Speculative Analysis

Homework 2

- On pair programming
- Due Monday, Oct 7, 9 AM on moodle
- This homework requires creativity
  - Creativity cannot be forced in the last day
  - Start early!

What's going on with projects?

- 621 students assemble into project groups
  - see project group self-assembly on moodle
  - due Monday Oct 7 as well
- 521 students do not have to do a project
  - but can if they want to

- Everyone who does a project will do 1 paper presentation
- Everyone else will do 2 paper presentations

What do I have to do by Monday?

- Homework 2
- 621 students: self-assemble into groups
  - complete moodle group selection assignment
- 521 students: if you want to do a project, complete moodle group selection assignment

DECISION MAKING

Implement a new feature?

Incorporate another developer's changes?

Fix a bug?

DECISION MAKING

Upgrade a library?

Refactor for code reuse?

Run tests?

Implement a new feature?

Incorporate another developer's changes?

Fix a bug?

DECISION MAKING

Developers often make decisions based on experience and intuition.

Upgrade a library?

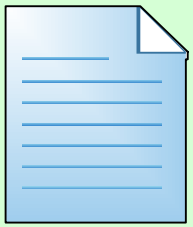
Refactor for code reuse?

Run tests?

Can we predict the future

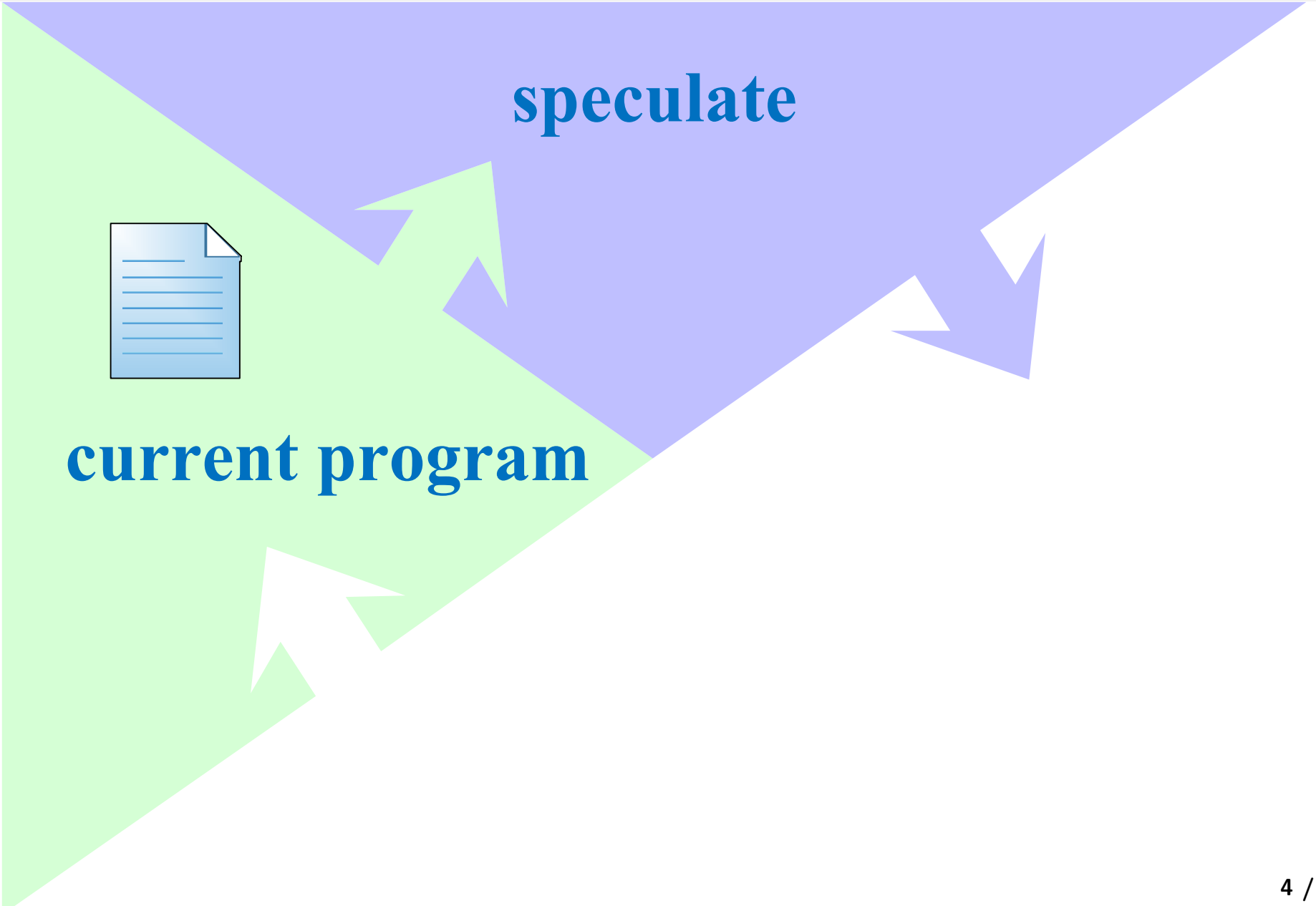
to help make decisions?

Speculative analysis: predict the future and analyze it



current program

Speculative analysis: predict the future and analyze it



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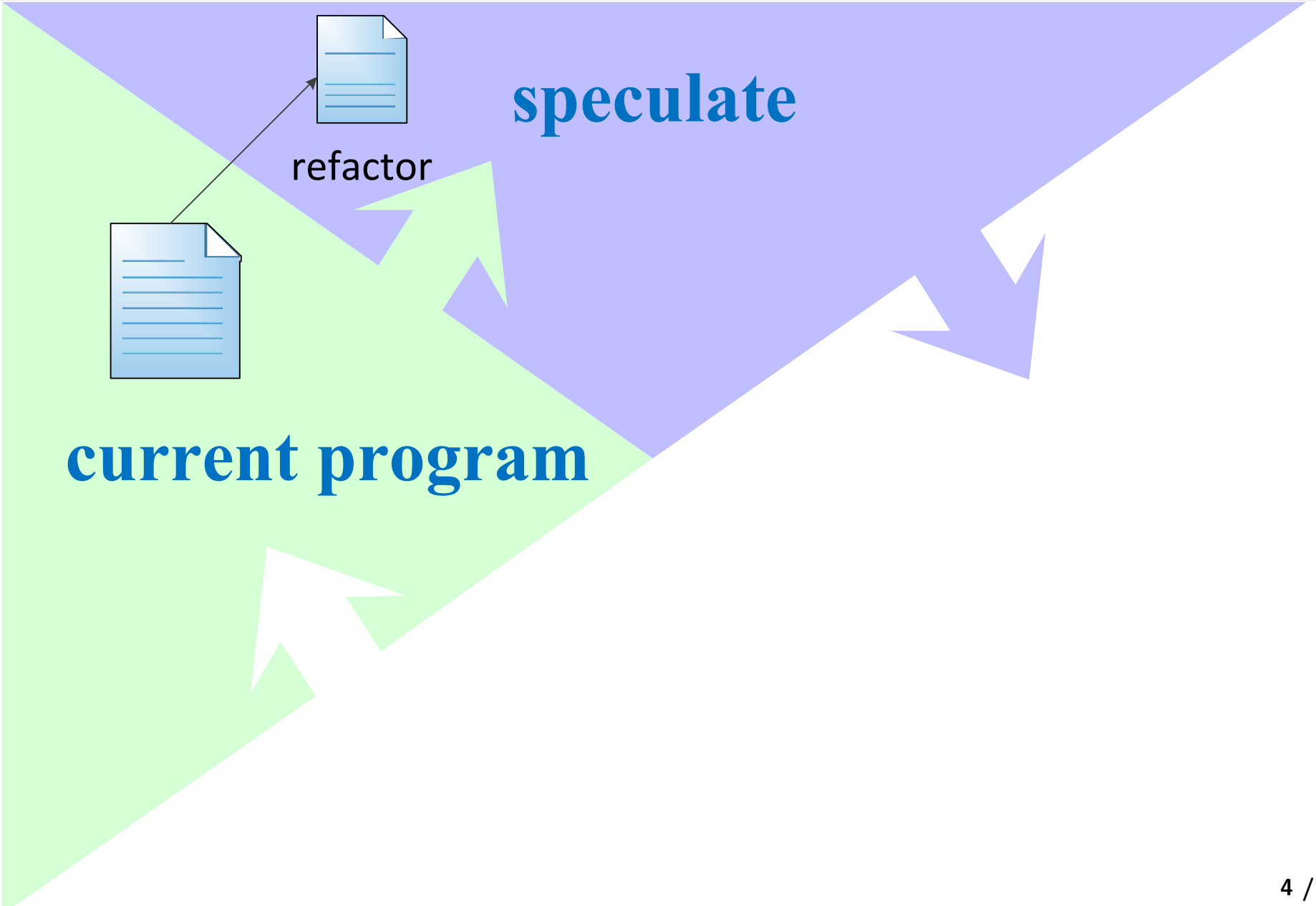

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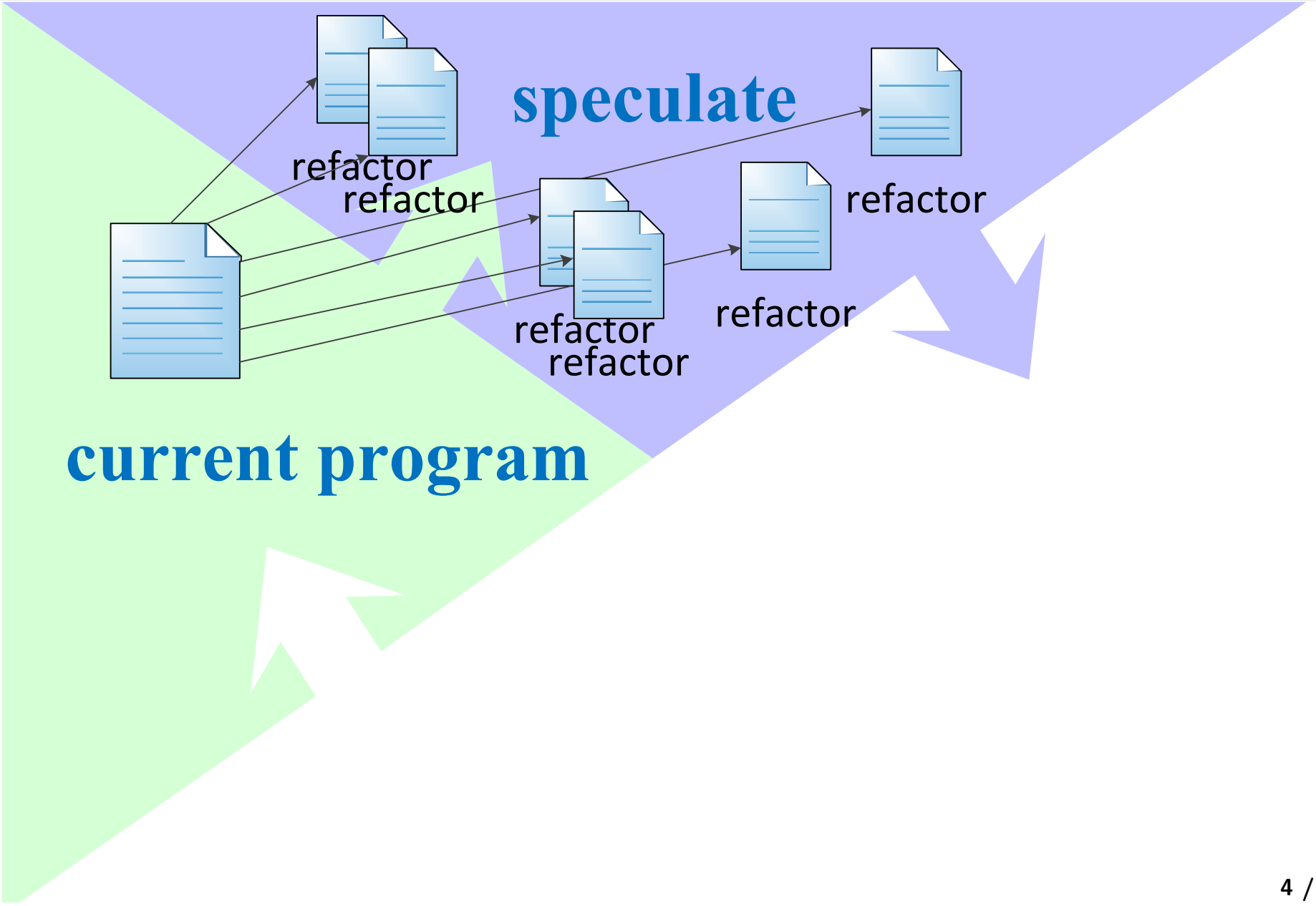

