The Ontological How and Why – Action and Objective – of Planned Processes in the Food Domain

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6th August 2022
at the Integrated Food Ontology Workshop (IFOW),
part of the Joint Ontology Workshops (JOWO), Jönköping, Sweden

Aims

Organise an upper-level hierarchy of **food processing terms**

- Differentiate between processing:
    - **objectives** - metrics for completion
    - **mechanisms** that can achieve such objectives over time

- Explore representation of other dimensions of process categorization in a knowledge graph
    - e.g. macro (food entity) and micro (molecular) processes; physico-chemical processes

Future: apply process model patterns to real-world data:

- Harmonising datasets where analytical data is limited/siloed (e.g. food composition databases involving processed food)
- Structured datasets for computational models
- Robotics as a test of granularity

The basics - BFO **Process**

"An occurrent that has temporal proper parts and for some time t, p s-depends_on [specifically depends on] some material entity at t."
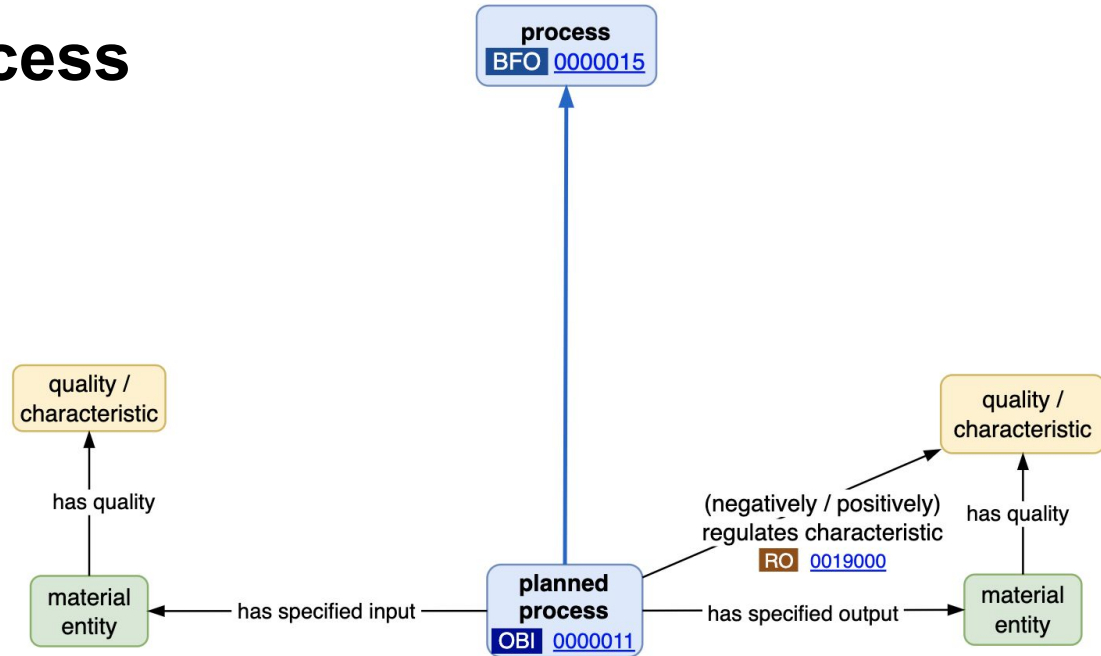
OBI/COB **Planned Process**

A process changes stuff!

COB: "A process that is initiated by an agent who intends to carry out a plan to achieve an objective through one or more actions as described in a plan specification"

- Lets review the relations emanating from a process

- Then we can examine the planned process hierarchy

COB = Core Ontology for Biology and Biomedicine

Planned Process Review

- Objectives expressed as
  - Change in material characteristic
  - Change in process efficiency
- Actions (steps)
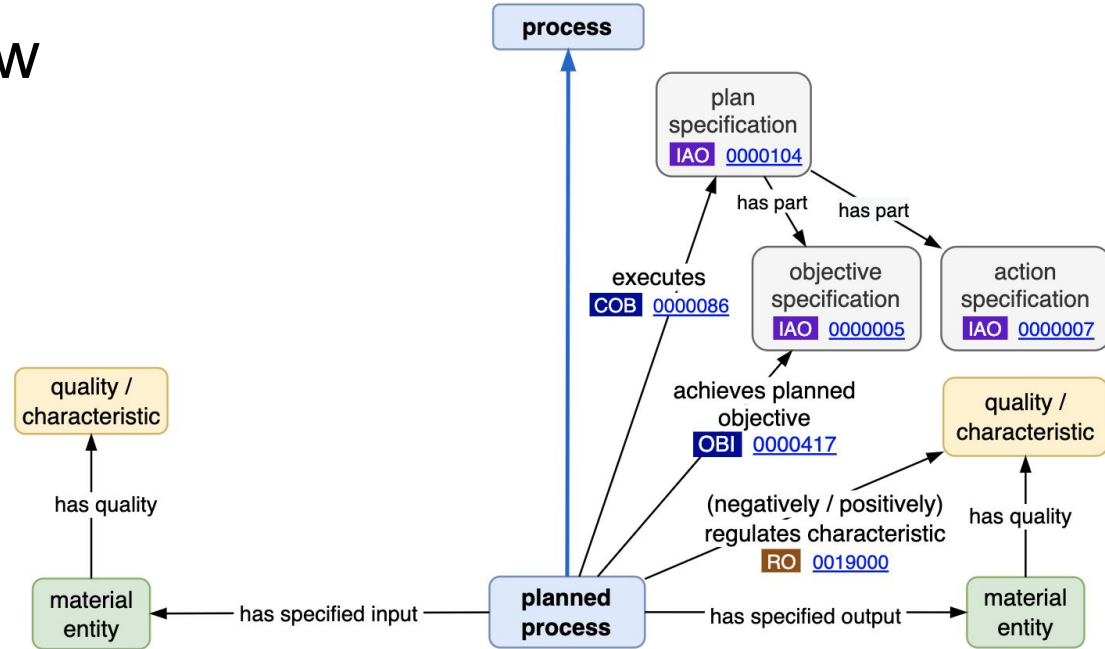
Planned Process Review

Process dependencies

Planned Process Review

Time:

