Databases and Software Engineering

Hochschule Harz
Harz University of Applied Sciences

MENSCH | TECHNIK
ORGANISATION | PLANUNG

Foundations of Collaborative, Real-Time Feature Modeling

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University of Magdeburg, Harz University of Applied Sciences, METOP GmbH

* Supported by pure-systems GmbH

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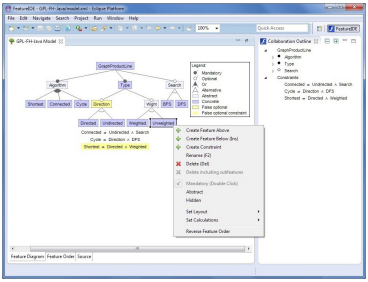
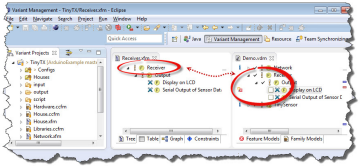
Motivation

- State of the art: **single-user feature modeling**





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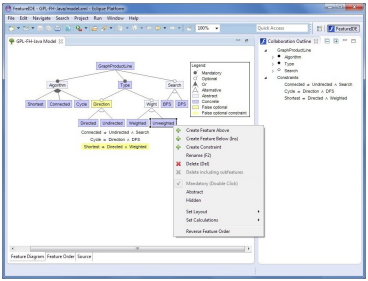

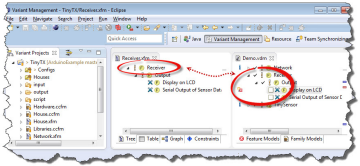

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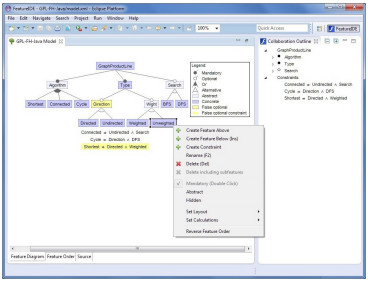

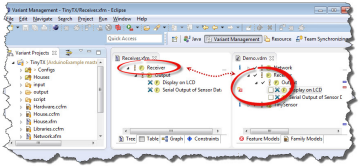

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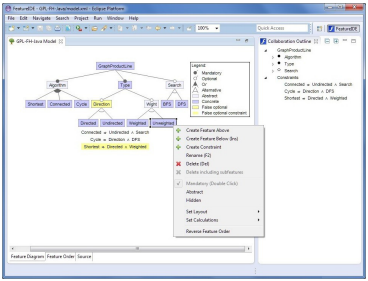

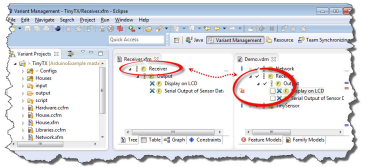

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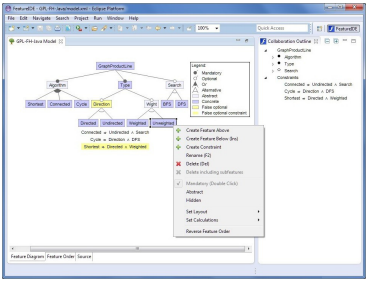
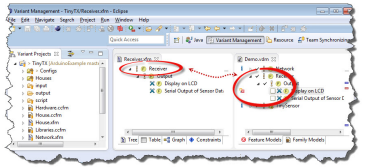
- **But:** No dedicated support for collaboration

- One solution: *Asynchronous collaboration* with VCS
- **But:**
  - not real-time
  - promotes divergence





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Why collaborate?

- Domain knowledge is typically spread across **different collaborators**
  $\Rightarrow$ Leverage group synergies for problem solving

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  $\Rightarrow$ **Real-time feedback**

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Why real-time?

