A Virtual Global Monorepo of Immutable Linked Data

Joeri Exelmans[1] Jakob Pietron[2] Alexander Raschke[2]
Hans Vangheluwe[1]

[1]University of Antwerp – Flanders Make, Belgium

[2]University of Ulm, Germany

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Outline

What is Model Management?

Dealing with:

- Heterogeneous Models

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- Access Control

“Research Question”

What would a MINIMAL CORE for model management look like?

And I also want . . .

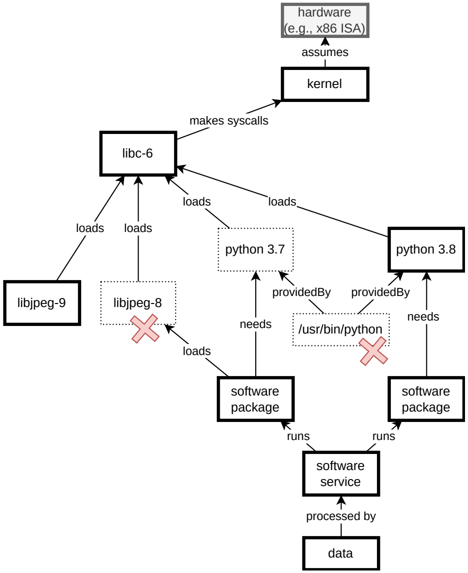
- Fully decentralized solution
- Access control without administration
- Eliminate software/model/data ‘rot’ (permanent replicability)

Outline

Software ‘rots’ . . .

- Software package developed 10 years ago, doesn’t work on my computer anymore . . .
- Why?

Software 'rots' . . .



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  1. **implicit** dependencies
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- Existing solutions

	(1)	(2)	(3)
Docker / VMs	sandboxing	flattening	
Lockfiles[1]		hash-based addressing	
Nix	sandboxing	hash-based addressing	hash-based addressing

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Often-centralized features include

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Decentralized systems can be deployed on a central server.
Distributing a centralized system can be very hard.

Access Control

Traditional approach = Access Control Lists

- users, groups, files / artifacts, access control rules

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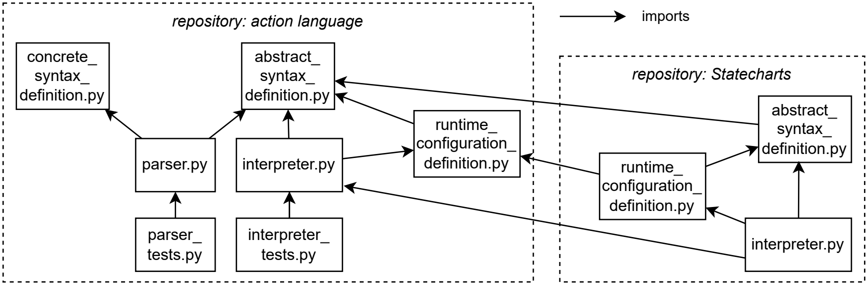
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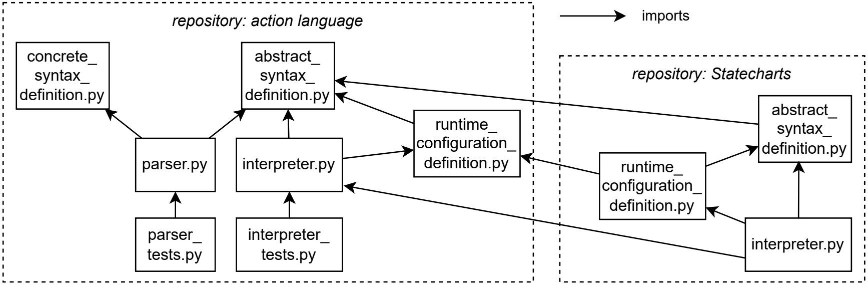
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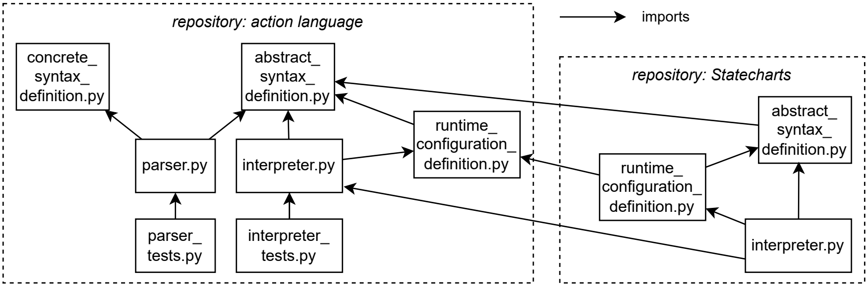
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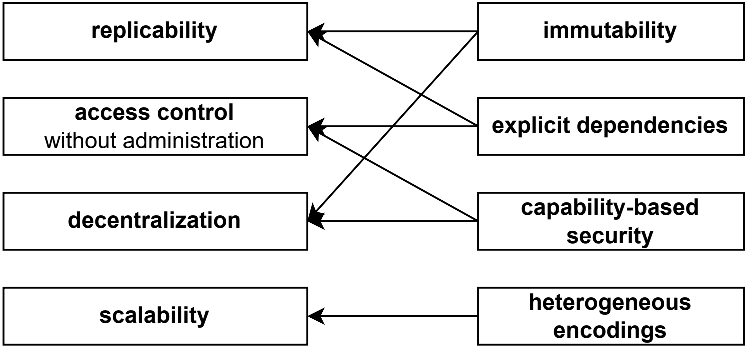
  which can be too much