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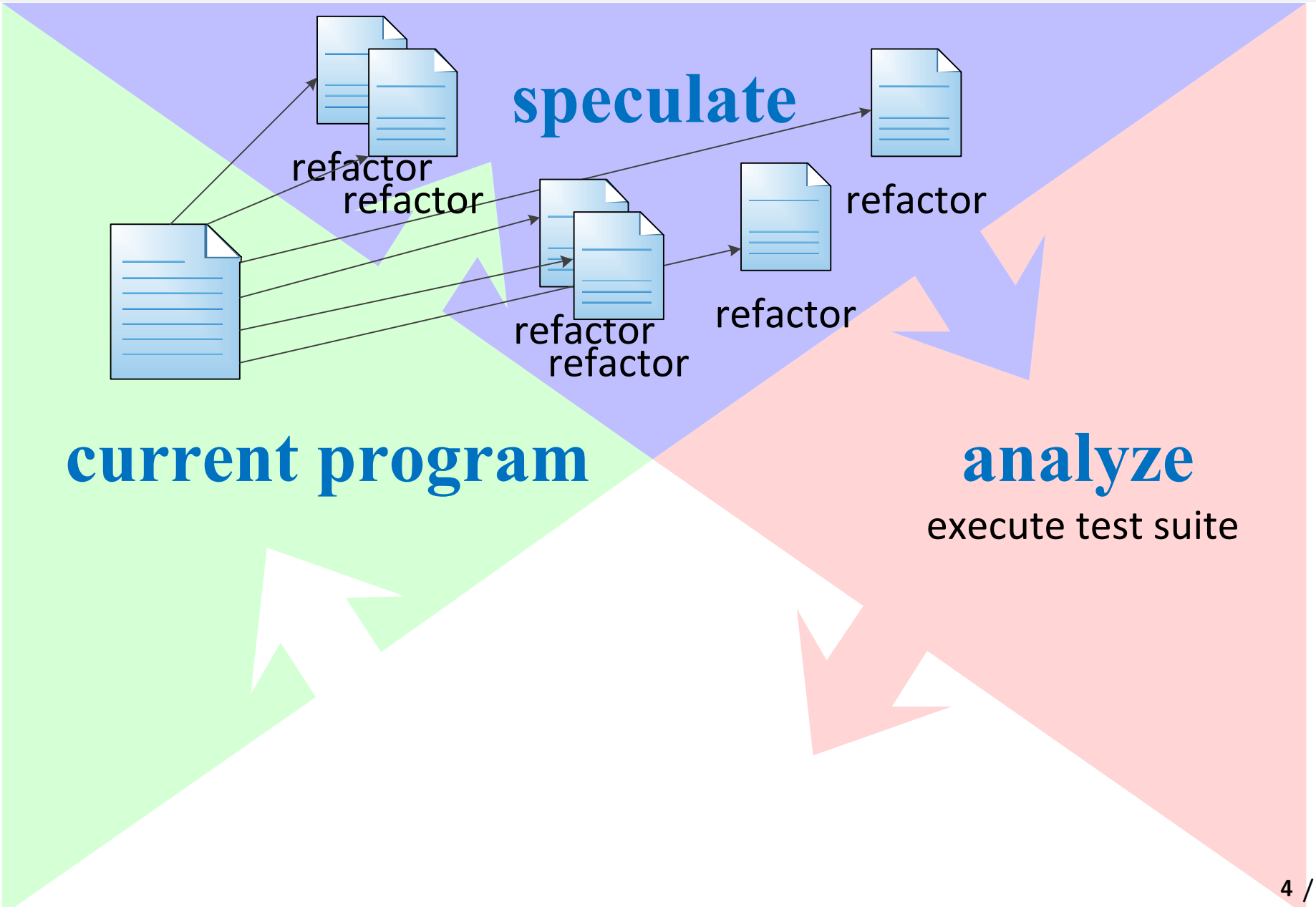

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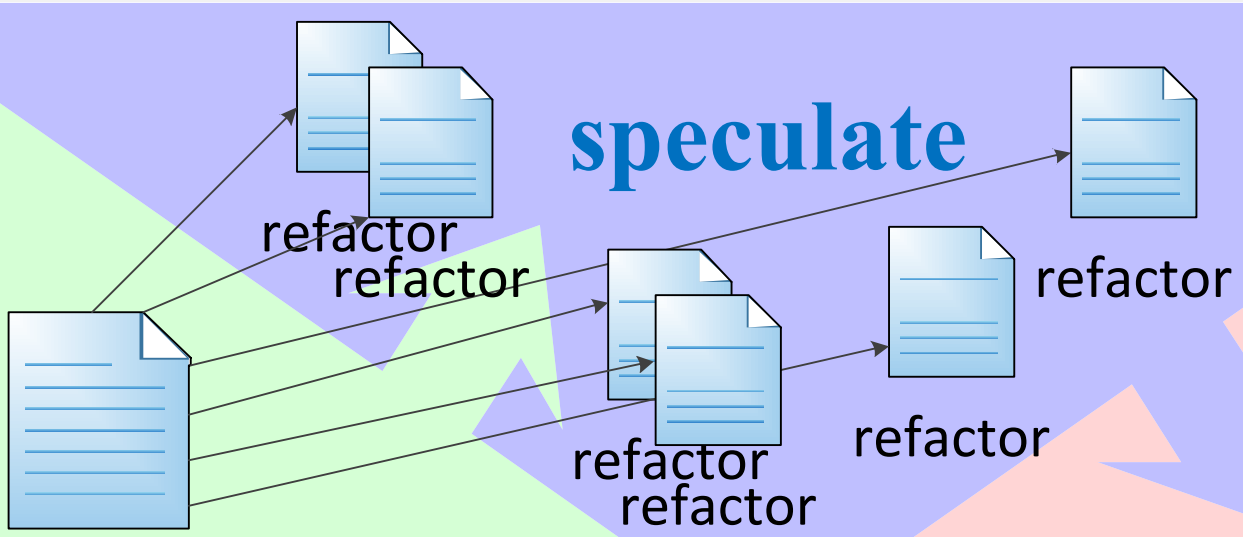


current program

analyze

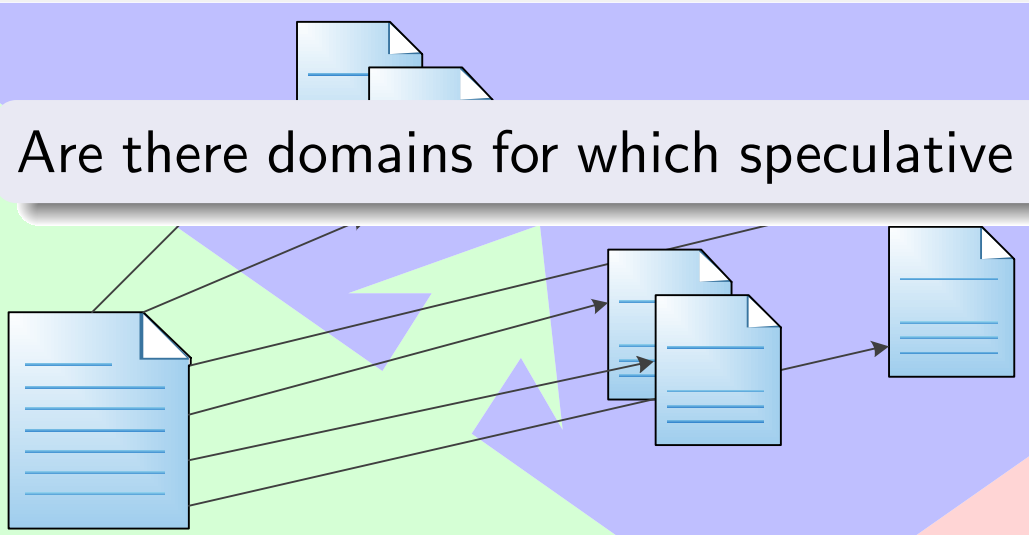
execute test suite

inform developer

# of resulting test failures

Speculative analysis: research questions

Are there domains for which speculative analysis is possible?



current program

Can speculative analysis be made computationally feasible?

Can speculative analysis help, and not overwhelm, developers?

Quick Fix Scout

Collaborators: Kıvanç Muşlu, Reid Holmes, Michael D. Ernst, and David Notkin

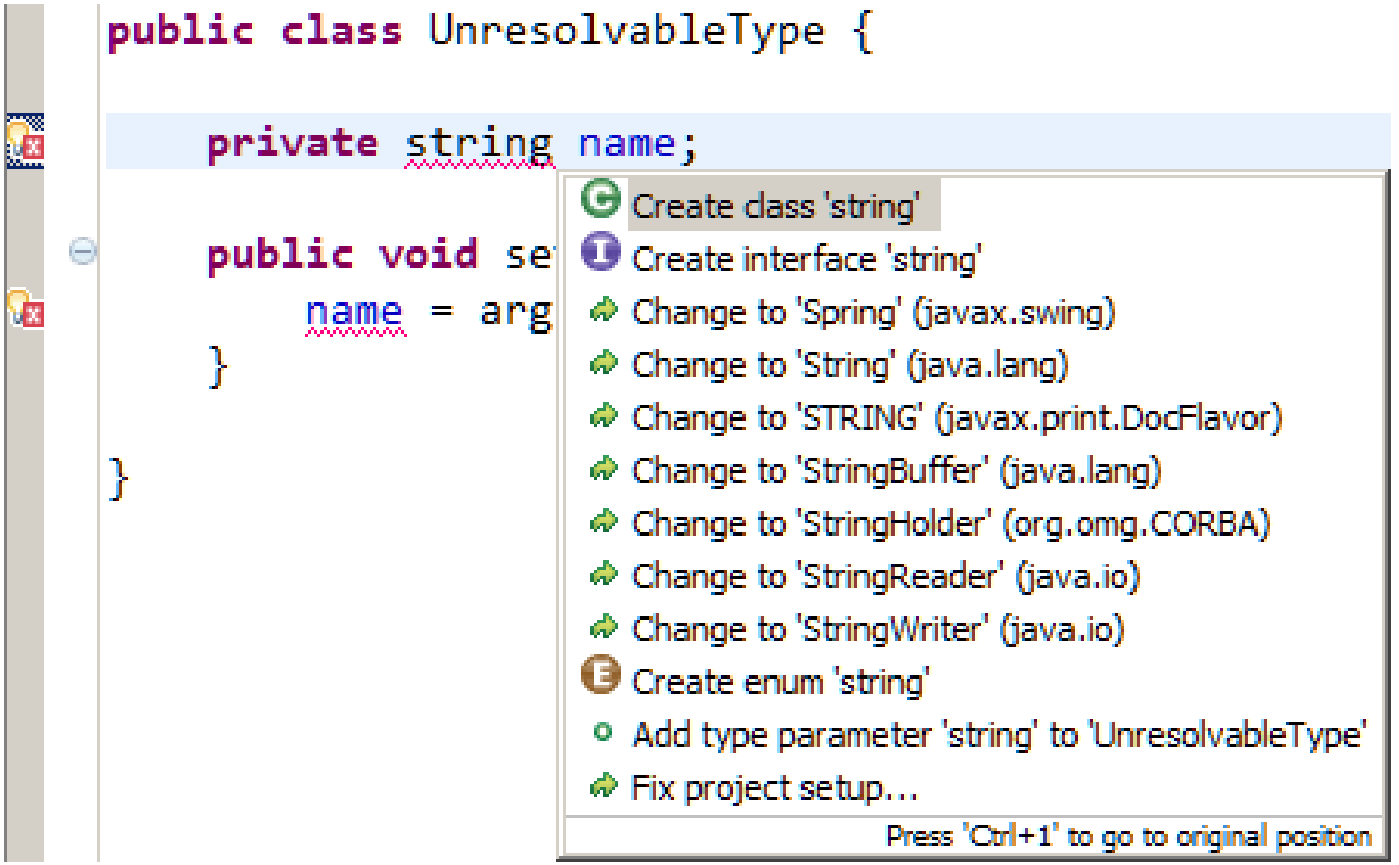
```
public class UnresolvableType {

    private string name;

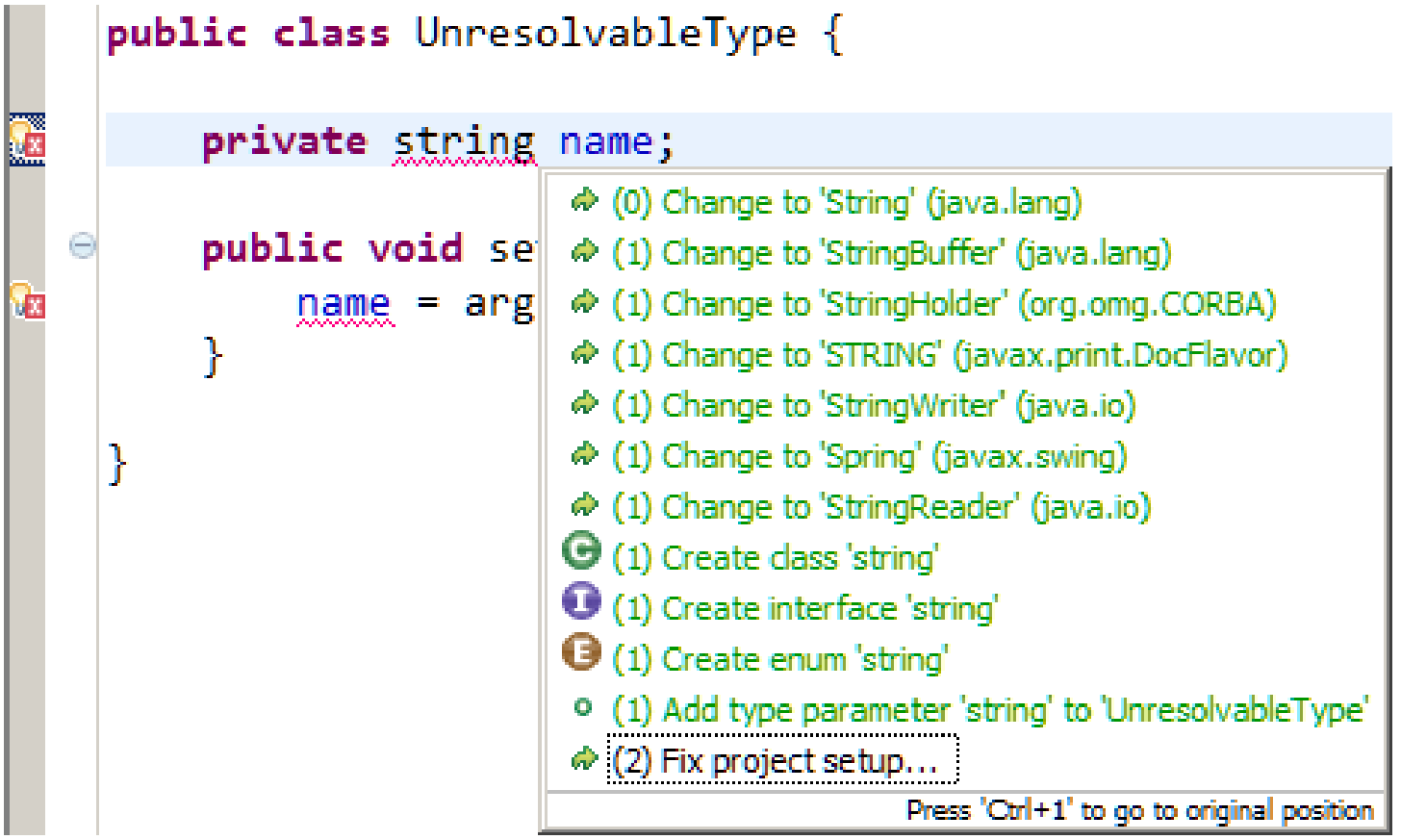
    public void setName(String arg) {
        name = arg;
    }

}
```

