Abstractness, Specificity, and Complexity in Software Design

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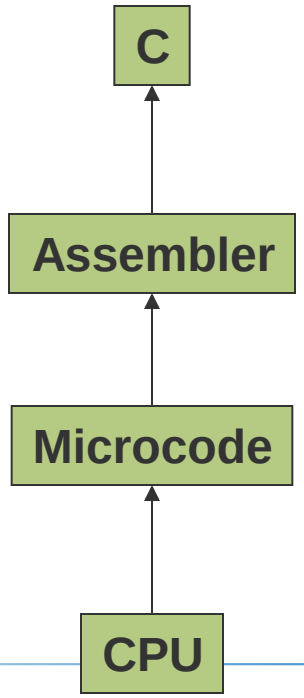
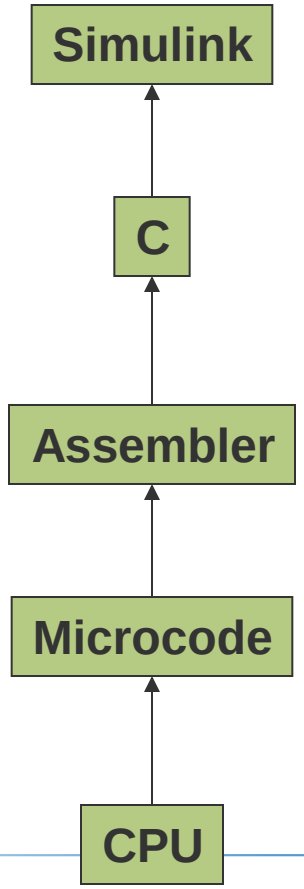
Abstraction Examples



Abstraction Examples



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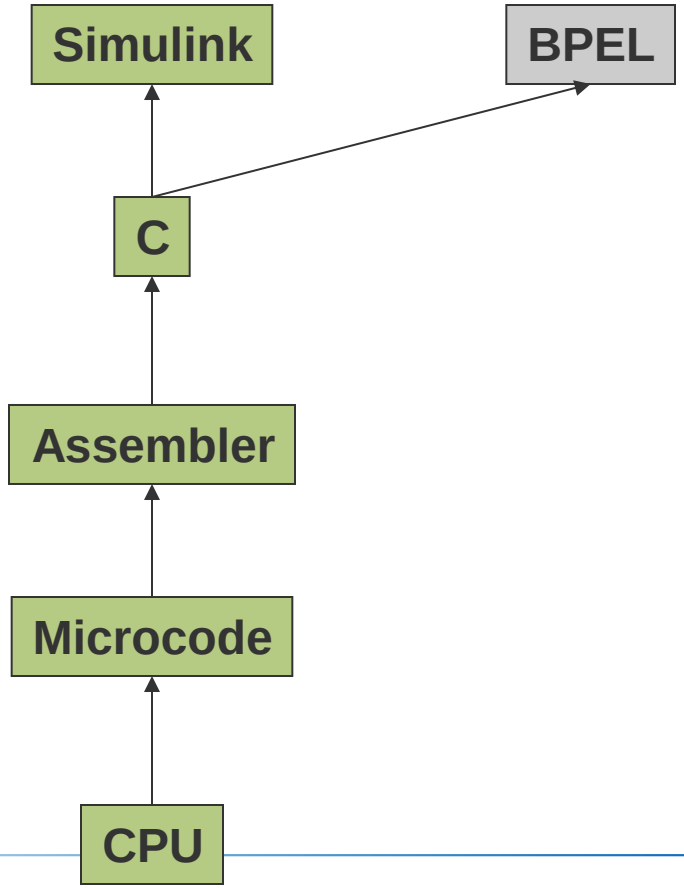