Outline

Proposed Solution



Problem Space ← Solution Space

Immutability & Explicit Dependencies

All data is immutable

- **Bare minimum** requirement for replicability (software / data rot)
- Every object (=piece of data) gets permanent, unique ID
  - We propose hash-based IDs
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Explicit dependencies

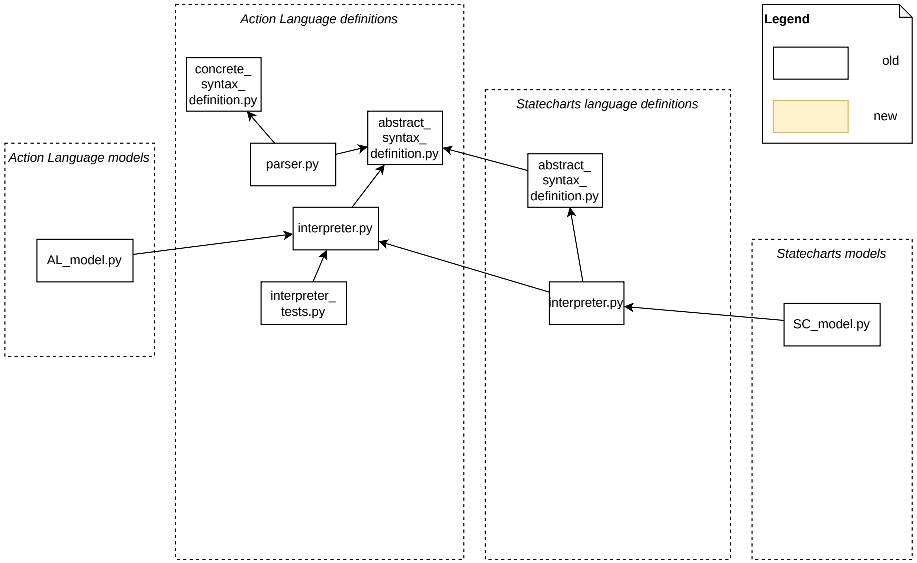
- An object must explicitly declare its dependencies (by referring to other hash-based IDs)
- An object's dependencies are 'part' of the object, and are immutable too

Examples of Dependencies

Examples

- A git-commit depends on the root of the snapshotted directory tree
- A directory depends on the items it contains
- A model depends on the model elements or sub-models it consists of
- A traceability link depends on the model elements it relates