- Engineers can discuss the feature model with domain experts
  $\Rightarrow$ **Real-time feedback**
- Allows **tight collaboration** on shared model elements
  (similar to pair programming)

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Our contribution:

1. Formal approach to
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   with focus on
   - Consistency maintenance
   - Conflict detection (& resolution)

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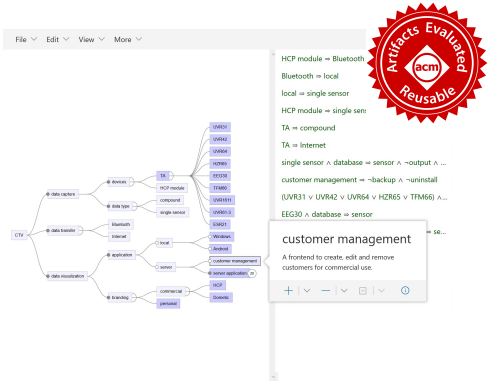
1. Formal approach to **collaborative real-time feature modeling** with focus on
   - Consistency maintenance
   - Conflict detection (& resolution)
2. Open-source research prototype



Requirements

Assumptions

- (Potentially) simultaneous edits

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- Remotely connected

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Which leads to ...

Requirements

- Concurrency

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- Concurrency ⇒ conflict detection

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- Concurrency $\Rightarrow$ conflict detection
- Intention Preservation

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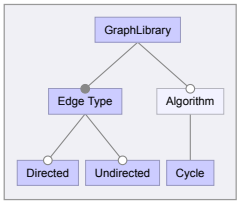
⇒ **Multi-Version Multi-Display**
(Sun and Chen, 2002)

Running Example



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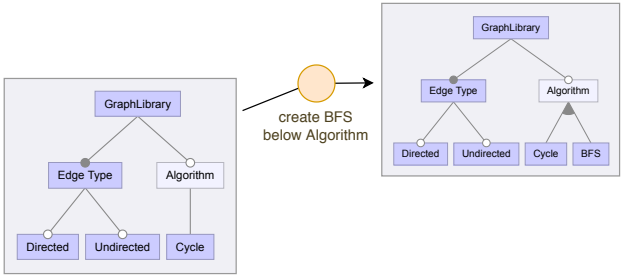

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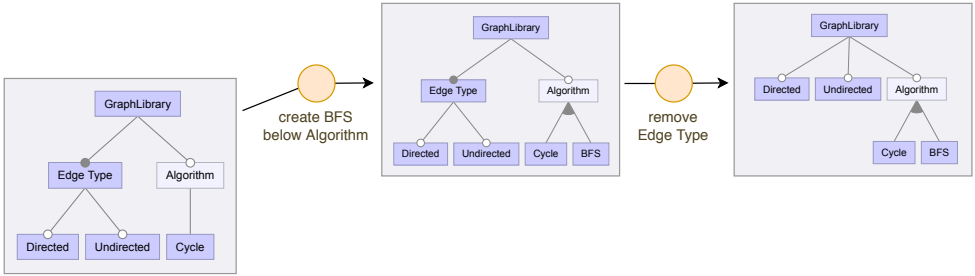

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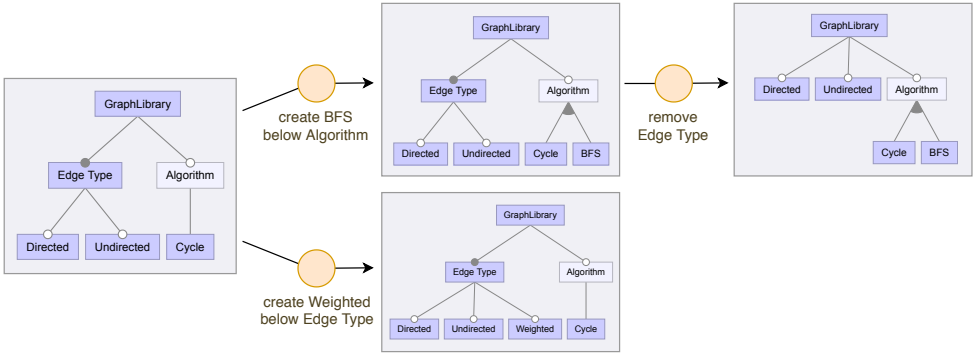