- Instant
- Duration
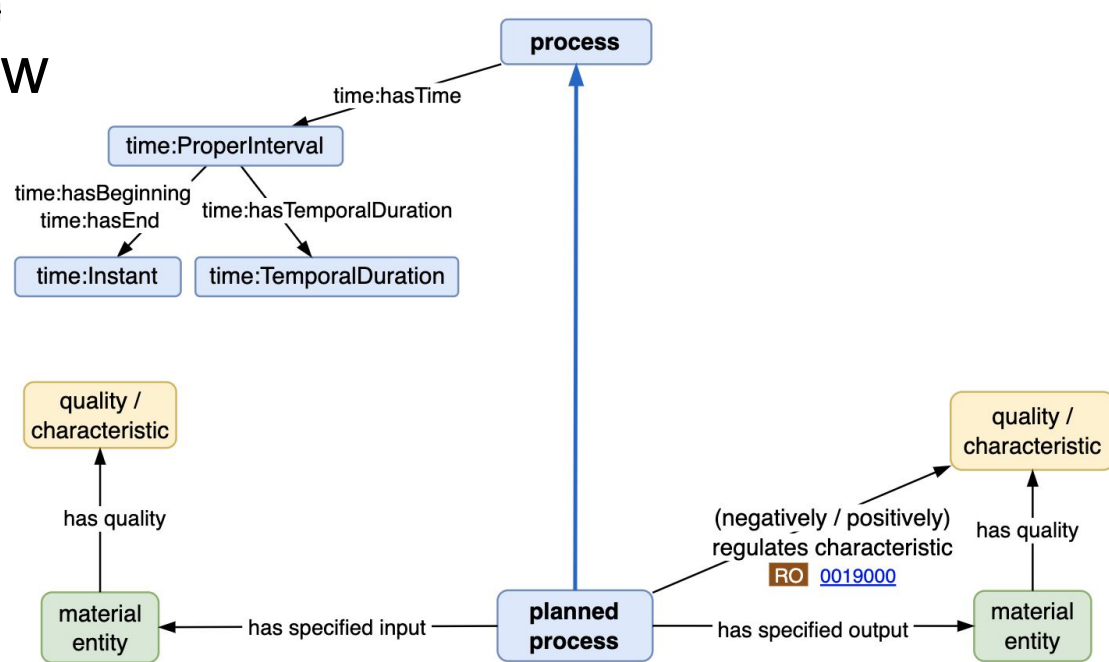
Planned Process Review

Information

Sensors and feedback loops
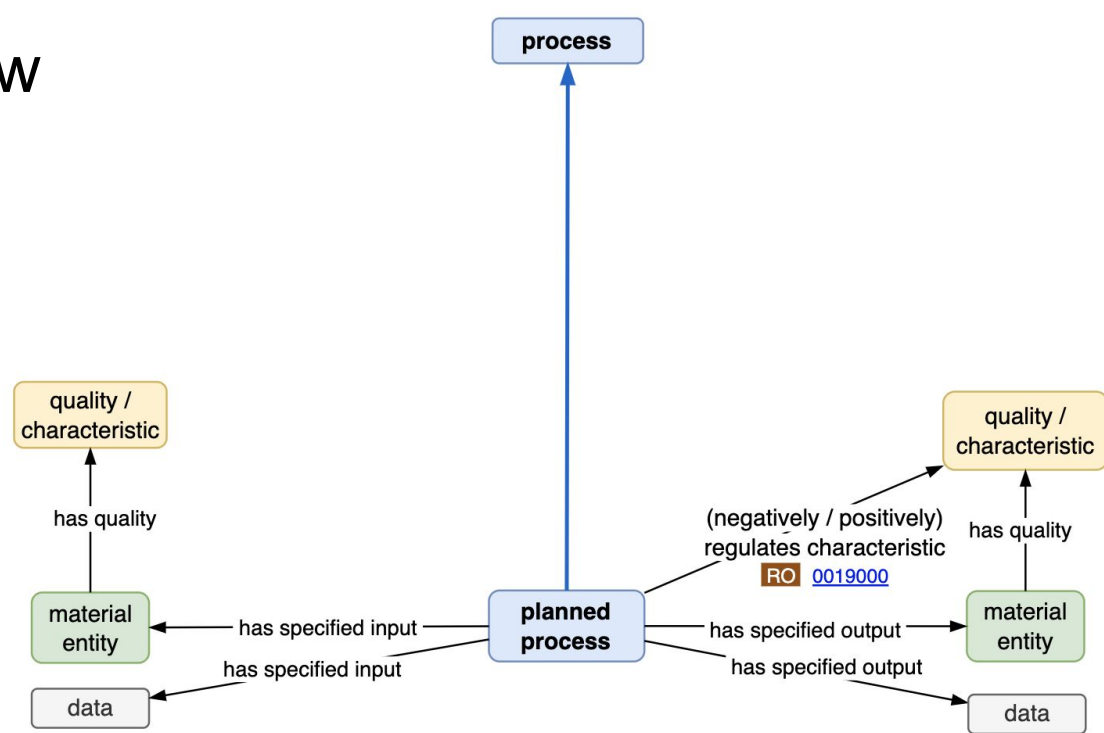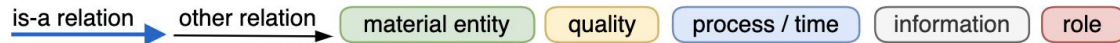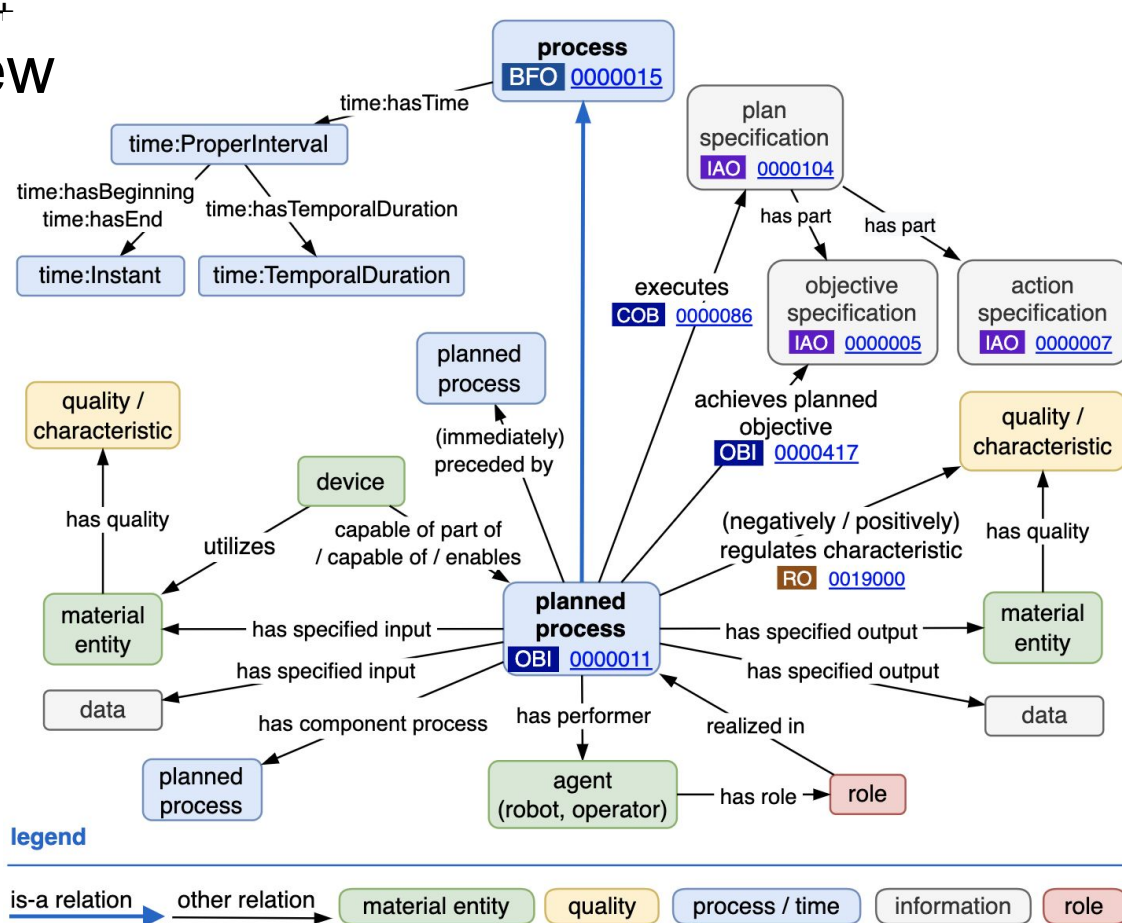
Planned Process Review