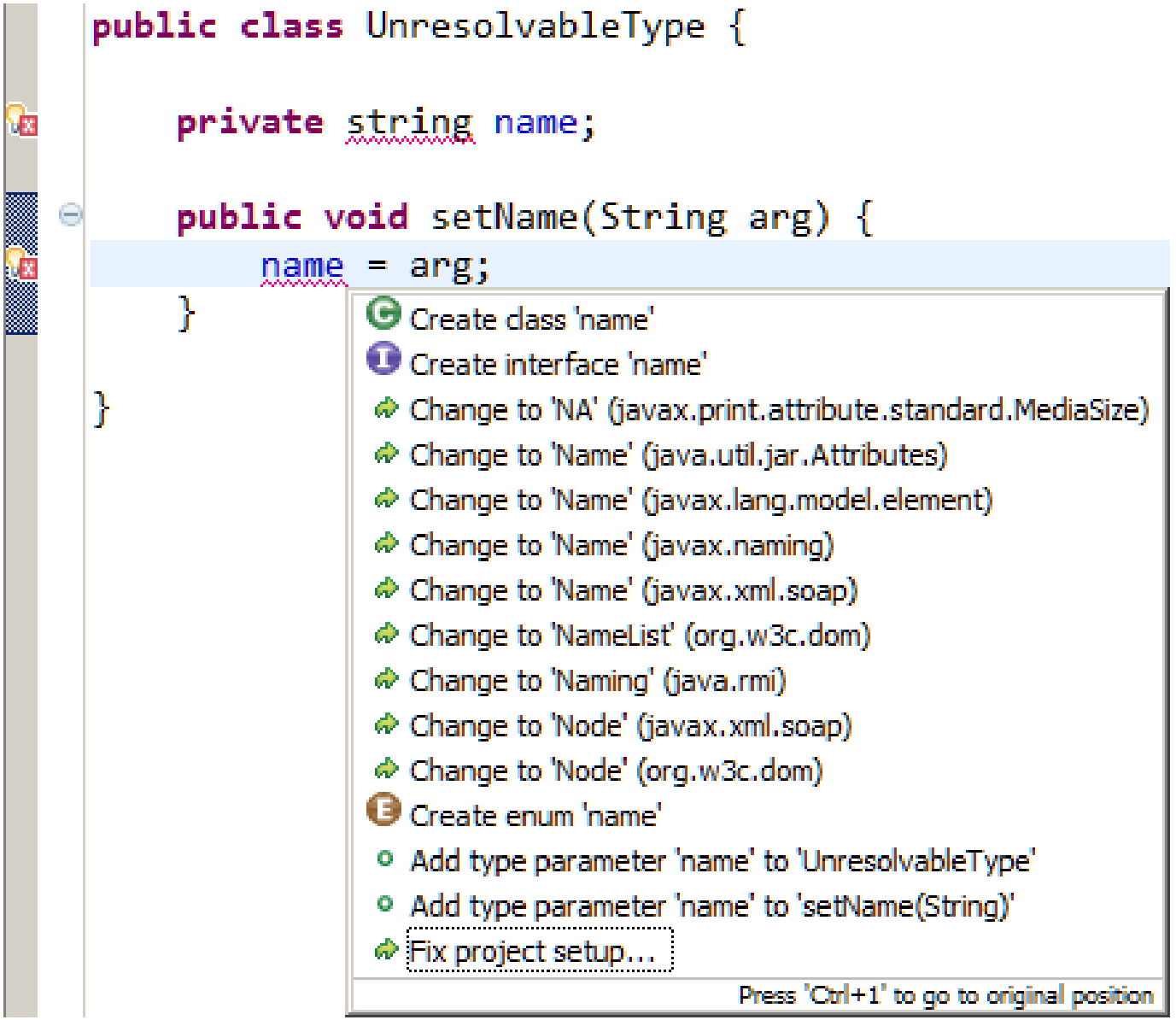
Eclipse provides Quick Fixes to resolve compilation errors.



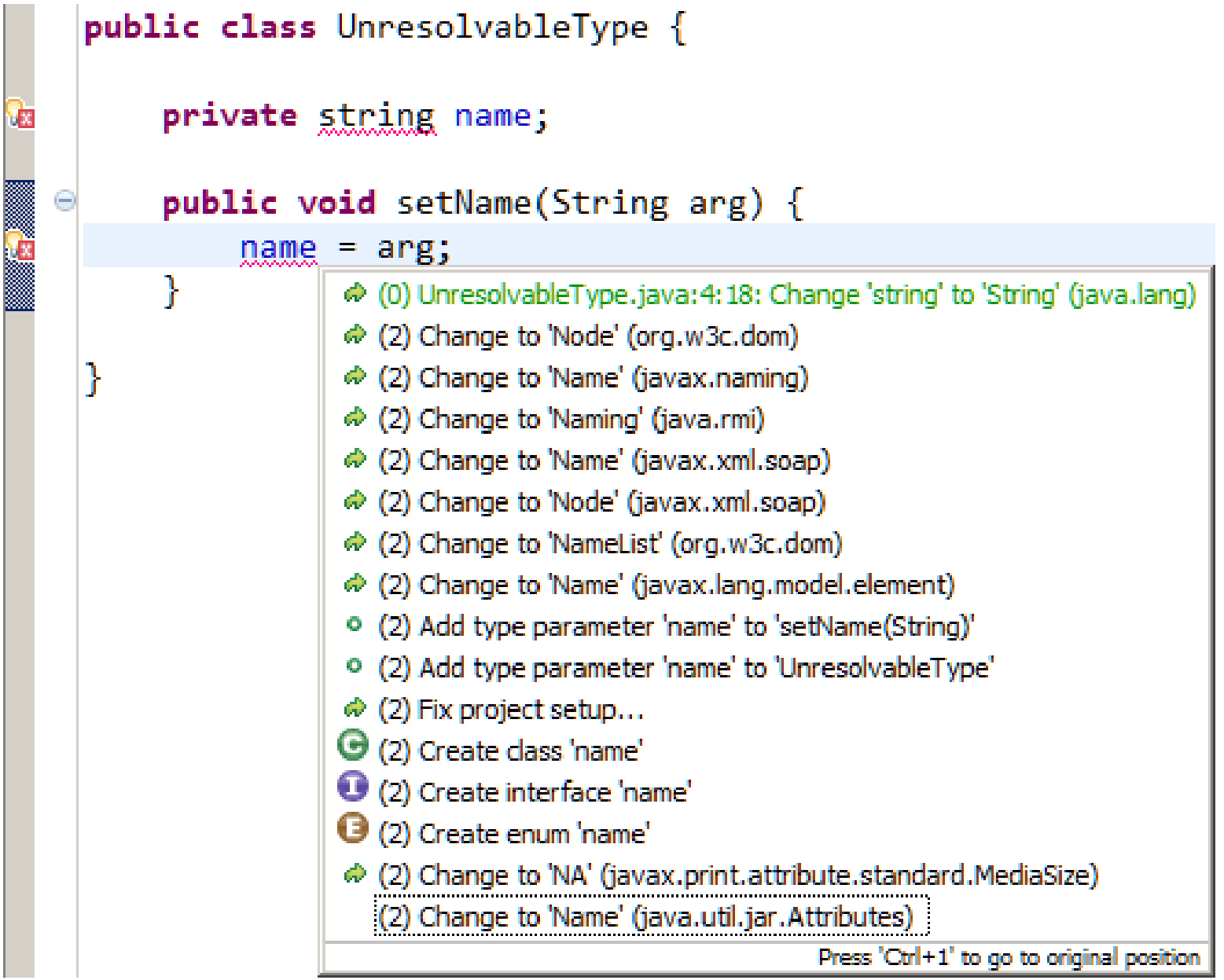
But Eclipse can't tell which fix is best.



We can speculatively apply each fix to find out how many errors remain.



Sometimes, local fixes cannot resolve an error.



Speculation can discover remote fixes that resolve errors.

Complex error dependencies

```
public class ExceptionalObject  {
    public void exceptionalMethod() {
        throw new MyException();
    }
}
```

. . .

```
public class SafeObject  {
    public void safeMethod() {
        try {
            ExceptionalObject eo =
                    new ExceptionalObject();
            eo.exceptionalMethod();
        } catch (MyException e) {}
    }
}
```

http://quick-fix-scout.googlecode.com

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}
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Remove catch clause
Replace catch clause with throws
Press 'Ctrl+1' to go to original position

