From Data to Wisdom : Constructing "The Wisdom Graph"

Concept for Postgraduate Research at The University of Edinburgh

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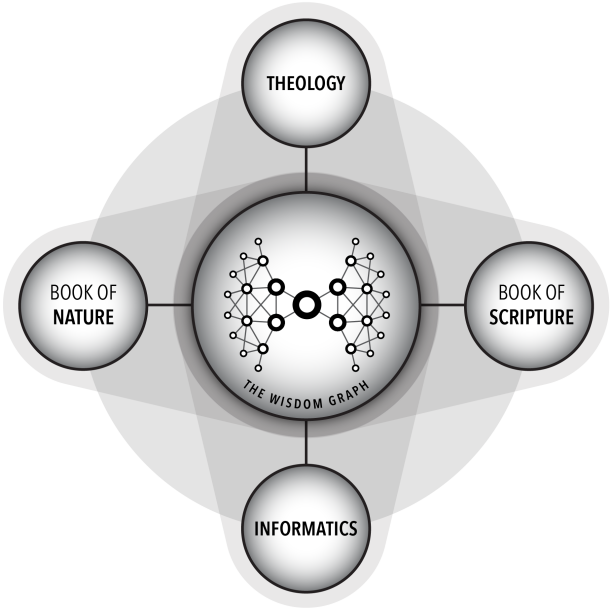
"Whence then cometh Wisdom,
and where is *the place of understanding?"*
(Job 28:20)

This question, posed in Job's "Song of Wisdom" long ago, is ever relevant, ever urgent. For we live in a powerful yet unwise age, an age that has, save for a few hearty souls, all but abandoned the very search for Wisdom at a time most portentous. And yet our age energetically excavates the *foundations* of Wisdom: *data*, *information* and *knowledge*, packaged in the hierarchical "DIKW" pyramid and pursued with vigor by professionals like data analysts, information architects and knowledge engineers. And while the "D" and the "I" and the "K" abound unabated, where, we may wonder, is the "W" in all this? Where are the *wisdom* analysts, *wisdom* architects and *wisdom* engineers that can codify and construct Wisdom from the raw materials so diligently mined?

A Unified Intellectual Structure

To proffer a response, I propose the construction of a new intellectual structure – "The Wisdom Graph" – that synthesizes the influences of four key elements: Theology & Informatics, Nature & Scripture:



The Wisdom Graph will aim to unify secular and sacred knowledge in the form of a semantic "knowledge graph" that codifies knowledge found in the "Book of Nature" and "Book of Scripture." We will construct The Wisdom Graph using the tools and perspectives of Theology and Informatics, including Exegesis and Hermeneutics, Natural Language Processing (NLP) and Artificial Intelligence (AI).

The "Two Books" Metaphor, Refactored

The "Two Books" metaphor posits that there are two repositories of revealed knowledge regarding God and creation: "The Book of Nature" and "The Book of Scripture." While the two have engaged in a sometimes complementary and sometimes conflicting coexistence over the centuries, the biblical texts are in fact replete with references to natural entities and phenomena, from light to life, from rain to vines, to fig trees, mustard seeds, sparrows and the lilies of the field. One need look no further than the parables of Jesus to see how one might infer great Wisdom by beholding Nature through the eyes of its Creator.

St. Augustine was one of the first Christians to view Nature as a repository of not only knowledge but truth and even Wisdom. His articulation of the *"magnus liber ipsa species creaturae"* – the great, big book of created nature, influenced centuries of natural philosophers and scientists. This notion of "sacred Nature" in fact permeates other wisdom traditions across time and place, from North American Navajos to the Buddhists of the Far East.

And when we return once more to Job and ask once again "whence then cometh Wisdom?" we hear Nature itself offer up a surprisingly coy response:

The depth saith, It is not in me:
and the sea saith, It is not with me.

And so are we then left to wonder whether Wisdom is in fact to be found in Nature? I contend that it is, *but not in Nature alone*. We must see Nature in its larger context, namely as part of a broader *system* that includes God as the originator and maintainer of that system:

God understandeth the way thereof, and he knoweth the place thereof.
For he looketh to the ends of the earth, and seeth under the whole heaven;

And finally, the unequivocal answer:

Behold, the fear of the Lord, that is wisdom;
and to depart from evil is understanding.

