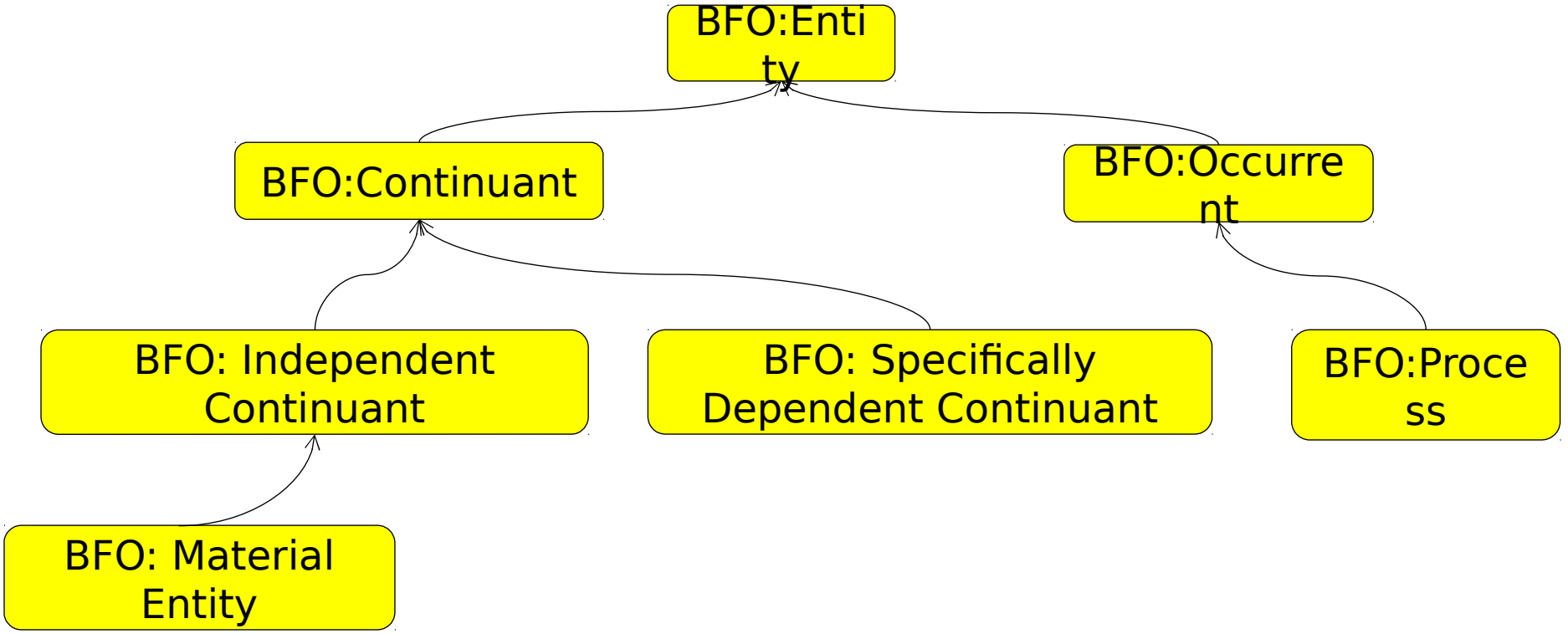
On Realizables: Roles, Dispositions, Capabilities, Functions

Barry Smith

ESAO, September 10, 2021

BFO = Basic Formal Ontology



Building Ontologies with Basic Formal Ontology

By Robert Arp, Barry Smith and Andrew D. Spear

Overview

In the era of "big data," science is increasingly information driven, and the potential for computers to store, manage, and integrate massive amounts of data has given rise to such new disciplinary fields as biomedical informatics. Applied ontology offers a strategy for the organization of scientific information in computer-tractable form, drawing on concepts not only from computer and information science but also from linguistics, logic, and philosophy. This book provides an introduction to the field of applied ontology that is of particular relevance to biomedicine, covering theoretical components of ontologies, best practices for ontology design, and examples of biomedical ontologies in use.

After defining an ontology as a representation of the types of entities in a given domain, the book distinguishes between different kinds of ontologies and taxonomies, and shows how applied ontology

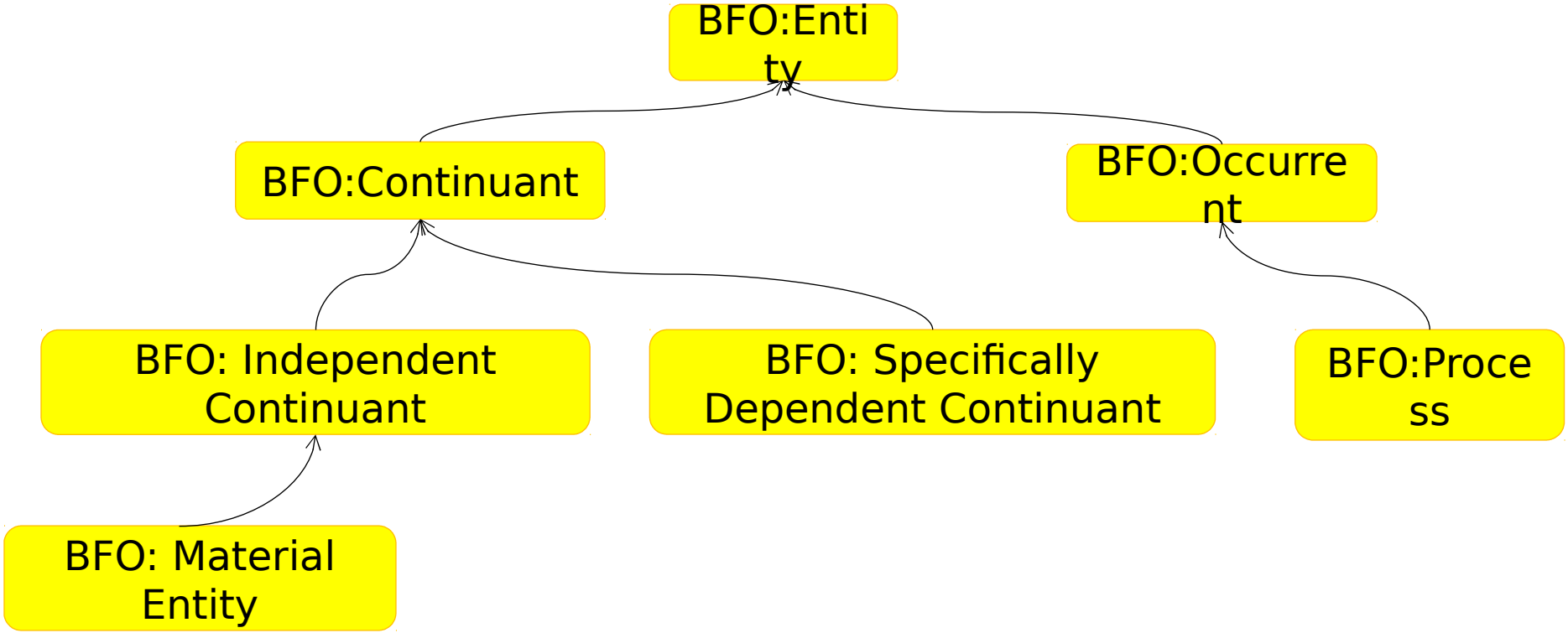
Paperback | $30.00 | £20.95 | ISBN: 9780262527811 | 248 pp. | 7 x 9 in | 32 b&w illus.| August 2015