Copy-on-write



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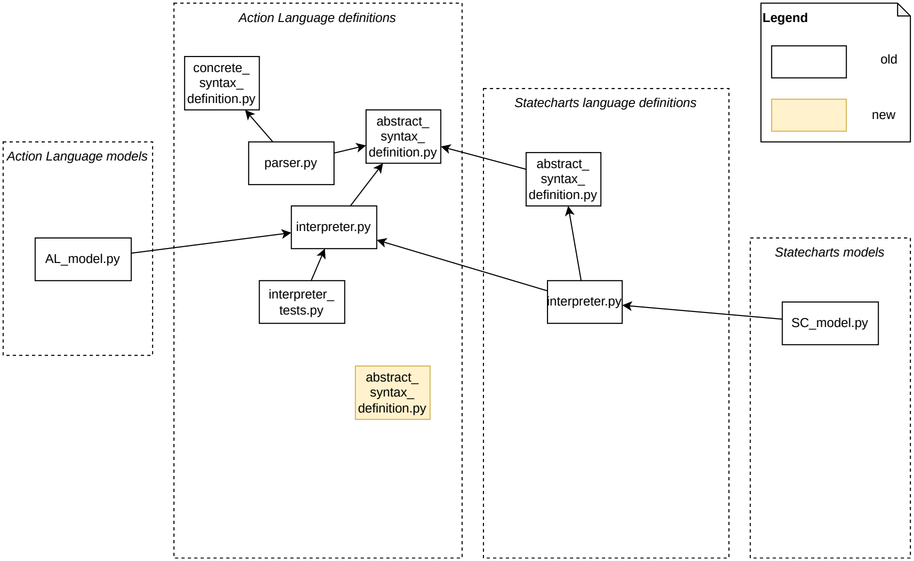
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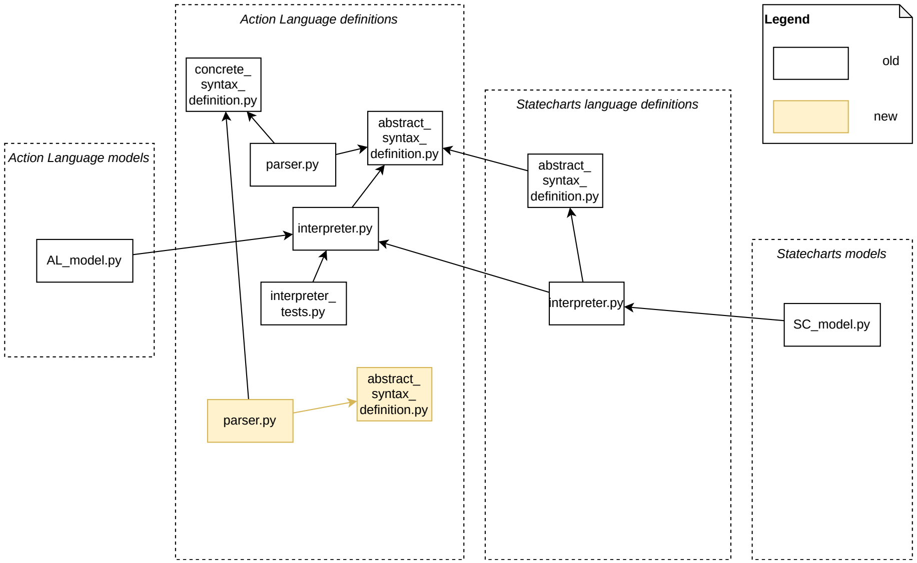
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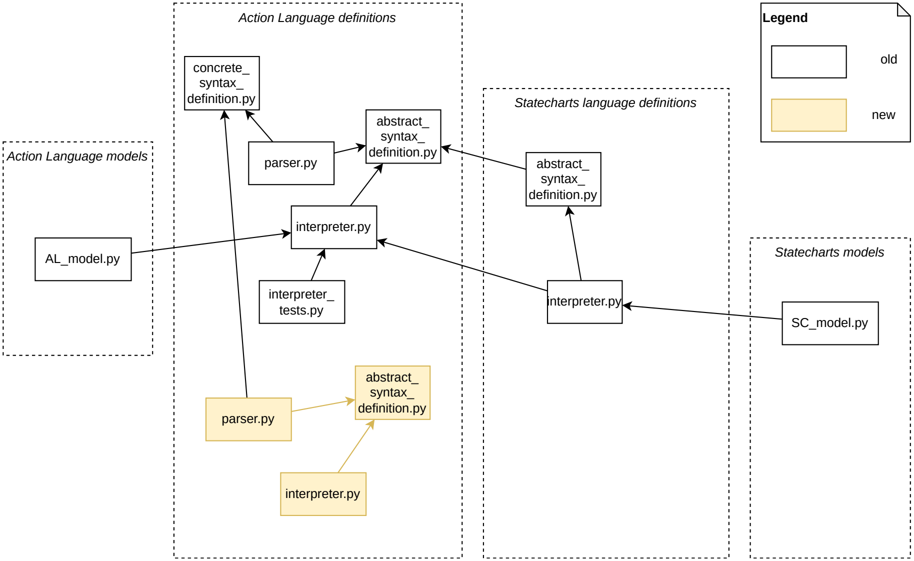
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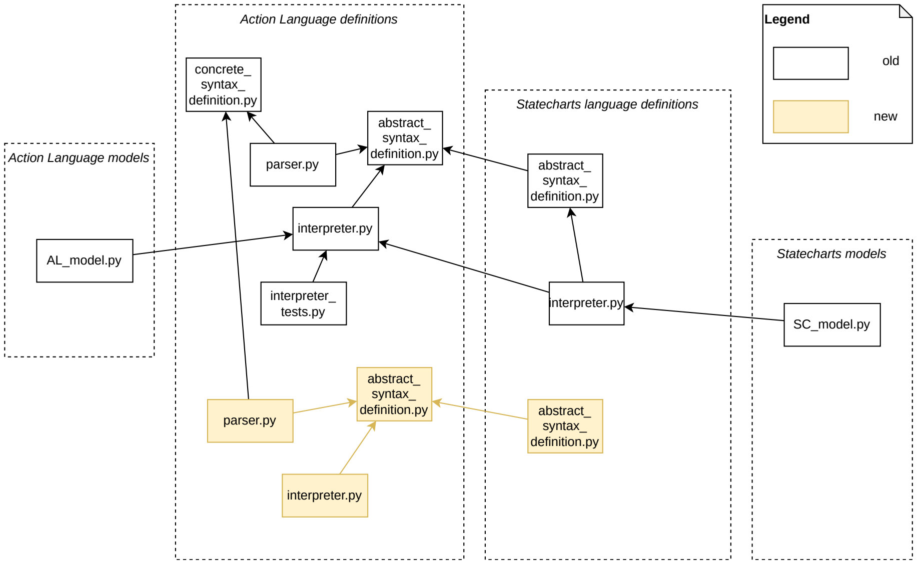