The phrase "fear of the Lord" is mentioned throughout the sapiential texts, with many definitions offered and debated. For our purposes, I offer a definition that antecedes "fear" with "acknowledgement," in that, since creation itself is dependent upon God for its origin and sustenance, from the mysteries of cosmology to the life of a single human being, any notion of Wisdom must *a priori* acknowledge God.

With The Wisdom Graph, I am proposing that we systematically parse the Books of Nature and Scripture using the tools and methods of modern computation informed by the disciplines of Theology, Philosophy and Science. And unlike the data analysts, information architects and knowledge engineers constructing partial pyramids, we will not stop at knowledge but will instead seek a higher elevation, for if God speaks to us, He surely speaks to us through His creation as well as His words.

Our first artifact on the path to The Wisdom Graph will lie in the creation of a foundational "knowledge graph" that codifies and fuses the core knowledge found in the Books of Nature and Scripture.

Knowledge Graphs – From Euler to Google

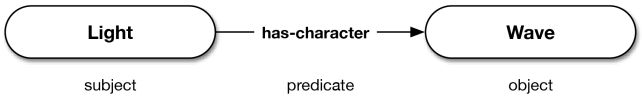
The term "knowledge graph" was popularized by Google in 2012 to promote its new semantics-based search engine based on graph theory. Knowledge graphs are the subject of a considerable body of research and have grown increasingly ubiquitous in academia, business and government, with major organizations like Facebook, LinkedIn and Amazon staking their successes on the power of the graph.

Graph theory, as conceived by Leonhard Euler while strolling the bridges of Konigsberg in 1736, is a vibrant branch of mathematics that defines nodes and edges as the "things" and "relationships" in a connected network. Graph theory forms the foundation of our interconnected world, including the World Wide Web and its progeny, the Semantic Web, both conceived by computer scientist Tim Berners-Lee.

The Semantic Web was proposed by Berners-Lee as a way for the Web to evolve from a human-readable "web of documents" to a machine-readable "web of data" that can be mined algorithmically using the methods of modern computation. It was intended as the next generation of the Web and as a way to increase the shareability of the world's knowledge.

While the term "Semantic Web" has been largely supplanted by "Linked Data" and now "Knowledge Graph," many of its foundational technologies (e.g., RDF, SKOS, OWL, SPARQL) remain vital and are in fact being used every day to effectively represent and share knowledge. Semantic Web technologies will be employed extensively in the construction of The Wisdom Graph.

The core technology and standard will be the Resource Description Framework (RDF) that represents atomic units of knowledge as "triples" in subject-predicate-object form:



These triples will be derived and encoded directly from both secular and sacred texts. In addition, it will be possible to create *inferred* triples that are not directly specified in the texts but that rather *emerge* from the application of inferential rules and axioms.

My hypothesis is that it is not only textual knowledge which can be represented as a graph but that Nature itself, if codifiable in machine-understandable terms, can as well, and that implicit Wisdom can be derived using the tools and methods of science and computation, including automated reasoning and inference.

This raises the possibility of generating new answers to a variety of compelling questions, including:

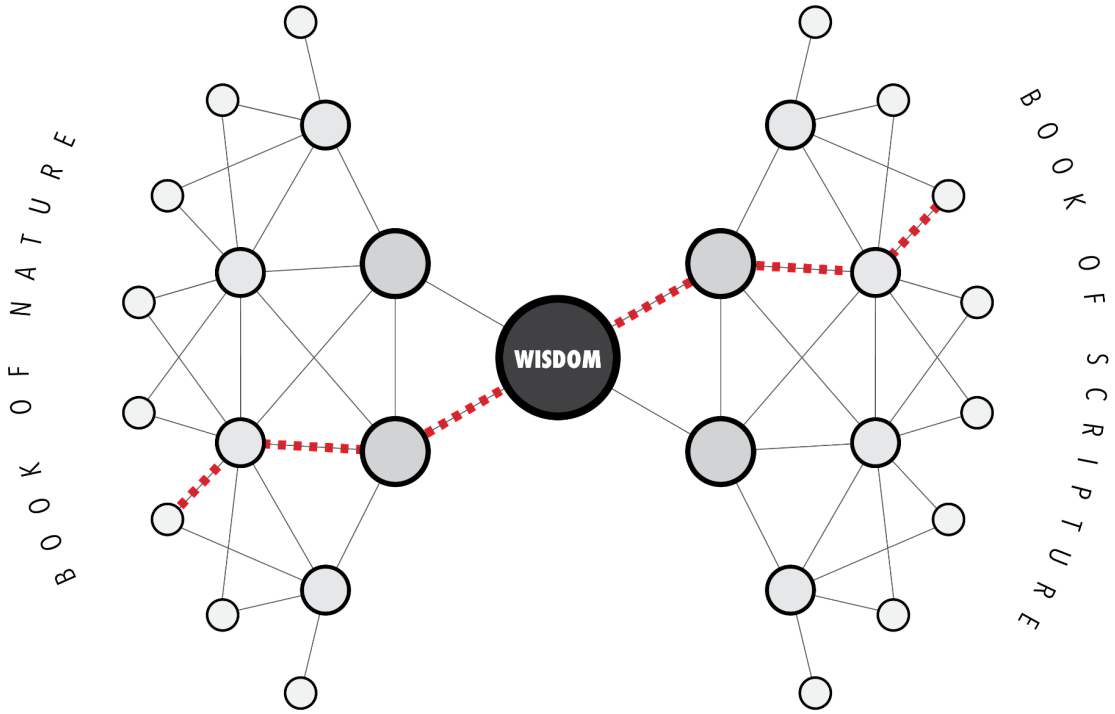
- Can Wisdom be sought for and found through automated means?
- Can the sapiential texts be faithfully transcribed into computational terms?
- Can the "Book of Nature" be sourced and analyzed as an *in vivo* "sapiential text"?

And more broadly:

- What is the nature of Wisdom?
- What is the difference between knowledge and Wisdom?
- What is the relationship between Wisdom, Nature and God?

Knowledge Unified – The Wisdom Graph

The Wisdom Graph will integrate secular and sacred knowledge from the Books of Nature and Scripture to form a new, unified graph that is literally *fused* via shared entities in common, as illustrated below:



The Wisdom Graph

Because both sides of the graph share a *literal* common node (in black), the power of linked data is ignited and an utterly new graph emerges – The Wisdom Graph. Powerful graph algorithms can then be marshaled to empower computers to traverse (in dotted red) the unified graph and search for the "Wisdom hidden in the knowledge," uncovering emergent insights that might otherwise go unperceived by human reasoning alone.

We will store The Wisdom Graph in a persistent and publicly accessible database (e.g., Wikidata, DBpedia, Amazon Neptune) so other researchers may build upon it in their own research. The graph will be compatible with Linked Open Data (LOD) standards, including the all-important Uniform Resource Identifiers (URIs) that allow for the literal linking of common entities across disparate graphs, as above. By conforming to well established World Wide Web Consortium (W3C) standards, The Wisdom Graph will be open and extensible and made immediately available to the global community.

The Wisdom Graph will be constructed and deployed in a phased sequence using a variety of components and standards of increasing expressivity and complexity comprising the "Semantic Stack," including Vocabularies, Taxonomies, Ontologies, Rules, Axioms and Queries, which collectively feed the inferencing process and are discussed next.

Vocabularies

A vocabulary is the collection of terms found in a specific domain. Deriving a detailed vocabulary from the sapiential texts is an important first step in constructing The Wisdom Graph. A vocabulary *by itself*, however, is not sufficient for Wisdom. A more ordered structure is required, starting with the Taxonomy.

Taxonomies

A taxonomy is an ordered arrangement of terms organized in a hierarchical semantic structure. Building a solid taxonomy is an essential next step on the path to Wisdom. We will employ tools and standards like the Simple Knowledge Organization System (SKOS) in the construction of our taxonomies.