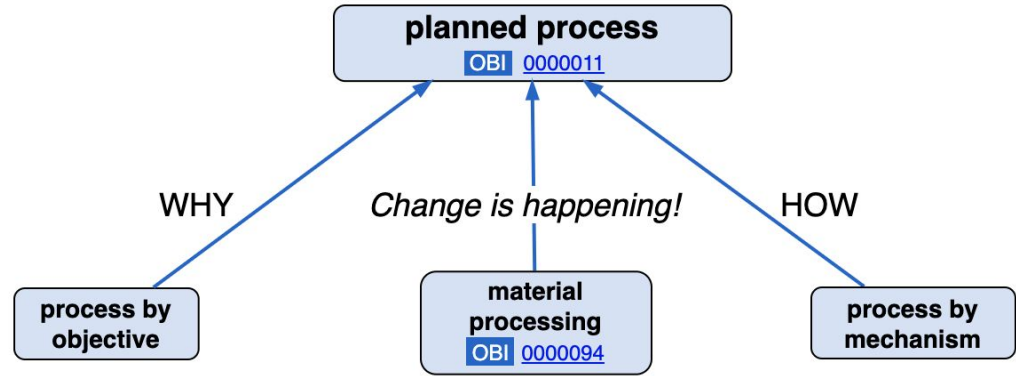Devices and agents
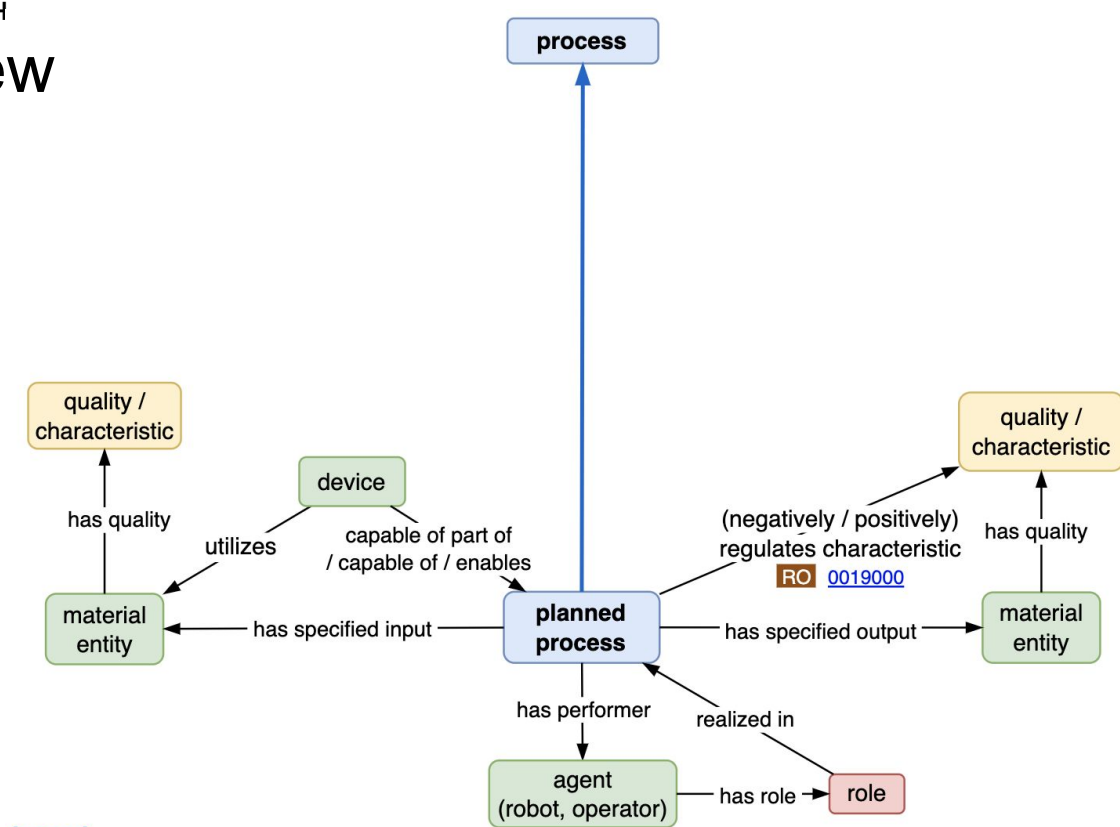
Planned Process Review

Why (Objectives) and How (Mechanism)

Objective:

- Takes time to achieve
- Success determined by:
  - Measuring output material or data to see if it meets objective criteria
  - Or a preset duration

Mechanism:

- re objectives are relative: the increase or decrease of a material characteristic e.g. reducing particle size (or digital metric, e.g. photo blur).
- No built-in endpoint other than inability to further transform an input.
- Provides alternative paths for reaching an objective.

