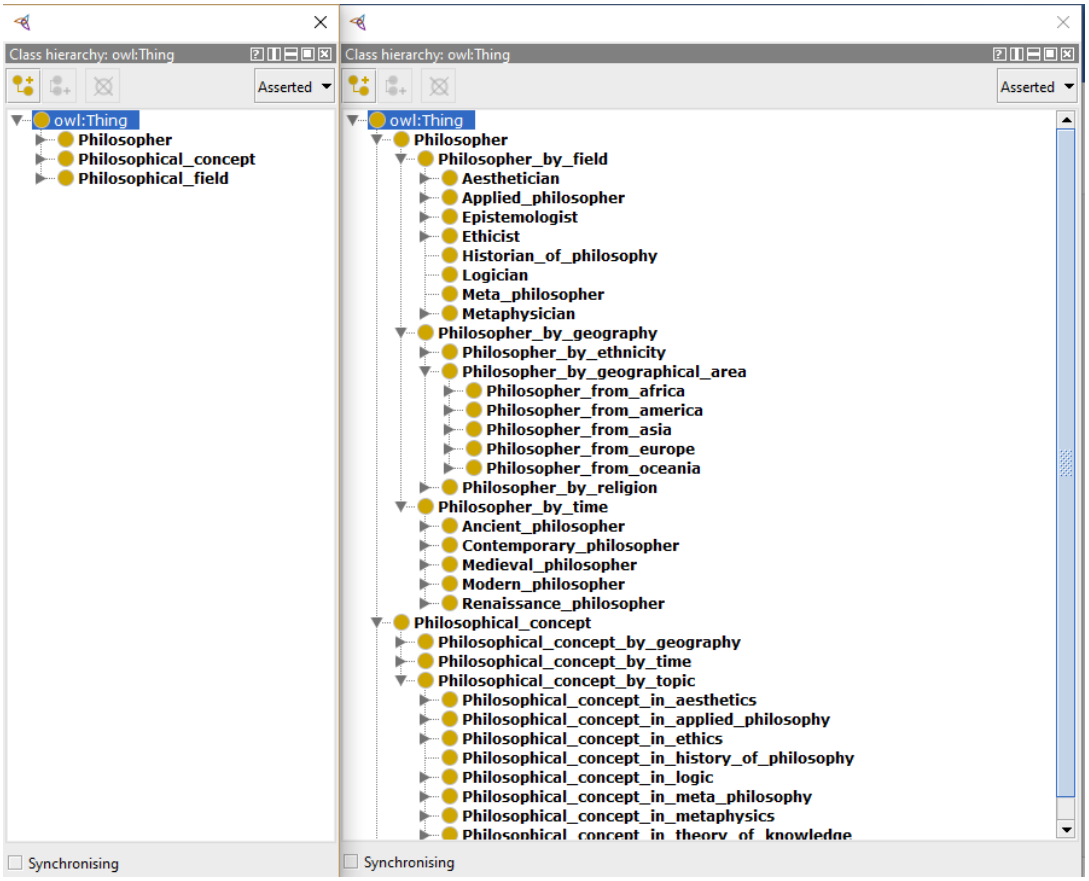
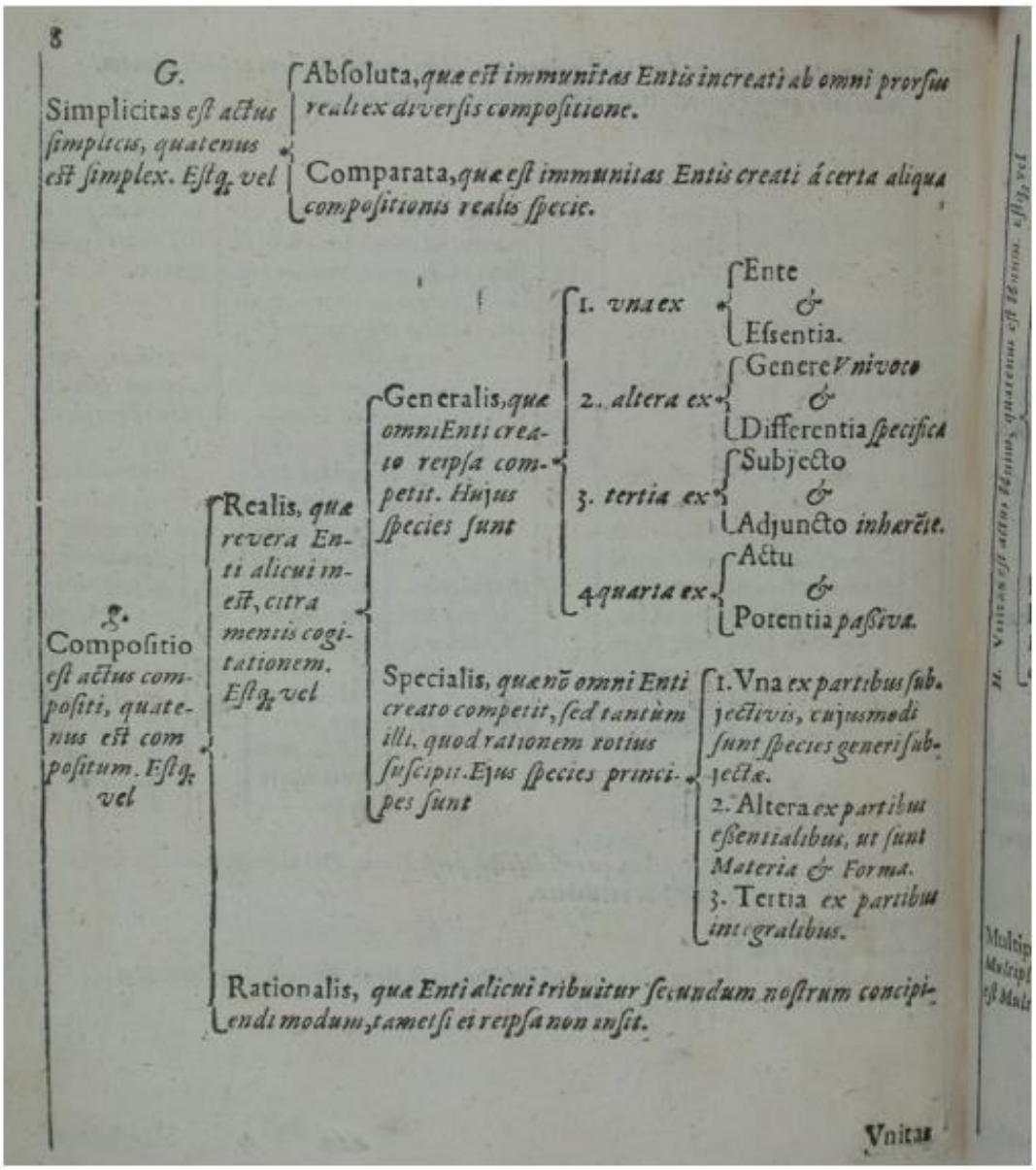