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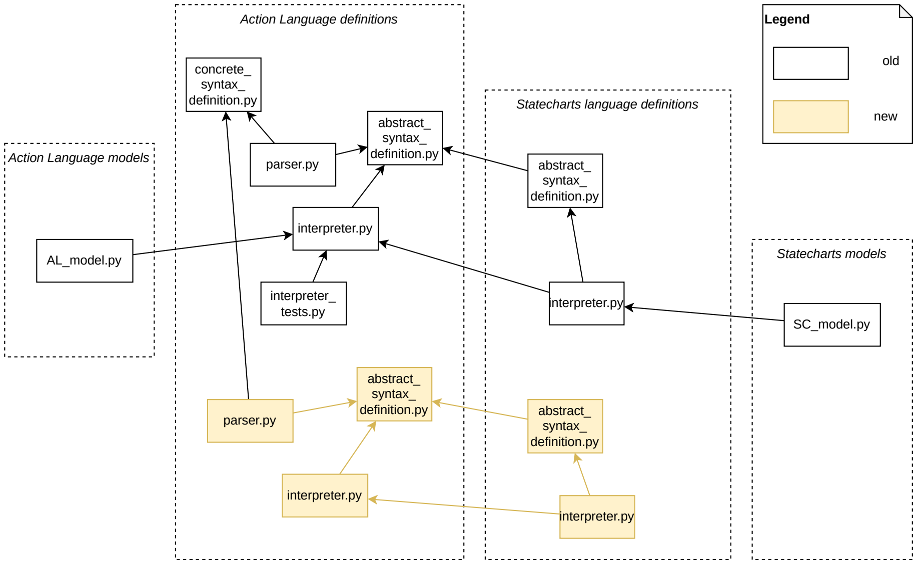