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}
```

(0) ExceptionalObject.java:6:12: Add throws declaration to 'exceptiona
(1) Replace catch clause with throws
(1) Remove catch clause
Press 'Ctrl+1' to go to o

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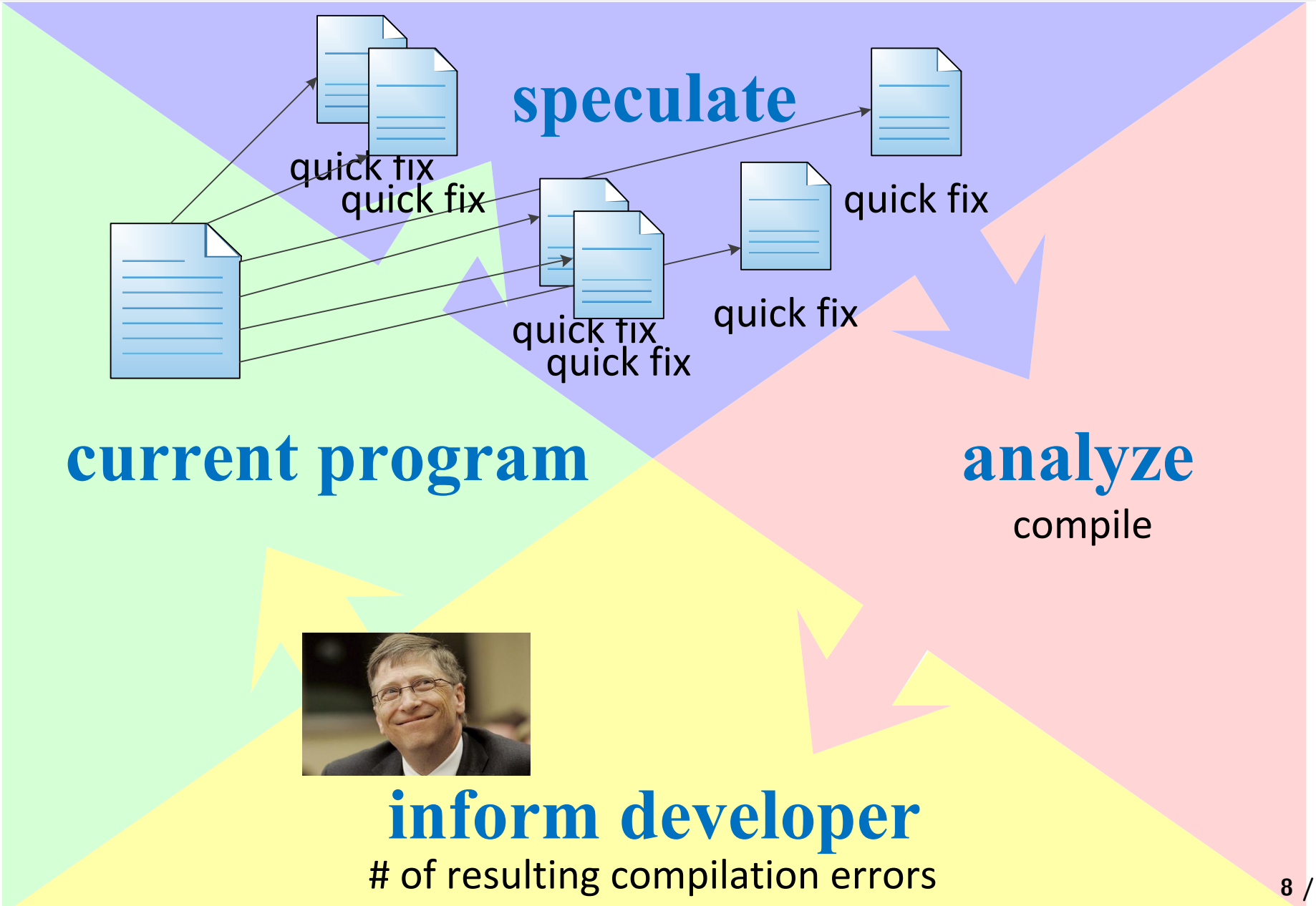
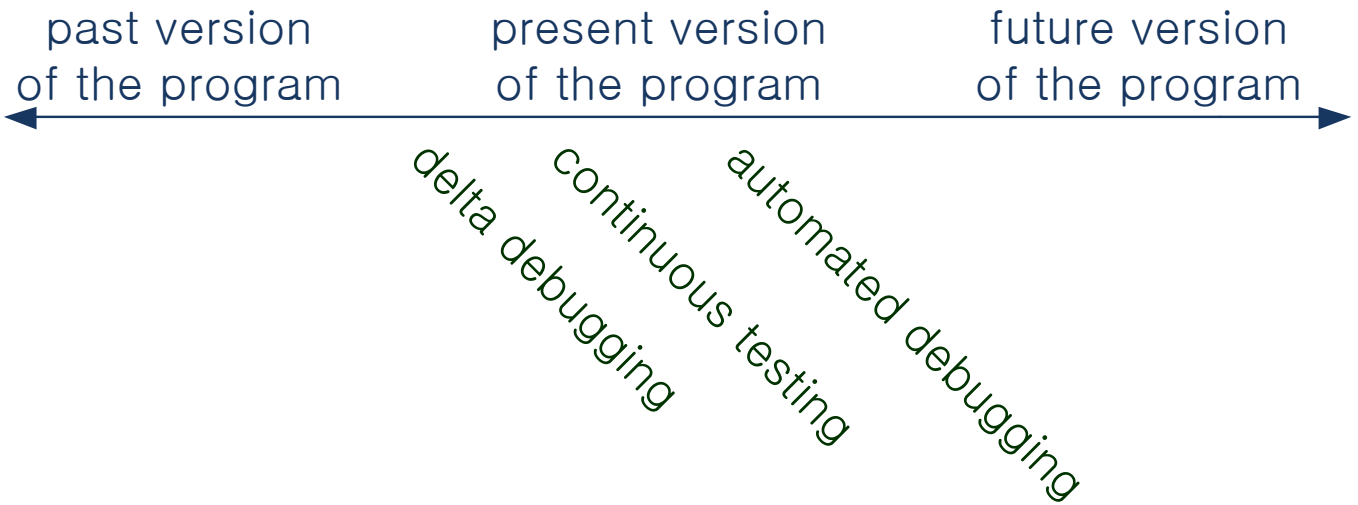
Speculative analysis for Quick Fix



Exploring the future



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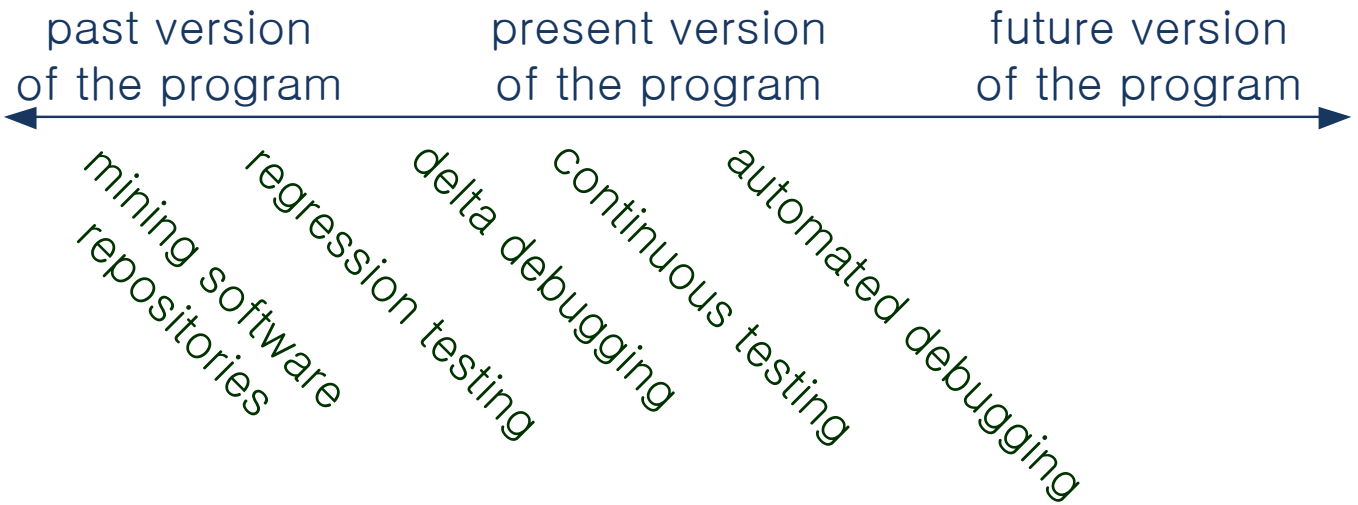

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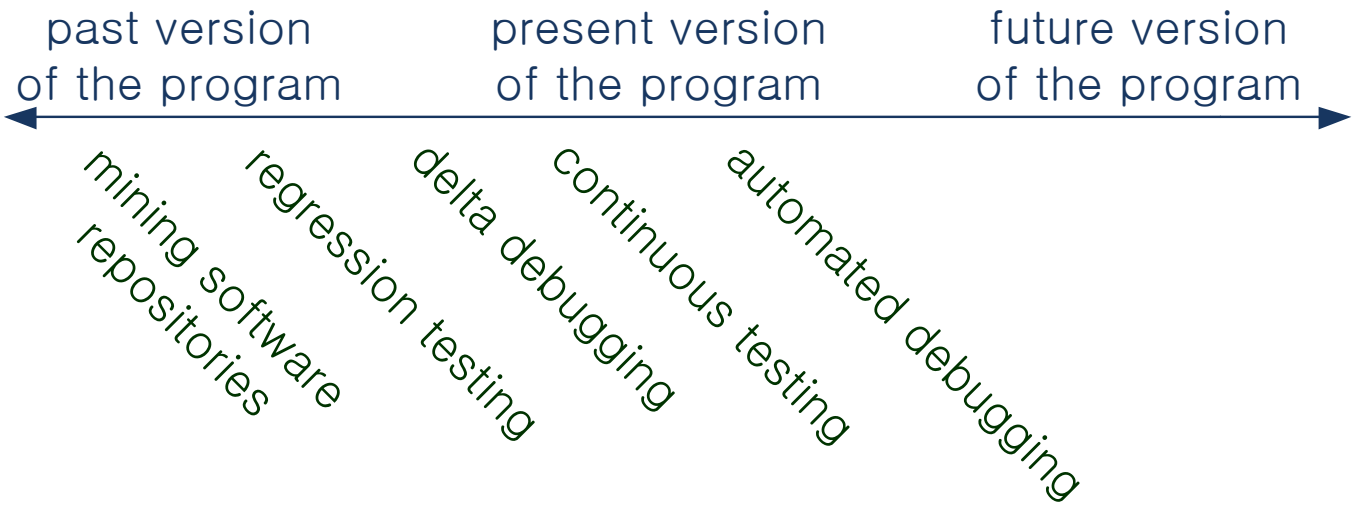

Continuous development

- compilation [Childers et al. 2003; Eclipse 2011]
- execution [Henderson and Weiser 1985; Karinthi and Weiser 1987]
- testing [Saff and Ernst 2003, 2004]
- version control integration [Guimarães and Rito-Silva 2010]

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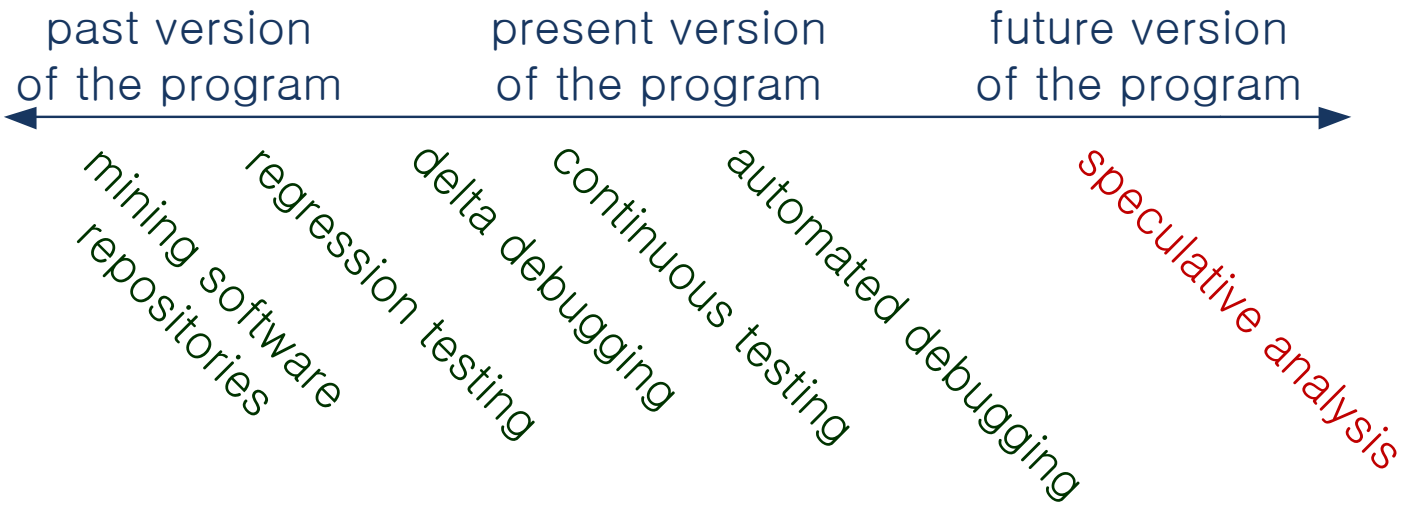

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Speculative analysis is **predictive**.

Proactive detection of collaboration conflicts

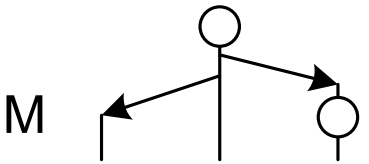
Collaborators: Reid Holmes, Michael D. Ernst, and David Notkin

Version-control terminology

Proactive conflict detection applies to both centralized and distributed version control.

	distributed (hg, git)	centralized (cvs, svn)
local commit:	commit	save
incorporate:	pull and push	update and commit

The Gates conflict



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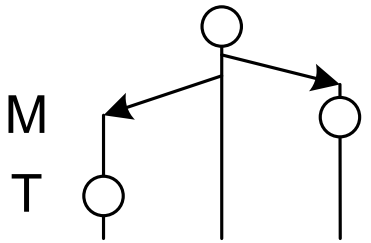

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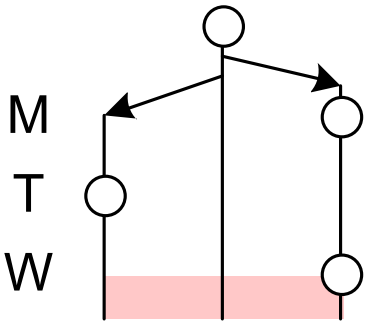