planned process
OBI 0000011

WHY   *Change is happening!*   HOW

process by objective

material processing
OBI 0000094
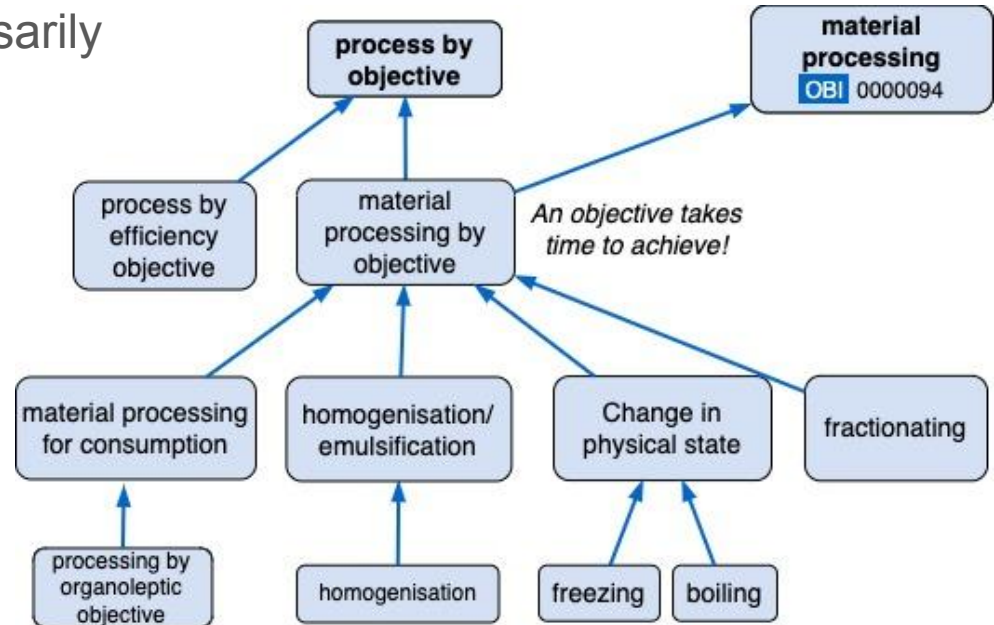
process by mechanism

Objectives: Materials, and Food specificity

Keep it general: material is not necessarily food (e.g. paint can be emulsified.)

Objective types:

- Effect on material
  - E.g. frozen (< 0° Celcius) or boiling temperature (~= 100° Celcius) material

- Efficiency: time, power usage
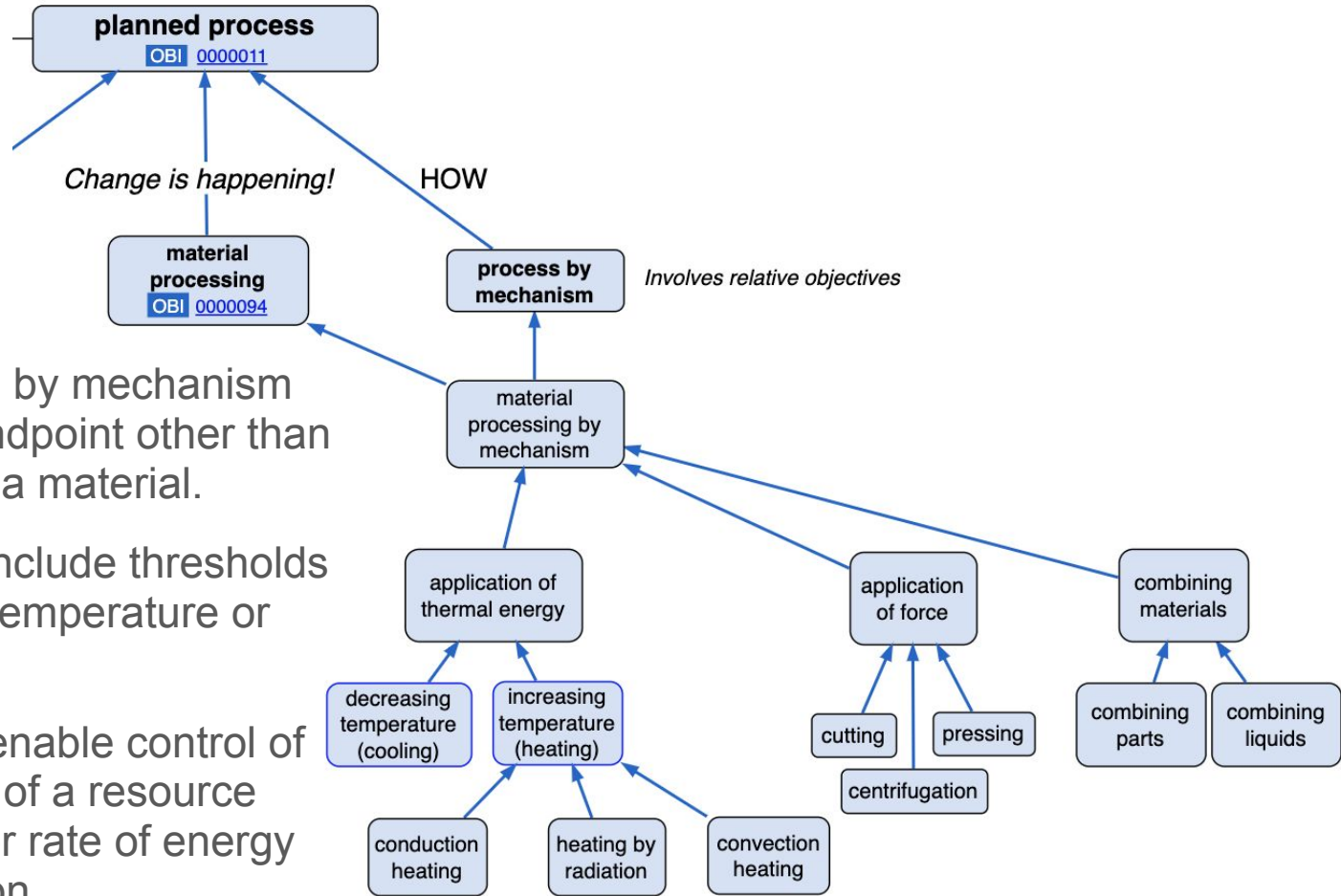 - Process X time < process Y time

Objectives: Materials, and Food specificity

"Material processing for consumption" is about food. Its classes are about the qualities and kinds of role conferred to food material.

