Systemic Framework for Enterprise Architecture & Transformation

Introduction to theoretical foundations

Introduction

- This document is an integral component of the SysFEAT architectural framework. It provides foundations to address the challenges posed by Enterprise Architecture in the 21st century, which include :
  - Increasing complexity in system structures and behaviors.
  - Growing intricacy in architecture, management and governance of these systems.
  - The mission of the framework is to demystify these complexities, ensuring they are comprehensible to a broad audience, thereby facilitating the design and management of complex-systems across all scales, from micro-systems to enterprise level systems.

- Enterprise Modeling refers to the overarching language and conceptual framework used to describe, understand, and communicate the complex structures and dynamics of an enterprise and its sub-systems.

- The following slides present the **theoretical foundations** used by SysFEAT to establish the discipline of enterprise and system modeling.

Introduction – a federation on ontology initiatives

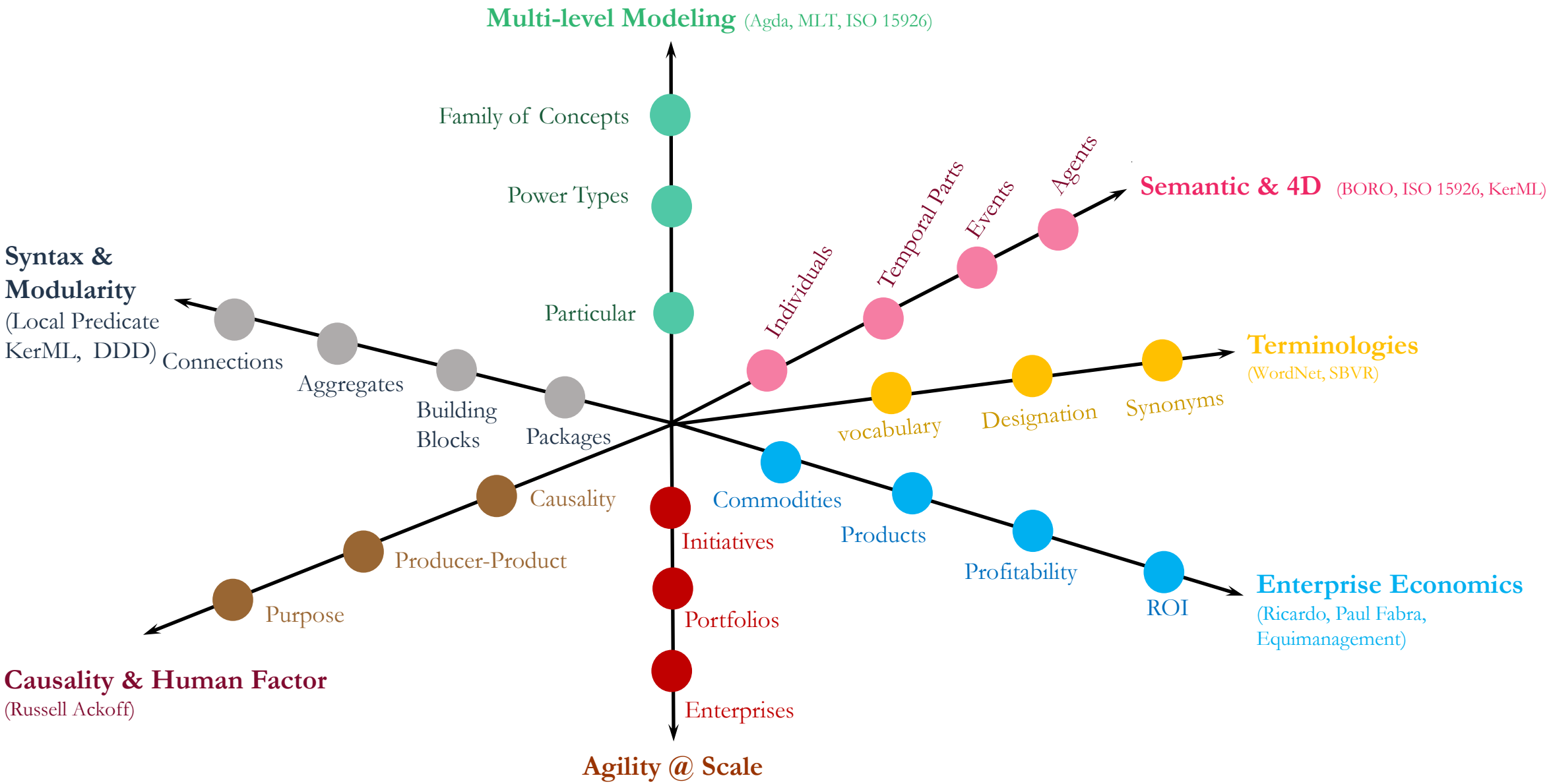
- SysFEAT contributes to conceptual modeling and ontology-based enterprise architecture by integrating multiple theoretical and standard foundations into a coherent, systemic framework.
  - SysFEAT extends established modeling standards such as ISO 15926, BORO, UFO, KerML, and SBVR by introducing lexical scoping, compositionality, and modularity as first-class principles for handling locality, context, and abstraction, linking ontology with mathematical formalization in the Agda language.
  - SysFEAT 4D semantic grounding builds on KerML, ISO 15926, BORO and Matthew West's work to capture temporal and extensional identity.
  - SysFEAT brings enterprise economics principles into enterprise architecting.