http://mitpress.mit.edu/building-ontologie

~ 400 ontologies re-using BFO

ACGT Master Ontology (ACGT MO)
Alzheimer Disease Ontology (ADO)
Adverse Event Ontology (AEO)
Adverse Event Reporting Ontology (AERO)
AFO Foundational Ontology
Actionable Intelligence Retrieval System (AIRS)
Bank Ontology
Beta Cell Genomics Application Ontology (BCGO)
BioAssay Ontology
Bioinformatics Web Service Ontology
Biological Collections Ontology (BCO)
Biomedical Ethics Ontology
Biomedical Grid Terminology (BiomedGT, retired)
BioTop: A Biomedical Top-Domain Ontology
BIRNLex: controlled terminology for annotation of BIRN data sources
Blood Ontology (BLO)
Body Fluids Ontology (BFLO)
Bone Dysplasia Ontology
Cancer Cell Ontology (OncoCL)
Cancer Chemoprevention Ontology (CanCo)
Cardiovascular Disease Ontology (CVDO)
Cell Behavior Ontology (CBO)
Cell Cycle Ontology
Cell Expression, Localization, Development and Anatomy Ontology (CELDA)
Cell Line Ontology (CLO)
Cell Ontology (CL)
Chemical Analysis Ontology (CAO)
Chemical Entities of Biological Interest (ChEBI)
Cigarette Smoke Exposure Ontology (CSEO)
CHRONIOUS Ontology Suite
Clusters of Orthologous Groups (COG) Analysis Ontology (CAO)
Cognitive Paradigm Ontology
Environment Ontology (ENVO)
Epidemiology Ontology (EO)
Epilepsy and Seizure Ontology (EPSO)
Evolution Ontology (EO)
Experimental Factor Ontology (EFO)
EXperimental ACTioins Biomedical Protocol Ontology (EXACT2)
Exposé: An Ontology for Data Mining Experiments
Flybase Drosophila Anatomy Ontology (FBbt)
Fission Yeast Phenotype Ontology (FYPO)
Flower-Visiting Domain Ontology (FV),
Flower-Visiting Behavior Application Ontology (FVB)
Foundational Model of Anatomy (FMA) Ontology
Gastrointestinal Endoscopy Ontology (GIEO)
Gene Regulation Ontology (GRO)
General Information Model (GIM)
Genomic Feature and Variation Ontology (GFVO)
Gestalt: Federated Access to Cyber Observables for Detection of Targeted Attack
Health Data Ontology Trunk (HDOT)
Human Interaction Network Ontology (HINO)
Human Physiology Simulation Ontology (HuPSON)
Infectious Disease Ontology (IDO)
Information Artifact Ontology (IAO)
Informed Consent Ontology (ICO)
Interaction Network Ontology (INO)
Interdisciplinary Prostate Ontology Project (IPOP)
Intracranial aneurysm (ICA) Ontology
Knowledge Base Of Biomedicine (KaBOB)
Known Flower-Visiting Group Domain Ontology (KFG)
Lipid Ontology
Materials Ontology (MatOnto)
Mental Disease Ontology (MDO)
Mental Functioning Ontology (MF)

BFO = Basic Formal Ontology



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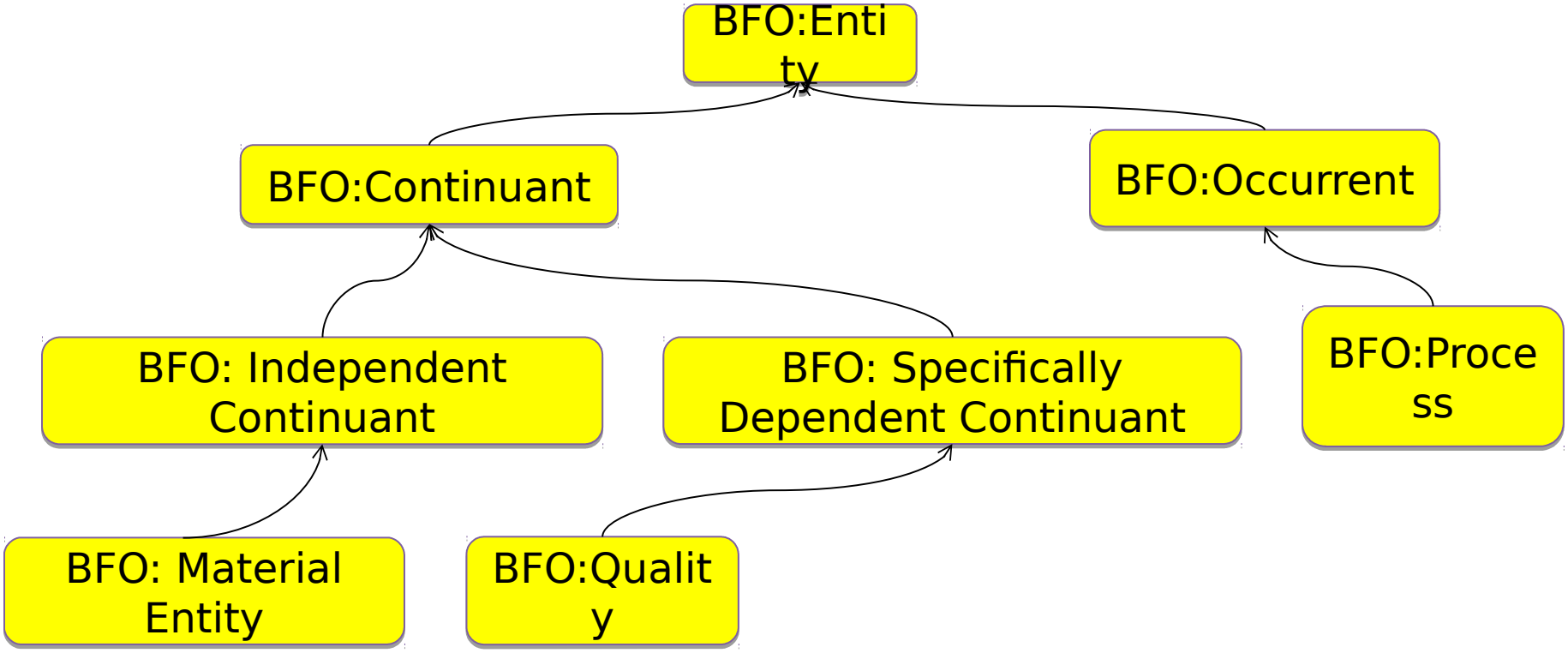