Like a vocabulary, however, a taxonomy alone is not sufficient for Wisdom. We must look to encode deeper meaning in the graph, and for that we look to the next critical component: the Ontology.

Ontologies

An ontology, in theological, philosophical and computer science terms, is an articulation of the actual *entities* of a domain, including their essential properties and relations. Building a meaning-filled ontology is an absolutely essential next step in the construction of The Wisdom Graph. We will employ standards like the Web Ontology Language (OWL) in the development of our ontologies, which will then form the foundation for wisdom-informed Rules and Axioms.

Rules and Axioms

A rule codifies the constraints and entailments of a given ontology. With rules we enter the powerful realm of *logic* and stand on the shoulders of the great logicians like Aristotle and Russell.

The sapiential texts are replete with rules intended to guide those on the path to Wisdom. From the concise admonitions of Proverbs to the more allegorical parables of Jesus, we will endeavor to transcribe natural language into codifiable computer-understandable rules and axioms. We will employ linguistic tools like Controlled Natural Language (CNL) in the codification of our rules and axioms.

The transcription from natural language to logical rules and axioms is where I believe that Wisdom will truly begin to emerge. Like the scribes of old, we will pursue this transcription task with great humility and reverence, and the wise counsel of the University of Edinburgh's School of Divinity will be vital.

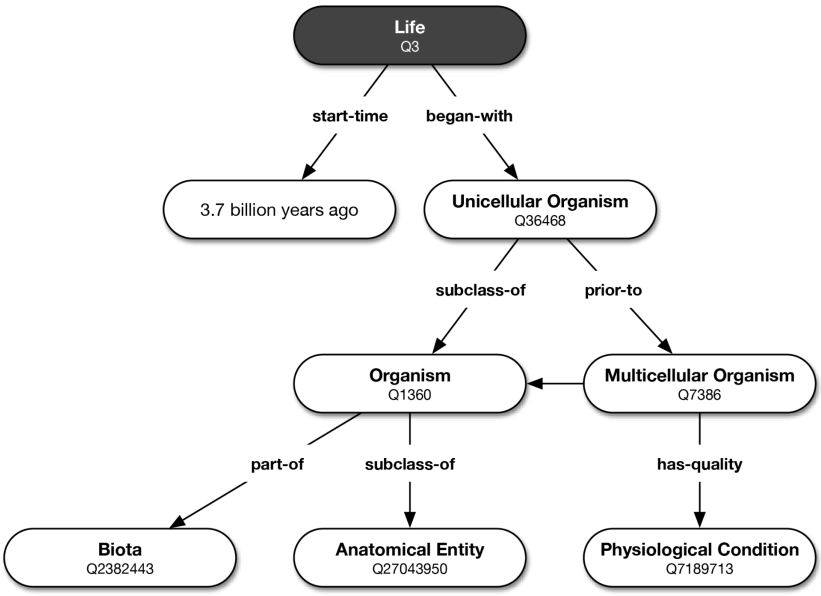
Queries

Once deployed, The Wisdom Graph will be interrogatable via the semantic query language SPARQL. The quality of the queries will be a crucial enabler for extracting Wisdom from the underlying data. Canonical queries will be authored and a repository of self- and community-created queries will be offered.

The next pages illustrate how The Wisdom Graph might be constructed using a publicly-available datasource like Wikidata and how secular and sacred knowledge can be fused into a single graph.