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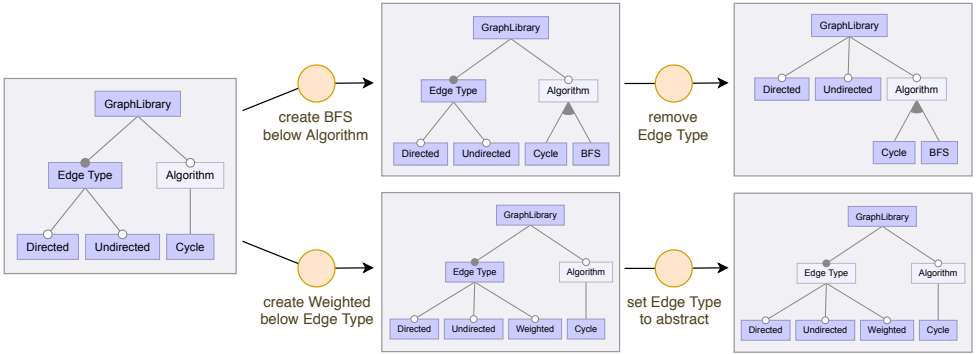

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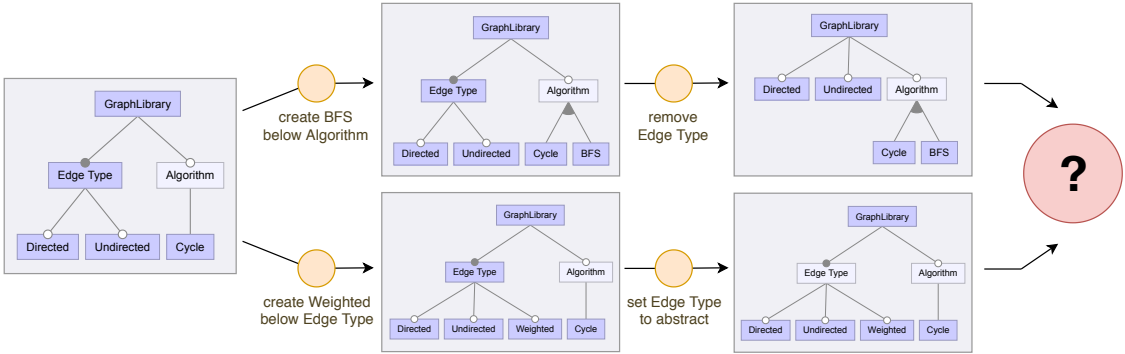

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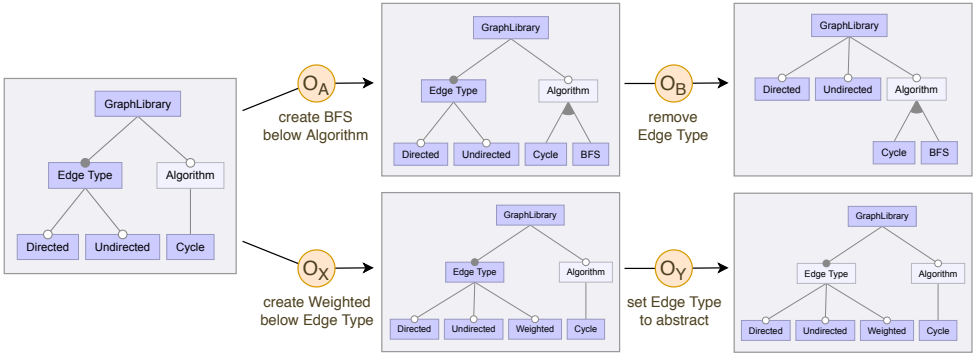