- In doing so, SysFEAT provides a unifying meta-ontological foundation that harmonizes and extends existing standards to better model, reason about, and manage the complexity of socio-technical and enterprise systems.

Introduction – a formalized theory

- All SysFEAT formalizations are expressed in Agda, a dependently typed functional programming language and proof assistant that serves as a formalization language, where types are first-class citizens and programs are synonymous with mathematical proofs.
- Agda provides a highly expressive foundation for SysFEAT's ontological requirements by leveraging its advanced dependent type theory:
  - Enforces the construction of local predicates through ∑-types and dependent records, which intrinsically index properties to specific contexts and prevent the trap of uncontextualized global definitions.
  - Enables multi-level classification, thanks to its polymorphic universe hierarchy (e.g., Set u or Type u), naturally modeling powertypes where concepts at one level mathematically instantiate those at a higher universe level without the need for cumbersome wrapper structures.
  - Handles the complex reflexivity required when powertypes act as subtypes of their own powerinstances.

Overview of SysFEAT's foundations



Terminology

"To name things wrongly is to add to the misfortune of the world."
— Albert Camus (related sentiment)

WordNet resource

- Before building a domain ontology, provide a **head start** so you aren't starting from scratch with every concept and relationship.
- WordNet acts as a **semantic scaffold**:
  - It helps define **classes and subclasses**.
  - It disambiguates **word senses**.
  - It expands **vocabulary and synonyms**.
  - It ensures **semantic consistency**.
  - It supports **inference and reasoning** once the ontology is operational.

- SysFEAT as many references to wordnet resources: https://www.framework.SysFEAT.com/pages/0ffefae6600be4de.htm

Example: “Is Human a Sub-Type of Person ?”

- WordNet definitions:
  - “*Person*” in WordNet: https://en-word.net/ili/i35562
  - “*Human*” in WordNet: https://en-word.net/ili/i48657
- Conclusion:
  - When considered as individual entities, person and human are **synonyms**.
  - In the context of biological classification, they are **unrelated**.
- Lesson learned: **Always build on existing definitions rather than starting from a blank page.**

Person

Nouns

(n) individual, mortal, person, somebody, someone, soul *a human being; person, singular, assertive existential pronoun; pronoun, person, singular; quantifier; assertive existential "there was too much for one person to do"*

Hypernyms (1)

Hyponyms (60)

Derived Forms (4)

Holonyms (member) (1)

Meronyms (part) (2)