Life – Book of Nature

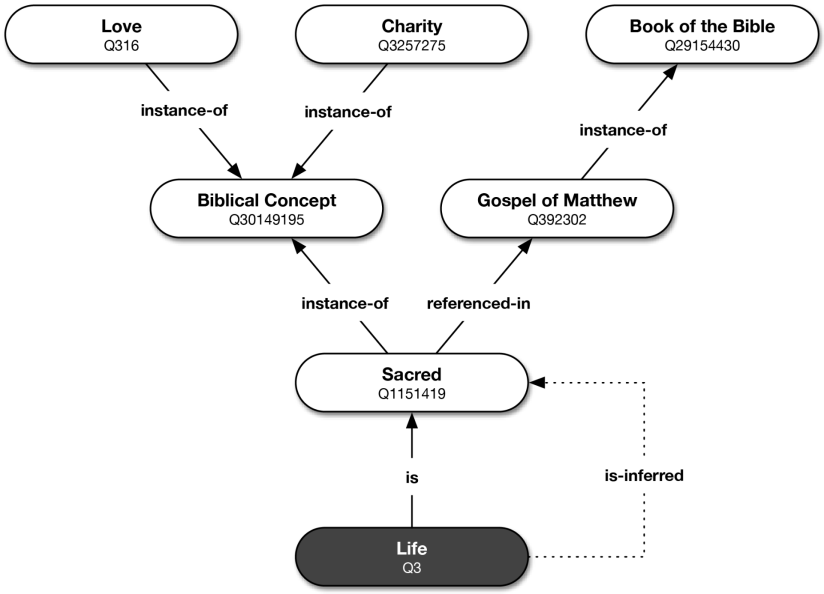
We begin by building a knowledge graph using data sourced from the Book of Nature, in this example designating the entity "Life" (uniquely identified in Wikidata as Item Q3) as our starting point:



Nature-Sourced

Life – Book of Scripture

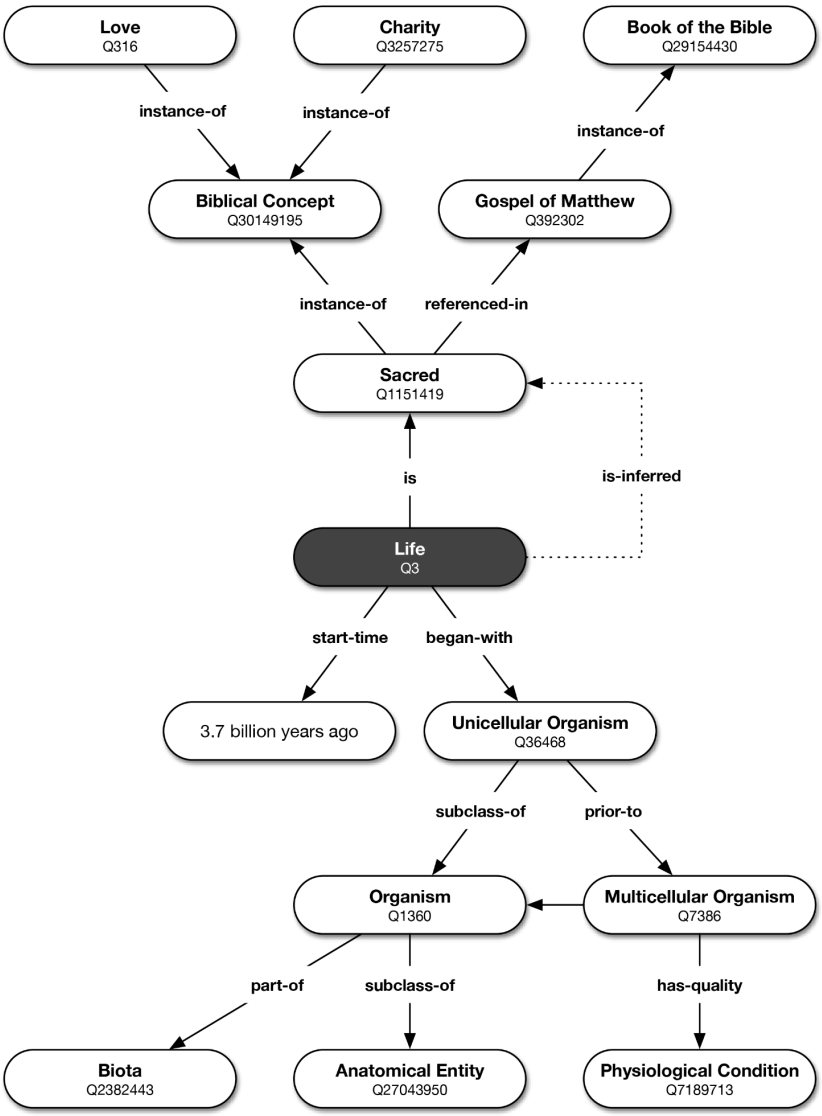
We then apply data sourced from the Book of Scripture (e.g., the *Gospel of Matthew*) that likewise contain references to the very same entity "Life," and from which we can infer or confirm a myriad of implicit or explicit dictums, such as "Life is Sacred":