Figure 42: Screenshot of the top classes and their subclasses classes in PhilO by Grenon and Smith.

Appendix 5: Comparison of the Ramism in Lorhard's *Ogdoas Scholastica*, Polanus' *Partitiones* and Ames' *The Marrow of Theology*

In this comparison, screenshots of the diagrammatical arrangements in three works offered.

<u>From *Ogdoas Scholastica* by Lorhard</u>



Page 8 containing one of the *realis* iterations.
(Vadianische Sammlung, St. Gallen, Switzerland)

Figure 43: Ogdoas Scholastica in Latin retrieved from (Øhrstrøm, Schärfe, & Uckelman, 2008, p. 13).

G. *Simplicity* is an actuality of simplicity, because it is simple. It is either

- *Absolute*, which is the immunity of a Being uncreated by any thoroughly real [thing] from diversities in composition.
- *Comparative*, which is the immunity of a Being created by a certain composition of a real species.

g. *Composite* is an actuality of composition because it is composite. It is either

- *Real*, which is in fact in some being, apart from the cogitation of a mind. It is either
  - *General*, which comes together in every created being in reality. The species of this are
    - 1. One out of
      - *Being*
      - &
      - *Essence*
    - 2. Another out of
      - *Genus* univocal
      - &
      - *Difference* specified
    - 3. The third is out of
      - *Subject*
      - &
      - *Adjunct* inhering
    - 4. The fourth is out of
      - *Actuality*
      - &
      - *Potentiality* common to many
  - *Special*, which coincides in not every created being, but only in that, which sustains the whole of reason. The species of this are foremost
    - 1. *One* out of subjective parts, of what this kind are the species of a genus of a subject.
    - 2. *Another* is out of essential parts, as are Matter and Form.
    - 3. The *Third* is out of integral parts.
- *Rational*, which is assigned to some being according to our mode of comprehension, as and since it may not be in reality.