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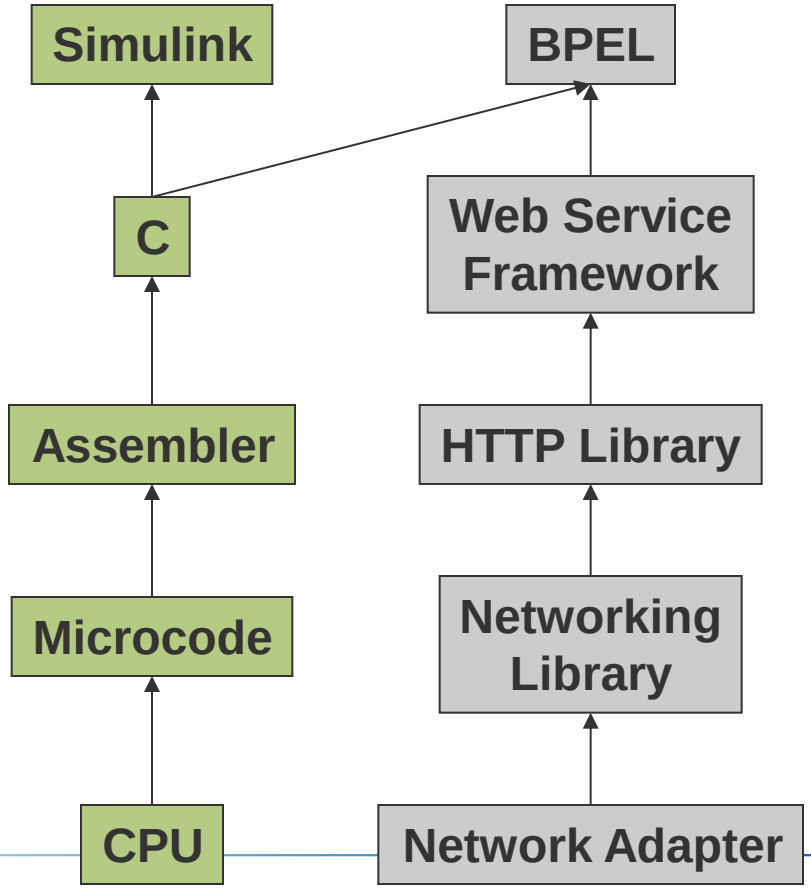

