Big Picture for Everyone

The relationship between the equation model and base vectors for mapping human semantic space.

Mindey

September 20, 2020

Abstract

Most humans seem to learn by contextualizing what they perceive to answer questions, like *"Why?"*, *"How?"*, *"What?"*, *"Where?"*, *"When?"*, *"Who?"*, to help them orientate themselves in their lives. Most formal *problem solving* in the modern science is done through the use of equation model, widely recognized as $F(X) = Y$, where equality sign "=" is used to separate the terms in search of parameters to satisfy the equality. *Is there a semantic relationship between these basic human questions and the equation model, and if so, then what kind?* We explore this question, and arrive at a qualitative categorical relationship, where broadly F is answered by questions *"What?"*, *"Where?"*, *"When?"*, the X is answered by *"Who?"* and *"How?"*, and the Y is answered by the question *"Why?"*. The result, while simple, may help us to define the base vectors for mapping human semantic space, and to create intuitions on how to convert human perceptions *("qualia")* and conceptions *("semasia")* into formal mathematical problems.

1 Motivation

The equation model $F(X) = Y$, which describes triplet (F, X, Y) is widely known as functional form of equation. It is easy to see that with the triplet defined in arbitrary spaces, it is sufficiently abstract to talk about **any goals Y**, with respect to **any world F**, pursued by **any process** that varies **X**.

However, in general, it seem to be hard for most humans and their groups to convert everyday problems into mathematical ones. The majority of humans seem to be unable to reduce their everyday problems into mathematical ones, and apply the formulas they've learned at their schools to arrive at the solutions of their problems. That motivated us to seek for a more concrete semantic decomposition of the components of the equation model into the more concrete concepts widely used by modern humans independent of their personal backgrounds, to create more of the general consensus in their inter-coordination.

2 Target

To maximize the applicability of this pan-disciplinary categorical relationship, we aimed to relate the equation model with ≤ 8 human concepts that describe its components, because that is the upper limit of short-term memory for most humans, and that way may be helpful for humans to use it for practical purposes.

Note: *For a practising mathematician it may occur natural to think of F as the rule defining relationship, and to realize, that it is the universe that defines it, and to think of humanity's approximation of the universe's rule with the totality of our mental models and theories as its statistical estimate $\hat{F}$ that is their model of the world, and think of Y as goals (set of desired properties defining the desired states), and think of themselves as probable processes $X(t)$ over time t that parametrize the world with actions in ways that the value of $F(\hat{X}(t))$ approaches the their imagined $\hat{Y}$. However, many may still find themselves confused as to how do the basic human questions relate to this interpretation of the world through the concept of equation. We further explore and elucidate this relationship.*

3 Reasoning

If we take a look at how do human kids understand the world, we may notice that they ask a lot of questions, and there seem to be just a few basic question categories that they use to do it. These categories of inquiry are identified by some of the basic questions like **"Why?", "How?", "Who?", "When?"**, etc. When humans grow up and get entrepreneurial, they try to answer the same questions using methodologies like the so-called *"Lean Canvas"*: **"Problem", "Solution", "Customers"**,..., and usually continue asking these questions in context of other organization frameworks about all sorts of things to help theirselves move in their state spaces until the end states of their lives.

Initially, we tried to identify the technical concepts that, in our opinion, correlate best with what the equation model implies, namely, realizing that the equation $\boldsymbol{F(X) = Y}$ has two parts separated at the equality sign: one part that specifies the desired condition to satisfy $= \boldsymbol{Y}$, and another part that describes the state $\boldsymbol{F(X)}$ dependence on our actions $\boldsymbol{X}$. From that, it was quite clear to us, that the conditions $= \boldsymbol{Y}$ part has to correspond to concepts that humans associate with things that they seek. We named that by the word **"Goals"** (because that is what is broadly recognized as formal definition of the concept of *"goal"* – *a set of conditions that when satisfied, what is to be referred to as "goal" is said to be "achieved"*), but later we realized that humans tend to use a variety of other related (synonymous, inverse, hypernymous, or strongly otherwise related) concepts to describe or imply goals, such as the concepts referred to by words **"Problems", "Challenges"**, etc., and many others. We realized that the most prominent among the question categories that people ask when they speak about **goals, is "Why?"**:

$$\boldsymbol{F(X) = Y}$$
$$\uparrow$$
$$\text{"Why?"}$$

Continuing, it was clear that what remains is a decomposition of **"Goals"** into actions. For example:

○ **A monkey wanted a banana. (Y - Goal)**

    → So it had an idea to use a stick to reach it. **(Arrow 1)**

        ⇢ So it had actually taken the actual stick and performed an action. **(Arrow 2)**

○ **A human wanted to the Moon. (Y - Goal)**

    → So it had an idea to use a rocket to reach it. **(Arrow 1)**

        ⇢ So it had actually made the rocket and performed an action. **(Arrow 2)**

So, we asked ourselves: **What parts of the equation do these arrows (→ Arrow 1, ⇢ Arrow 2) represent, and what human questions answer them?** We thought that these have to be the concepts of an **"Idea"** and **"Plan"** (project). There we had our model:

○ **Goal**

    → **Idea**

        ⤏ **Plan**

This model is just a set of simple words known to most people, corresponding to more technical words like intent, principle and action, that we saw in examples of the behavior of living beings, and how they operate (i.e., how humans and monkeys decompose their intents into actions). This way, it is easy to see that these concepts (goal, idea, plan) correspond to questions "Why?", "How?" and "What?" (grammatical *accusative case*, or a so-called "object" in *subject–object–verb* language model).

○ **<u>Goal</u>** ("Why?")

    → **<u>Idea</u>** ("How?")

        ⤏ **<u>Plan</u>** ("What?")

We later identified other words (synonyms), that people use to answer those questions, such as:

○ **<u>Goal</u>:** "Problem", "Challenge", "Question", "Category", "Domain", "Concept", "Intent",...

    → **<u>Idea</u>:** "Solution", "Opportunity", "Answer", "Transformation", "Algorithm", "Principle", "Method",...

        ⤏ **<u>Plan</u>:** "Organization", "Company", "Group", "Delivery", "Activity", "Actions", "Project",...

On a side note, you can see the reflection of that in our current website, as the top titles like **"Question"**, **"Idea"**, **"Project"** that, communicate these categories in such a way that they feel naturally actionable to most English speakers – it's easy to ask a question, suggest an idea, and start a project.

We call the questions or categories like these – "**<u>semantic</u>** base vectors", and we just explained **3** of them (we came up with **6** in total, described below).

So, when someone asks a question like **"Why?"** – what they are asking, is for the other party (whom they are asking) to project whatever they are doing or planning onto the axis defined by the **"Why?"** dimension to elucidate the answer.

These three vectors were sufficient for basic understanding. However, let's take a look how do they correspond to parts of the equation model. We had:

$$\overset{\displaystyle ?\quad\ ?}{\underset{}{F(X) = Y}}$$

$$\underset{\text{"Why?"}}{F(X) = Y}$$
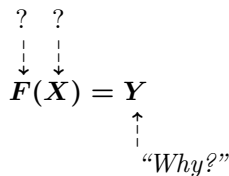
When mathematicians speak, what they mean by writing equations, is that we write the de-facto circumstances that we have in the world on one side of equality sign ("="), and the desired circumstances on the other side:

$$\underset{\substack{\text{"What we have"}\qquad\text{"What we want"}}}{F(X) = Y}$$
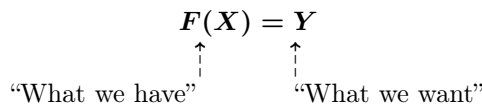
That is the semantics of equation as a concept. Pragmatically, to solve an equation, one or the other side is transformed, until we have the equality not as a condition, but as a fact already.

From here, it is easy to notice the concepts of **"Idea"** and **"Plan"** (introduced through examples of a monkey and a human, moon and banana) in the equation model.