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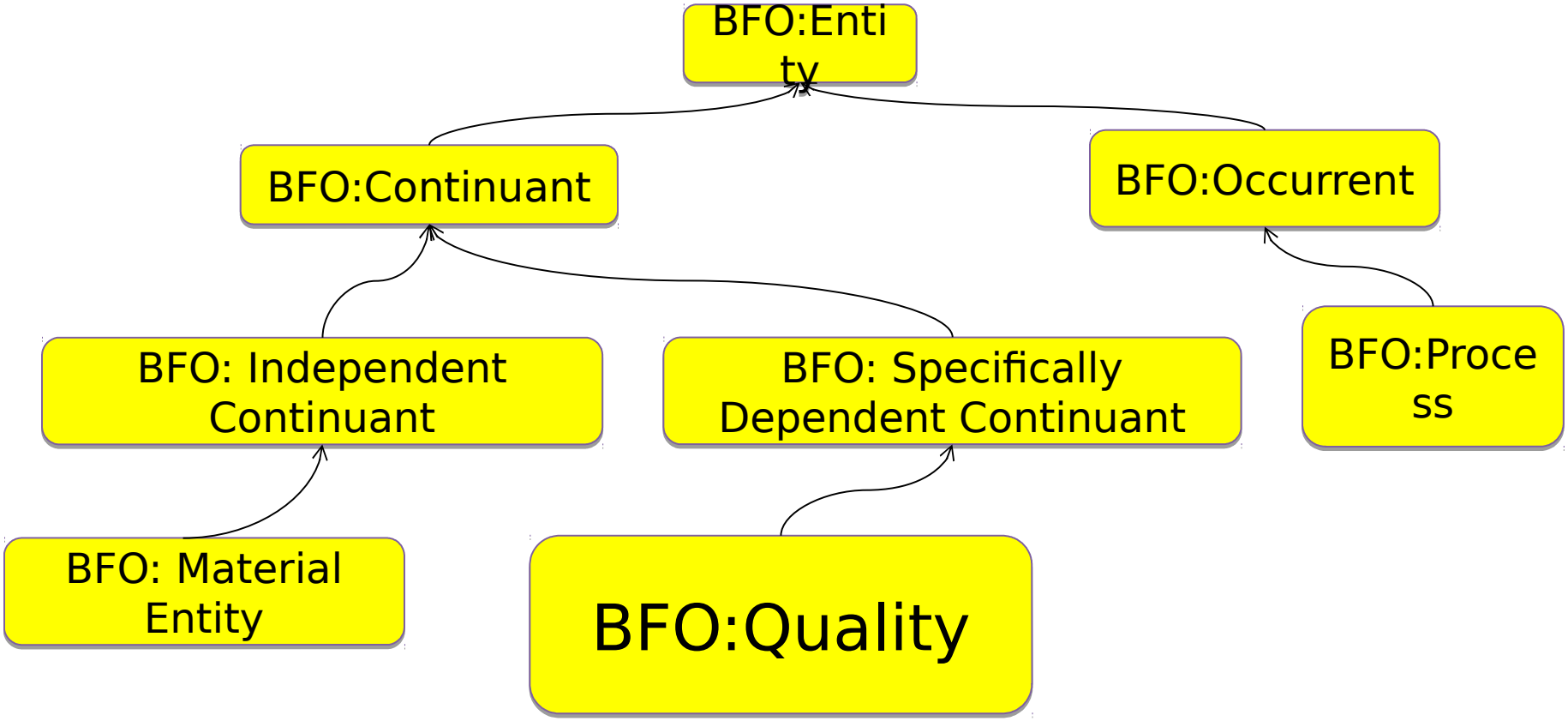
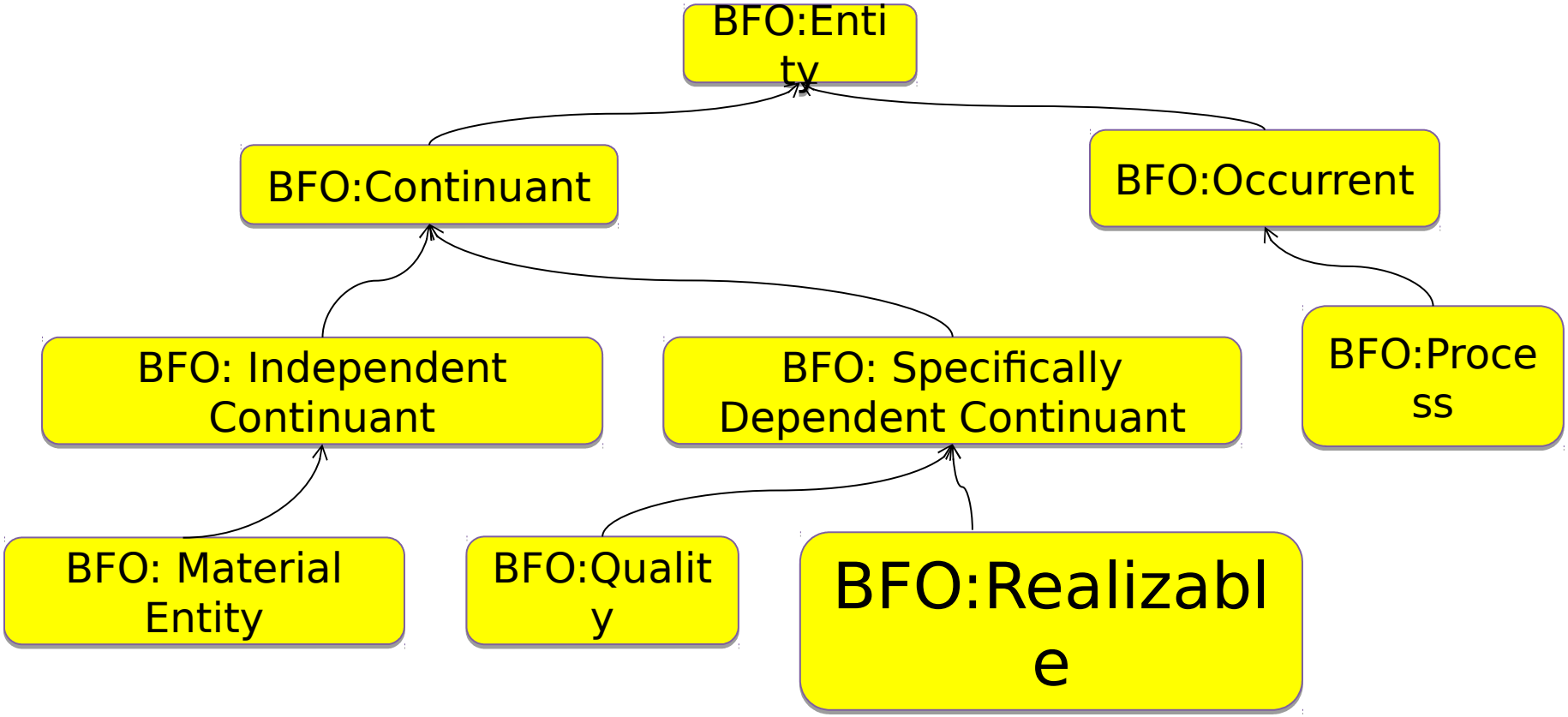