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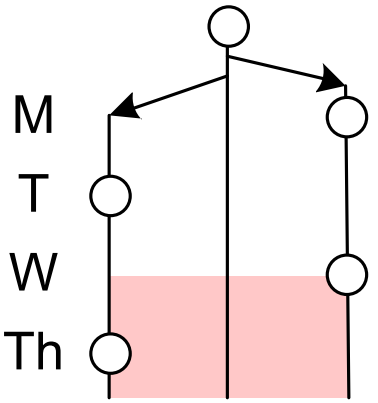

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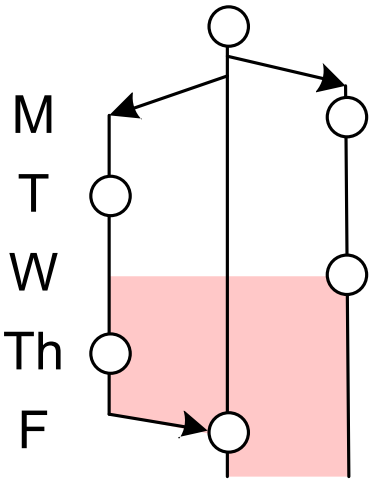

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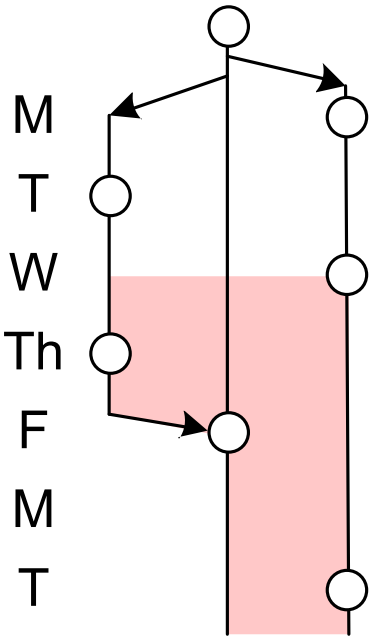

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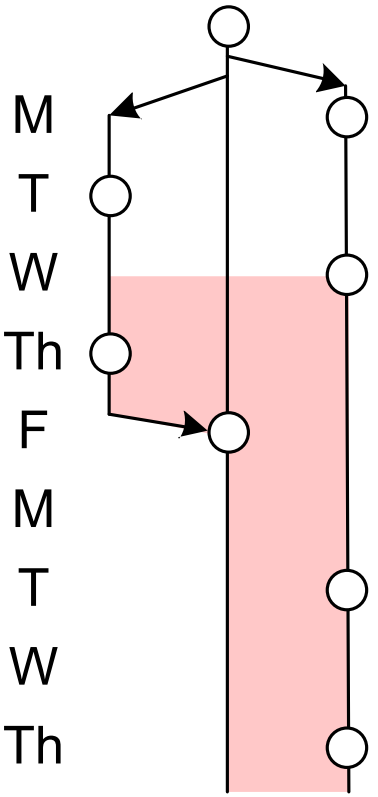

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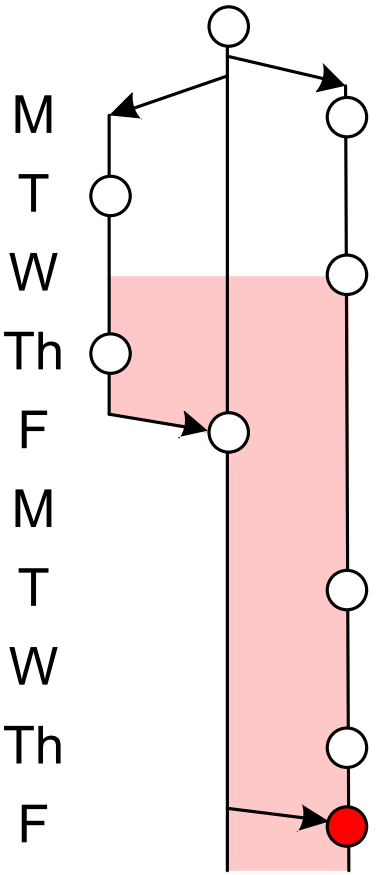

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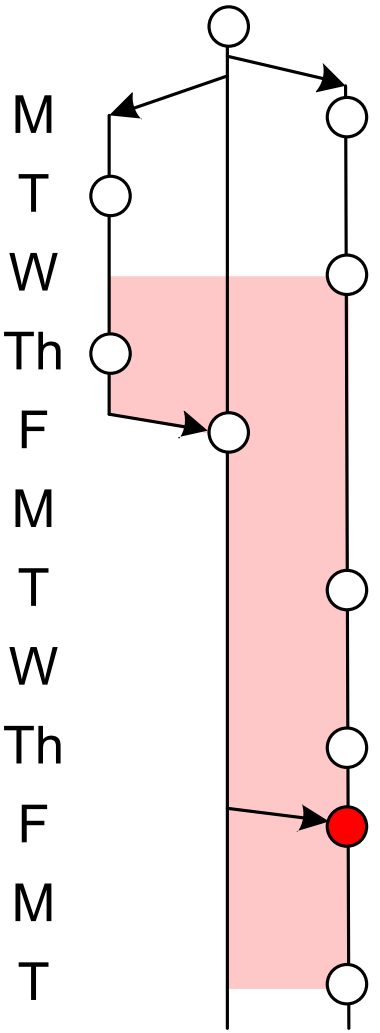

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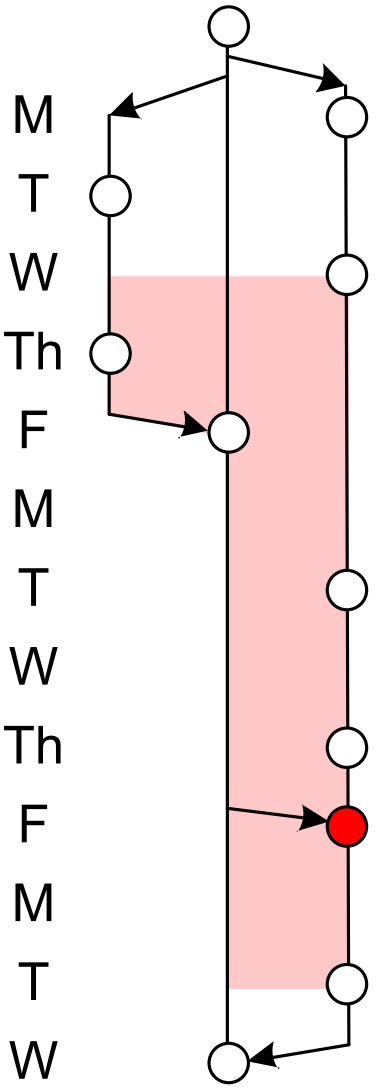

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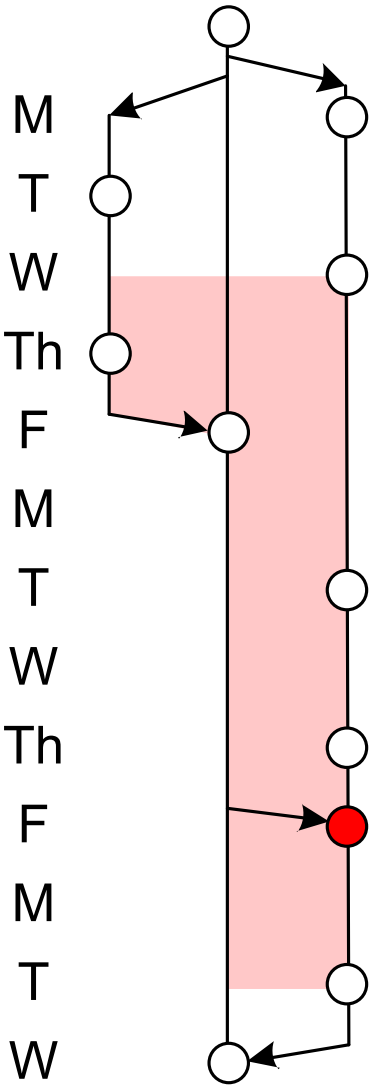
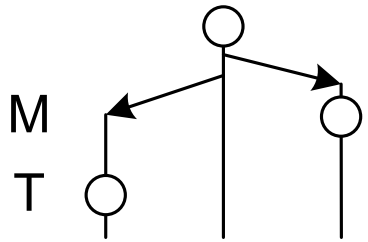


The information was all there, but the developers didn't know it.

What could well-informed developers do?



- avoid conflicts

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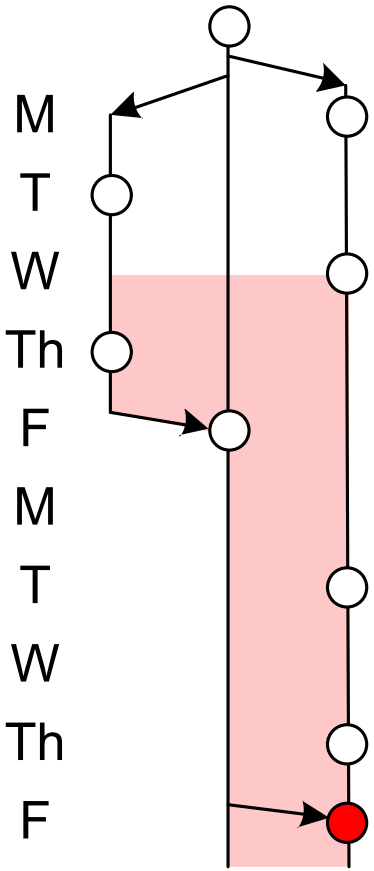


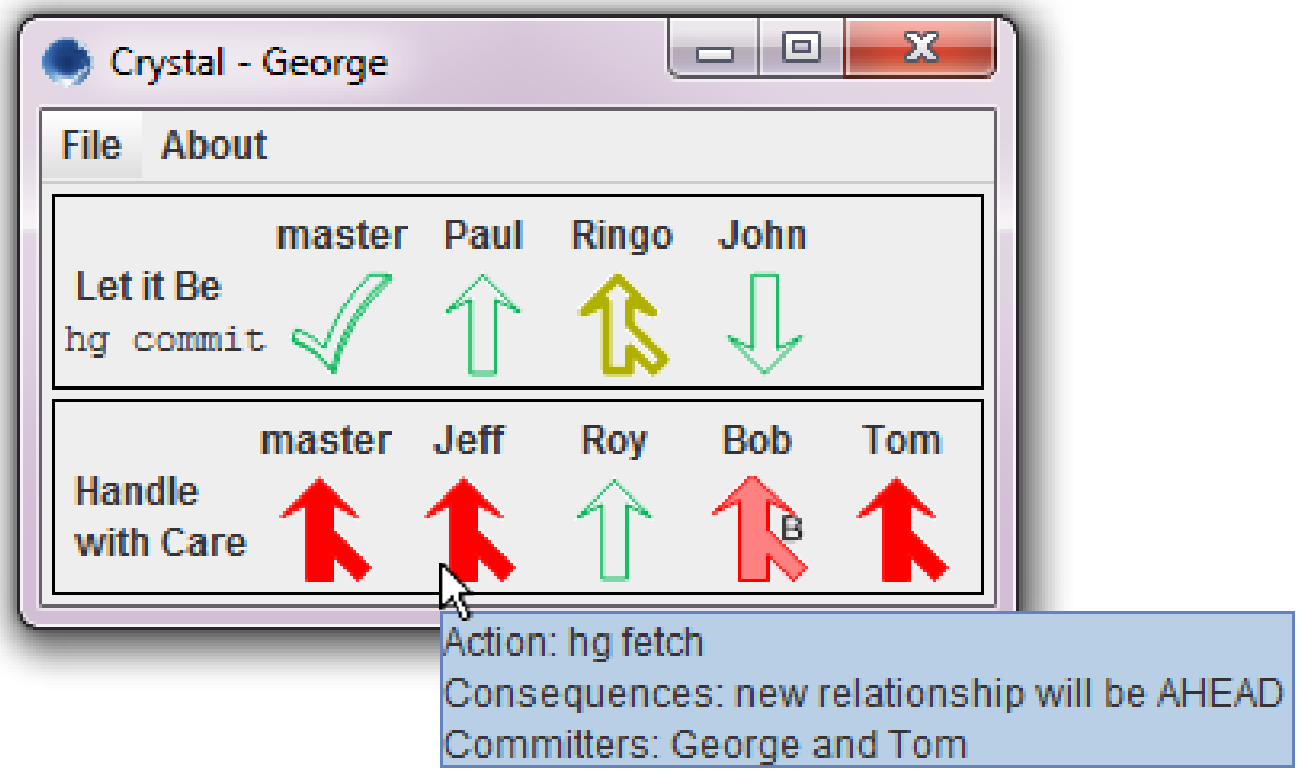
- avoid conflicts
- become aware of conflicts earlier

Introducing Crystal: a proactive conflict detector

DEMO

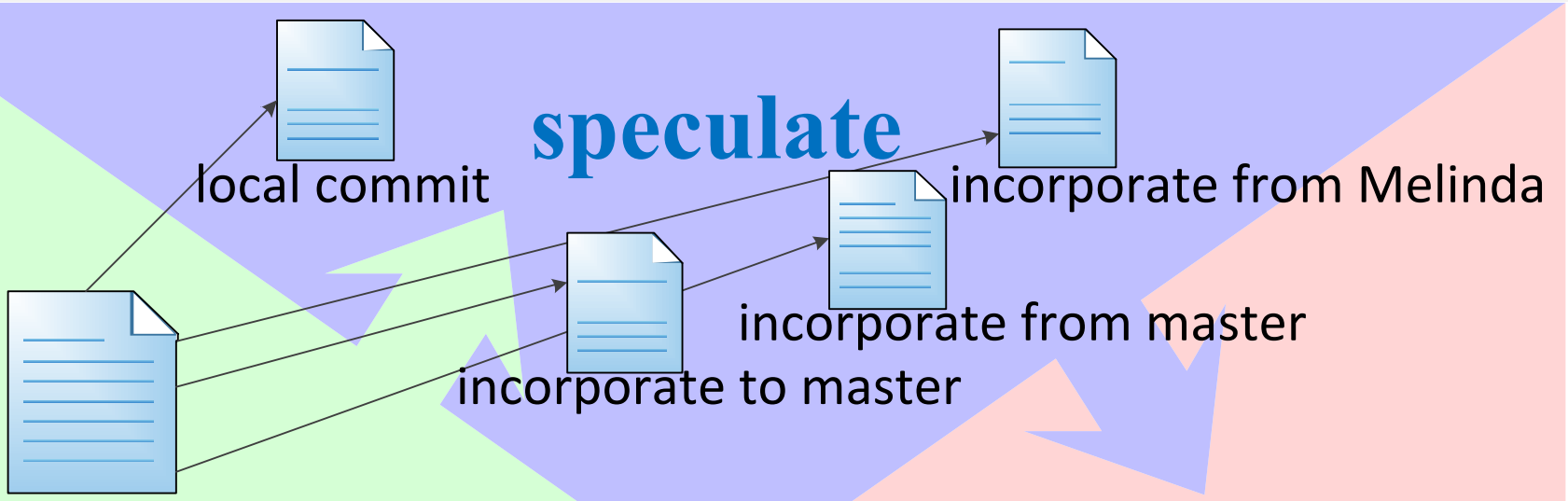
Introducing Crystal: a proactive conflict detector

DEMO



http://crystalvc.googlecode.com

Speculative analysis in collaborative development



Reducing false positives in conflict prediction

Collaborative awareness

- Palantír [Sarma et al. 2003]
- FASTDash [Biehl et al. 2007]
- Syde [Hattori and Lanza 2010]
- CollabVS [Dewan and Hegde 2007]
- Safe-commit [Wloka et al. 2009]
- SourceTree [Streeting 2010]