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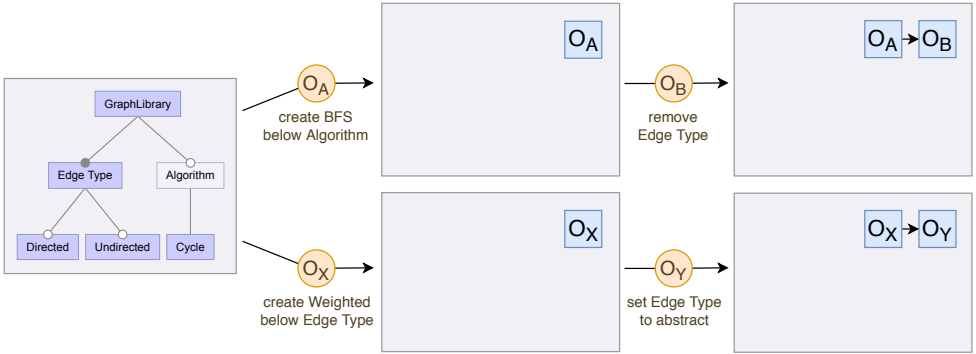
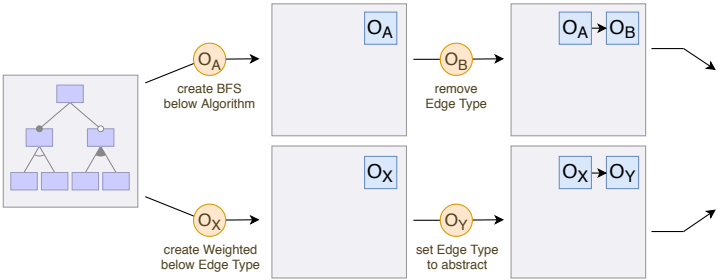


Feature Modeling Conflicts

How to determine conflicts algorithmically?



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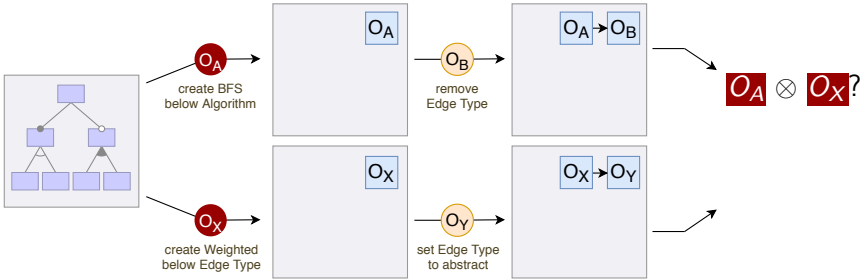

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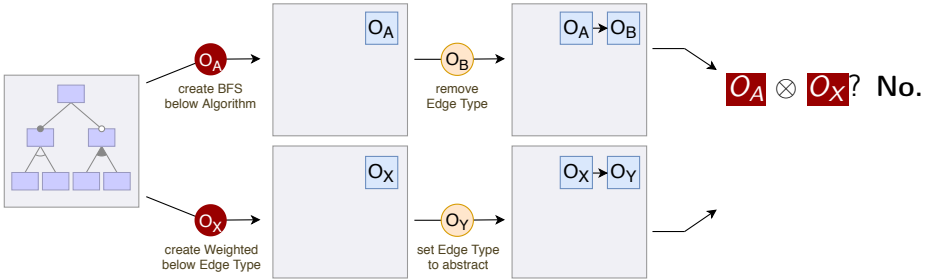

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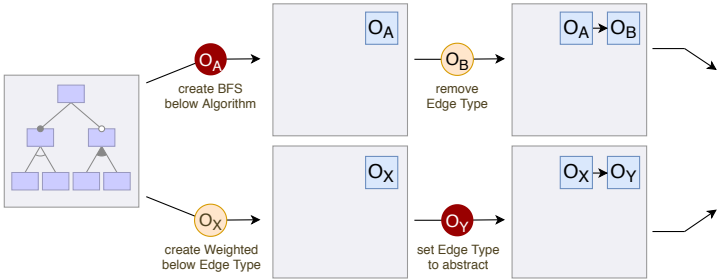

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$O_A \otimes O_Y$, based on O_X?