- Organoleptic qualities
- Nutritional components
- Food safety
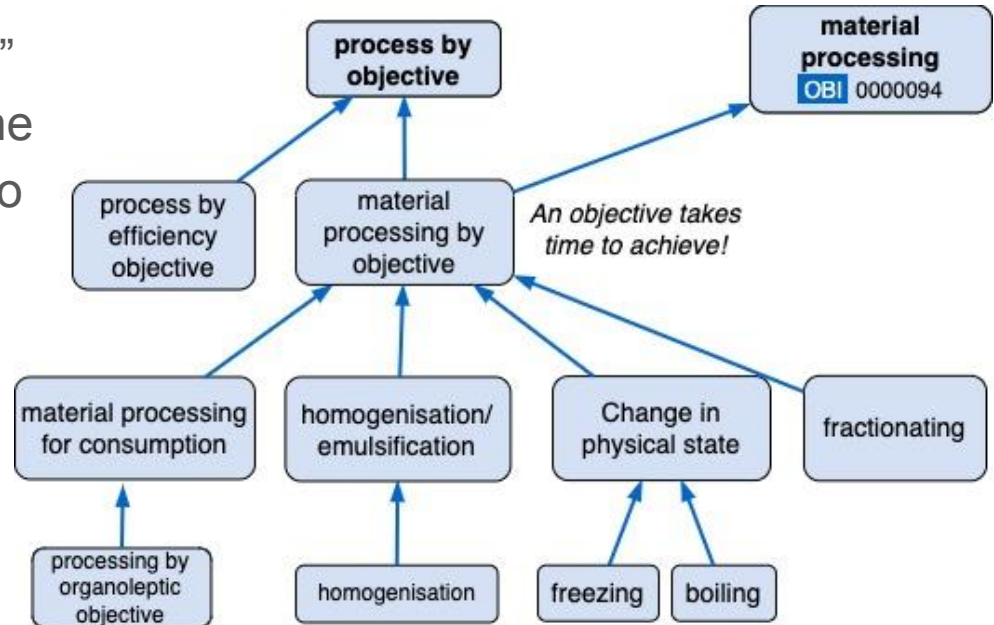
Mechanism

None of the process by mechanism terms suggest an endpoint other than a relative change in a material.

Subclasses do not include thresholds or cutoffs like time, temperature or particle size limits.

However they may enable control of a rate of application of a resource such as frequency or rate of energy or catalyst application.

Polyhierarchy

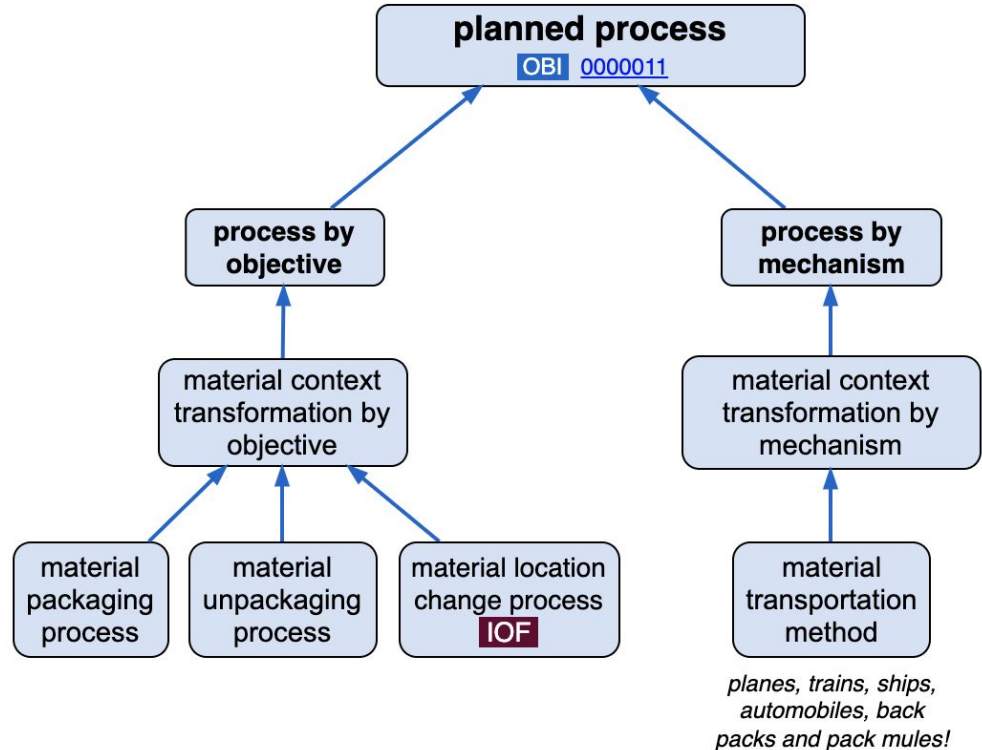A process can be categorized under more than one parent.

A "**boiling in stove pot**" process must achieve a boiling objective, and also falls under "**direct heating of container**".
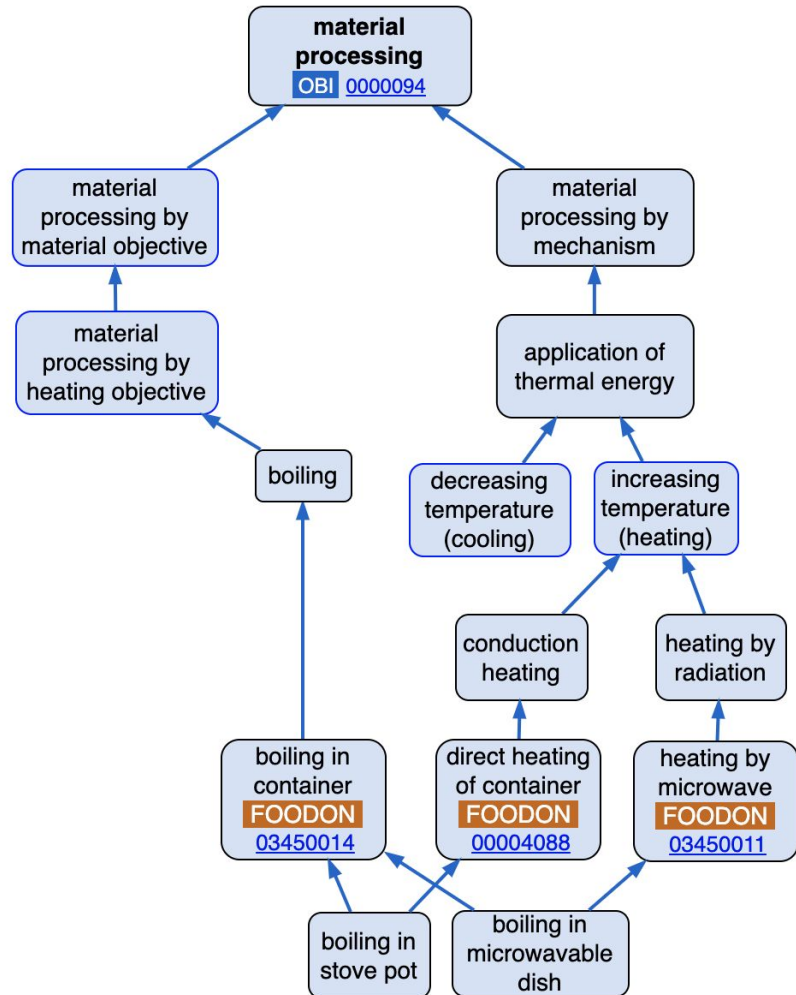
Context manipulation: packaging and movement