Figure 44: Translation of Lorhard's Ogdoas by Sara L. Uckelman retrieved from (Uckelman, 2018, p. 8)
http://www.illc.uva.nl/Research/Publications/Reports/X-2008-04.text.pdf

FF. *Uncreated*, which exists from itself and through itself: as in the sole God, who is a Being first, most simple and most perfect, the foundation of all good in Nature. Of him we come examining according to our mode of conception either

- *Essence*, which is a pure act, through which God is that which he is, and is distinguished from every other Being. The condition of this is
  - It is *to be not universal*, either by genus or one species,
  - *But singular*, that is by one number.
- *Divine attributes*, which are either
  - *Properties of God* which are
    - *Supreme simplicity*. See γγγ.
    - *Supreme perfection*. See δδδ.
  - *Actions* of God. See ZZZ.

Figure 45: Translation of Lorhard's Ogdoas by Sara L. Uckelman retrieved from (Uckelman, 2018, p. 42)
http://www.illc.uva.nl/Research/Publications/Reports/X-2008-04.text.pdf

From *Partitiones* by Polanus:

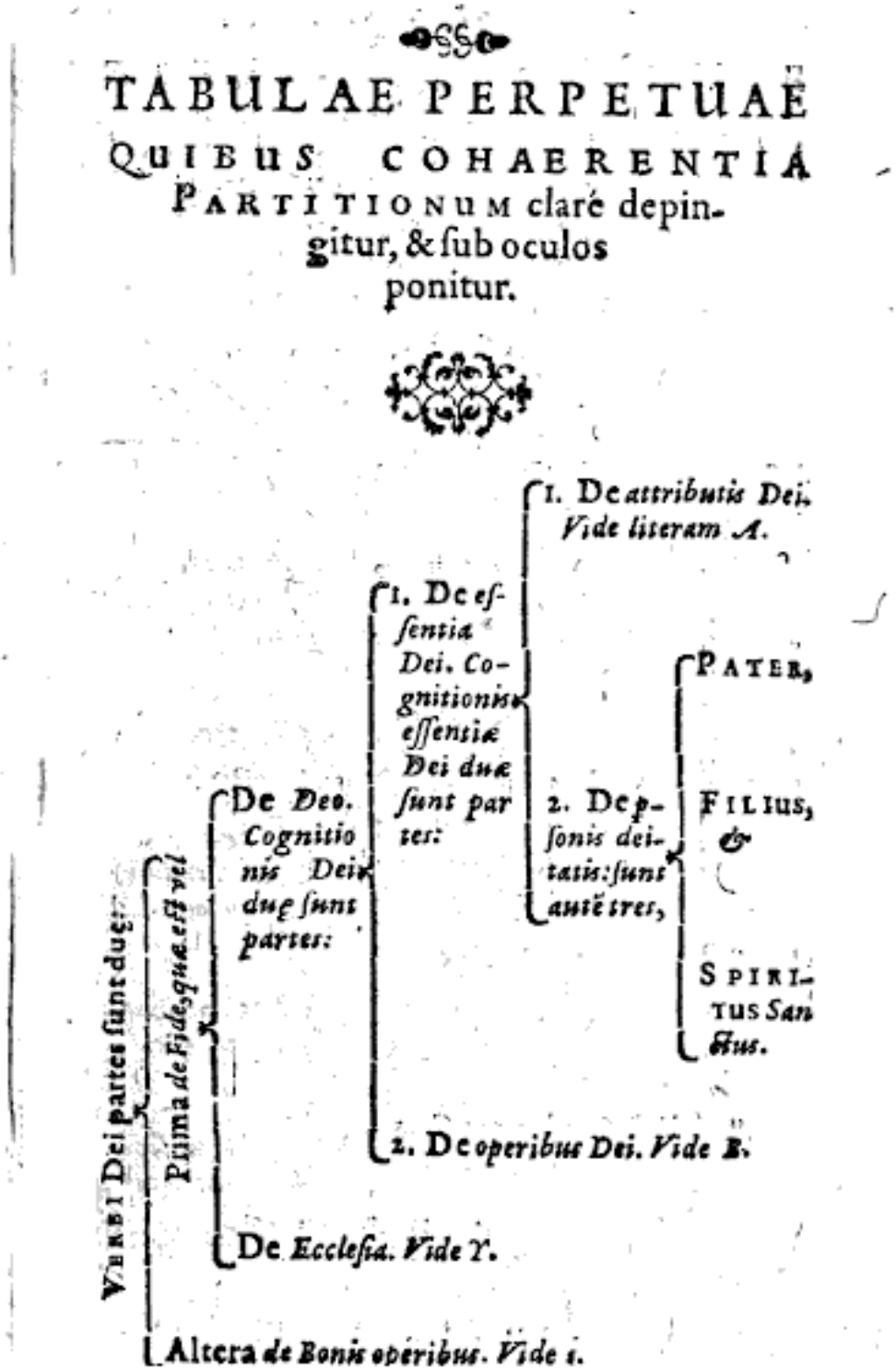


Figure 46: Ramist arrangement in Polanus' Latin Partitiones p. xvii

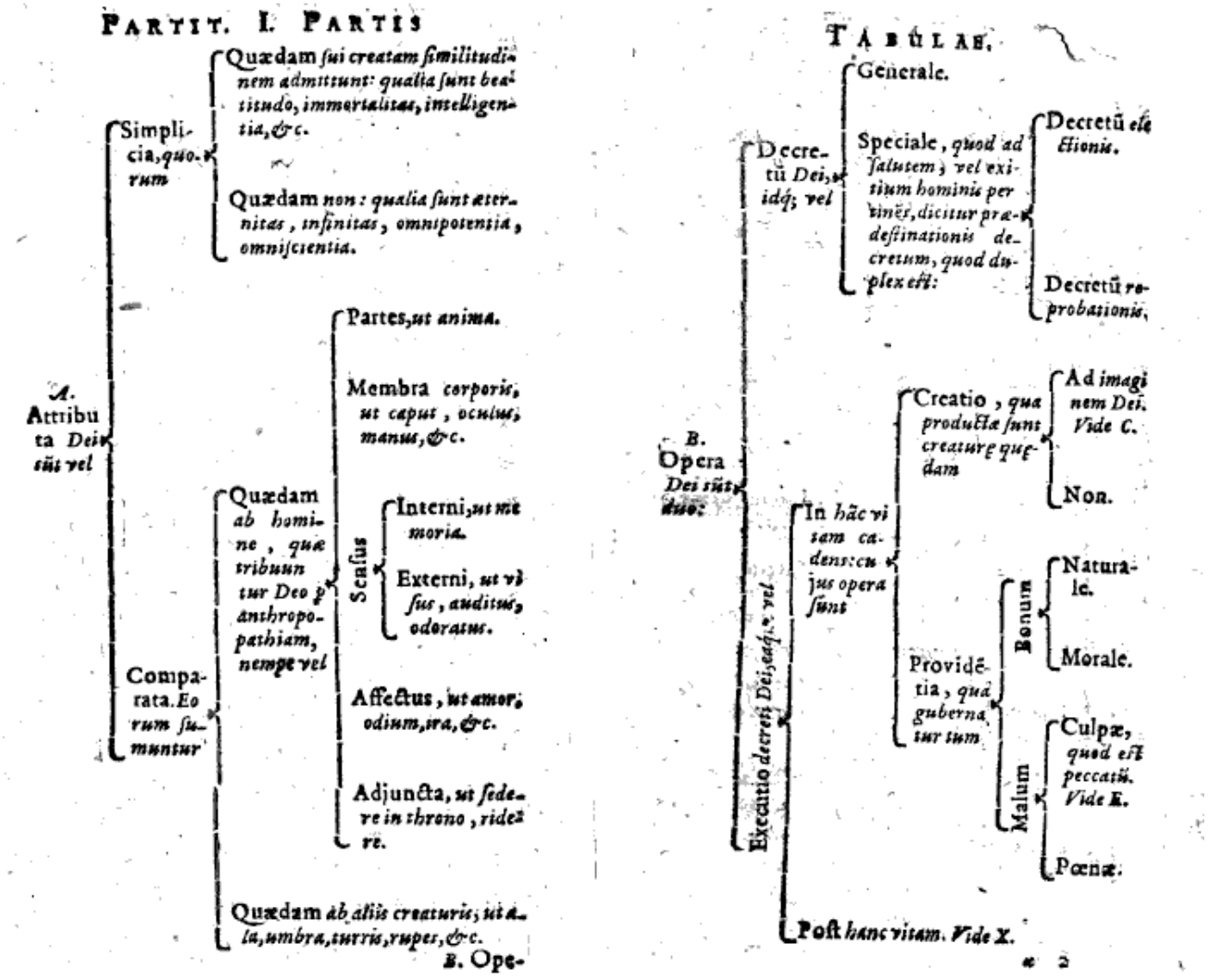


Figure 47: Figure 31: Ramist arrangement in Polanus' Latin Partitiones pp. xviii-xix

