The background of the slide features a complex, abstract graphic composed of various blue lines and arrows. These lines are both solid and dashed, creating a network-like structure. Some lines are straight, while others are curved or looped. Arrows of different sizes are placed along these lines, indicating a flow or direction. The overall effect is a technical or mathematical aesthetic, consistent with the theme of logic and ontology.

DEVELOPMENT OF AXIOMATIZATION FOR THE CHOLANGIOCARCINOMA ONTOLOGY USING COMMON LOGIC INTERCHANGE FORMAT

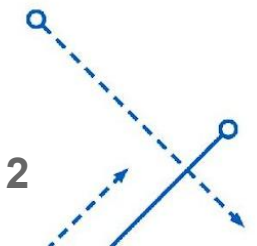
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CCAO AXIOMATIZATION

- We are developing a first-order logic axiomatization using the Common Logic Interchange Format (CLIF) with negation, equality, and multi-argument predicates.
- To render the CCAO fully compatible with Basic Formal Ontology 2020 (BFO2020), and to allow for reasoning that goes beyond mere classification.
- CCAO uses all axioms, subset, and style of CLIF from BFO2020.
- CCAO is expanded to include CLIF-based axioms for relevant terms from
 - BFO-compatible ontologies such as
 - The Information Artifact Ontology (IAO)
 - Ontology for General Medical Science (OGMS)
 - Non-BFO-compatible ontologies such as
 - SNOMED-CT



Input

- CCAO and BFO axioms A

Outputs

- A BFO2020-style CLIF parser
 - Clausal form (CF)
 - Conjunctive normal form (CNF)
 - Kowalski-rules using B
- A BFO2020-style CLIF reasoner
 - Term expansion based on BFO2020 Axioms C

Acknowledgement

- Werner Ceusters, MD
 - Suggestions and software development

```
(cl:comment "elucidation of perihilar cholangiocarcinoma [ccao-9]"
  (forall (p t)
    (iff (instance-of p ccao-perihilar-cholangiocarcinoma t)
      (and (individual-of p sctid-cholangiocarcinoma-of-perihilar-bile-duct)
        (instance-of p ccao-cholangiocarcinoma t)
        (exists (h)
          (and (instance-of h uberon-common-hepatic-duct t)
            (overlap p h)))))))
)

(cl:comment "elucidation of sctid-cholangiocarcinoma-of-perihilar-bile-duct [ccao-10]"
  (forall (i)
    (if (individual-of i sctid-cholangiocarcinoma-of-perihilar-bile-duct)
      (exists (t)
        (instance-of i ccao-perihilar-cholangiocarcinoma t))))
  )
)
```

```
% elucidation of perihilar cholangiocarcinoma [ccao-9]
r(48,1,[10], "ccao-9", kow(if([instance-of, A,
  ccao-perihilar-cholangiocarcinoma, B])),
  then([overlap, A,
    [e, 10, [A, B], B]])).
r(49,1,[10], "ccao-9", kow(if([instance-of, A,
  ccao-perihilar-cholangiocarcinoma, B])),
  then([instance-of, [e, 10, [A, B],
    uberon-common-hepatic-duct, B]])).
r(50,1,[1], "ccao-9", kow(if([instance-of, A,
  ccao-perihilar-cholangiocarcinoma, B])),
  then([individual-of, A,
    sctid-cholangiocarcinoma-of-perihilar-bile-duct])).
r(51,1,[1], "ccao-9", kow(if([instance-of, A,
  ccao-perihilar-cholangiocarcinoma, B])),
  then([instance-of, A,
    ccao-cholangiocarcinoma, B])).
r(52,4,[1], "ccao-9", kow(if([individual-of, B,
  sctid-cholangiocarcinoma-of-perihilar-bile-duct],
  [instance-of, A, uberon-common-hepatic-duct, C],
  [instance-of, B, ccao-cholangiocarcinoma, C], [overlap, B, A, C])),
  then([instance-of, B,
    ccao-perihilar-cholangiocarcinoma, C])).
```

| | | | | | |
|-----|------|----------------------------------|----------------|---|--------------------------------------|
| 86 | TRUE | continuant-part-of | cancer-of-john | cancer-of-john | t |
| 228 | TRUE | continuant-part-of-at-some-time | cancer-of-john | cancer-of-john | |
| 230 | TRUE | entity | cancer-of-john | | C |
| 17 | TRUE | exists-at | cancer-of-john | t | |
| 227 | TRUE | has-continuant-part | cancer-of-john | cancer-of-john | t |
| 82 | TRUE | has-continuant-part | cancer-of-john | sk1 | t |
| 237 | TRUE | has-continuant-part-at-some-time | cancer-of-john | cancer-of-john | |
| 851 | TRUE | identical | cancer-of-john | cancer-of-john | |
| 1 | TRUE | individual-of | cancer-of-john | sctid-cholangiocarcinoma-of-perihilar-bile-duct | |
| 2 | TRUE | instance-of | cancer-of-john | ccao-cholangiocarcinoma | t |
| 10 | TRUE | instance-of | cancer-of-john | ccao-perihilar-cholangiocarcinoma | t |
| 83 | TRUE | instance-of | cancer-of-john | continuant | t |
| 7 | TRUE | instance-of | cancer-of-john | independent-continuant | t |
| 14 | TRUE | instance-of | cancer-of-john | ogms-disorder | t |
| 85 | TRUE | overlap | cancer-of-john | cancer-of-john | t |
| 4 | TRUE | overlap | cancer-of-john | chd-of-john | t |