Applying Social Network Analysis Techniques to Architectural Smell Prediction

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Software Evolution & Dependencies

As software systems evolve, the **amount and complexity of the interactions** amongst their components increases.

- More coupling.
- **"*Undesired*" dependencies** amongst certain components.
- Degradation of intended design → Architectural Smells appear!

Early detection is important to plan ahead for actions to stop degradation

- We do not only need to fix local problems.
- Know which modules are likely to get coupled in the future.

Anticipate problems! **Proactively look for solutions.**

Example: Cycle Evolution

What do we want?

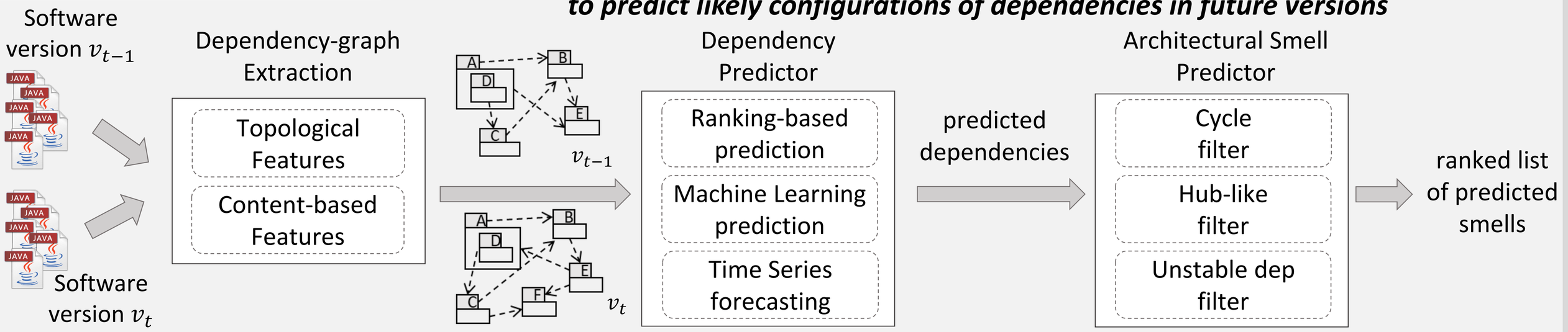
Predict when a dependency-related problem is likely to manifest!

- Software systems and underlying architecture behave as social networks.
- Changes can be predicted based on the appearance of dependencies between design elements.

We argue that **Social Network Analysis** techniques can be used for **software dependency prediction**!

Smell Prediction Proposal

To what extent we can leverage on information from previous software versions to predict likely configurations of dependencies in future versions

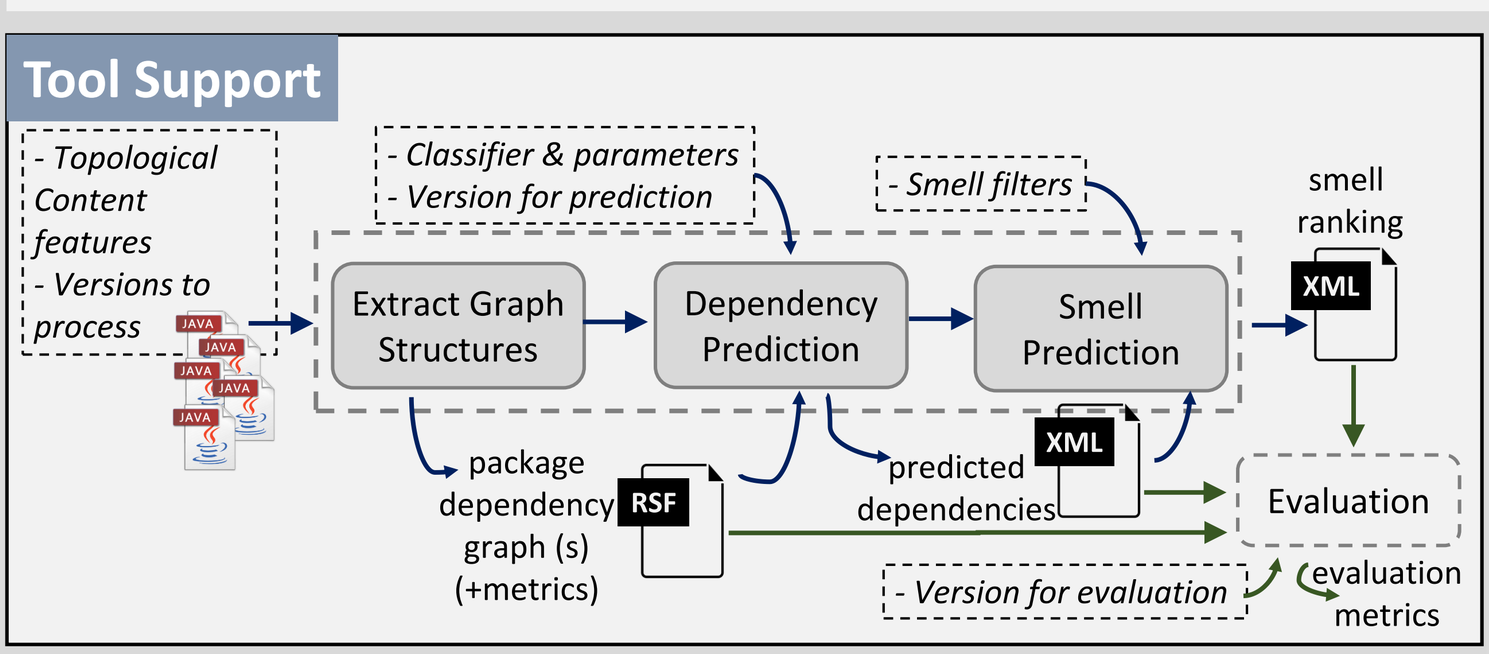


- Build a graph $DG(V, E)$ for system version n, where:
  - Each node v in V is Java package, and each edge *e* in *E* is a usage relationship between a pair of packages v_1 and v_2.
  - Edges represent similarity between packages (topological or content-based).

Dependencies predicted based on…		
	current version	*Link prediction* Homophily-based
	previous and current version	Machine Learning approach Classifier-based
	history of versions	Time series Forecasting Dynamic SNA

- The prediction of a dependency is not enough to predict the appearance of an architectural smell.
  - **Not every predicted dependency might cause an smell to emerge.**
- Predicted dependencies undergo a filtering process.
  - Filters are **smell-dependent**.

Tool Support



There is still work to do!

- More features. Design metrics? OO metrics?
- Analyse other dependency-based problems!
- Can we predict the appearance of new nodes (e.g. new packages, classes)?
- Can we predict the disappearance of dependencies?

Lessons Learned

Machine Learning techniques have the potential for Link Prediction applied to software dependencies

- An initial evaluation with cycles & hubs showed a good performance!
  - High recall, low precision.
- Including content-based features improves dependency prediction.
- **Leveraging on information from previous versions gives reasonable predictions**, although not all versions seem useful.
- The choice of the filter variant (for a given smell type) can affect both recall and precision.
  - We preferred good recall over precision in the analysed cases.