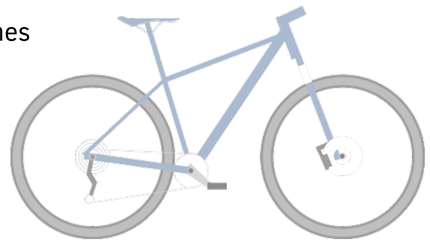
Collaborative Forgetting for Engineering Design

The previous bicycle design assumes human traction only.

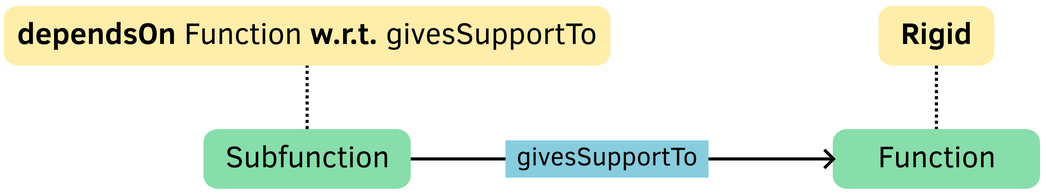


An electrical traction is added.
Components must be redesigned.
Assumptions must be revised.

1. How to forget design property values?
2. How to forget concept inclusions?
3. How to resolve design inconsistencies?
4. How to enable variant design with semantic annotations?
5. How to forget and infer new constraints?

1. Cascade Forgetting using Metaproperties, OWL-DL, and SPARQL [17, 19, 20]

Metaproperties **"rigid"** and **"depends on"** describe which components are forgotten after updating an engineering design.



Function(measuring_forces)
Subfunction(measuring_friction)
givesSupportTo(measuring_friction, measuring_forces)

Forgetting because of a redesign

DELETE Function(measuring_forces)

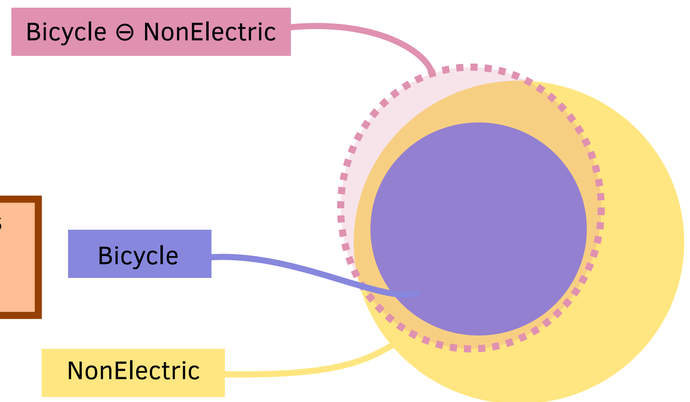
Cascade forgetting

DELETE Subfunction(measuring_friction)
DELETE givesSupportTo(measuring_friction, measuring_forces)

2. Concept Contraction for the Description Logic *EL* [16]

Given two concepts C and D with $C \sqsubseteq D$,
C is generalized as a concept $C \ominus D$ that must be as similar as possible to C, and do not be subsumed by D.

Designers must forget that bicycles are non-electric to design with a more general concept of bicycle.



LCS concept contraction:
- Subtraction between concepts
- Reformulates AGM postulates for first-order theory revision

Postulates

Preservation: If $D \equiv D'$ then $C \ominus D \equiv C \ominus D'$.
Success: If $D \not\equiv \top$ then $C \ominus D \not\sqsubseteq D$.
Inclusion: $C \sqsubseteq C \ominus D$.
Failure: $C \ominus \top \equiv C$.
Relevance: If $C \sqsubseteq X$ and $C \ominus D \not\sqsubseteq X$ then there is a Y such that $C \sqsubset Y \sqsubseteq C \ominus D$, $Y \not\sqsubseteq D$, and $Y \sqcap X \sqsubseteq D$.

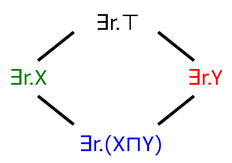
Redundant Postulates

Vacuity: If $C \not\sqsubseteq D$ then $C \ominus D \equiv C$. (inferred from Fullness and Inclusion
Fullness: If $C \sqsubseteq X$ and $C \ominus D \not\sqsubseteq X$ then $(C \ominus D) \sqcap X \sqsubseteq D$. (inferred from Relevance)

Unsuitable Postulate

Recovery: $(C \ominus D) \sqcap D \sqsubseteq C$.

Recovery contradicts the lattice.