From *The Marrow of Theology* by Ames:

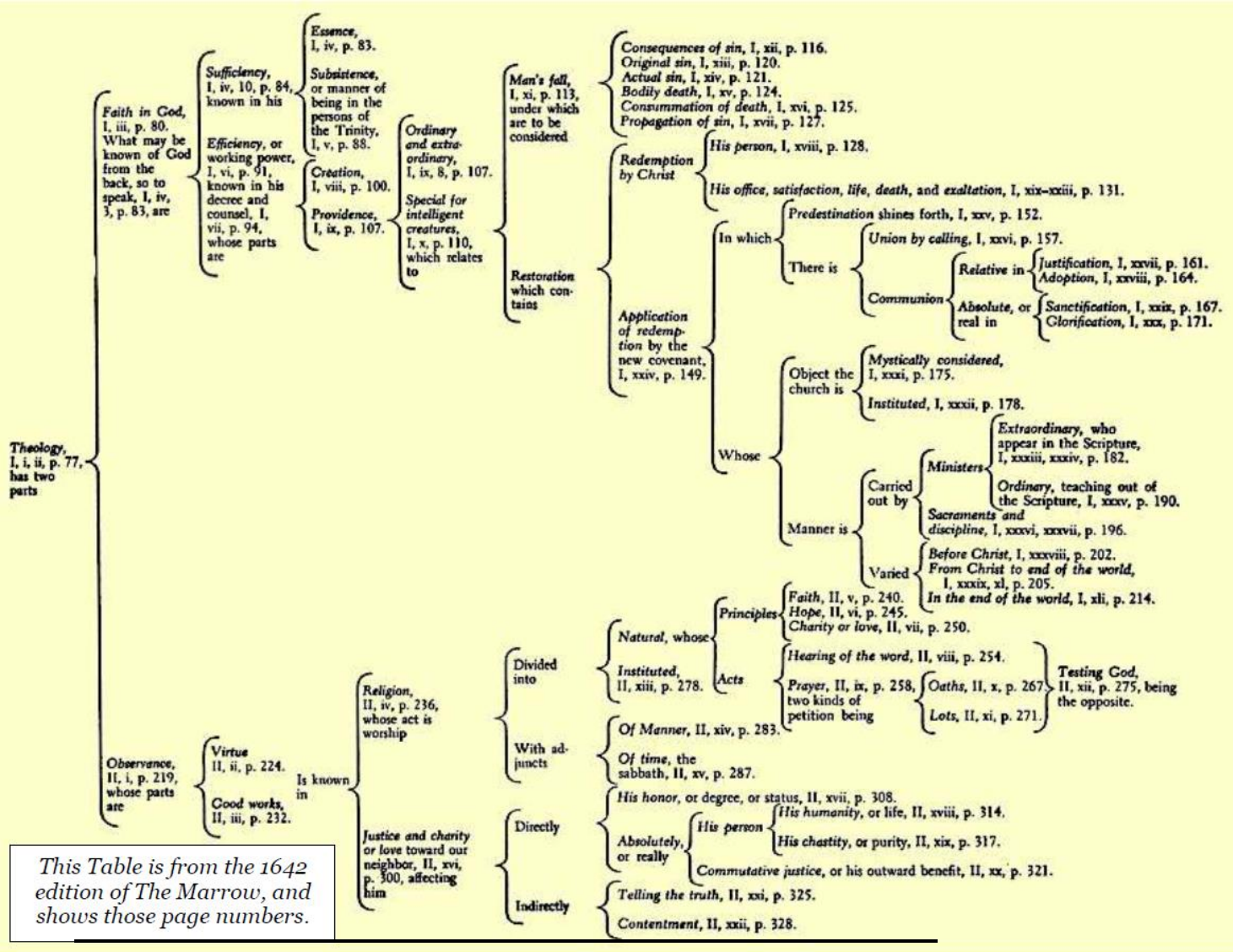


Figure 48: Ramism in The Marrow transcribed and edited by William H. Gross (2014) p. 272 retrieved from http://www.apuritansmind.com/wp-content/uploads/FREEEBOOKS/TheMarrowofTheology-WilliamAmes.pdf

