

Automatic Learning of User Design Rationale from Examples

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Background

Computer Aided Design (CAD) interchange formats:

- **STEP:**
 - Standard for the Exchange of Product model data
 - (ISO 10303-21 or .step/ .stp / .p21)
- **IGES:**
 - Initial Graphics Exchange Specification

CAD kernels: ParaSolid, ACIS, ShapeManager, CGM

Proprietary ways of interpreting these formats leads to ambiguity while editing.

How can we mitigate this **interoperability** problem ?

Problems and Hypothesis

Inadequate coverage of design knowledge

Heterogeneous CAD systems and data formats (Catia, Solidworks, AutoCAD, etc)

The lack of capabilities to capture errors in translating CAD data between data formats

Slow evolution of CAD neutral format standards (AP214/STEP made in 1994-2014)

We are building a framework that gives the user the flexibility to define and use a rich semantic model beyond the current standards.

Our approach will be able to efficiently map a CAD file from / to a user-defined ontological representation, thus achieving interoperability.

The STEP format

Only saves geometrical data and some topological structure

- Missing relations
- Missing original sketches
- Missing operations (Extrude, Cut...)

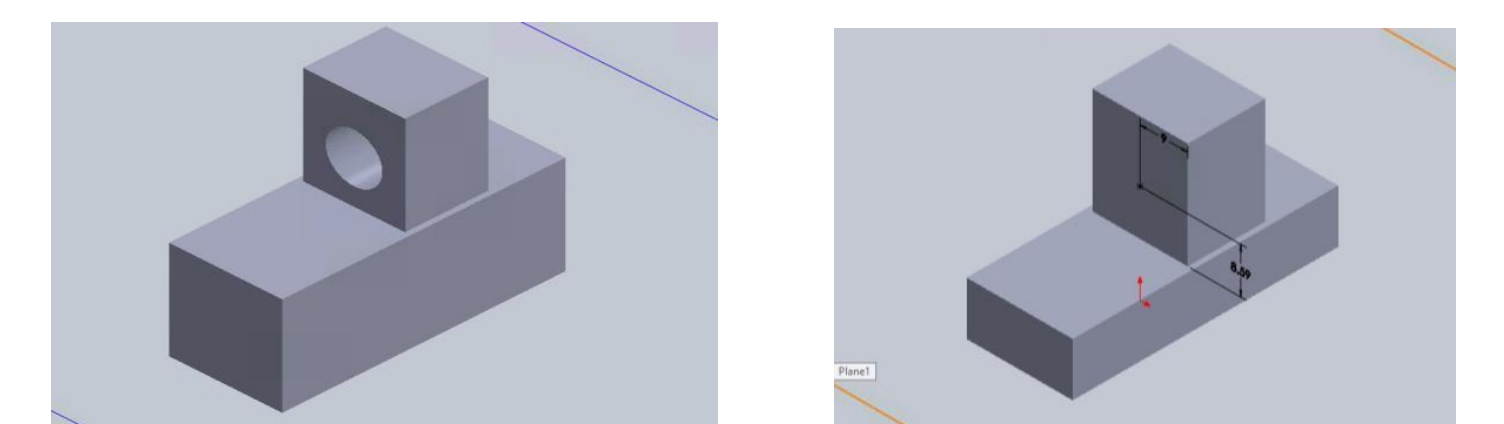
What about **Design Intent** ?