Human

Nouns

(n) homo, human, human being, man *any living or extinct member of the family Hominidae characterized by superior intelligence, articulate speech, and erect carriage*

Hypernyms (1)

(n) hominid *a primate of the family Hominidae*

Hypernyms (1)

Hyponyms (7)

Derived Forms (1)

Holonyms (member) (1)

SBVR - Semantics of Business Vocabulary and Business Rules

- SBVR in an OMG specification about "*documenting the semantics of business vocabularies and business rules for the exchange of business vocabularies and business rules among organizations and between software tools.*"

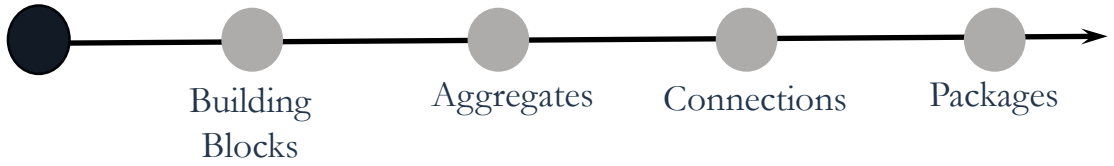
- Key concepts introduced by SBVR:
  - **Designation**: The formal link between a concept and the terms or phrases that represent it.
  - **Synonymy**: The explicit recognition that different terms can designate the same concept.
  - **Vocabulary & Speech Communities**: Emphasizes that meaning is defined within the context of a specific community that shares a common language (vocabulary)."

- SysFEAT references to SBVR: https://www.framework.SysFEAT.com/pages/732afa5663d7d175.htm

Modularity & Compositionality Why?

Complexity is good; It is confusion that is bad

Don Norman : The DESIGN of EVERYDAY THINGS



The need for syntax: scientific foundations

- Holland, John H.. Signals and Boundaries: Building Blocks for Complex Adaptive Systems (The MIT Press) (p. 36).
  - *Typically, the rules of deduction are drawn from symbolic logic, in which the rules manipulate symbols without reference to the interpretation or the meaning of the symbols. That is, the manipulations are syntactic, depending only on the arrangement of the symbols. <..>*
  - *This syntactic approach comes close to being a sine qua non for theoretical science. Matters of speculation and interpretation are moved from the argument back to the premise.*

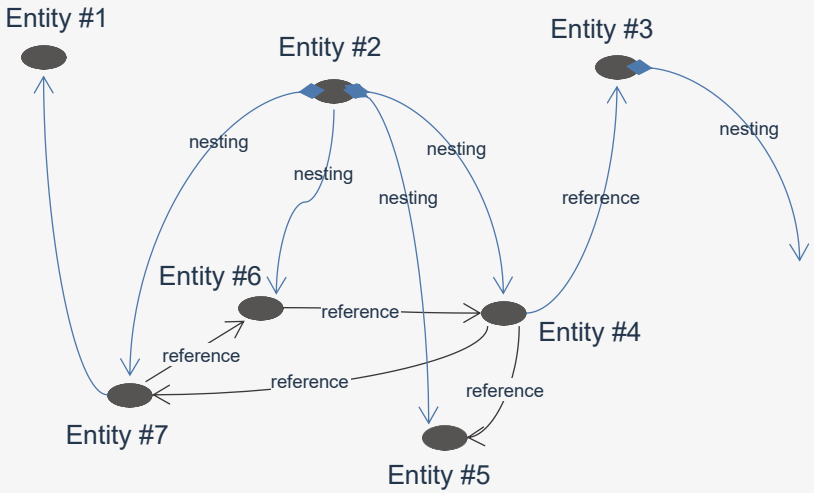
- Not only an ontology concerns, but rather an architectural concept:
  - In business and technology, this is reflected in Modularity Theory, which explains product adoption and market performance, as championed by the Christensen Institute)
  - https://www.christenseninstitute.org/theory/modularity/