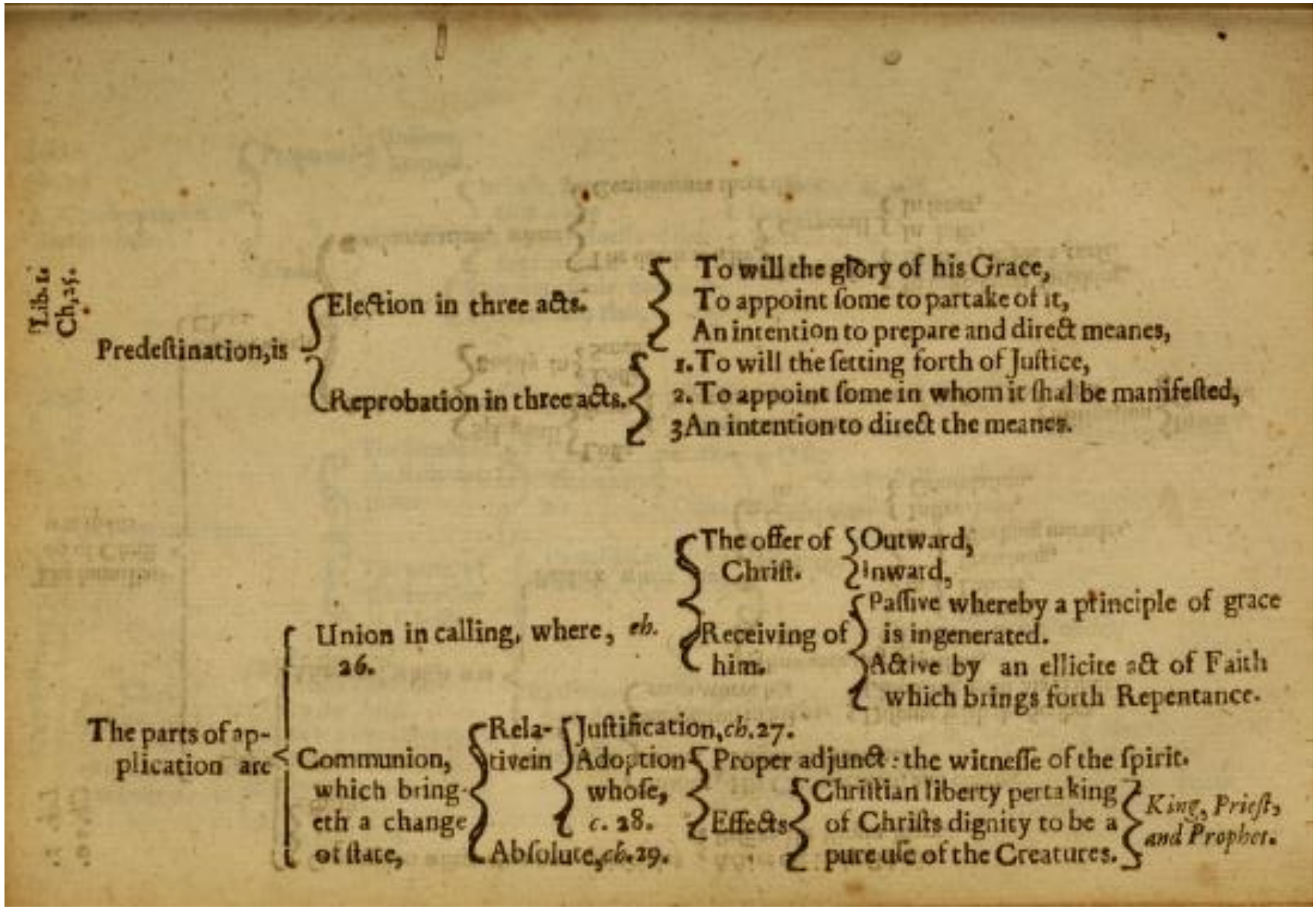