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Crystal analyzes **concrete artifacts**,
eliminating false positives and false negatives.

Utility of conflict detection

- Are textual collaborative conflicts a real problem?
- Can textual conflicts be prevented?
- Do build and test collaborative conflicts exist?

Are textual collaborative conflicts a real problem?

histories of 9 open-source projects:

size:	26K–1.4MSLoC
developers:	298
versions:	140,000

Perl5, Rails, Git, jQuery, Voldemort, MaNGOS, Gallery3, Samba, Insoshi

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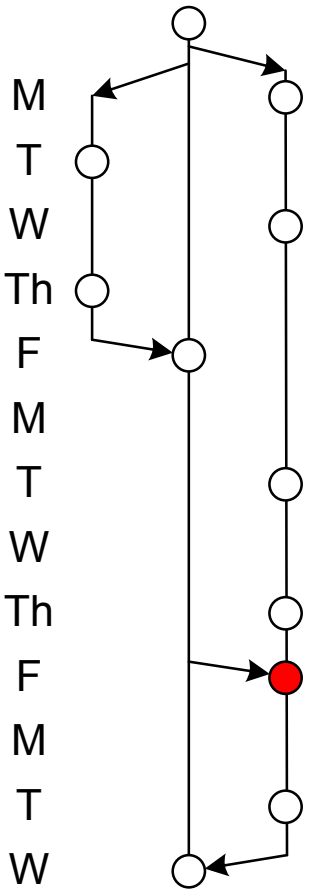

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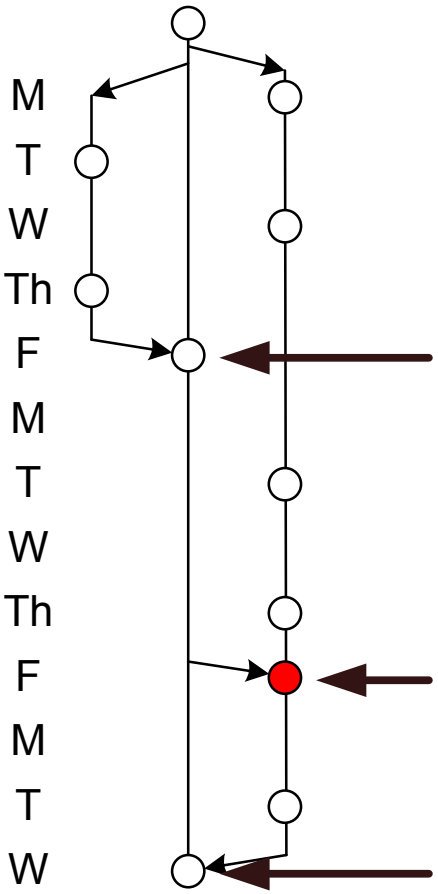
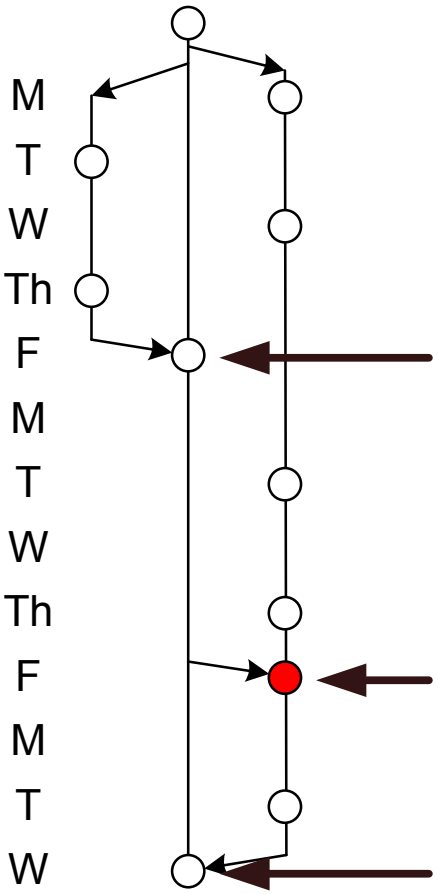


How frequent are textual conflicts?

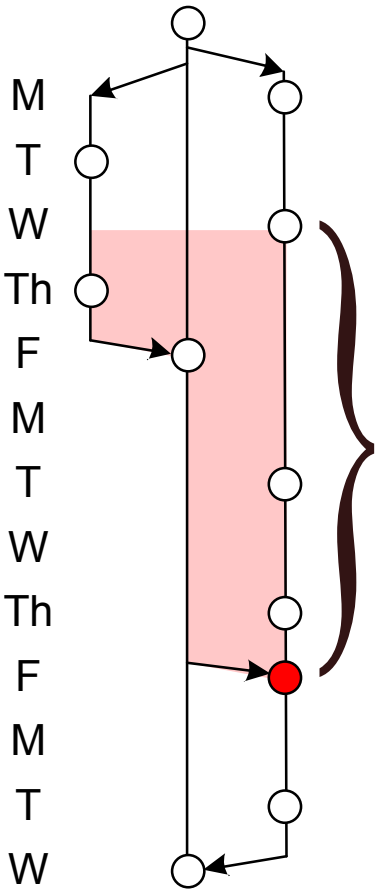
Are textual collaborative conflicts a real problem?



How frequent are textual conflicts?

16% of the merges have textual conflicts.

Are textual collaborative conflicts a real problem?



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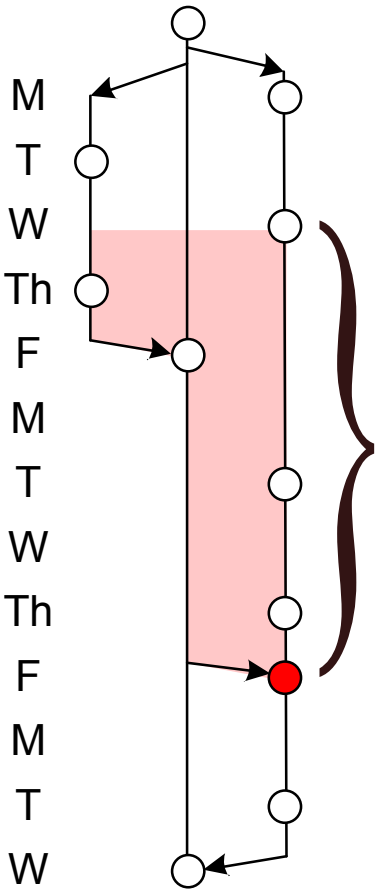

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Conflicts live a mean of 9.8 and median of 1.6 days.
The worst case was over a year.

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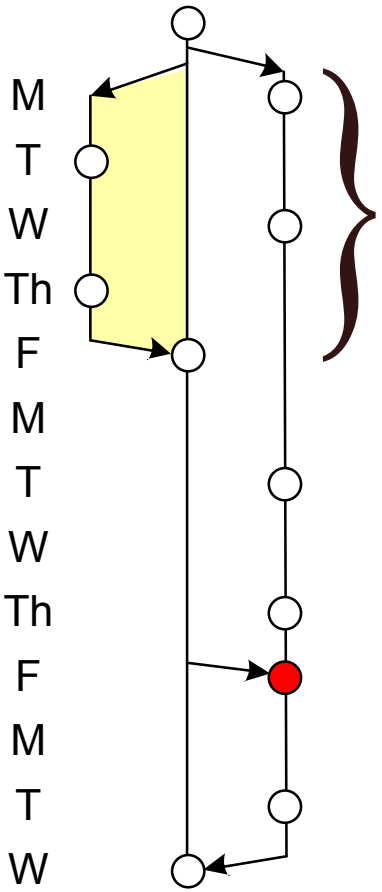

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How long do textually-safe merges persist?

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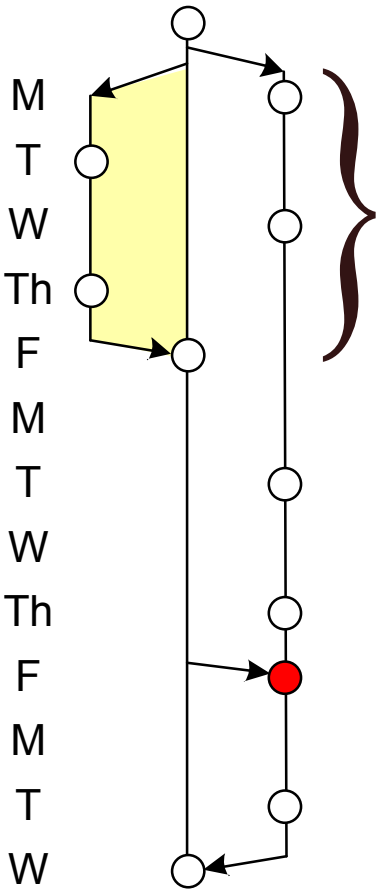

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How long do textually-safe merges persist?