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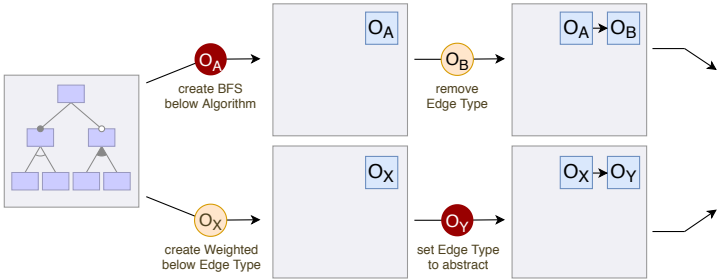

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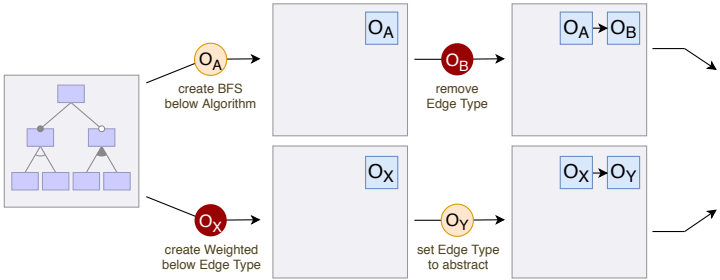

$O_A \otimes O_X$? **No.**

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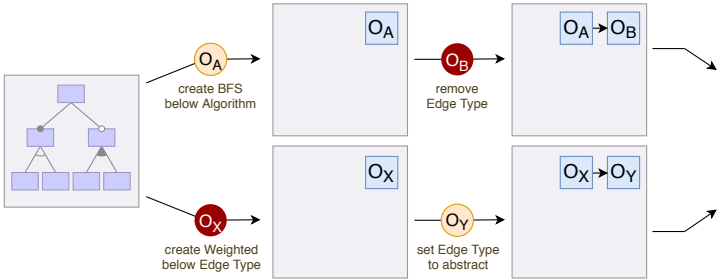

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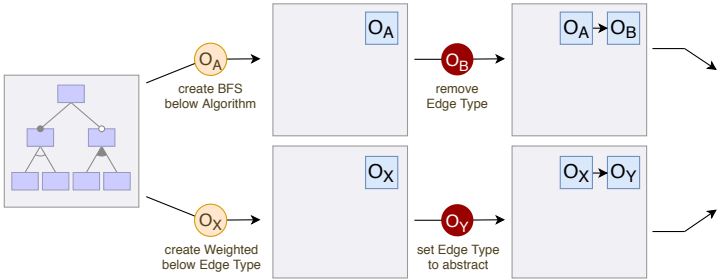

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Thus, also $O_Y \otimes O_B$.

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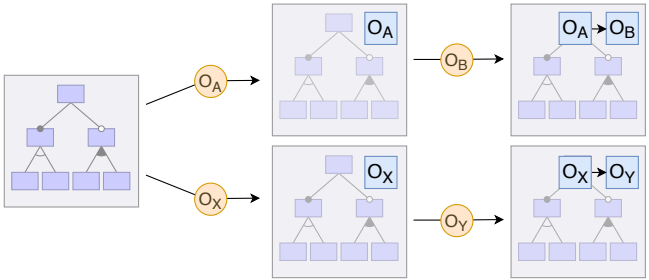

Decompose into *primitive operations*.