SysFEAT layered approach of relationships

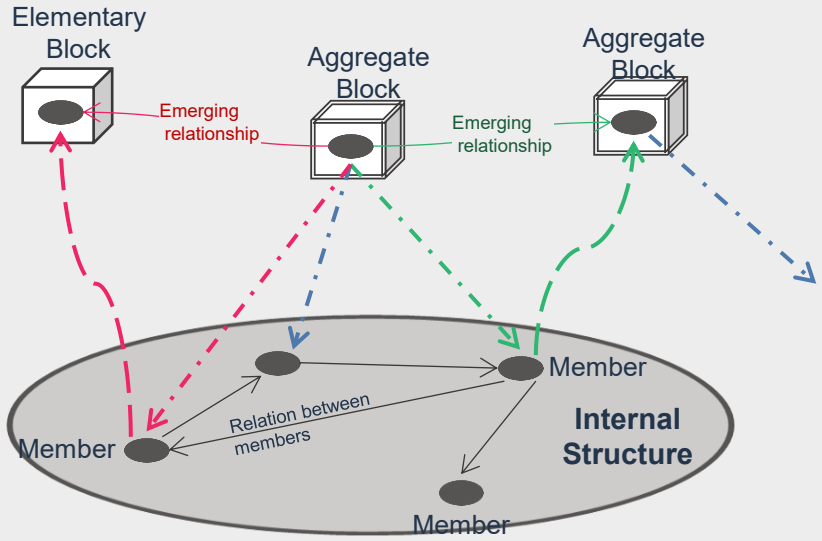
The modularity principles of SysFEAT aims at providing modular connectable structures, using a layered approach of relationships.

1. Locality of relationships: every relationship is anchored in its source entity: it lives inside the source.
2. Lexical scoping provides the ability to nest entities *(namespace in KerML)*.
3. Compositionality provides dynamic locality for entities *(aggregates in DDD, that and connectors in KerML).*

Elementary Graph



Secondary Graph



SysFEAT modularity documents

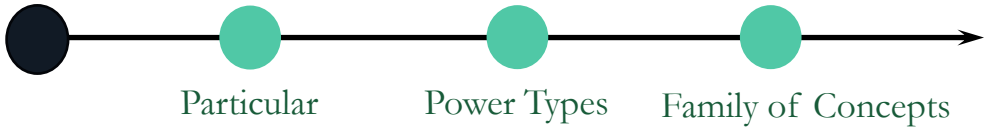
- Detailed descriptions of the locality principle are available in the following document:
  - SysFEAT-TheoraticalFoundations-LocalityPrinciple.pdf

- Detailed descriptions of the various aspect of modularity are available in the following document:
  - SysFEAT-ModelingFramework-01-Modularity.pdf

Muti-level modeling and conceptual partitioning

"The major problems in the world are the result of the difference between how nature works and the way people think."