Scripture-Sourced

Life, Unified

Because the "Life" node in both graphs represents *the exact same entity* (Q3), the potential and power of linked data is catalyzed and an entirely new element is formed – The Wisdom Graph:



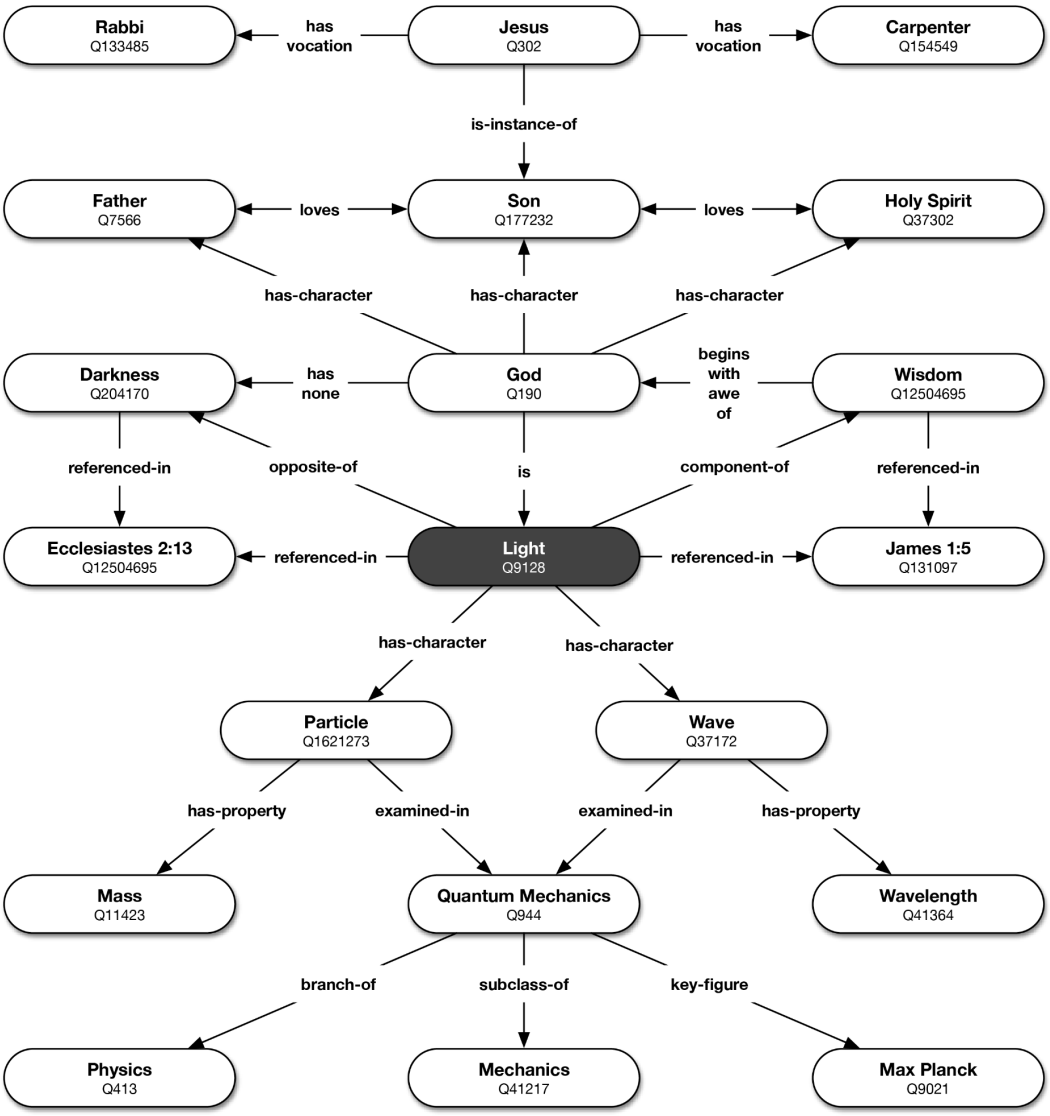
The Graph of Life

The Wisdom Graph is seen as a single graph and so artificial intelligence and machine learning algorithms can be employed in its traversal and analysis. The true potential of The Wisdom Graph lies in both the quality of the sapiential data transcription and in the ontologies, rules, axioms and queries that feed the inferencing engine in the creation of new implicit knowledge.