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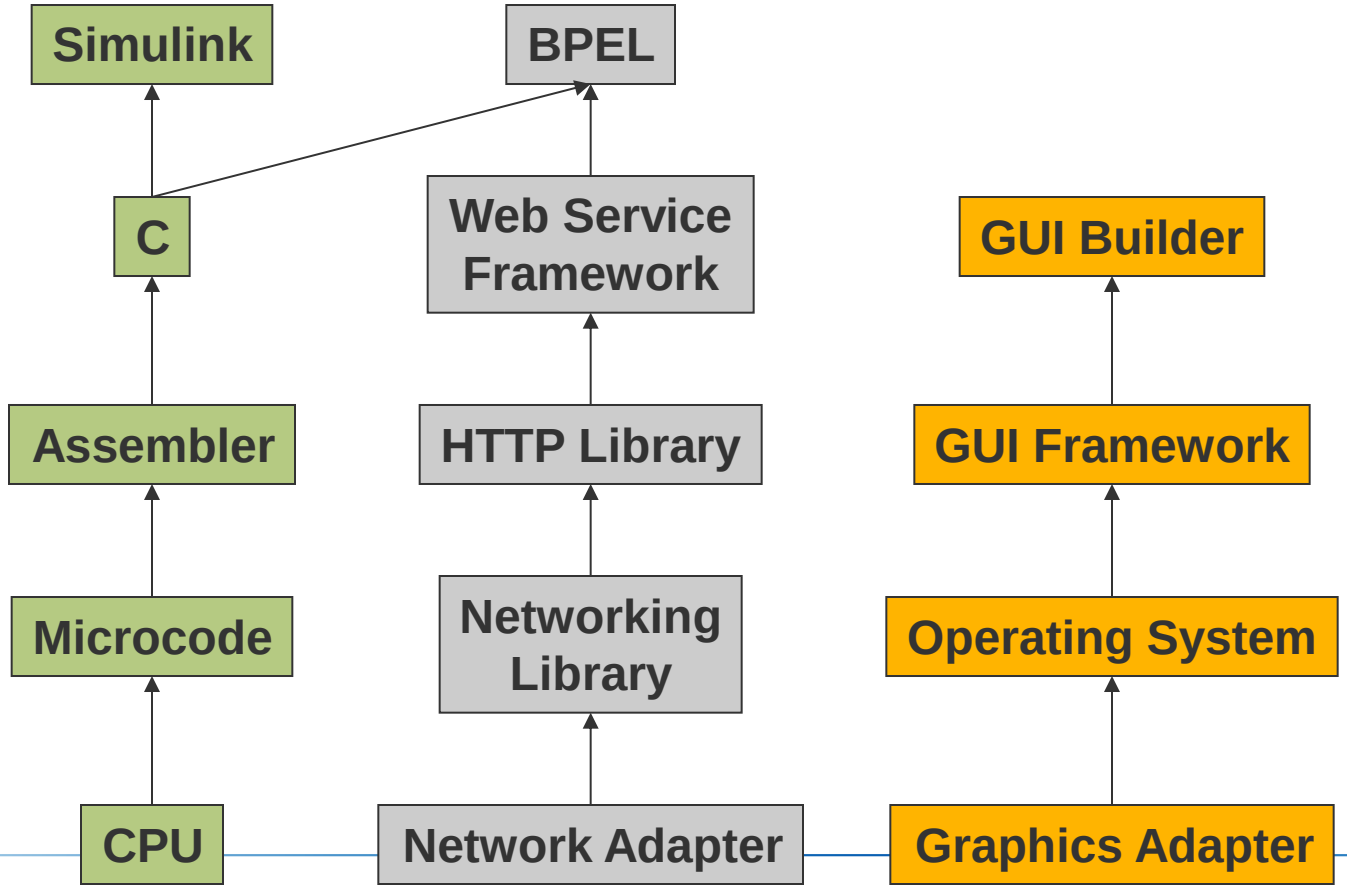
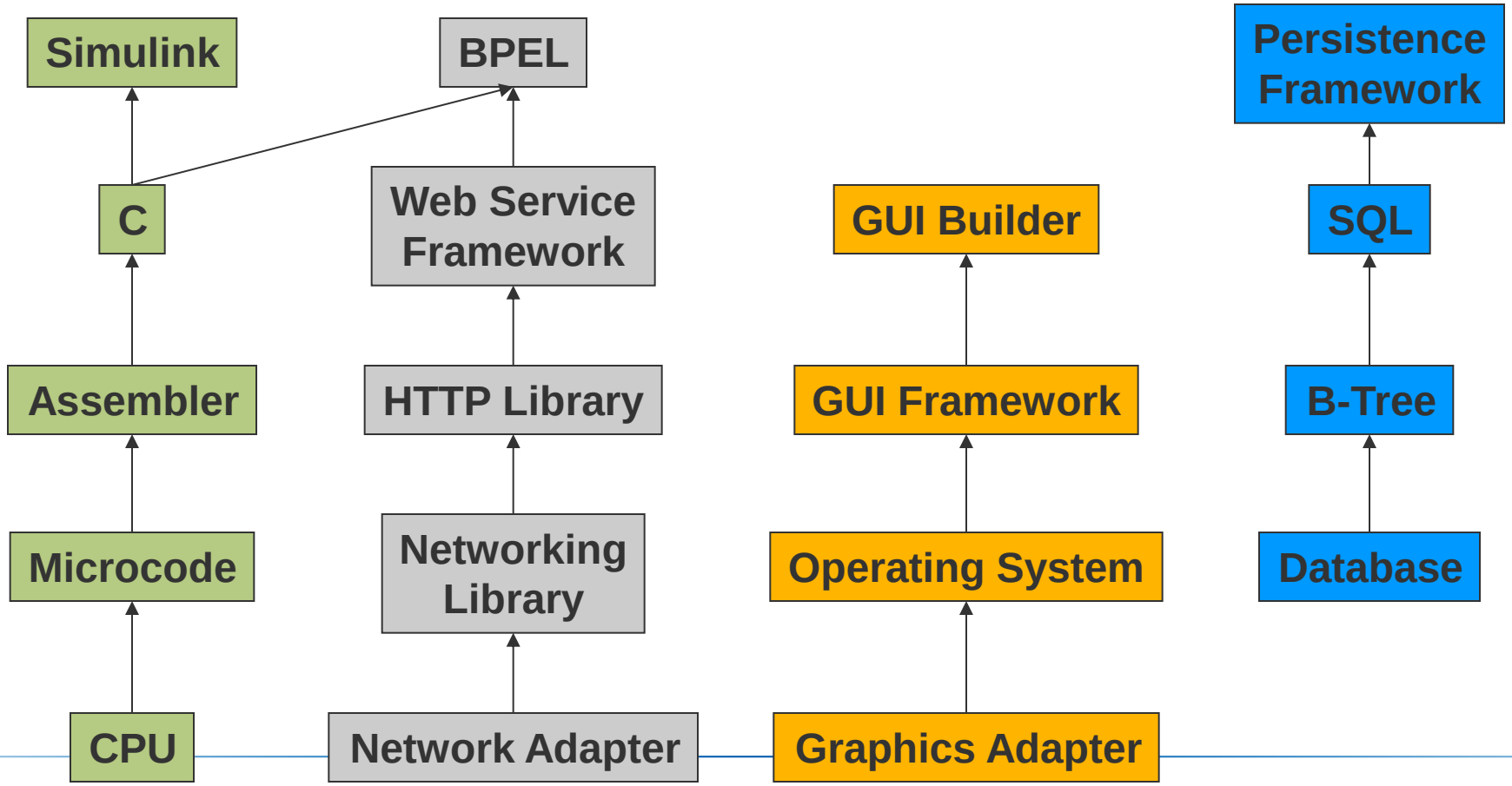