— Gregory Bateson,



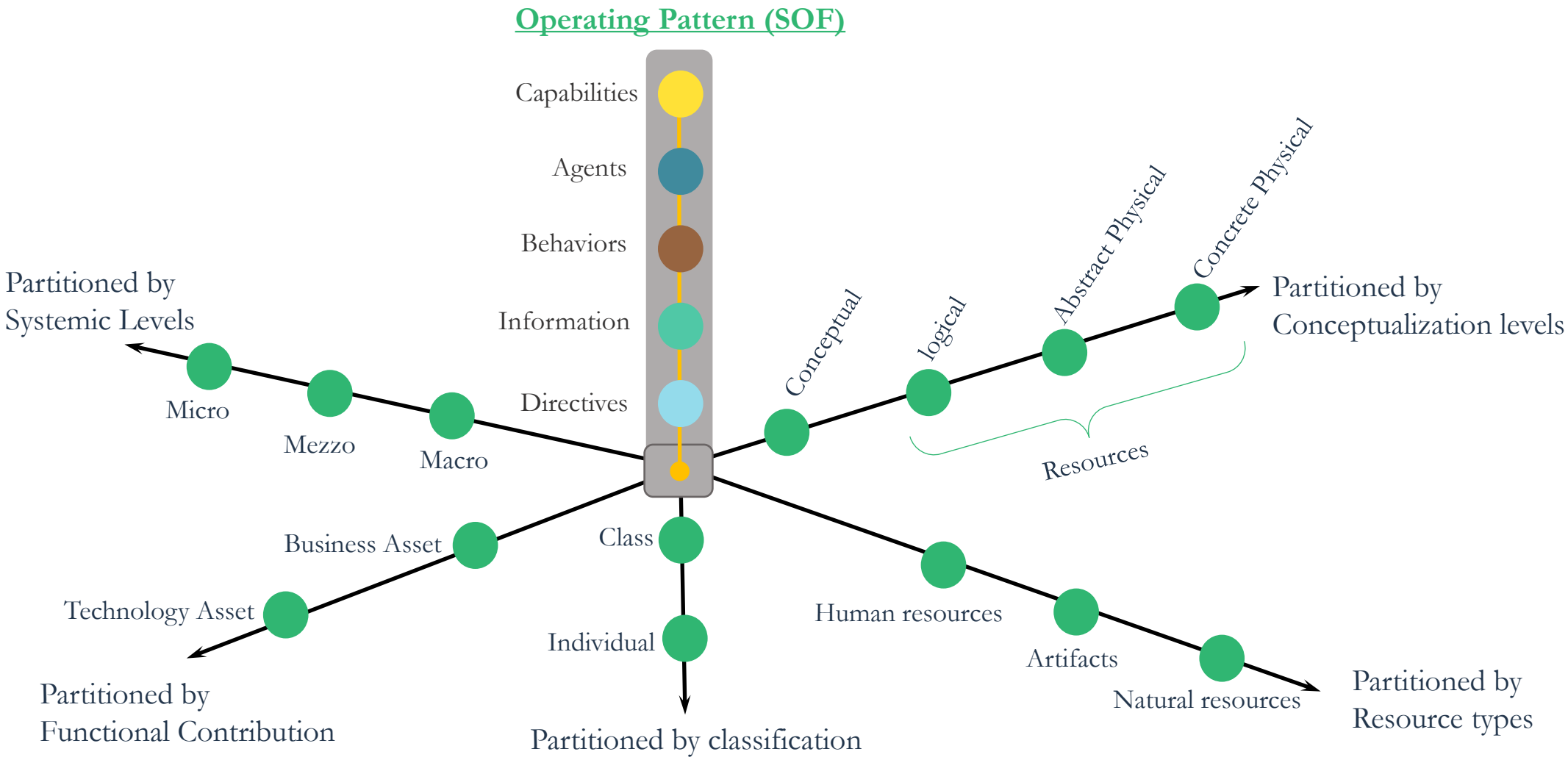
Metamodeling foundations.

- SysFEAT combines and extend ISO-15926, MLT, BORO and Cyc approaches by:
  - Grounding multi-level classification on power-types (MLT and BORO).
  - Adding meta-circularity (Cyc), based on non-well founded set theory (Mattthew West and Stanford Encyclopedia of Philosophy) and power-types.
  - Organizing conceptualization patterns as set theory partitions.

Multi-level modeling

- **Multi-level stratification**: the world is higher-ordered (UFO is finally adopting it through its MLT initiative).
- **Power-types as meta-classes**: it gives the foundation for a layered classification of higher order types (Cyc has MLT meta-classes but they are not power-typed based).
- **Meta-circularity**: need for self-referential meta-classes, that live at higher levels but can instantiate themselves.
  - This avoids artificial separation between meta-class levels. The system can represent and reason about itself.
- **Meta-Patterns**: need to group classes in family of classes and be able partitions class hierarchies by level of abstraction.

The SOF as an example of partition based conceptual patterns



4D, spatio-temporal semantics

"He who has been can no longer not have been: henceforth this mysterious and profoundly obscure fact of having lived is his viaticum for eternity"

Vladimir Jankélévitch, L'Irréversible et la Nostalgie.