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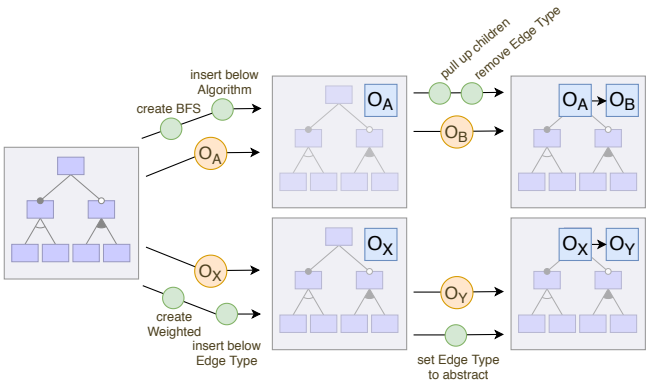

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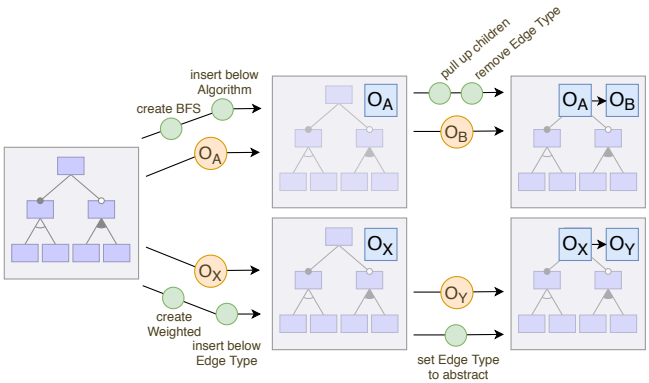

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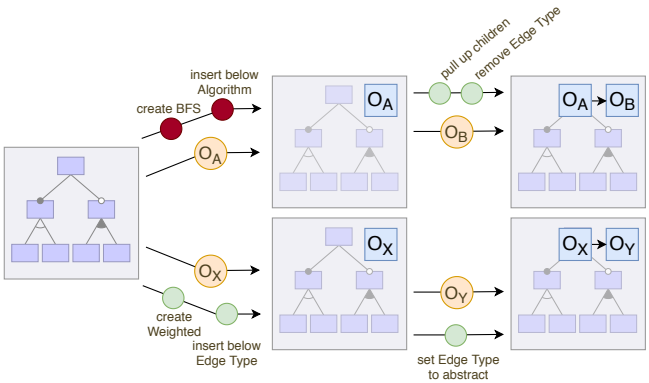

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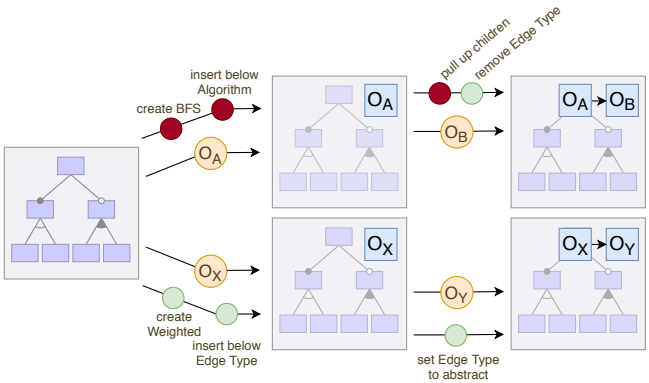

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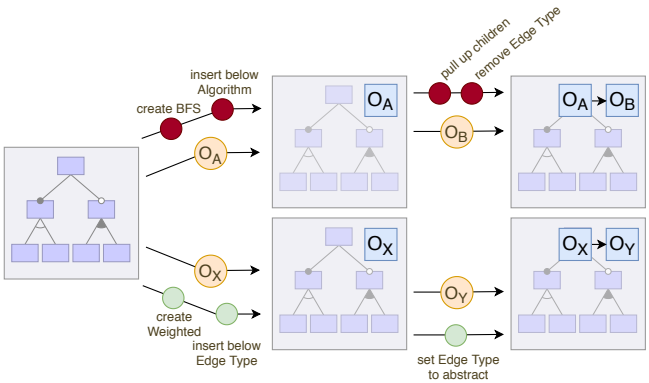