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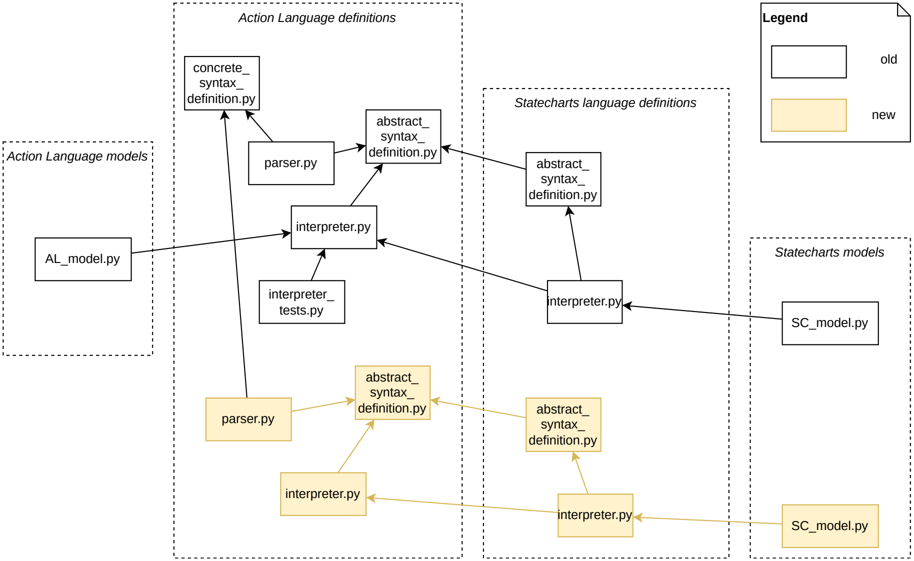
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- The alternative, "write-in-place" can only support snapshots with expensive deep-copy.

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- **Read** access is restricted:
    - You can only see data you created, and data that was explicitly shared with you
    - Data is shared by sharing its hash-based ID (‘share-by-link’)
    - Having read-access to a piece of data, implies having read-access to its dependencies (but not vice versa)

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- Objects & dependencies forms a DAG (by construction)
  - can use *reference counting* AKA *poor man's garbage collection* to clean up unreachable data

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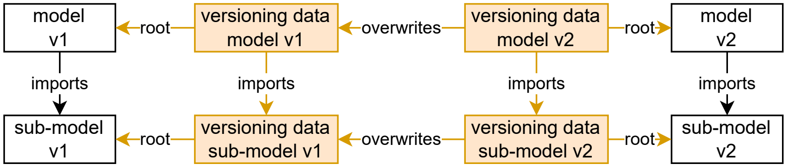
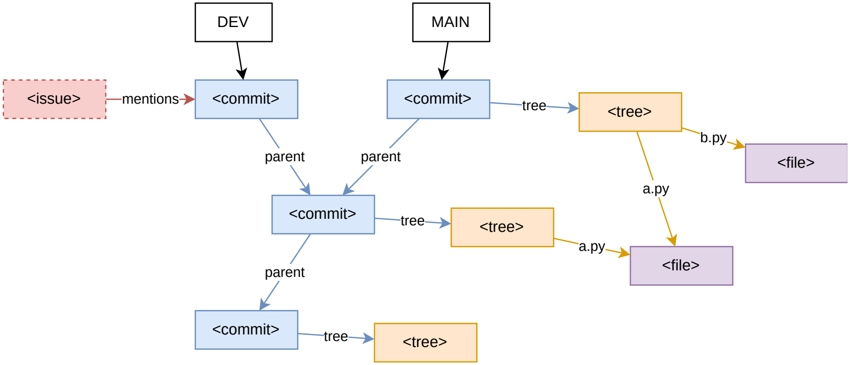
- Currently experimenting with hierarchical versioning approach that records all causes of computed values



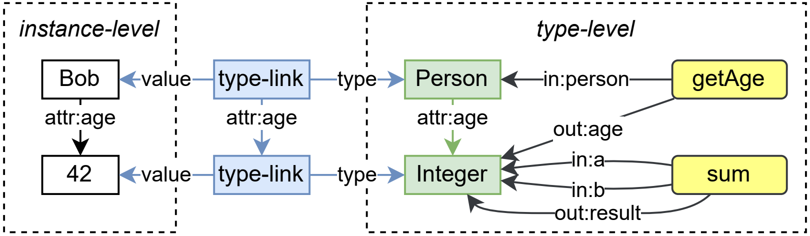
Versioning – Git integration



A git repo is already a store of immutable objects.
Easy to integrate!