Abstraction Examples



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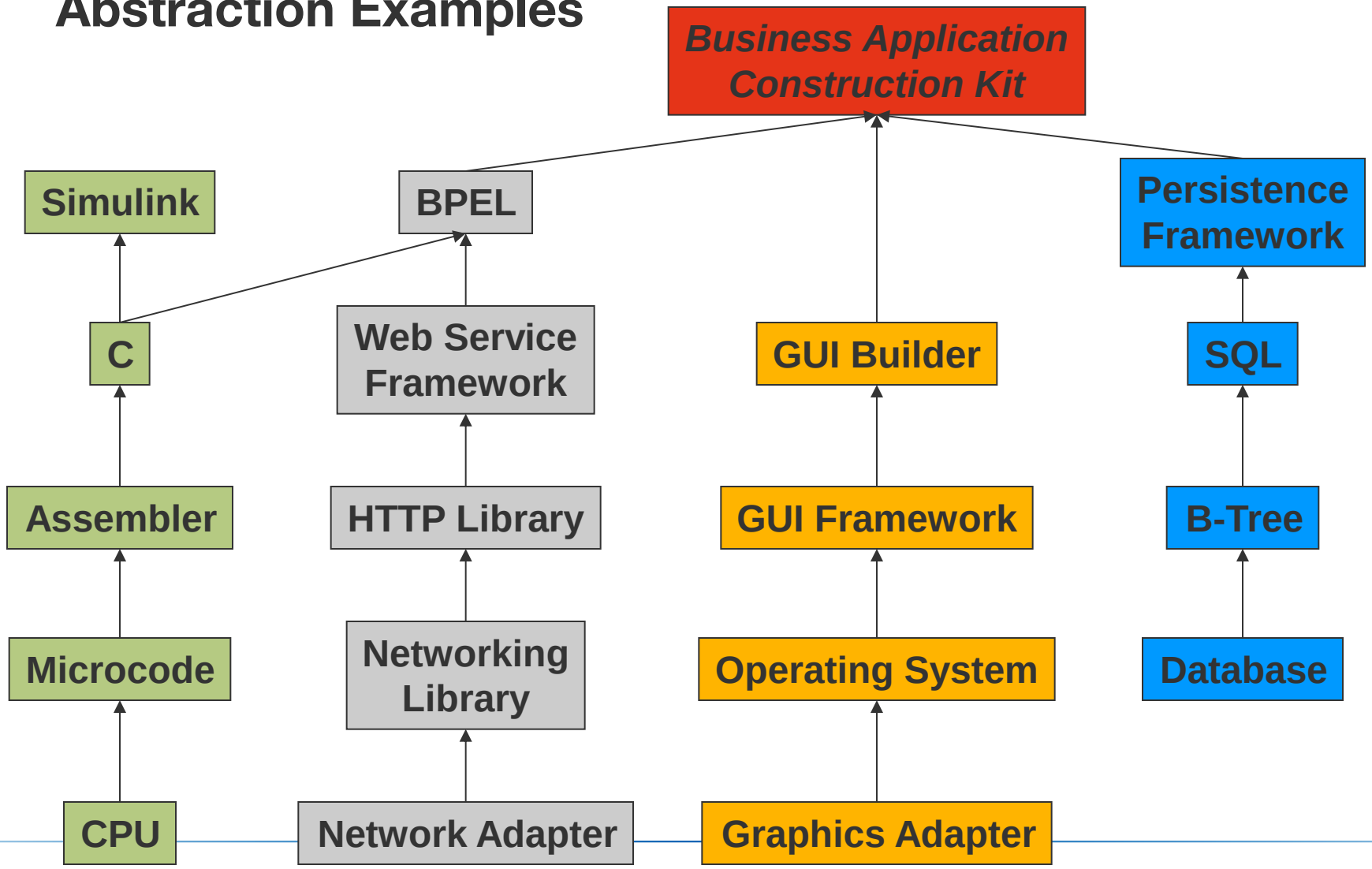