Qualities are realized whenever they exist

BFO = Basic Formal Ontology



BFO:Realizable Entity

attribute of an independent continuant entity that only becomes manifest under certain conditions

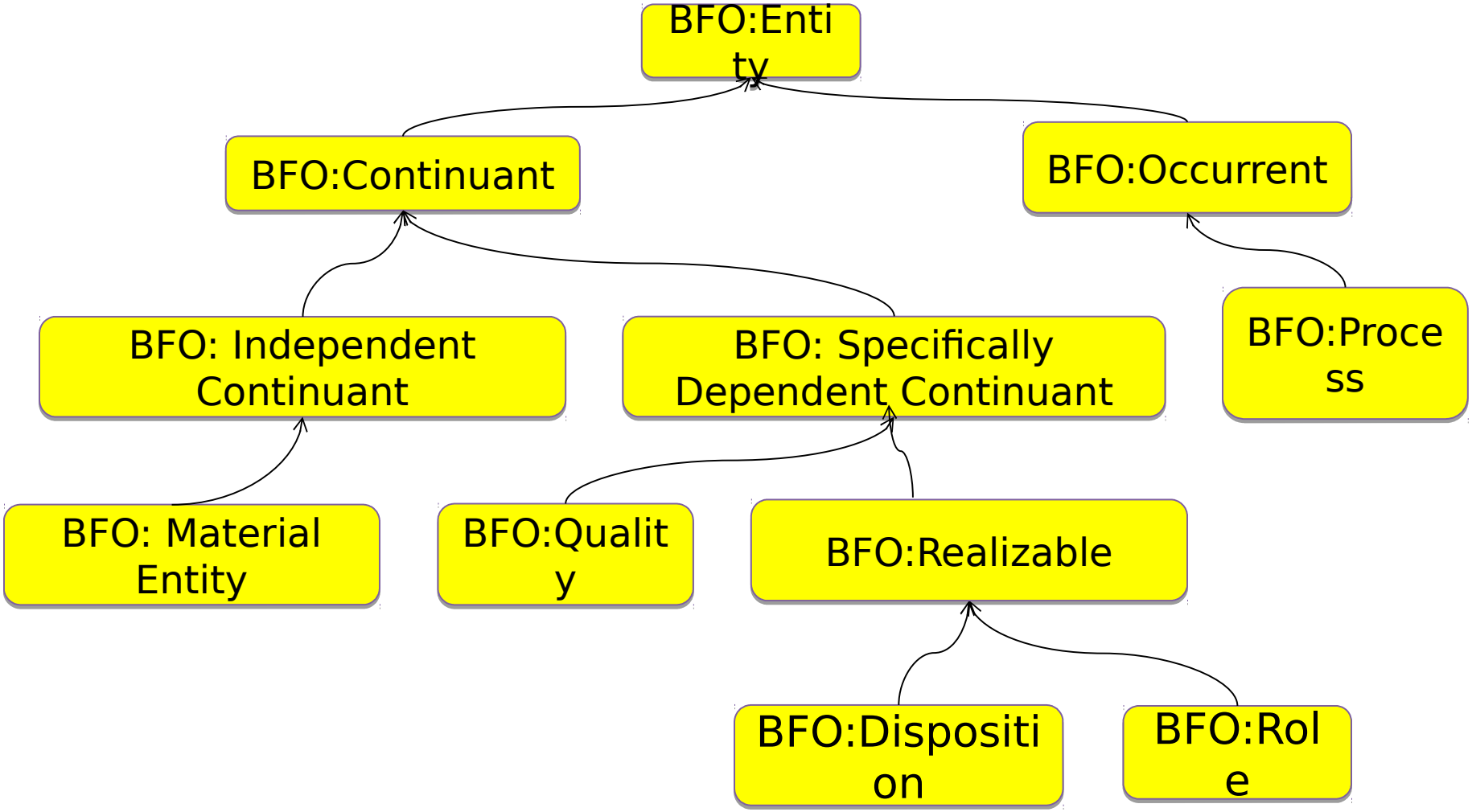
- externally grounded = **role**
- internally grounded = **disposition**

You have the **role** of student even when you are asleep

You have the **disposition** to go bald even when you are still hirsute

Disposition = a tendency/potential that an entity has because of the way it is structured physically

BFO = Basic Formal Ontology



Realizables and their realizations

- An instance of a realizable entity type need not be realized (some students never study)
- Each realizable entity *type* is associated with one or more BFO: process *types*
- The disposition to go bald is associated with the process of losing hair
- The role of student is associated with the process of studying