Typing

- Typing information is **just data**



- type-level data is FTG

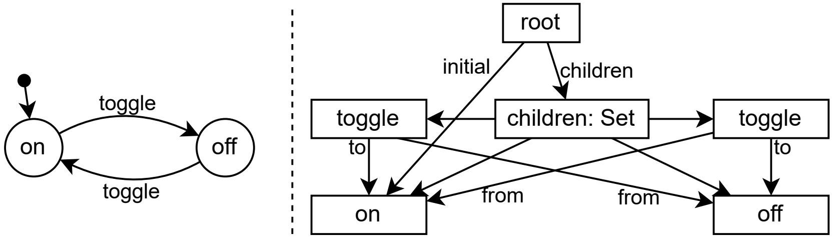
Outline

Challenges

- Scalability (cost of copy-on-write – already discussed)
- Inability to revoke read-access
- Inability to encode cyclic references (next slide . . .)

Breaking up cycles

We follow WebGME's approach:



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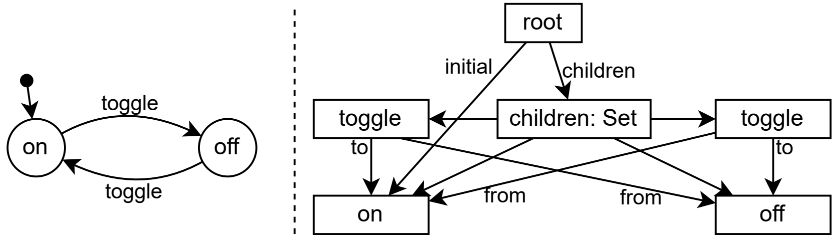

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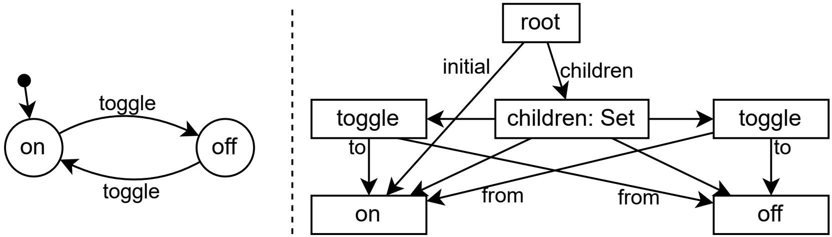

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- BUT we can *memoize* this information (due to immutability)

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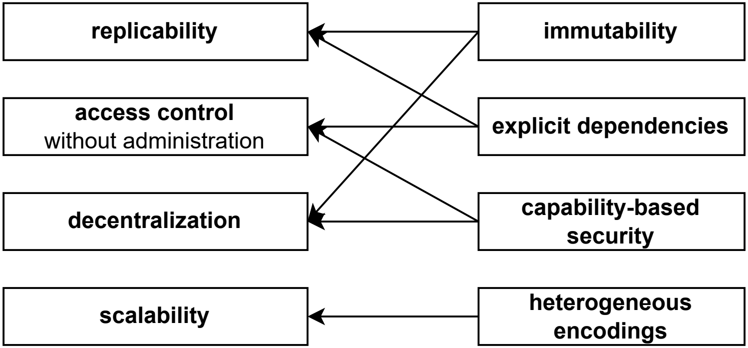

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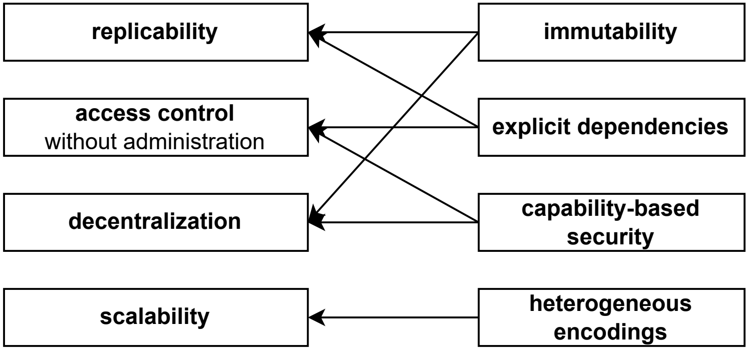

- **Access control** is **fundamental**

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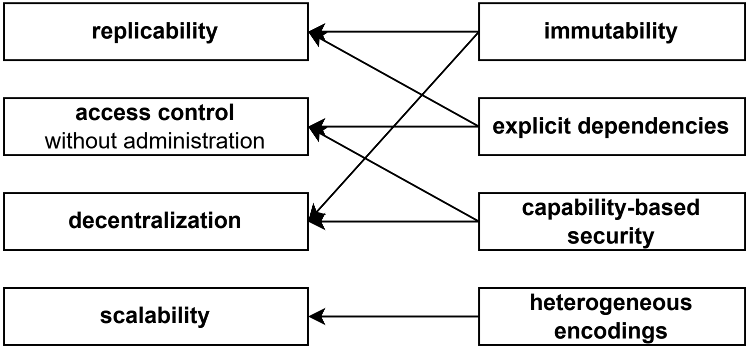