No change to the food entity itself

- Packaging
- Shelf placement
- Transportation
- Placing a quantity of water into a container!

Heating and boiling water

Problem: FoodOn's existing boiling processes are simplistic. "**boiling in container**" claims the result is boiled food. How boiled?
"**cooking in container**" - how much?

Heating and boiling water

1) Get container
2) Get water
3) Put water in container
4) Apply heat
5) Wait until boiling
6) (Add something & wait until boiling)
7) Boil until …

boiling in container
FOODON
03450014

boiling water
FOODON
00004090

heating liquid in container
FOODON
00004089

adding liquid to container
FOODON
00004079

container
OBI
0000967

drinking water
ENVO
00003064

Place quantity of water in container
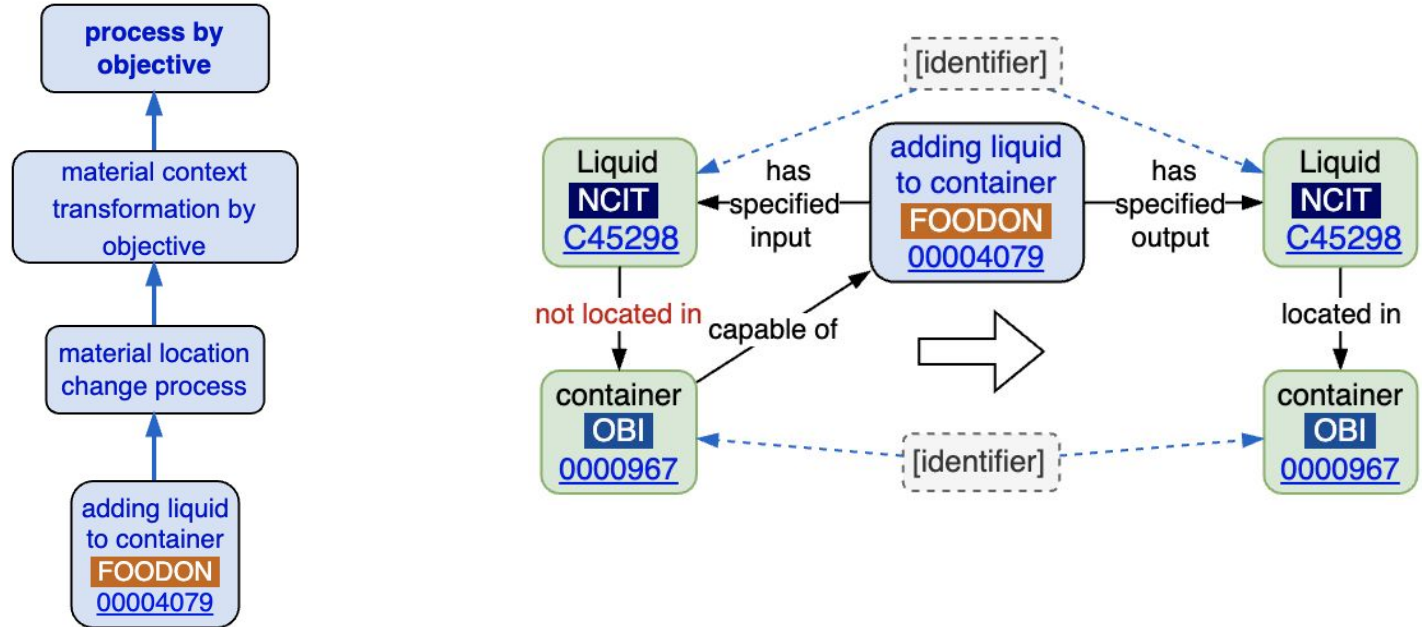
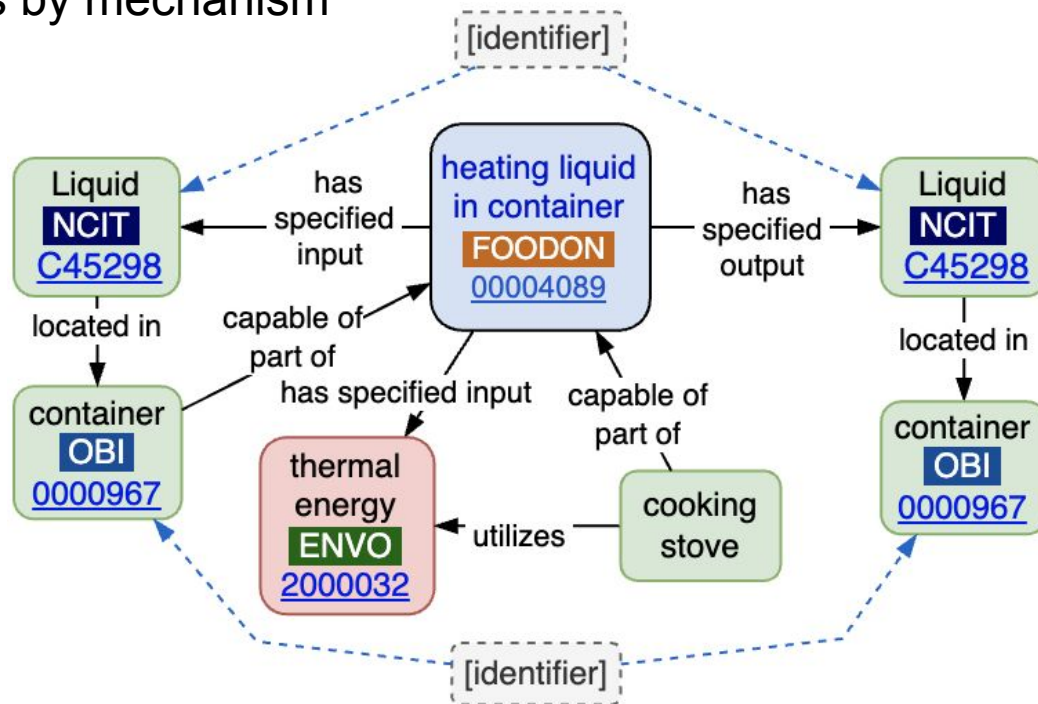It appears that process objectives can be expressed directly as process output data structures?