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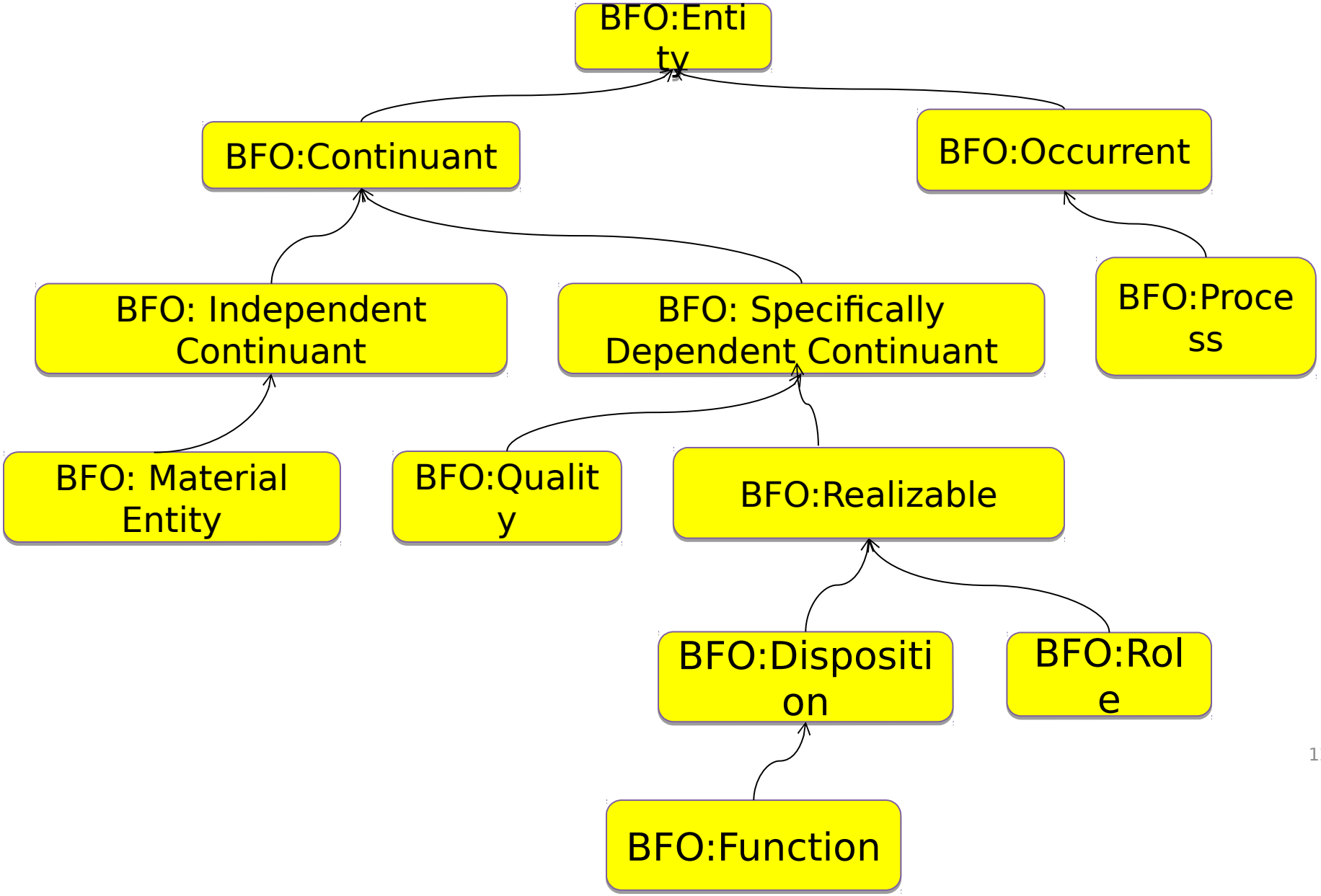


BFO Definition of Function

- Function = a disposition that an object has because it was designed or selected to do this thing (to realize this function)
  - function of heart = to pump blood
  - function of pump = to pump
  - function of screwdriver = to drive screws

  Every function is associated with a type of process whose instances are *realizations* of that function (pumping, heating, …)

Two kinds of functions

- biological (mitochondrion, lung, digestive system …)
- designed (artifacts: laptops, cellphones; organizations …)

To be the function of X $\approx$ to be the reason why X was selected for / made

Definition of ‘function’

Function =def. a disposition that an entity has because it was designed or selected to realize it

This is the **selected effect** theory of function (Ruth Millikan’s ‘proper function’)

Millikan (simplified)

Reproduction ≈ offspring, copy (some properties are reproduced)

A **has function** F =def.

1. A originated as a reproduction of some prior item or items that, due in part to possession of the properties reproduced, have actually realized F in the past, and

2. A exists because (causally historically because) of this or these realizations.

What kinds of entities can have functions?