Relations to model intent

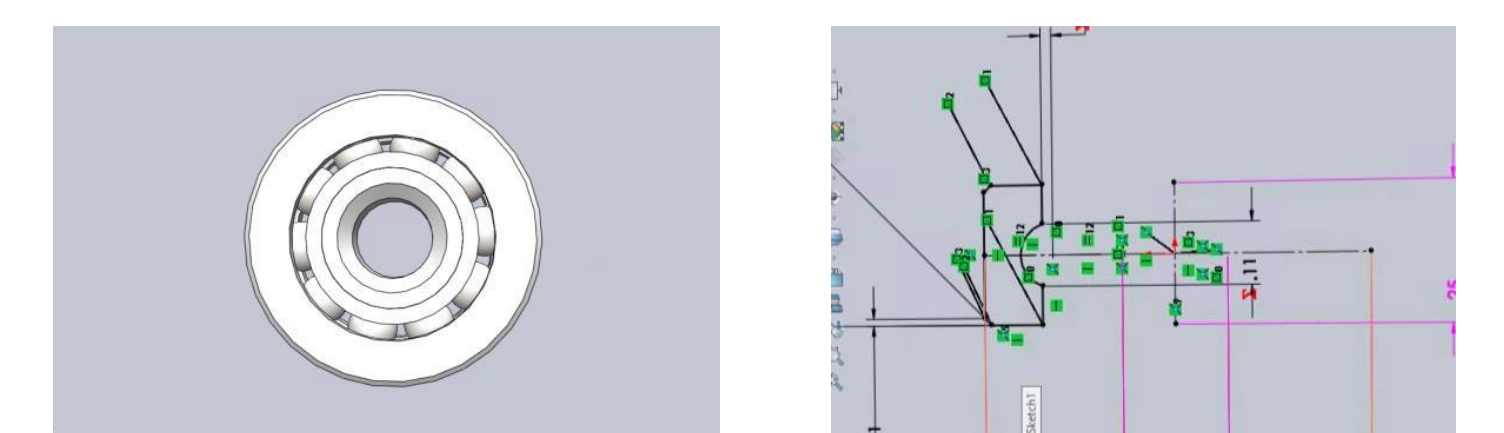
- Relations can help resolving ambiguity
- Constrained editing of CAD easier
- However
 - If we have very few or no relations : Ambiguity (the cube example video)
 - Too many relations : Lack of flexibility (the ball bearing example video)
 - **Manually adding relations is tedious**
- Eg. Coradial, Parallel, Fixed, Dimension