But note OWL issues in "Food Process Ontology Requirements" paper

Heating liquid
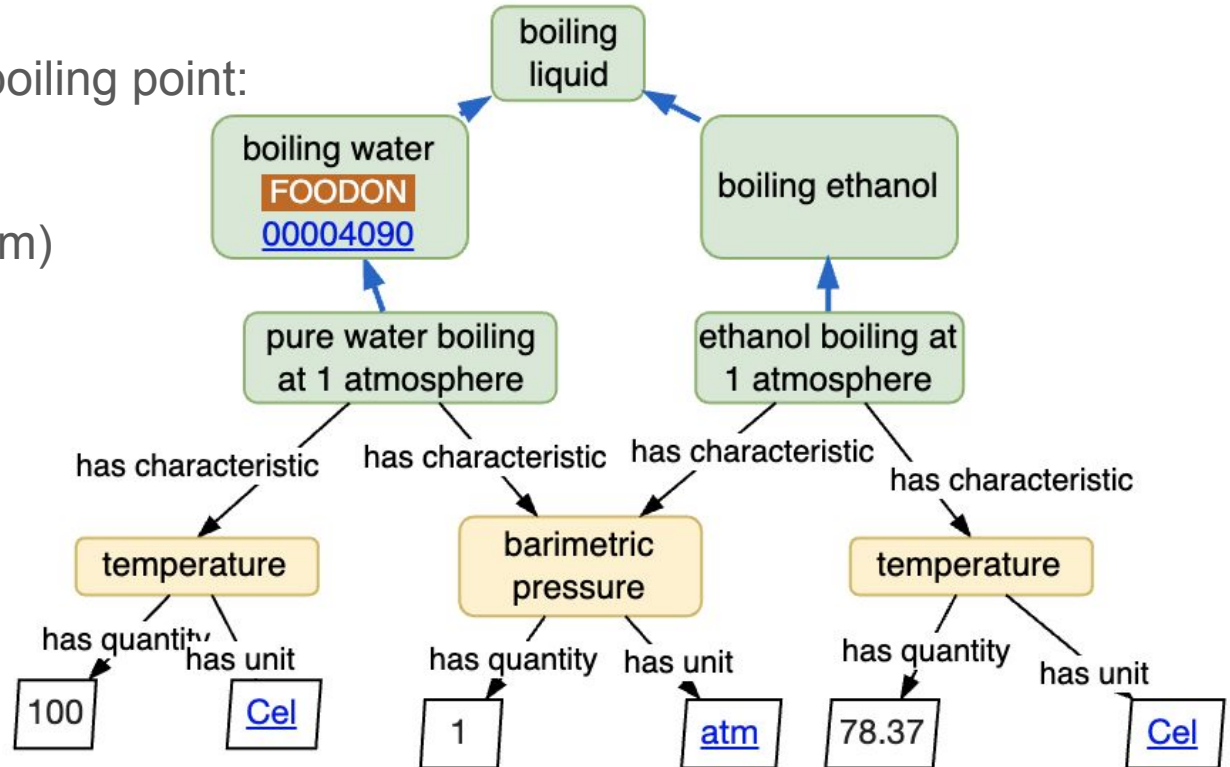
- This seems to be process by mechanism
- No endpoint specified!
- The liquid will boil away!

Heating water to boiling point

Ways of testing water at boiling point:

- Temperature sensor
- Vision (bubbles, steam)
- Sound

Heating water to boiling point

- Now there is an output objective: boiling water!

- Shown as instance level process model, but could be expressed at class level.
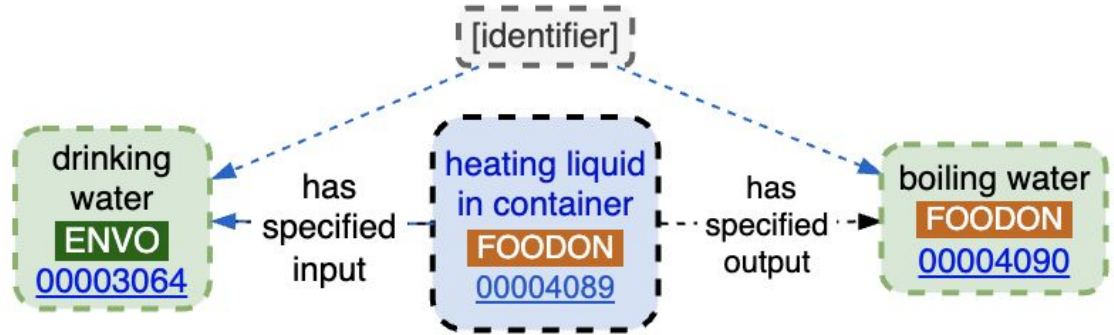
Heating water to boiling point

- How exactly is the liquid in container being heated? Stove? Microwave?
- A process by objective is facilitated by a hidden process by mechanism.