In context of the equation semantics above, the obvious answers to questions "What we have?" and "What we want" would be:

F(X): "What we have?" is:

> → We have **the world**. (world state 1)

Y: "What we want" is:

> → We want **the goals**. (world state 2)

We already connected the "Y" with concept of "Goal", so we leave it out and focus on the "F(X)", — asking: *What are F and X, if the F(X) is the world?*

The most natural answer to this question that we've got, is that:

> → **F** is "remaining **world** without agent (doer, or process) itself"

> → **X** is "the **agent** (doer, or process), that is part of the world"

By looking at what human questions identify these categories, we match up:

> **X : "Who?"** (agent)

> **F : "What?"** (world)

However, up above in the introduction of the model, we observed that the concept of **"Plan"** answers the question **"What?"** (we said — grammatical *accusative case*, or a so-called *"object"* in *"subject–object–verb"* language model). So, how do these mappings relate?

It is easy to see that the so-called **"subject"** (of *"subject–object–verb"* language model) corresponds here to **agent (X)**, and the so-called **"object"** of the model corresponds to **world (F)**, so that we correctly interpret that *agent acts on world: we say – "agent parametrizes the world, seeking to make it equate to goals"*. That is, so that agents like humans or monkeys parametrize the world (**F**) with what they are (**themselves as world parameters**) in terms of their actions (**selves as processes**), to achieve their goals (**the following future states of the world**).

The fact that both semantic categories of **"Plan"** and **"World"** are answers the same question of **"What?"** do not contradict: by answering the same question (**"What?"**) they are both just being part of the world (as is **"agent"**), but **"agent"** has this extra category of **"Who?"** that is useful to people's minds to help figure out causal social relationships, and that is probably why people have this semantic dimension or question.

In context of mathematics and optimization theory, it is widely known that what we mean by **"X"** in many contexts is not just a parameter, but an optimizer, or a process, that searches for parameters (just like agents do), and we identify analogies:

> **X : "Who?", (agent) – "Process", "subject" – the Human, the Monkey,...**

> **F : "What?" (world), "Plan", "object" – the Banana, the Moon,...**

For clarity: *in the context of language model ("subject-verb-object") –* ***"X"*** *part of the equation corresponds to* ***"subject+verb"*** *part, while* ***"F"*** *part of the equation corresponds to* ***"object"*** *part. That is true because we consider agent (* ***X*** *) here as both a part of the* ***world ("subject")***, *and an actor* ***doing ("verb")***.

We go back to first insights, and plug in what we have:

○ **Goal ("Why?")** − **Y** – *having "imaginary (desired) Banana in monkey's mouth" is cool.*

    → **Idea ("How?")** − **???**
        --→ **Plan ("What?")** − **part of F** – *"the Banana in the real world, and steps of getting Banana".*

Then, and ask ourselves:

    – **Where do the steps of getting Banana come from?**

    – **What does the X correspond to as "subject+verb"?**

    – **Does X really correspond to Ideas?**

With a little bit of abstraction, namely, the concept of **"class and instance"** (as in object-oriented-programming) (or the concept of a **"random process and its realization"**, as in process theory), we realize that an **"Idea"** has to be an abstract principle (that emerges as a representation that is a result of mental processes) to be able to be an **"actions generator"**, or **"plan steps generator"** for it all to make sense. Thus we define an **"Idea"** as <u>an abstract prescriptive principle</u> **"X"**, that can generate actions (and then the **actual actions (like plans and projects)**, must be the concrete **realizations of its process "$\hat{X}(t)$"** (samples of a random variable defined by an **"Idea"**)).