Textually-safe merges live a mean of 11.0 and median of 1.9 days.

Can textual conflicts be prevented?

Where do textual conflicts come from?

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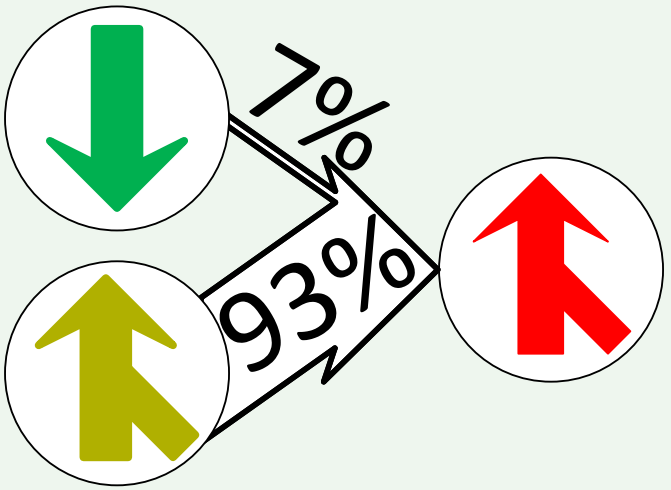
93% of textual conflicts developed from safe merges.



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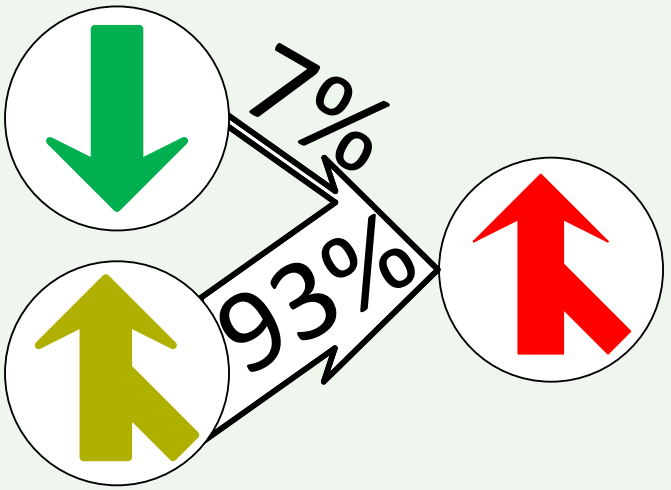


The information Crystal computes can help prevent conflicts.

Do build and test collaborative conflicts exist?

program	conflicts			safe merges
	textual	build	test	
Git	17%	<1%	4%	79%
Perl5	8%	4%	28%	61%
Voldemort	17%	10%	3%	69%

Does merged code fail to build or fail tests?

One in three conflicts are build or test conflicts.

Microsoft Beacon

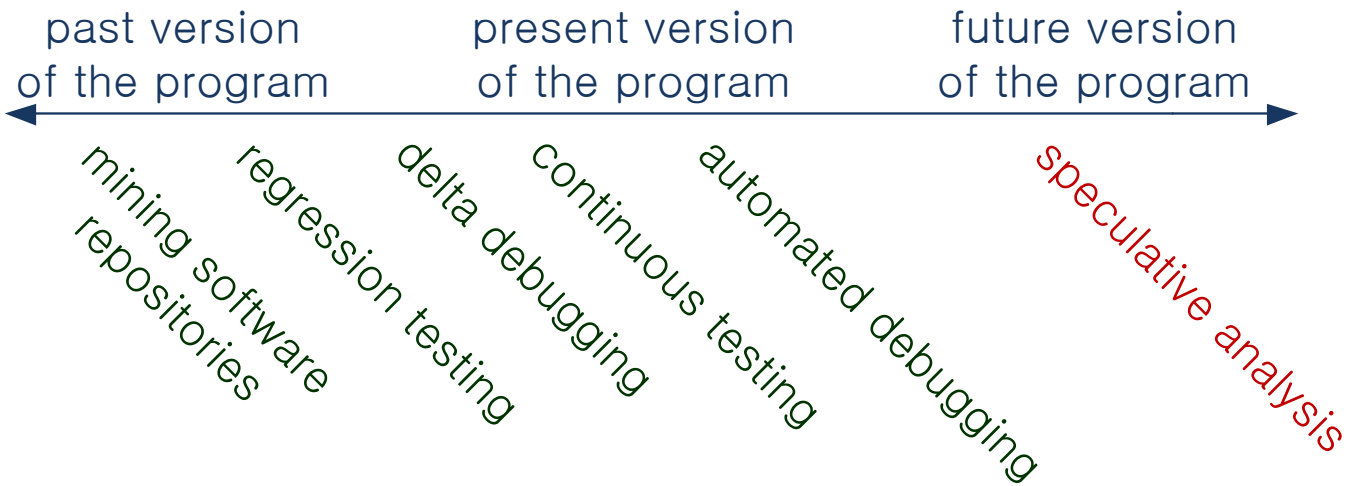
- A centralized version control-based tool.
- Microsoft product groups are using Beacon to help identify conflicts earlier in the development process.

Next steps:

- Measure Crystal's effect on conflict frequency and persistence
- Evaluate qualitative effects on user experience
- Identify what helps and what does not

Additional collaborators: Kıvanç Muşlu, Christian Bird, Thomas Zimmermann

Contributions of speculative analysis



Improving developer awareness when making decisions

- compute precise, accurate information
- convert a pull mechanism to a push one

Expanding the space of speculative analysis

Identify a domain with:

- likely, automatable developer actions
- informative, efficient analyses
- inferable developer intent

Next speculations:

- automated fault removal
- code parallelization
- test generation and augmentation