Organs, bodily systems, …

Machines, artifacts in general …

Organizations: fire brigade, ant colony…

Colonial organisms can have functions

- the function of the worker ant is: to work

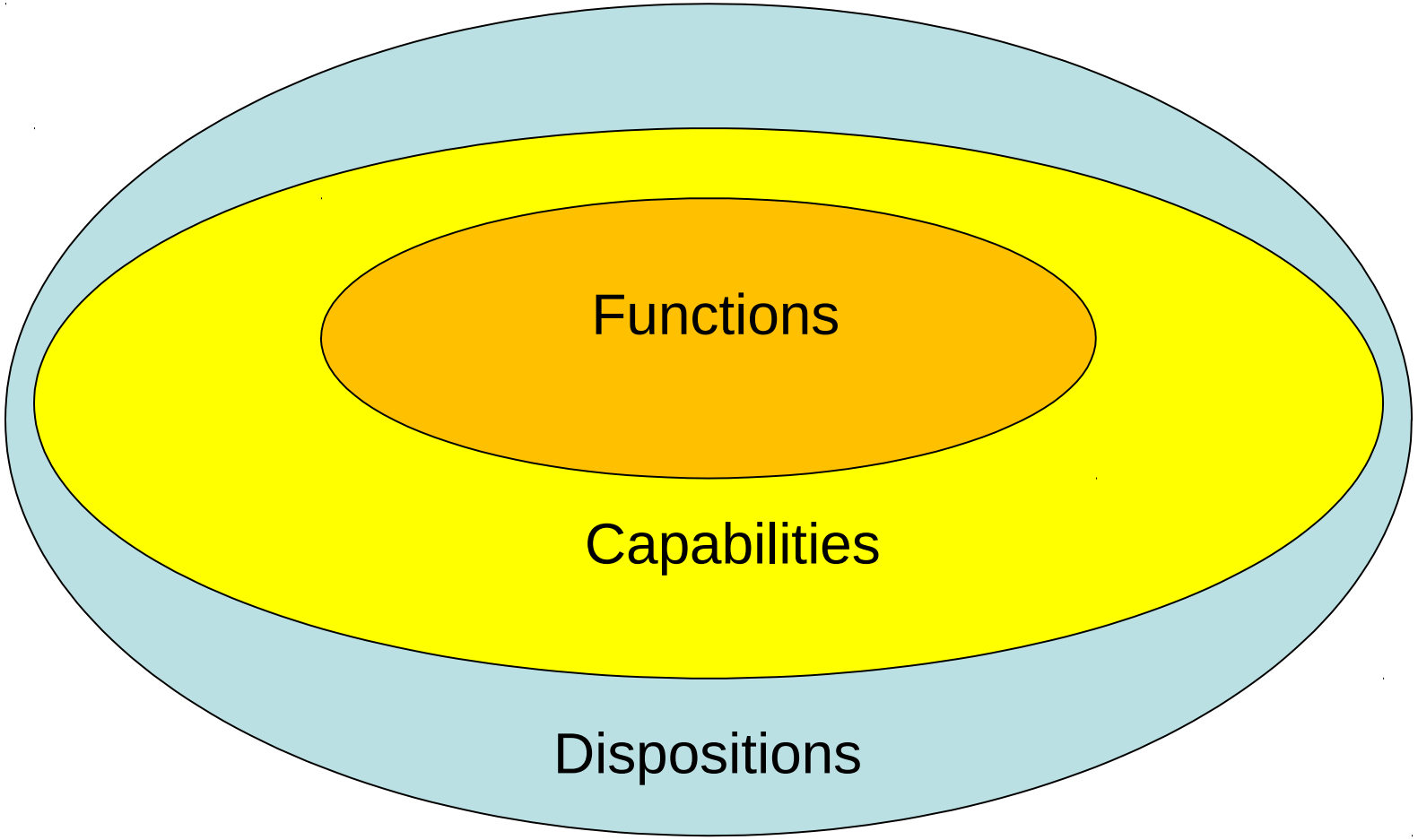
Hypothesis: people never have functions

My digestive system has the function: to digest food

I do not have the function: to digest food

I have the *capability* to digest food

Capabilities fall between Dispositions and Functions



Every Function *is_a* Capability

Every Capability *is_a* Disposition

What kinds of entities can have capabilities

Organs, bodily systems, parts of organisms in general…

Machines, artifacts in general, parts of machines…

Organisms, very much including people

Groups of people, capabilities

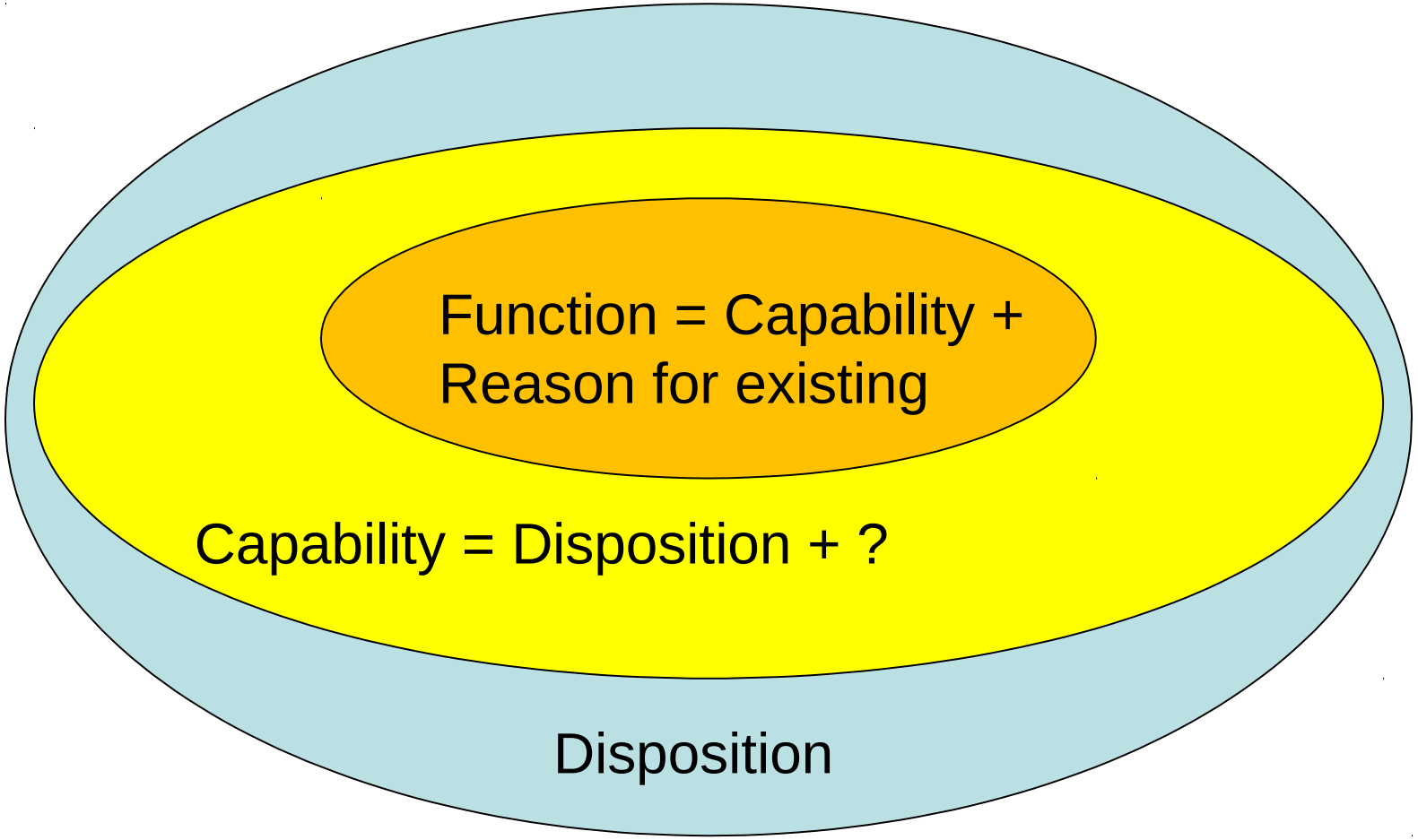
Complex artifacts typically have many capabilities in addition to the function for which they were designed

Artifacts have functions and other capabilities

An artifact's function is the reason why the artifact was built (why the bearer of the function exists)

But artifacts also have capabilities (e.g. to operate at high temperature, to operate continuously, to operate safely, …)

How to define ‘capability’?



Function and capability

My digestive system has the *function* to digest food

Therefore, *I* have the *capability* to digest food

Many more capabilities than functions

I have the *capability* to digest tiramisu, but nothing in my body has the *function* to digest tiramisu

My car has the *function* to transport people, but it has the *capability* to *transport people safely*, to *drive for 10,000 miles without an oil change*, to *connect to the internet*, …, …

Capability: Proposed Definition

capability =def. a disposition whose realization an organism or group of organisms has an interest in

Examples:

to ripen, to breathe, to speak Latin, to perform a symphony, to manufacture cars, to transmit torque, to generate heat in an oven, to act as a paperweight …

Elucidating ‘has an interest in’

This relation must satisfy the following four axioms:

1. *Biological Axiom*

- Every organism has an interest in the realization of the functions of all its parts

2. *Prescription Axiom*

- If a person or group of persons has a plan, then there is an interest in all the realizations prescribed by that plan

3. *Facilitation axiom*

- If *x* has an interest in the realization of disposition *y*, and the realization of disposition *z* is required for the realization of disposition *y*, then *x* has an interest in the realization of disposition *z*.

4. *Permanence axiom*

- If *x* has an interest in the realization of disposition *d* at time *t*, then *d* is a capability at *t* and at all times subsequent to *t* at which *d* exists.