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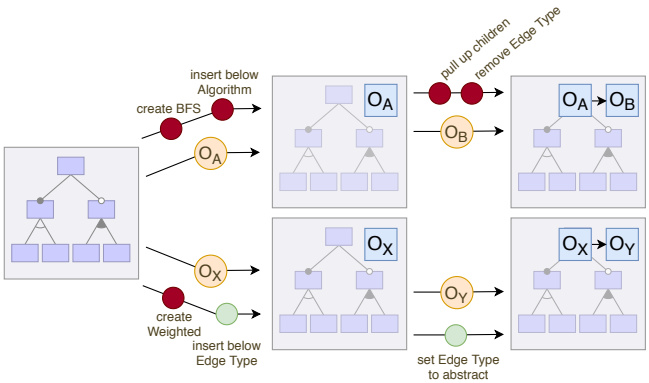

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Now apply O_X ...

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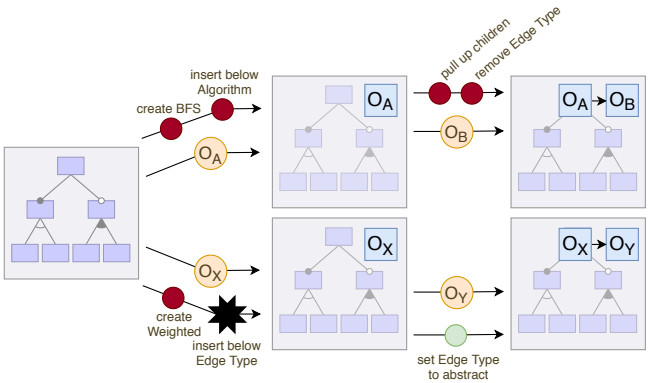

Decompose into *primitive operations*.

$O_X \otimes O_B$ because:

Based on O_A, apply O_B.

Now apply O_X ...

... but a conflict rule applies.

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Version Creation

- Detected conflicts: $O_X \otimes O_B$ and $O_Y \otimes O_B$

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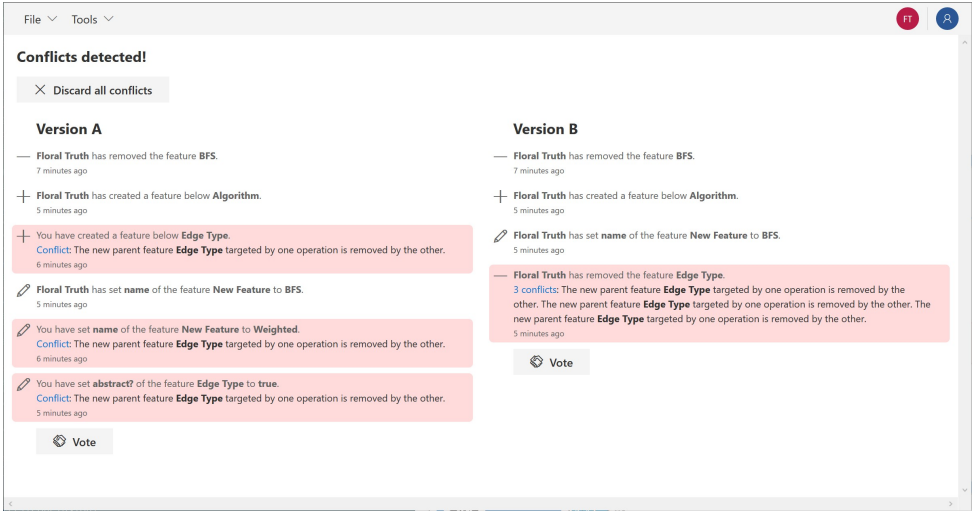
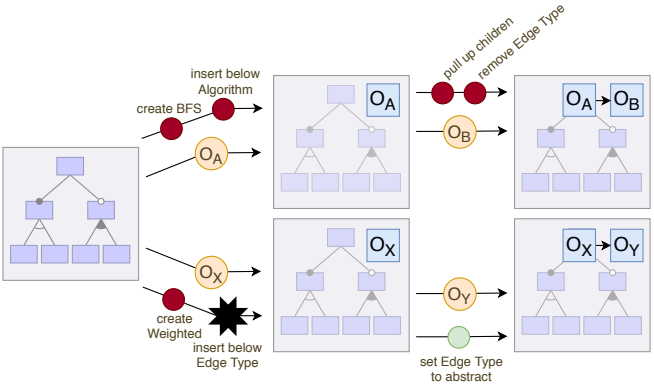
- ... minimizes the number of versions
- ... maximizes the number of operations per version