Matthew West – ISO 15926 - BORO

- 4-dimensional foundation (Matthew West)
  - 4-dimensional spatio-temporal extents with extensional identity,
  - Dissective and non-dissective classes,
  - 4-Dimensional Patterns,
    - Mereology and replaceable parts,
    - Levels of reality for what things are constituted from,
    - Activities and events,
    - Roles as temporal parts of individuals,
    - Relationships as states with states of individuals as parts,
    - Possible Worlds for dealing with plans,
  - Classes as sets, since membership does not change,
  - Properties of various sorts including physical quantities

- SysFEAT integrates the 4D the above foundations while combining them with KerML and the pattern of Compositionality:
  - Events as behavior boundaries.
  - Interaction behaviors as boundaries of agents.
  - Contextual properties to qualify internal parts.
  - Inheritance from dynamic locality (an aspect of compositionality).

Undergoing work to map with UFO (properties and identity)

- Matthew West (about properties)
  - On the other hand, the traditional idea of a property, with the notable exception of temporal properties, would seem to correspond closely to temporally dissective sets of individuals.
  - Thus properties are inherited by states of the spatio-temporal extent to which they apply (although it is not only individuals that can have properties).

- Mathew West (this is about UFO Kind):
  - It is interesting to note that temporally non-dissective sets correspond closely to the traditional idea of natural kinds, and can perhaps be thought to usefully be the 4-dimensional definition of a natural kind. (Ontology Meet business)

Causality and Human Factors

It cannot be stressed enough that the indiscriminate application of engineering concepts to biological situations is fraught with danger.

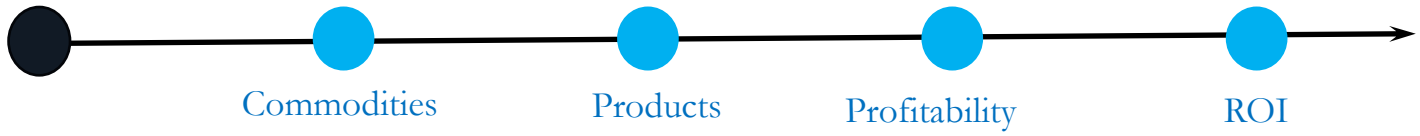
Russell Ackoff

Choice and purposeful individuals – Russel Ackoff

- **Purposeful individuals** are agents capable of choosing among alternatives based on goals, values, and anticipated consequences rather than merely reacting to stimuli.
- This introduces what Ackoff called **probabilistic causality (producer–product)** into choice processes:
  - instead of behavior being determined by past events (as in deterministic, mechanistic causality), a purposeful individual's actions are *produced* by expectations about desired future states.
  - The "product"—the outcome the individual intends—serves as a **probabilistic cause** of present choices, shaping behavior through forecasts, preferences, and perceived likelihoods of achieving goals.
  - In Ackoff's systems view, this forward-looking, goal-directed causality explains how purposeful agents navigate uncertainty and select actions that increase the probability of producing preferred outcomes.
- Purposeful individual constructs a mental model of reality—an internal, evolving representation used to imagine possible futures, assess probabilities, and choose actions that advance preferred outcomes.
  - Teleology becomes objective when purpose is inferred from how an agent uses its mental model to select actions that consistently increase the probability of producing particular outcomes—making purposive behavior analyzable within a systematic, scientific framework.
- Probabilistic causality: Russell Ackoff - Choice & Communication
  - Classifications based on the common properties of production enable us to define the concepts of function, goal-seeking, and purpose with all the rigor of the concepts used in the physical sciences, and yet retain the core of meaning these terms have gained over the ages

Enterprise Economics

Automatically attributing to individuals a universal will to maximize their personal gain is not a liberal principle, despite claims to the contrary. The foundation of a free society is that every person—natural or legal—must take full responsibility for their self-determined goals, knowing that the initial creators of economic wealth, are individuals.



Agile @ Scale

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