Normativity

Functions satisfy normativity. This means: they are such that their realizations

1. can be graded on a scale from zero to positive and

2. (when in the normal range) bring benefits to an organism or group of organisms

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Functions in Basic Formal Ontology

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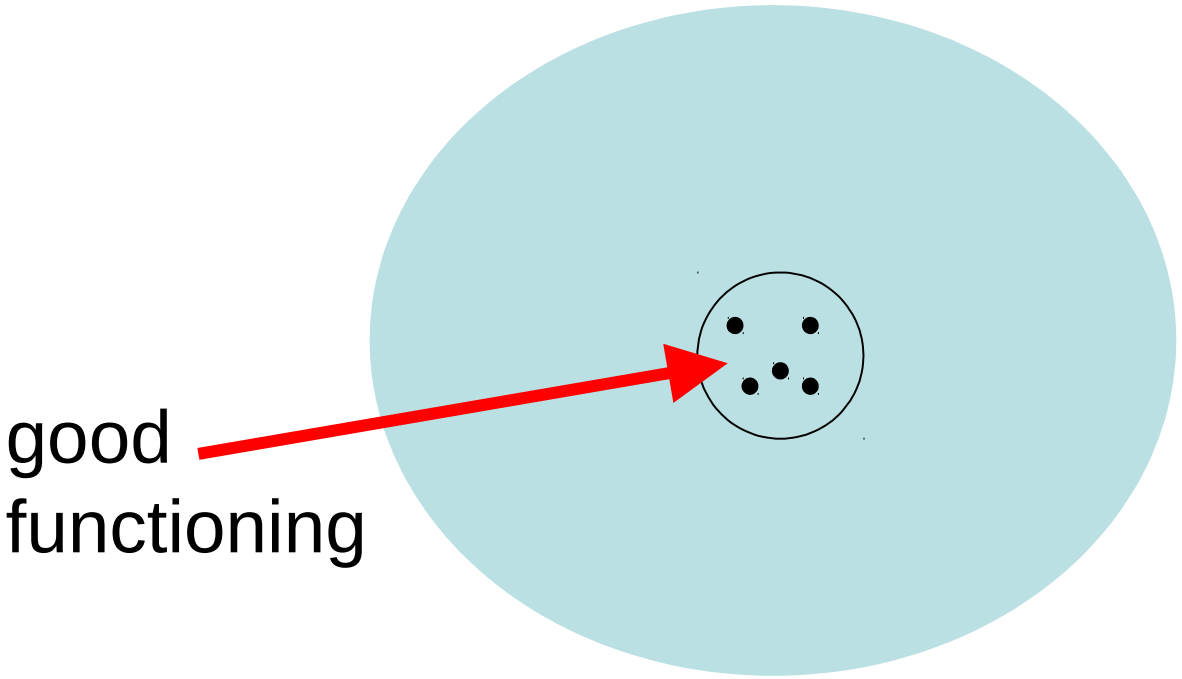
Abstract. The notion of function is indispensable to our understanding of distinctions such as that between *being broken* and *being in working order* (for artifacts) and between *being diseased* and *being healthy* (for organisms). A clear account of the ontology of functions and functioning is thus an important desideratum for any top-level ontology intended for application to domains such as engineering or medicine. The benefit of using top-level ontologies in applied ontology can only be realized when each of the categories identified and defined by a top-level ontology is integrated with the others in a coherent fashion. Basic Formal Ontology (BFO) has from the beginning included *function* as one of its categories, exploiting a version of the etiological account of function that is framed at a level of generality sufficient to accommodate both biological and artifactual functions. This account has been subjected to a series of criticisms and refinements. We here articulate BFO's account of function, provide some reasons for favoring it over competing views, and defend it against objections.

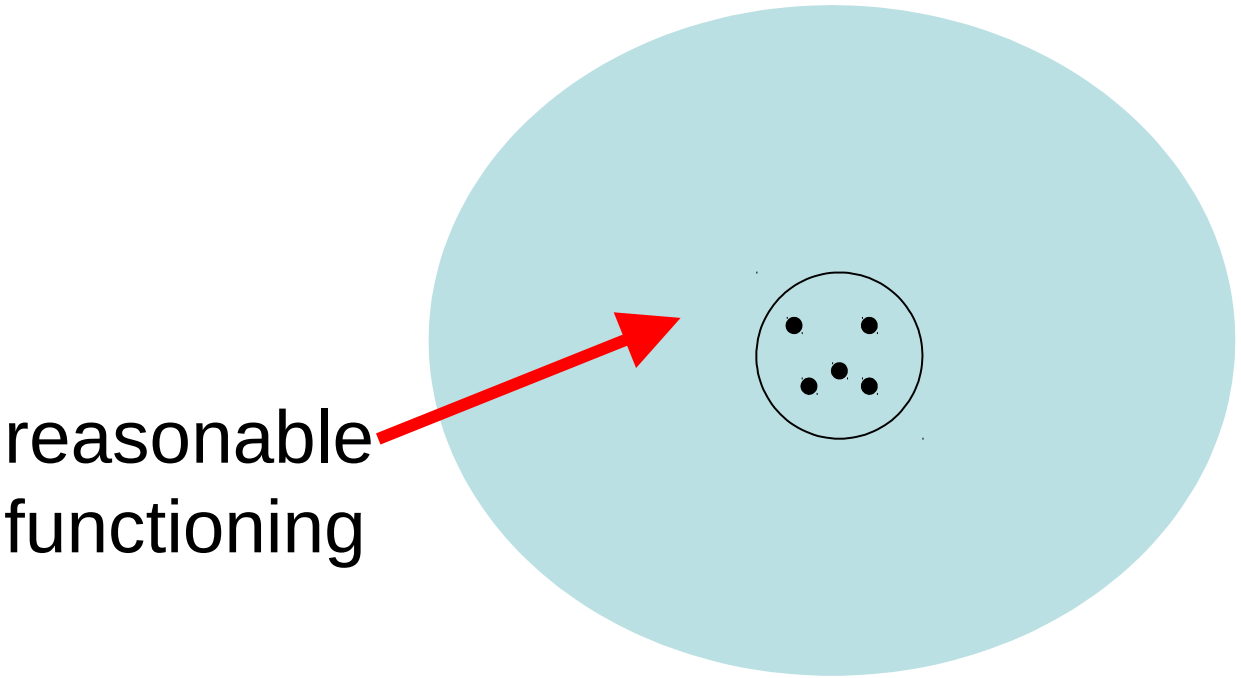
Keywords: Function, disposition, Basic Formal Ontology, biological function, artifacts, malfunction