With these abstractions in place, we can indeed say that **"X"** really correspond to **"Idea"**, and write:

○ **Goal ("Why?")** − **Y**

    → **Idea ("How?")** − **X**
        --→ **Plan ("What?")** − **part of F** − **X(t)**

Now that we have elucidated the ontological anatomy of the equation model –

$$
\begin{array}{cc}
\text{"What?"} & \text{"How?"} \\
\downarrow & \downarrow
\end{array}
$$
$$
\boldsymbol{F(X) = Y}
$$
$$
\uparrow
$$
$$
\text{"Why?"}
$$
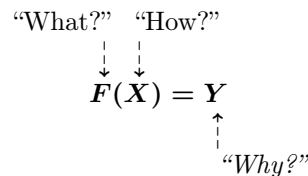
We finally have a mapping between mathematical equation model and the basic human questions asked by children.

However, we said that when human kids understand the world, they also ask the questions like **"Who"** and **"When?"**, one of which is obviously not covered in the among our three semantic base vectors. **Do we need more semantic vectors?**
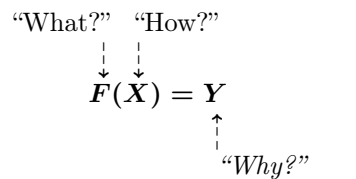
We thought – yes. Namely, because the current **"What?"** in the **"F"** part is too broad – it can be pretty much anything, and from experience, we know that people move in the **3+1-dimensional spacetime**, where there

are a couple of very useful coordinate systems and reference systems, that people use to talk about things as parts of the world, like <u>identities</u>, <u>space</u> and <u>time</u>, that as we know are answers to questions **"Who?"**, **"Where?"**, **"When?"**, and therefore we include them as the remaining **3** dimensions, totalling **6**.

You might notice that we arrived to the fact that both **"How?"** and **"Who?"** correspond to **"X"** somehow. What does it mean? Well, think about it: the **"X"** as a process is as much an agent as it is an algorithm. So, "algorithmness" of it is addressed by **"How?"** and "identityness" of it is addressed by **"Who?"**.

There, we arrive at our core model:

<div align="center">

"Who?", "Where?", "When?" DOING "What?", "How?", "Why?"

</div>

$$\overset{\text{``What?''}}{\underset{}{\downarrow}} \; \overset{\text{``How?''}}{\underset{}{\downarrow}}$$
$$F(X) = Y$$
$$\underset{\text{``Why?''}}{\uparrow} \qquad ,$$

where, **F** is world, **X** is processes, **Y** is goals, and where $F(X)$ is:

$$\overset{\text{``Where?''}}{\downarrow} \; \overset{\text{``Who?''}}{\downarrow}$$
$$F(X)$$
$$\underset{\text{``When?''}}{\uparrow} \qquad .$$
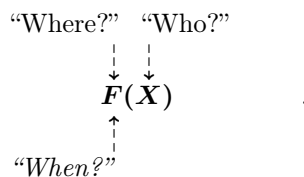
It's **6** questions that answer basic questions about world's **processes**, and closely corresponds to and meaningfully decompose common philosophical decompositions of the world, like:

<div align="center">

subject – verb – object

substance – entity – essence

world – operations – dreams

(entities – processes – conditions)

⋮

</div>

Note: In a broader sense, any world is really about **"What does what?"** rather than **"Who does what?"**, because processes are more general than agents – it is sufficient to focus on **processes**, and their **input-output** quality to understand the world and its systems, in a similar way how it is sufficient to understand sentences as pairs like *(object, subject+verb)* and not triples like *(subject, verb, object)*.

4 Applications

Obtaining and retaining simple human-understandability of world's systems and processes. Transforming semantic spaces to forms more conducive to human understanding. Embedding of databases into the space of the semantic vectors by labeling tables, collections and entities with the question categories. Creating database indexes optimal for human interpretation and application of the equation model for information retrieval, machine learning, machine reasoning and search for actions to achieve goals. Simple interpretability to most people:

$$\text{WHERE} \quad \underset{\text{WHAT}}{\overset{\text{WHEN}}{\mathbf{F}}}(\underset{\text{WHO}}{\overset{\text{HOW}}{\mathbf{X}}}) = \underset{}{\overset{\text{WH}}{\mathbf{Y}}}$$

Latest revision at: https://mindey.com/equation-semantics.pdf.