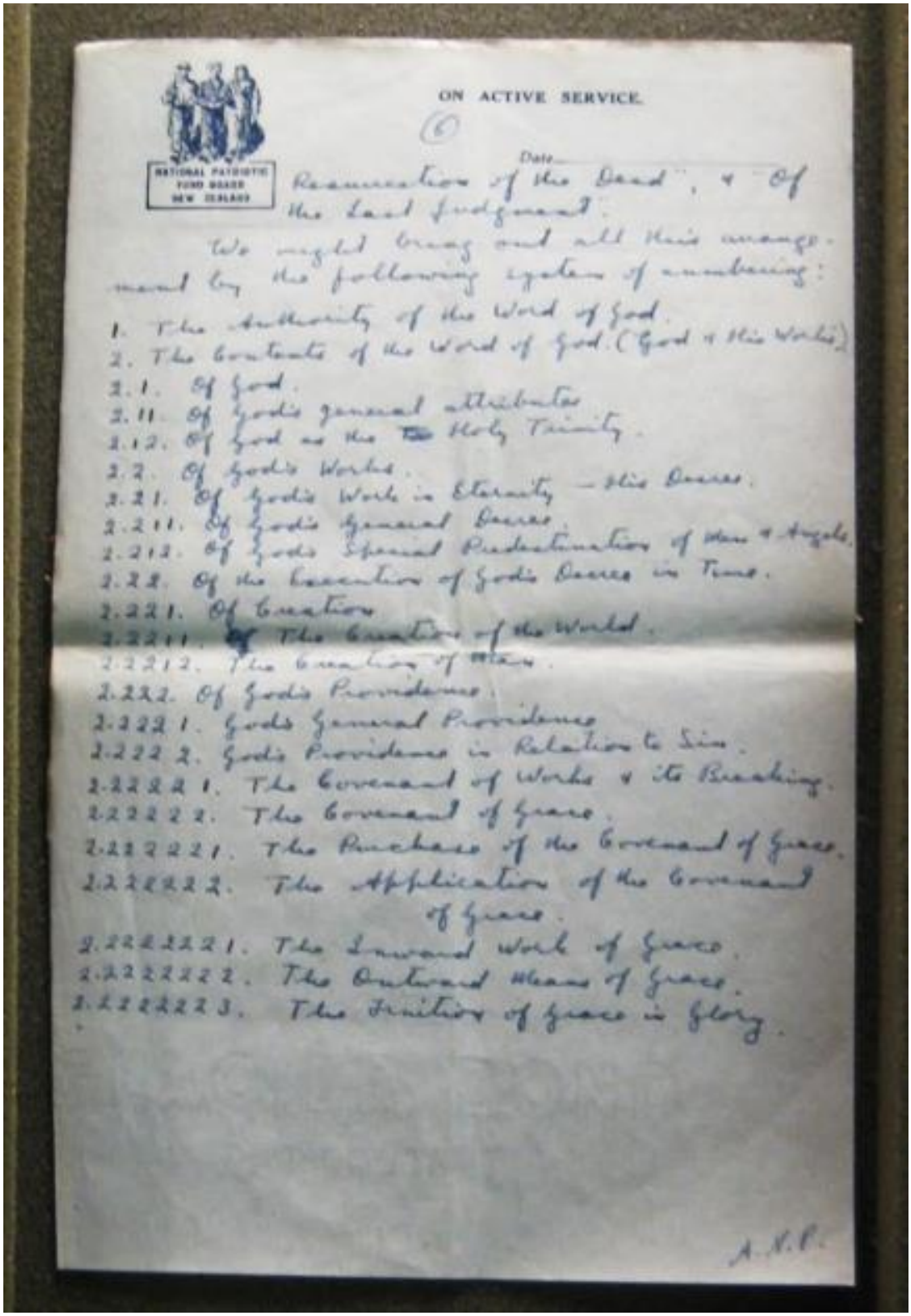