Examples

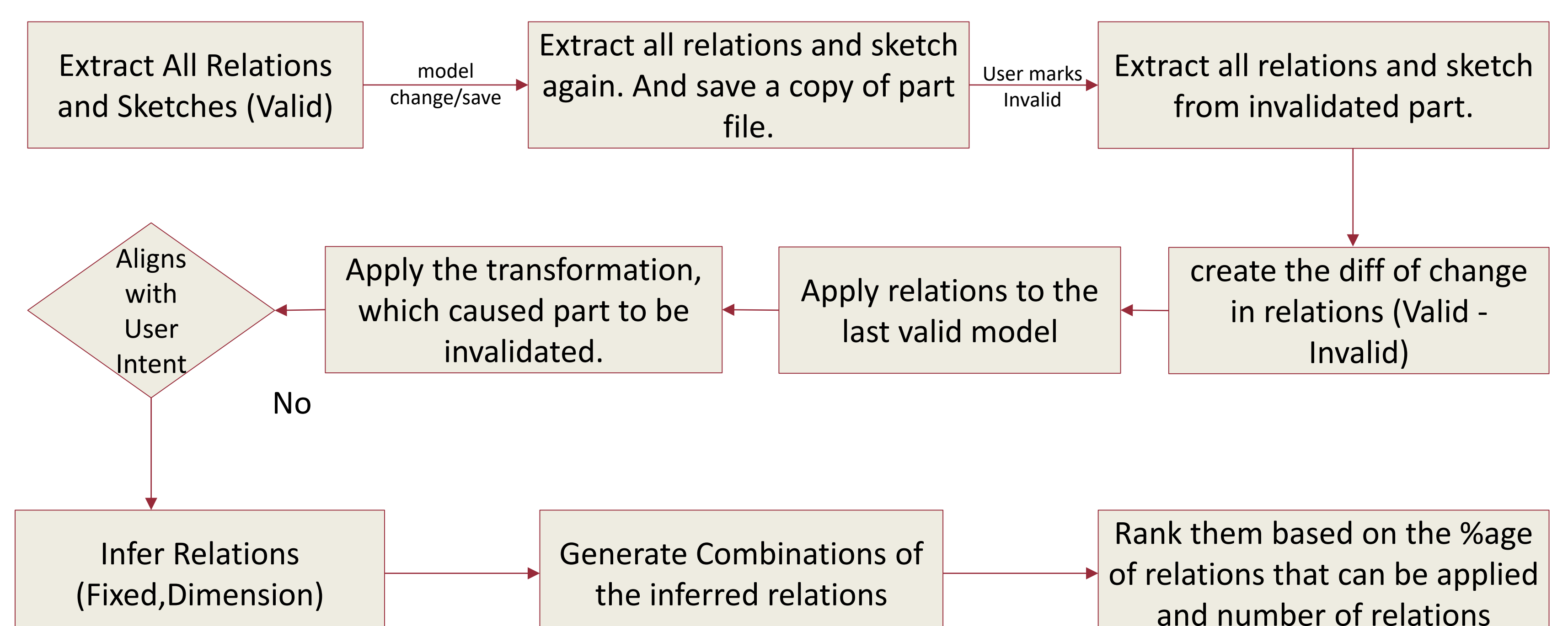
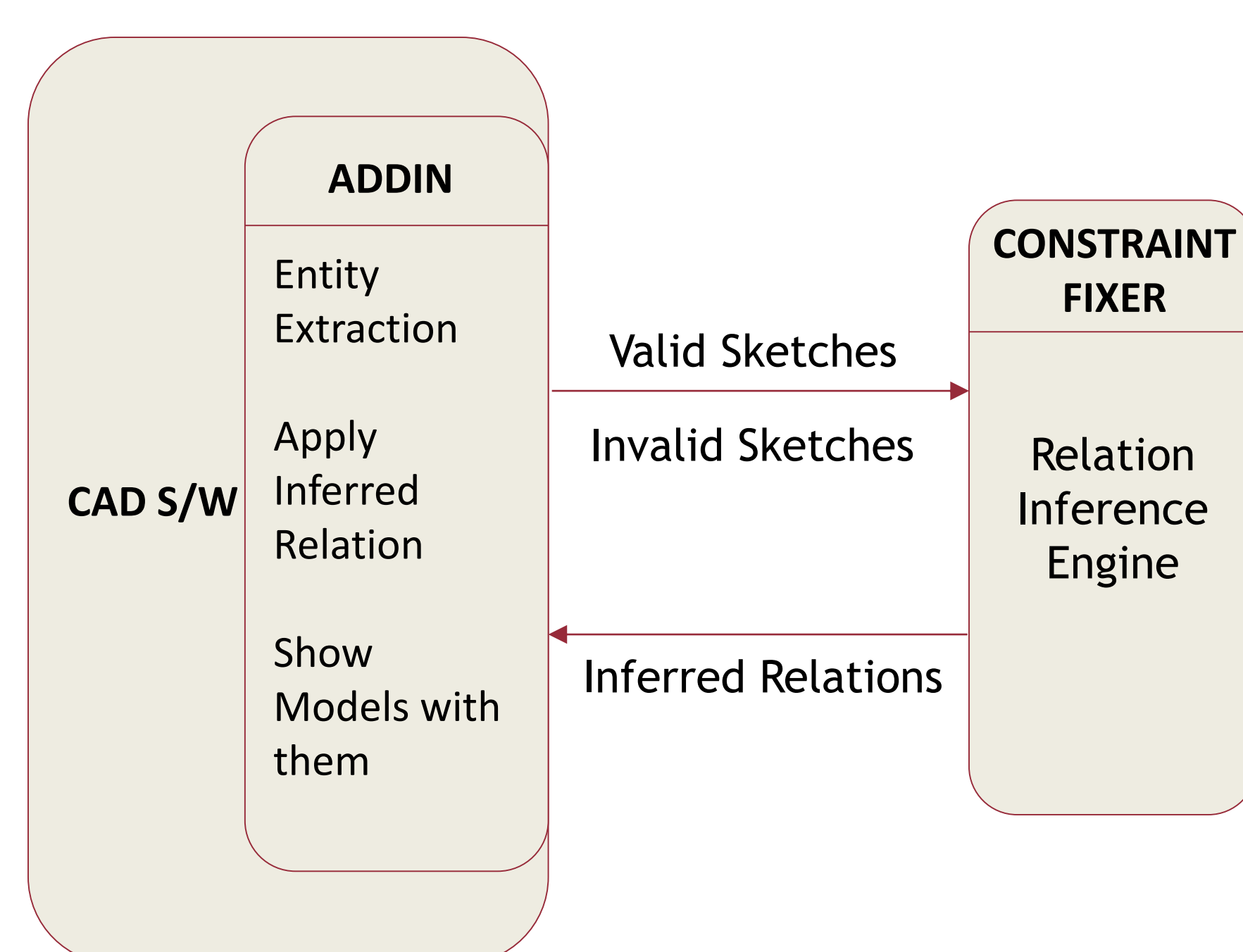
- Stack of Cubes



- Ball Bearing



Architecture and Algorithm



Results, Current and Future Work

- The interoperability of STEP can be enhanced by our automatically inferred relations
- Design intent can be derived for simple models
- Testing the performance of filtering out results from constraint sets
- What kind of design issues can be resolved?
- Developing newer algorithms where current approaches might fail
- Learning heuristics for automation
- Incorporating semantic info and translating them to CAD commands