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- **Immutability** seems expensive, but **pays off** (in our opinion)

Conclusions

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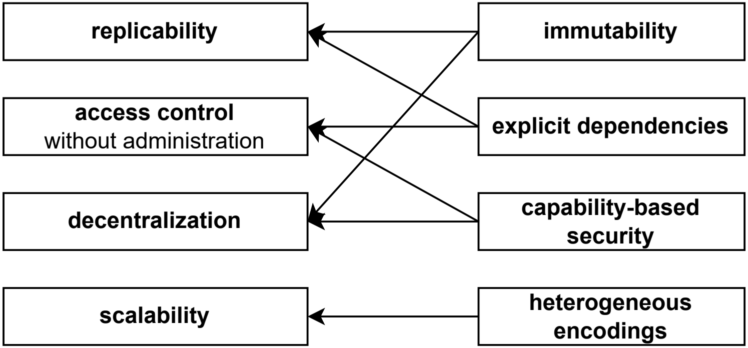

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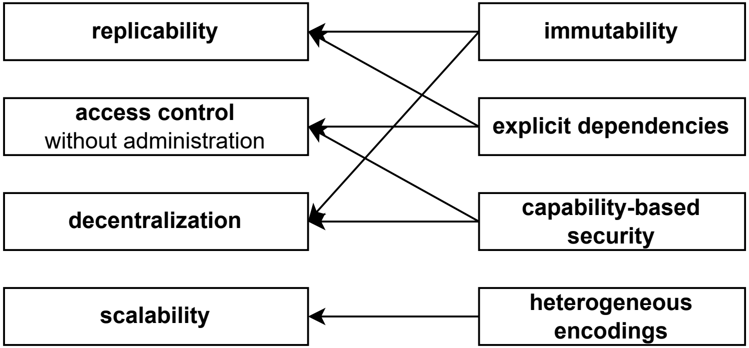

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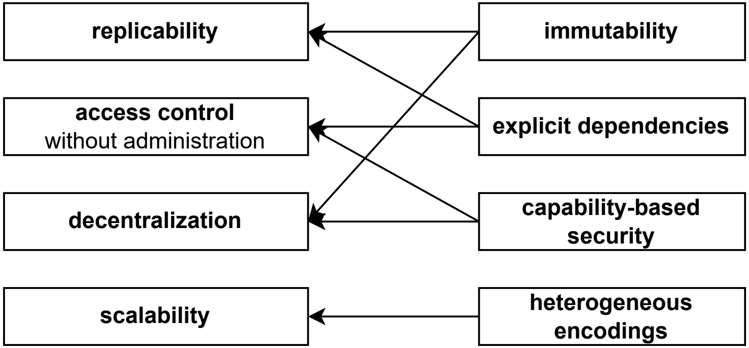
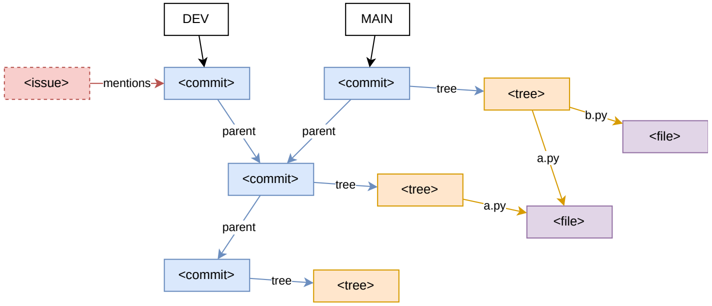


- **Access control** is **fundamental**
- **Immutability** seems expensive, but **pays off** (in our opinion)
- Surprise: **Versioning** is **not** a **fundamental** feature, but **immutability is**
- Easy to integrate immutable data (e.g., git)

Backup slide

- Write-in-place + storing (immutable) deltas has one big shortcoming: The deltas are 'special' (separate from the data being versioned)
- Cannot treat versions / deltas as data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