Heating water, then boiling a bit

Chaining processes : Blanching

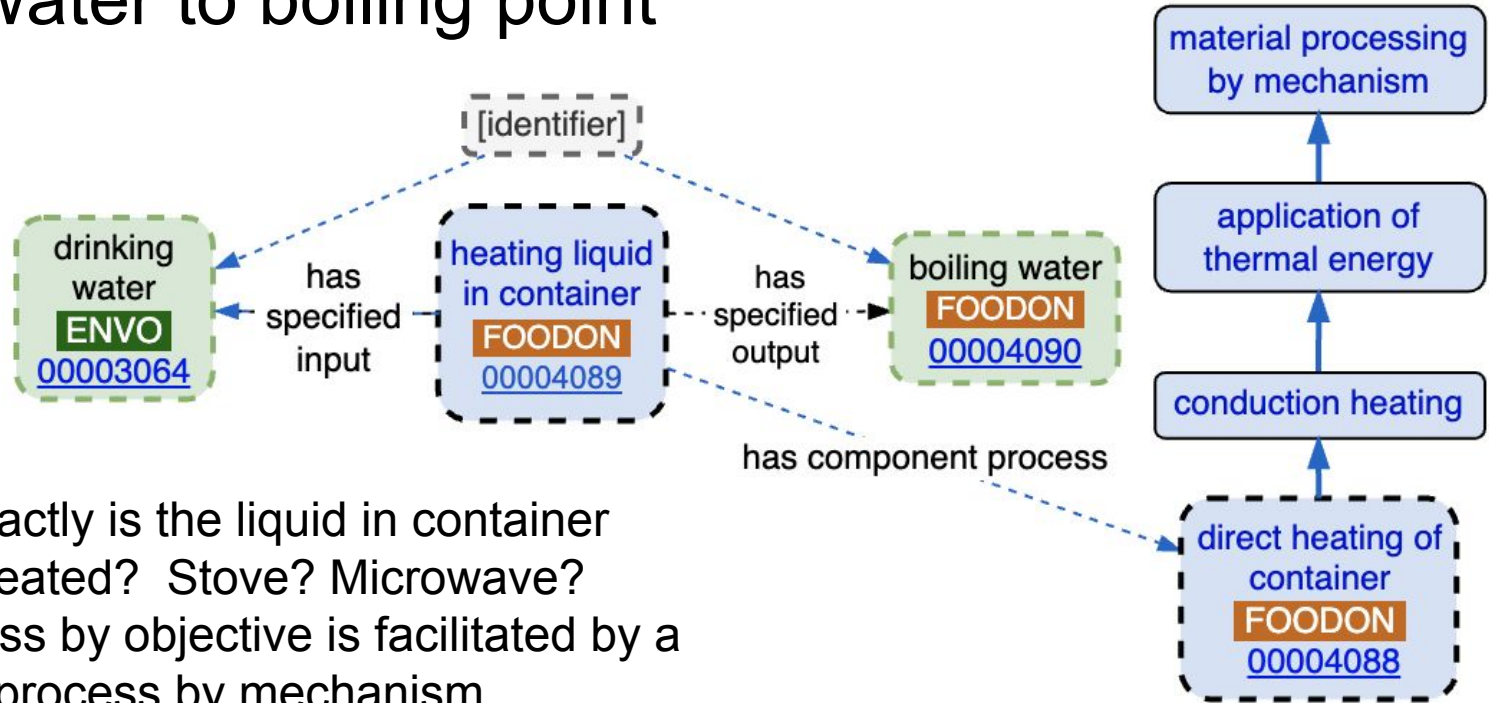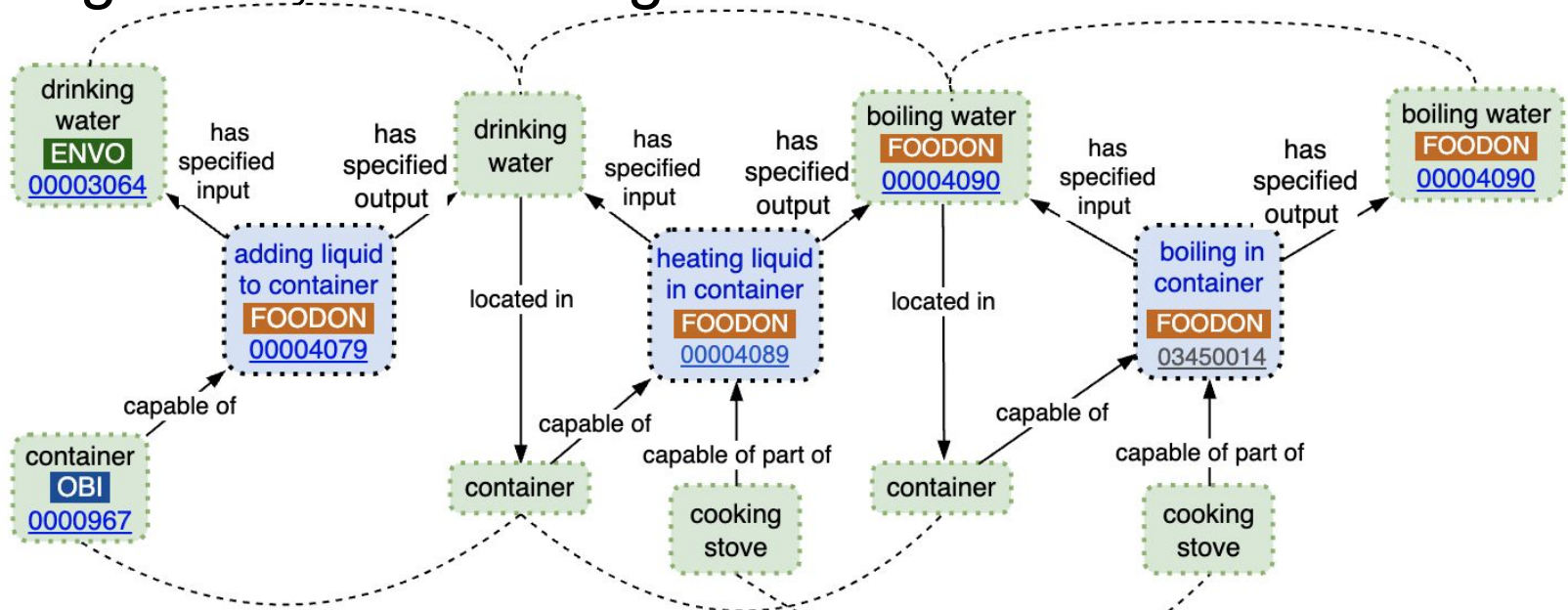*Blanching is a cooking process wherein a food, usually a vegetable or fruit, is scalded in boiling water, removed after a brief, timed interval, and finally plunged into iced water or placed under cold running water (shocking or refreshing) to halt the cooking process.*

People often use blanching as a pre-treatment prior to freezing, drying, or canning

The process has three stages: preheating, blanching, and cooling. The most common blanching methods for vegetables/fruits are hot water and steam, while cooling is either done using cold water or cool air.

Challenges

Need a way to express Macro-level objectives that differ depending on food material anatomy.

- Blanching achieves material transformation objectives:
  - Macro objective:
    - peeling the skin (tomatoes, peaches, where the skin detaches),
    - preserving fruit or vegetable colour
  - Microlevel / molecular objective:
    - halt enzymatic process

- Fractionation: pitting vs seeding: differentiation due to anatomy. Pits have a protective covering.

Immediate scope and future work

Scope

- Terms from existing vocabularies/datasets like FoodEx2, FDC.. etc
- Robotic application
- Extending the ontology by automated NLP tools

Future work/Collaboration

- Complementary "Objective" ontologies - eg: Food Safety
- Equipment ontology
- Mapping processes to foods