Accepted by: Pawel Garbacz

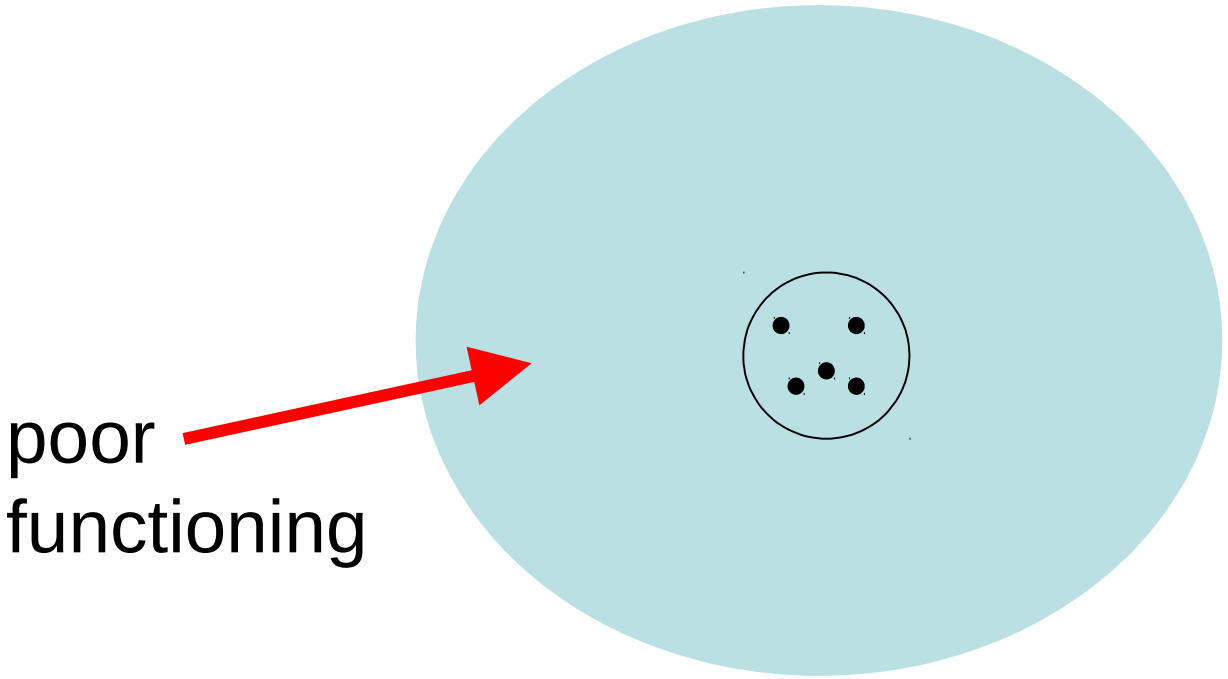
Prototype function*ings* of the heart



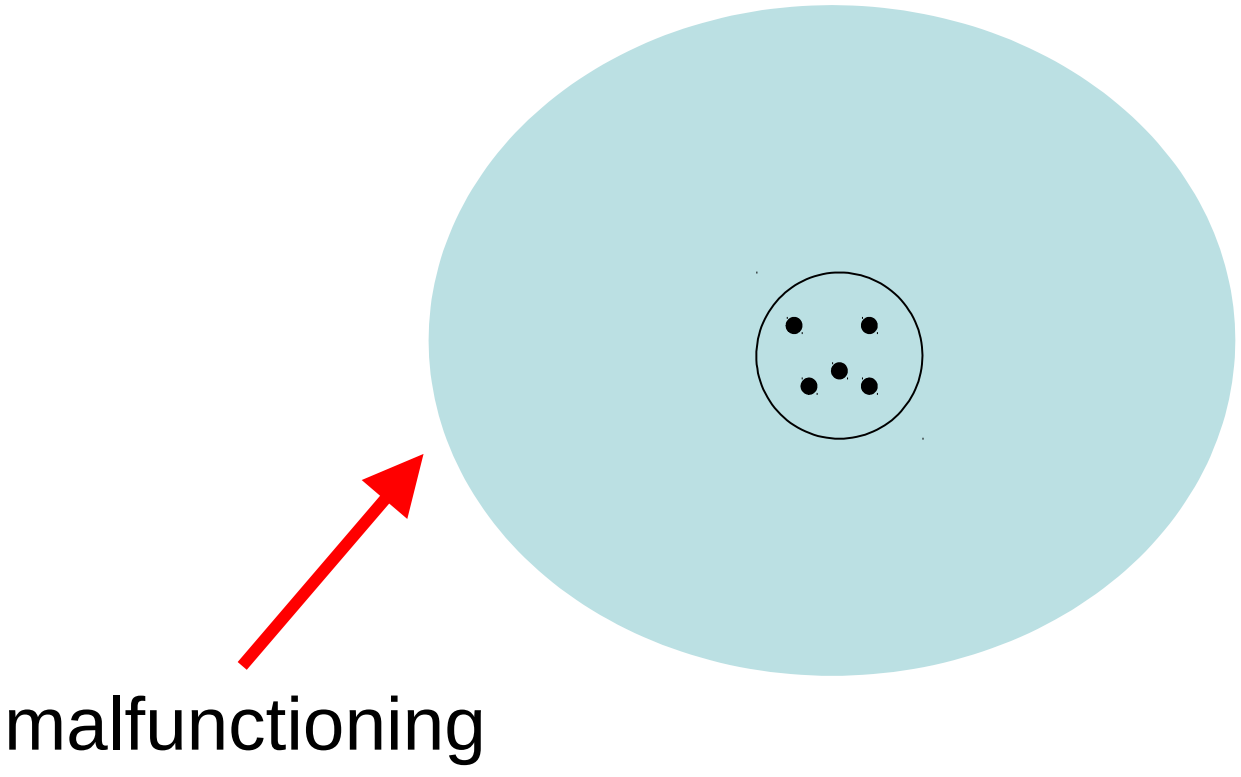
Modest deviation from the prototype



Poor functioning



Malfunctioning



You’re dead, Jack

Normativity is a necessary but not a sufficient condition of function

There are dispositions which satisfy normativity which are not functions

The lathe operator has a disposition to operate a lathe, but that is not her function

(People do not have functions)

The car has the disposition to play stereo music, but that is not the car’s function

Normativity = gradeability + benefit

We know that all functions display normativity

Do all capabilities display normativity?

Is there anything that is not a capability that displays normativity?

Biological Axiom Every organism has an interest in the realization of the functions of all its parts

Prescription Axiom If a person or group of persons has a plan, then there is an interest in all the realizations prescribed by that plan

Facilitation axiom If *x* has an interest in the realization of disposition *y*, and the realization of disposition *z* is required for the realization of disposition *y*, then *x* has an interest in the realization of disposition *z*.

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