Figure 49: The Marrow of Theology (1639) p. 364 retrieved from https://archive.org/stream/marrowsacdi00ames#page/n363/mode/2up

Appendix 6: Scanning of page 6 in A. N. Prior's manuscript of "The Logic of Calvinism"



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Resurrection of the Dead, & Of the Last Judgment.

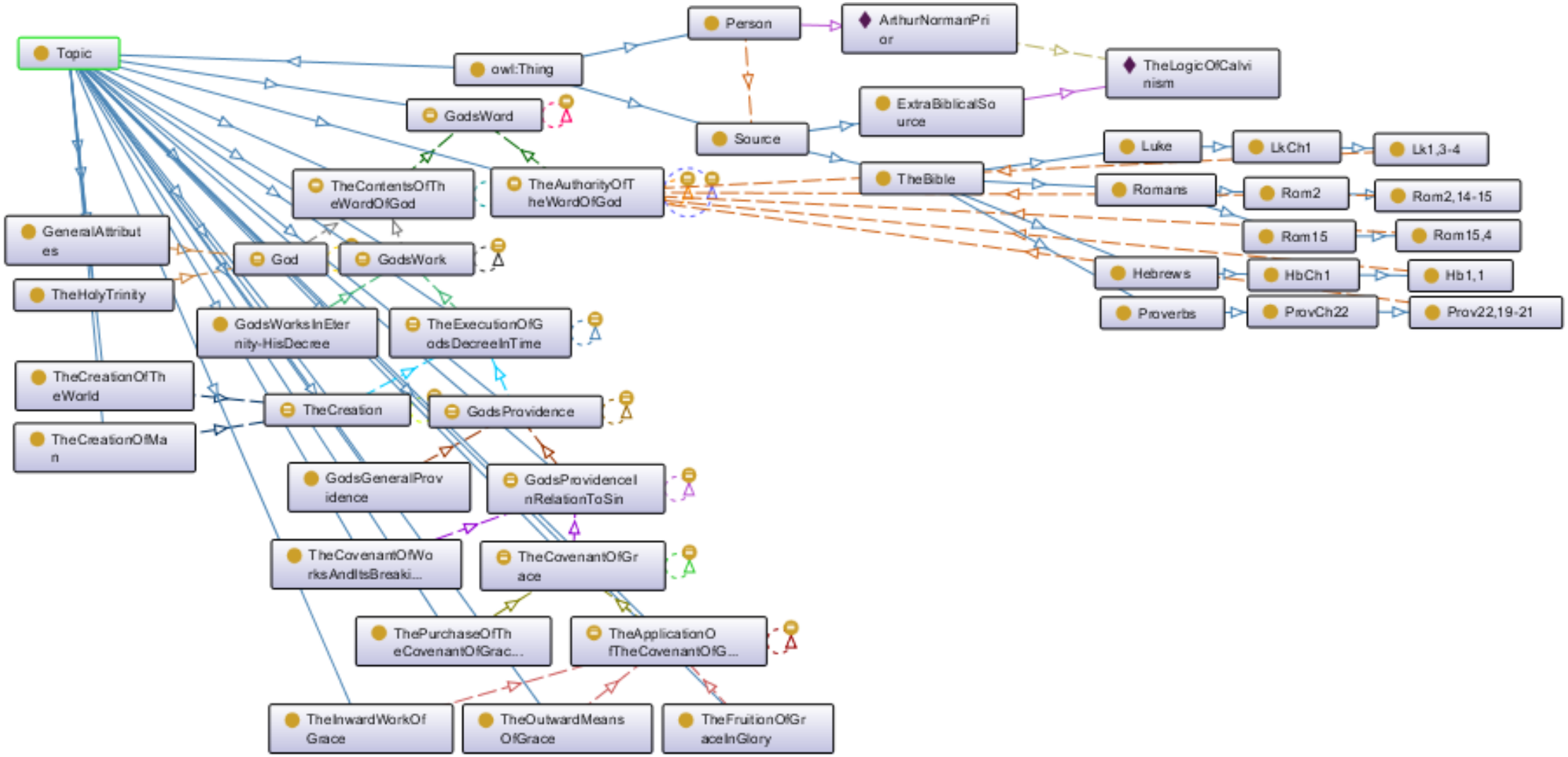
We might bring out all this arrangement by the following system of numbering:

1. The Authority of the Word of God.
2. The Contents of the Word of God. (God & His Works)
2.1. Of God.
2.11. Of God's general attributes
2.12. Of God as the Holy Trinity.
2.2. Of God's Works.
2.21. Of God's Work in Eternity – His Decrees.
2.211. Of God's General Decrees.
2.212. Of God's Special Predestination of Men & Angels.
2.22. Of the Execution of God's Decrees in Time.
2.221. Of Creation
2.2211. The Creation of the World.
2.2212. The Creation of Man.
2.222. Of God's Providence.
2.2221. God's General Providence
2.2222. God's Providence in Relation to Sin.
2.22221. The Covenant of Works & its Breaking.
2.22222. The Covenant of Grace.
2.222221. The Purchase of the Covenant of Grace.
2.222222. The Application of the Covenant of Grace.
2.2222221. The Inward Work of Grace.
2.2222222. The Outward Means of Grace.
2.2222223. The Finition of Grace in Glory.

A. N. P.

Figure 50: Page 6 of Prior's handwritten manuscript of "The Logic of Calvinism" which is located in the Bodleian Library, Oxford, and retrieved from the Virtual Lab for Prior Studiesdasd.

Appendix 7: A graphical representation introducing classes and their relations in CalvOn



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