$\exists r.(X \sqcap Y) \ominus \exists r.X \equiv \exists r.Y$

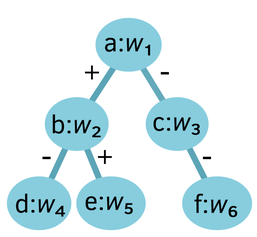
but

$\exists r.Y \sqcap \exists r.X \not\equiv \exists r.(X \sqcap Y)$

3. Argumentation used to resolve design inconsistencies [3, 5, 6, 8, 10, 11, 14, 15]

Bipolar argumentation

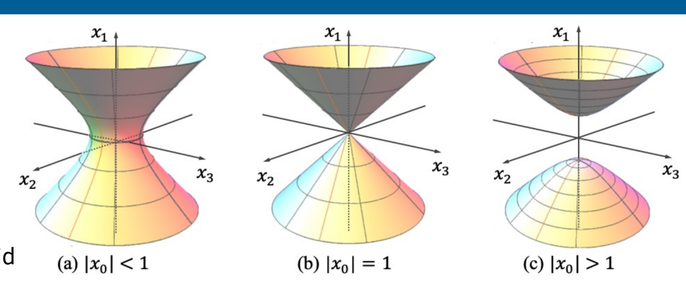
Attack (-):
arguments contradicting a statement.
Support (+):
arguments supporting a statement.



Strengths of arguments based on weights allow for learning to assign levels of acceptance for statements.

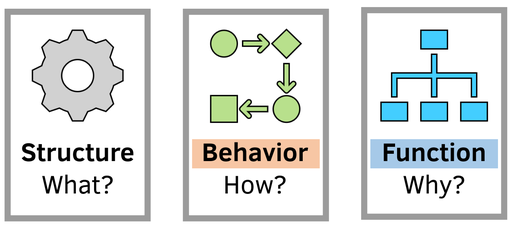
Pseudo-Riemannian graph convolutional neural network for description logics ABoxes and argumentation graphs.

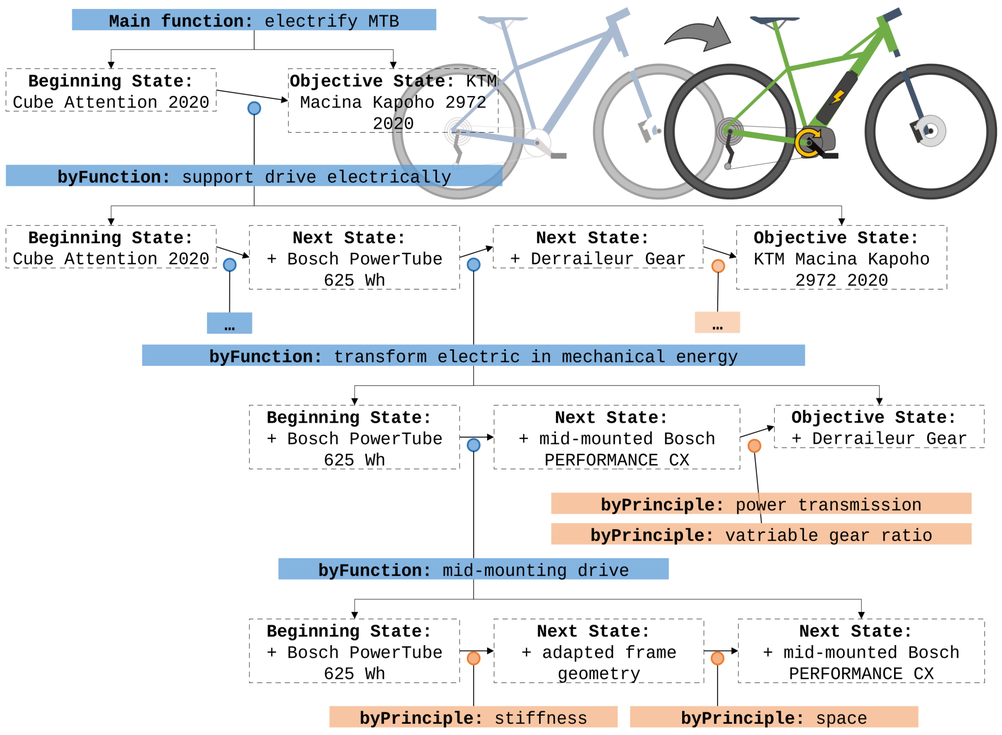
Submanifolds of a pseudo-hyperboloid



4. Semantic annotations enabling variant design [1, 4, 12, 13, 22, 23]

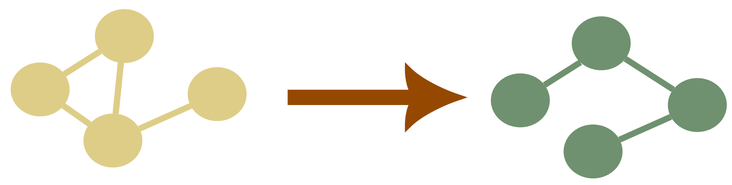
Lack of established formal knowledge models as prerequisite for ontology-based intentional forgetting operations can be overcome by semantic annotation techniques based on the Structure-Behavior-Function model and design rationales explaining the decision-making process in design.





5. Inferring schema constraints from knowledge graph data mappings [24]

```
CONSTRUCT {
   hasFrame(x, y), hasGears(x, z)
}
WHERE {
   Bicycle(x), component(x, y), component(x, z),
   Frame(y), Gears(z)
}
```



$\text{Bicycle} \sqsubseteq \exists \text{component.Frame} \sqcap \exists \text{component.Gears}$

$\exists \text{hasFrame}.\top \equiv \exists \text{hasGears}.\top$

Methodology
1. Axiomatize the input, graph, the input graph, and the query.
2. Check what restrictions are entailed by the axiomatization.

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