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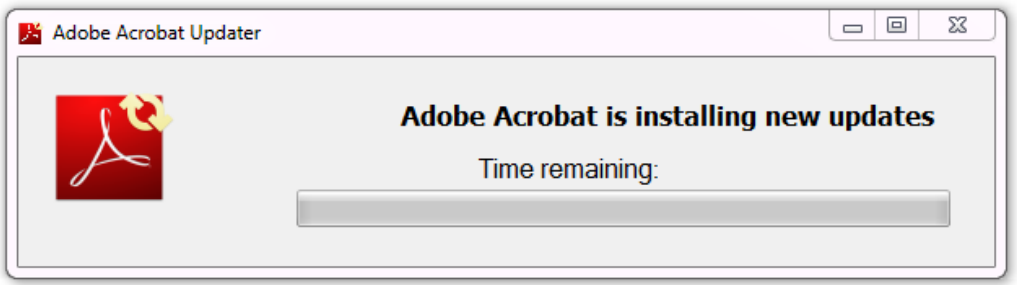

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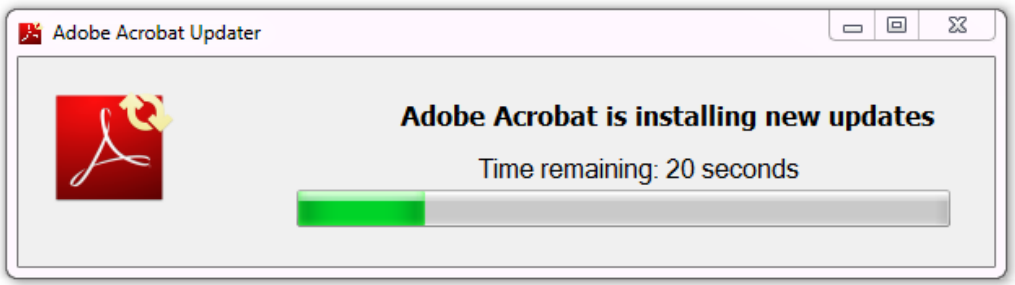
- inferable developer intent



Next speculations:

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Expanding the space of speculative analysis

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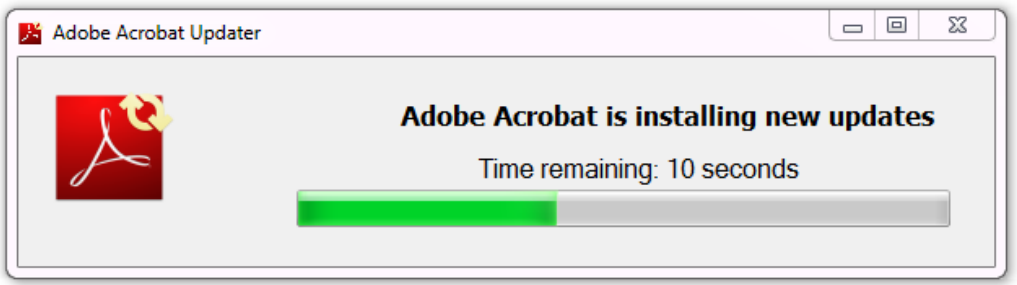

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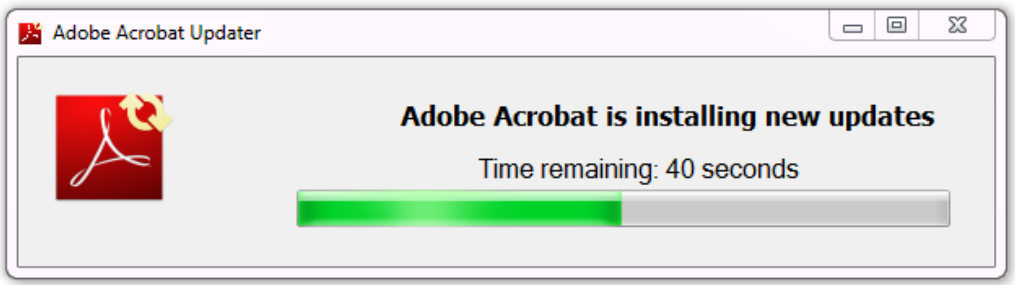

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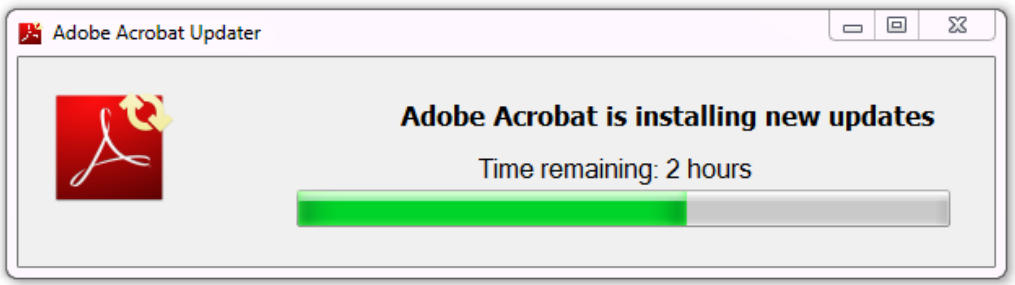

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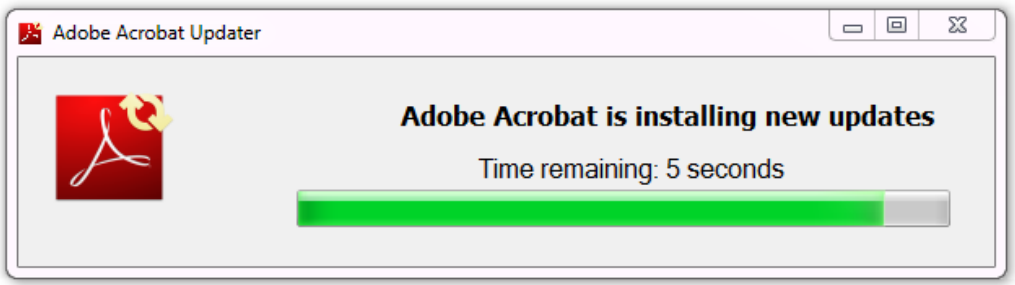

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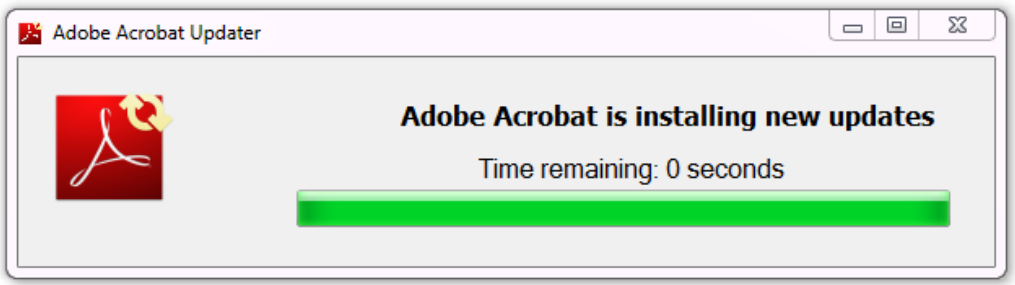

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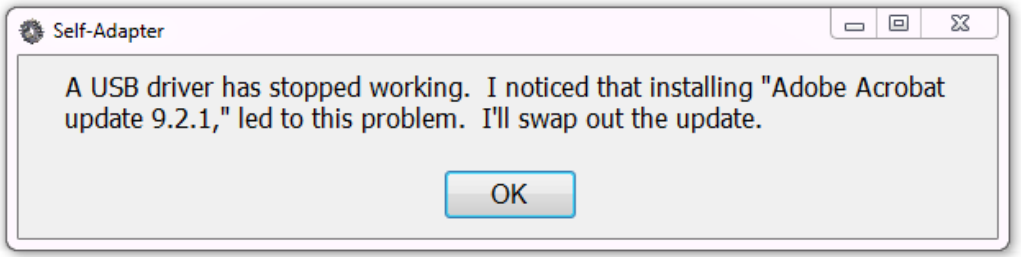

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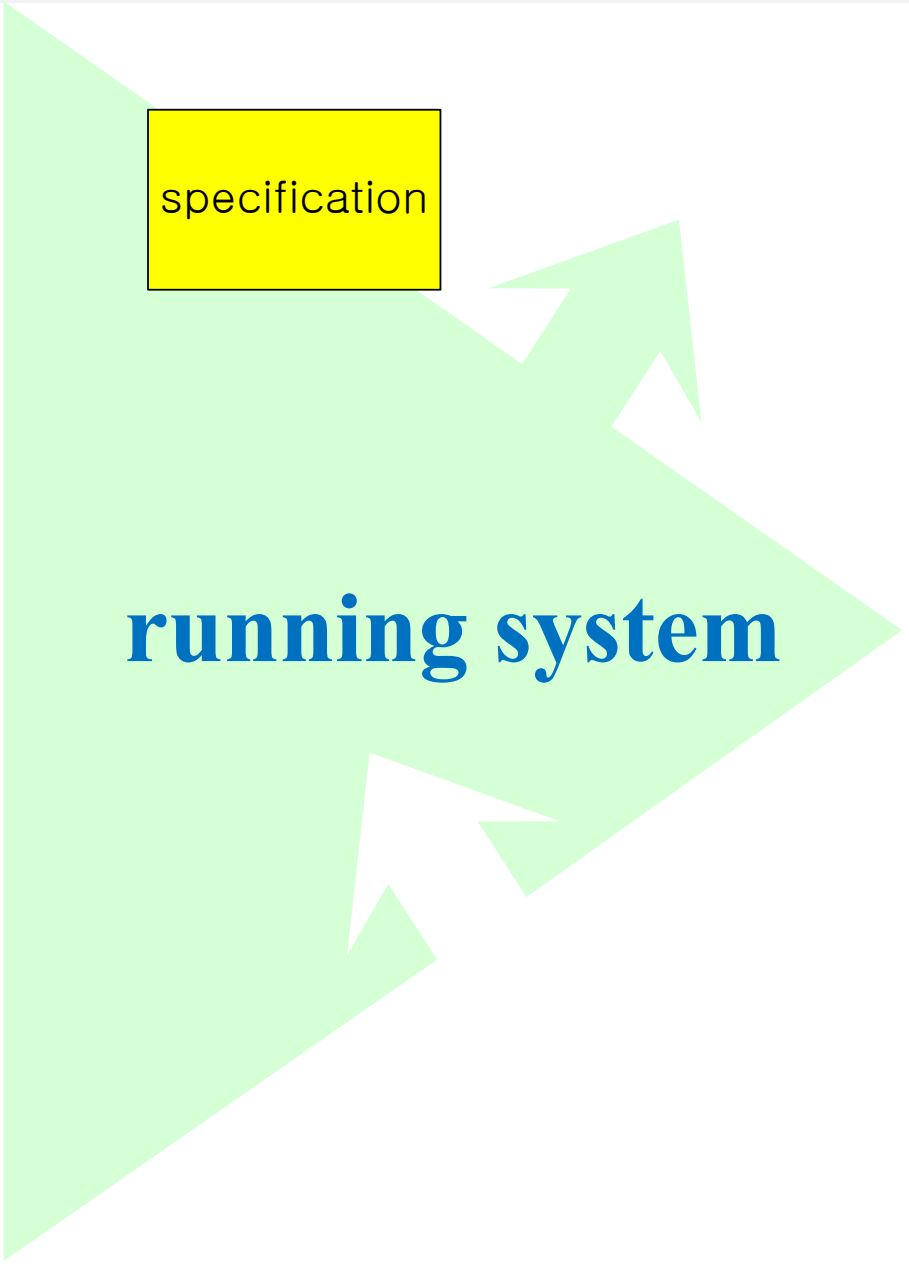
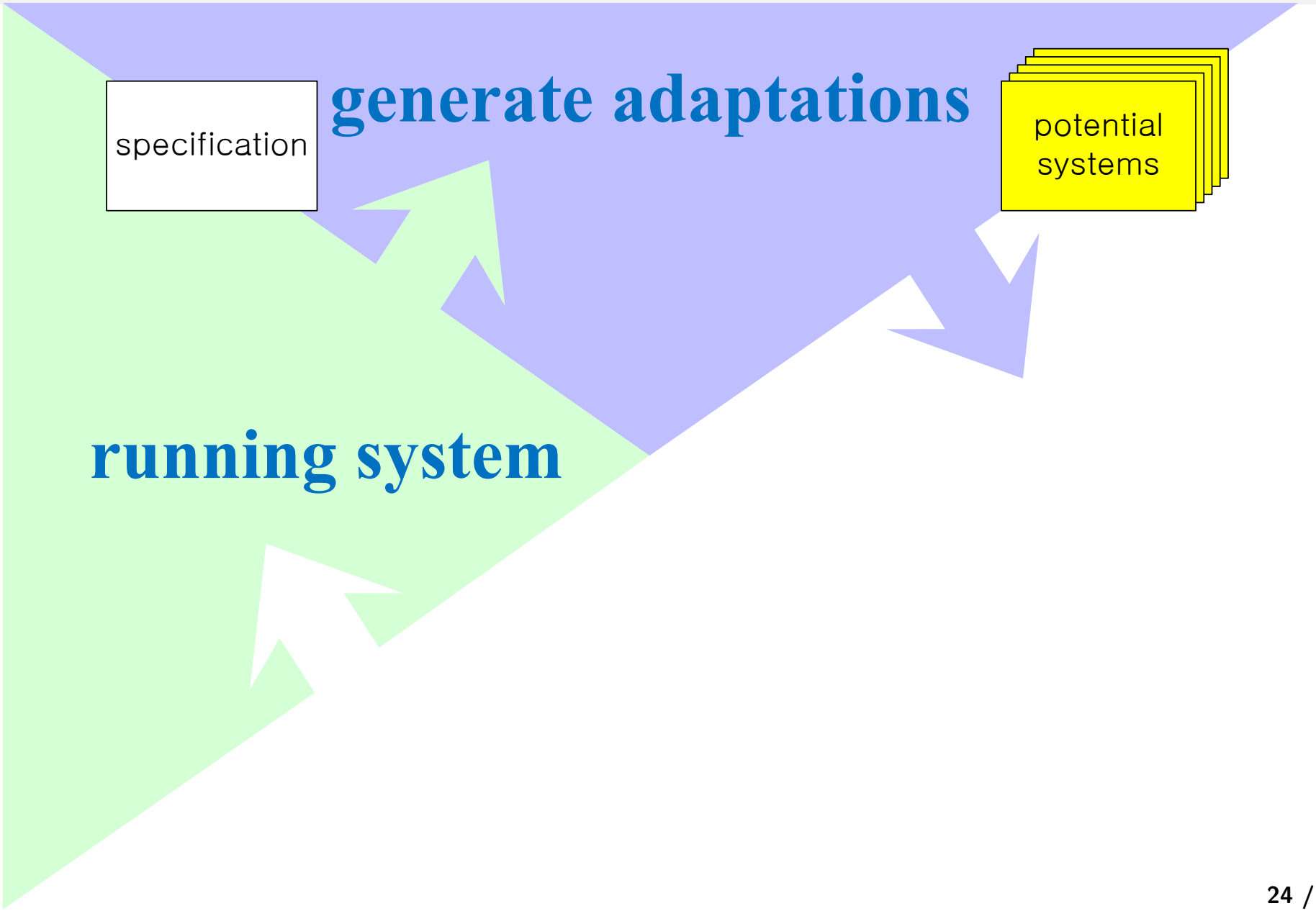
Automating decision making: self-adaptation



Automating decision making: self-adaptation



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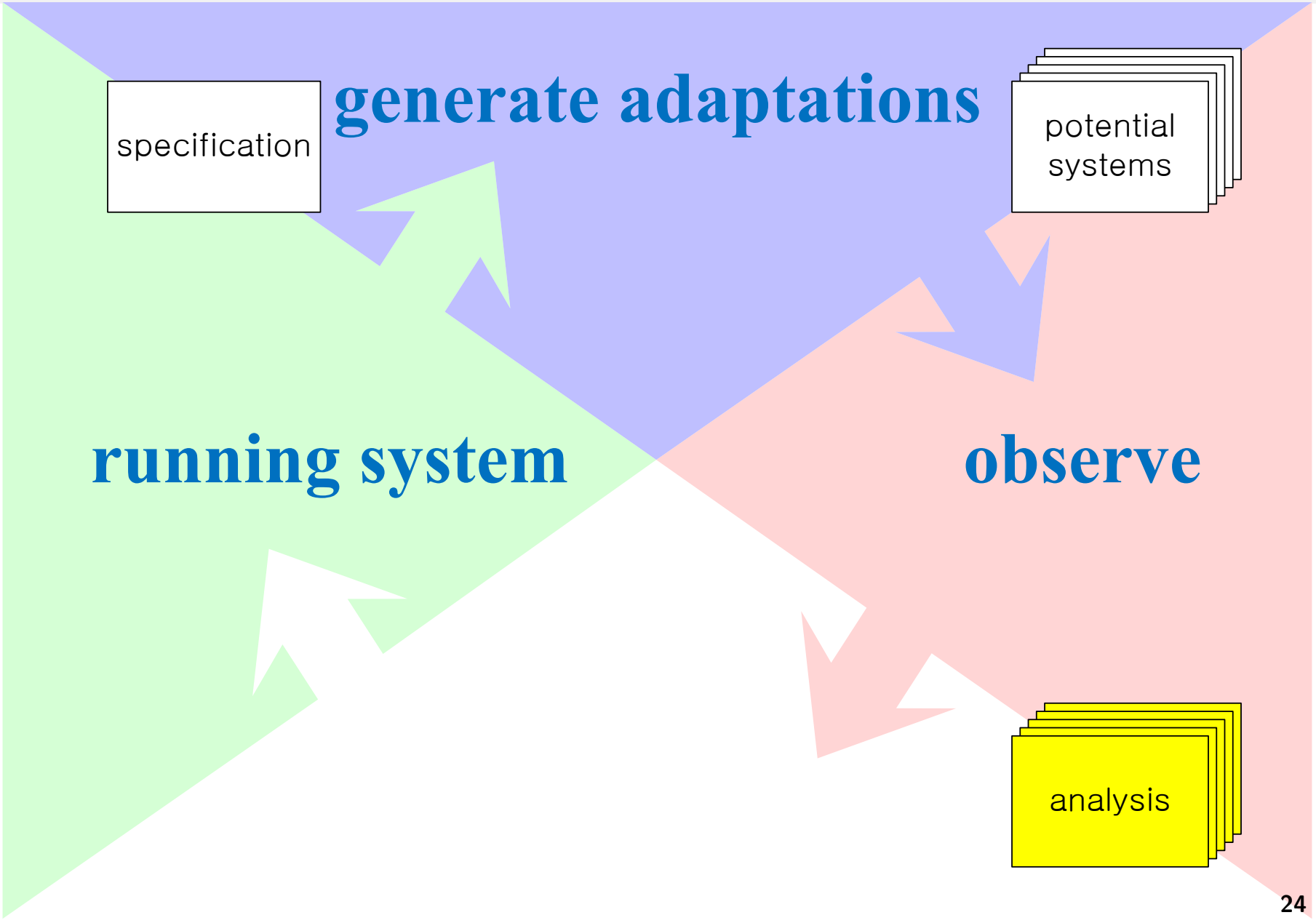

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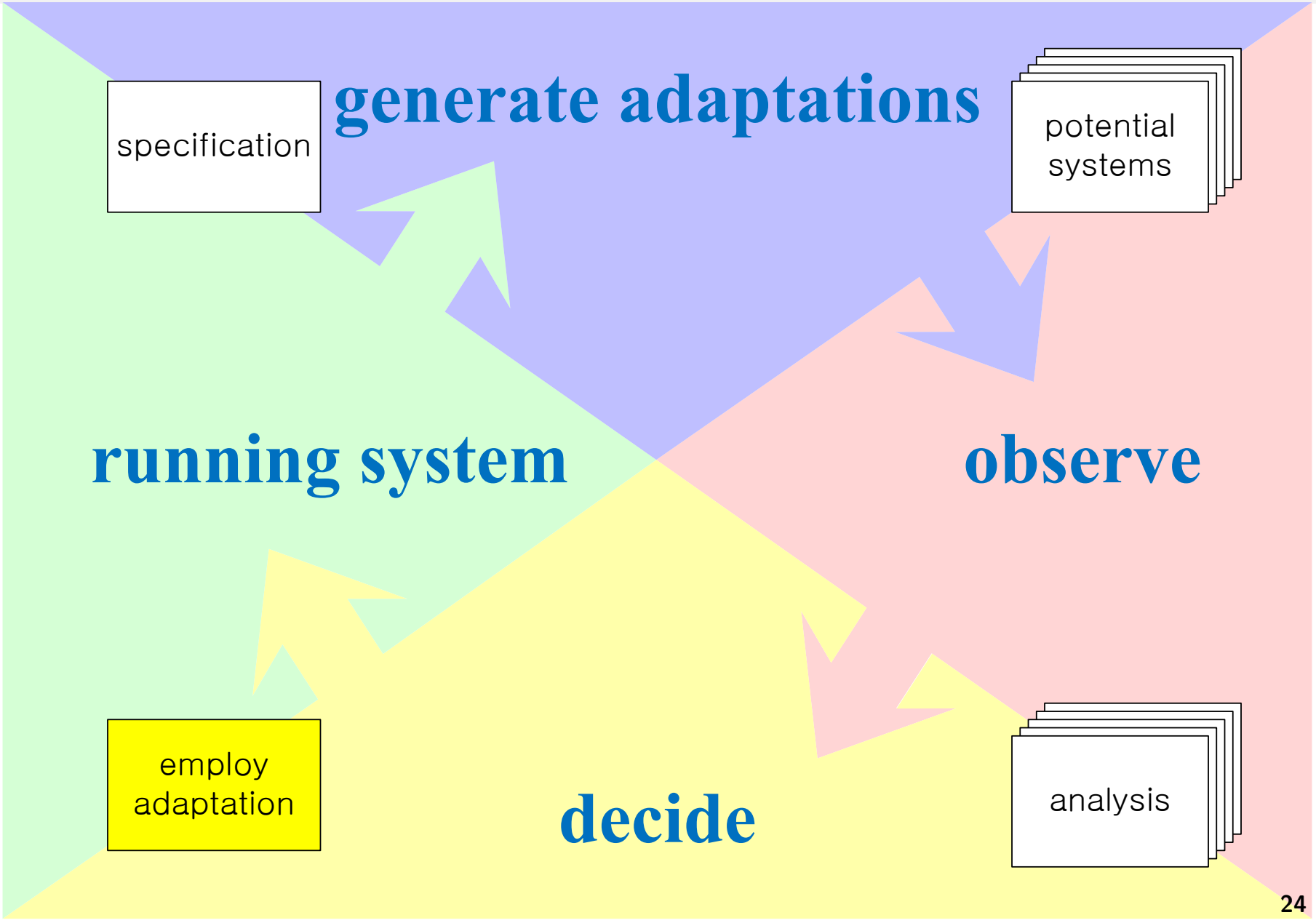
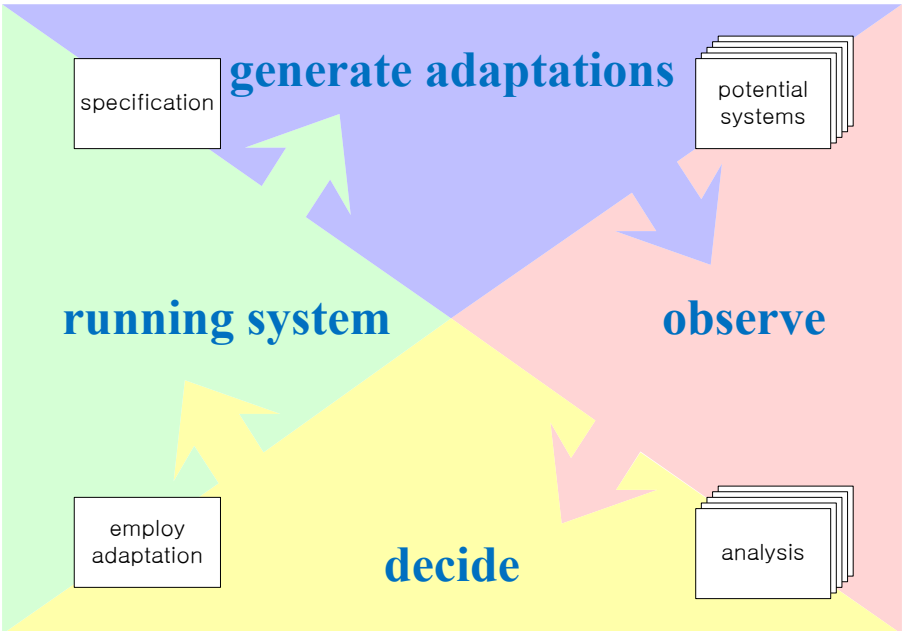


Future research: automation



1. Automating decision making: removing the developer
2. Using new automation to enrich speculative analysis
3. Bridging requirement specification and behavioral model inference

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