Both the data and the queries will be available to the global community and will thus form a large part of the lasting legacy of this work. I envision a future in which modern-day scribes pour through sapiential texts, ever adding to the globally unified body of knowledge – and more importantly, to Wisdom.

Light, Unified

To reiterate the concept of unification, we offer "Light" as another of the many subjects to which significant references are made from both the Book of Nature and the Book of Scripture:



The Graph of Light

By examining the graph visually, an interesting parallel may be seen between the dual-nature of Light (wave vs. particle) and the tri-nature of God (Father, Son, Holy Spirit) as expressed in the theological doctrine of the Trinity.

By looking at the same subject from both perspectives in a single graph visualization, such parallels may begin to organically emerge. By automating graph traversal via semantic querying, such parallels will not be dependent on human processing but will instead emerge automatically. It is in these emergent insights that the anticipated promise of The Wisdom Graph lies.

And finally, some words to the Why's...

Why Me?

Over the past several years, as I have seen our society increasingly stray from the path of Wisdom, I have been increasingly dogged/haunted/cajoled/inspired by the question of Wisdom, which admittedly has dogged greater minds than mine going back to well before even Socrates. As a person of faith, I believe that there can be no true Wisdom without God, or as already discussed, a "Fear of the Lord," which in my mind begins with the humble recognition that it is God's Universe and that we, like Isaac Newton, are merely children playing on its shores.

My background is somewhat unique but oddly well suited to this endeavor. Educated initially as an architect (Bachelor of Architecture, Cornell), I am at heart a designer who seeks to make the world more understandable and beautiful through built artifacts, both physical and digital. The "Via Pulchritudinis" resonates with me, for I believe that in the end it may be our appreciation for Beauty that saves us all.

As a student and educator (Master of Arts, Education, UCLA), I was particularly enamored of the "Generative Theory of Learning," which I learned from its creator, Dr. Merle Wittrock, who posited that all learning is *associative* and that we build knowledge as a network – years before the term "knowledge graph" was ever conceived.

Having worked in the Research & Development community for several years, collaborating with notable American computer scientists Alan Kay and Danny Hillis, I saw firsthand the power of programming and graph technology. And now, as a software engineer working "by day" for the US Navy, I have developed a proficiency in mission-critical software engineering, including the database design that forms the basis for this work. And my yearning for Wisdom ever grows...

Why a PhD?

And all this now leads me here, where I am considering pursuing a PhD. Why a PhD, and why at this stage of my life? Because I believe that the stakes are high and that this is a project worth pursuing and that it will have a greater chance of success by passing it through the rigors of a formal PhD program.

And just as Socrates journeyed to Delphi to consult the Oracle, I too feel the need to humbly seek wise counsel and mentorship on this quest. There are roads yet unseen and signposts that I know I will miss traveling solo and so I seek my own wise oracles in the faculty and researchers of venerable Edinburgh.

Why Edinburgh?

I first learned of the Edinburgh School of Divinity from a colleague pursuing his PhD in the Department of Theology at Durham, Bradley Myers, with whom I have had numerous conversations regarding both PhDs and studying in the UK. I have always come away from these conversations inspired about both.

With its deep historical roots and modern view to the future (as evidenced in its programmes in Science and Religion), the University of Edinburgh is to me the ideal academic setting in which to pursue this work. With Edinburgh's world-class Schools of Divinity, Philosophy and Informatics, I am excited about working closely across disciplines with those who can sagely guide me on this journey.

I thank you most sincerely for your consideration and look forward to further explorations.

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