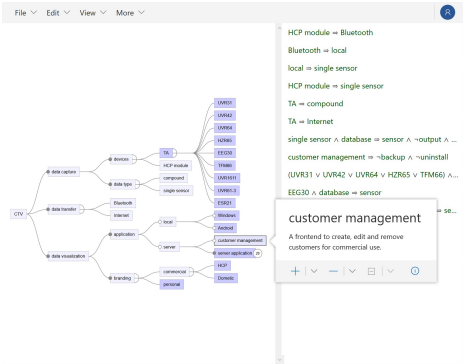
Conflict Resolution GUI



Conclusion



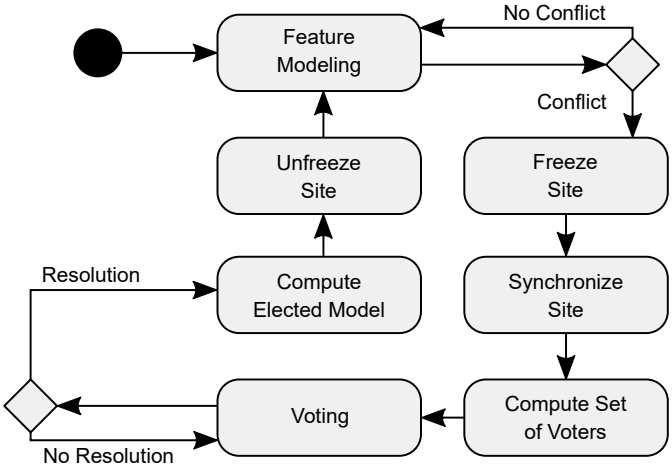
Formal description



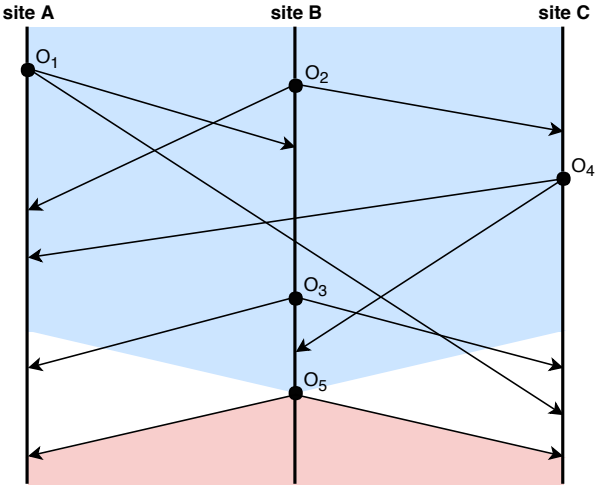
Open-source prototype

`github.com/ekuiter/variED`

Resolution Process



CCI Model



- Convergence
- Causality Preservation
- Intention Preservation

Concurrency Control

	Turn-Taking	Locking	CRDTs	Serialization	OT	MVSD	MVMD
Concurrency	○	◐	●	●	●	●	●
Optimism	◐	○	●	●	●	●	●
Intention Preservation	●	○	○	○	○	◐	●
Flexibility	●	○	○	○	○	○	◐
Correctness	●	◐	◐	●	○	○	◐

Architecture