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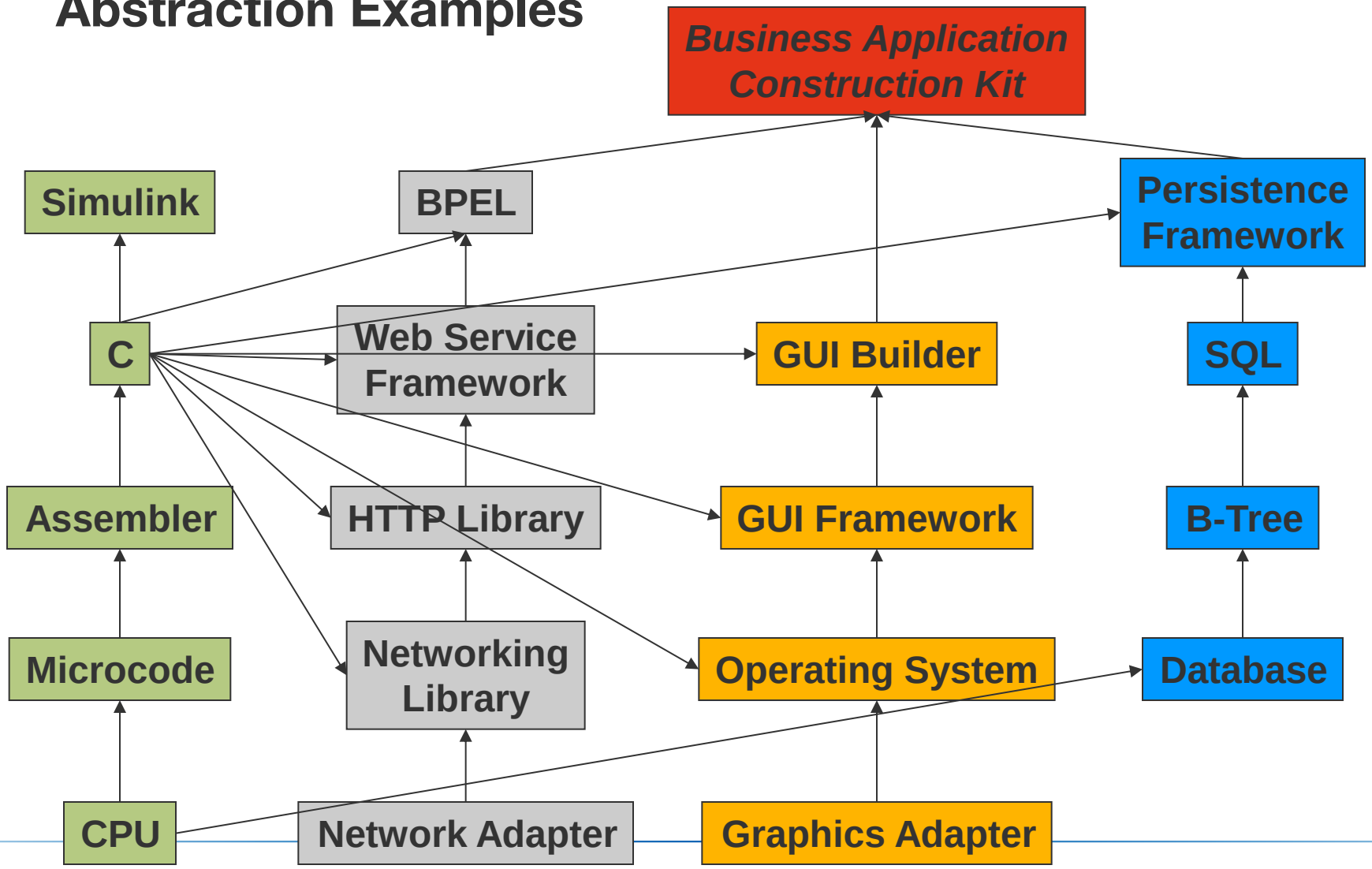

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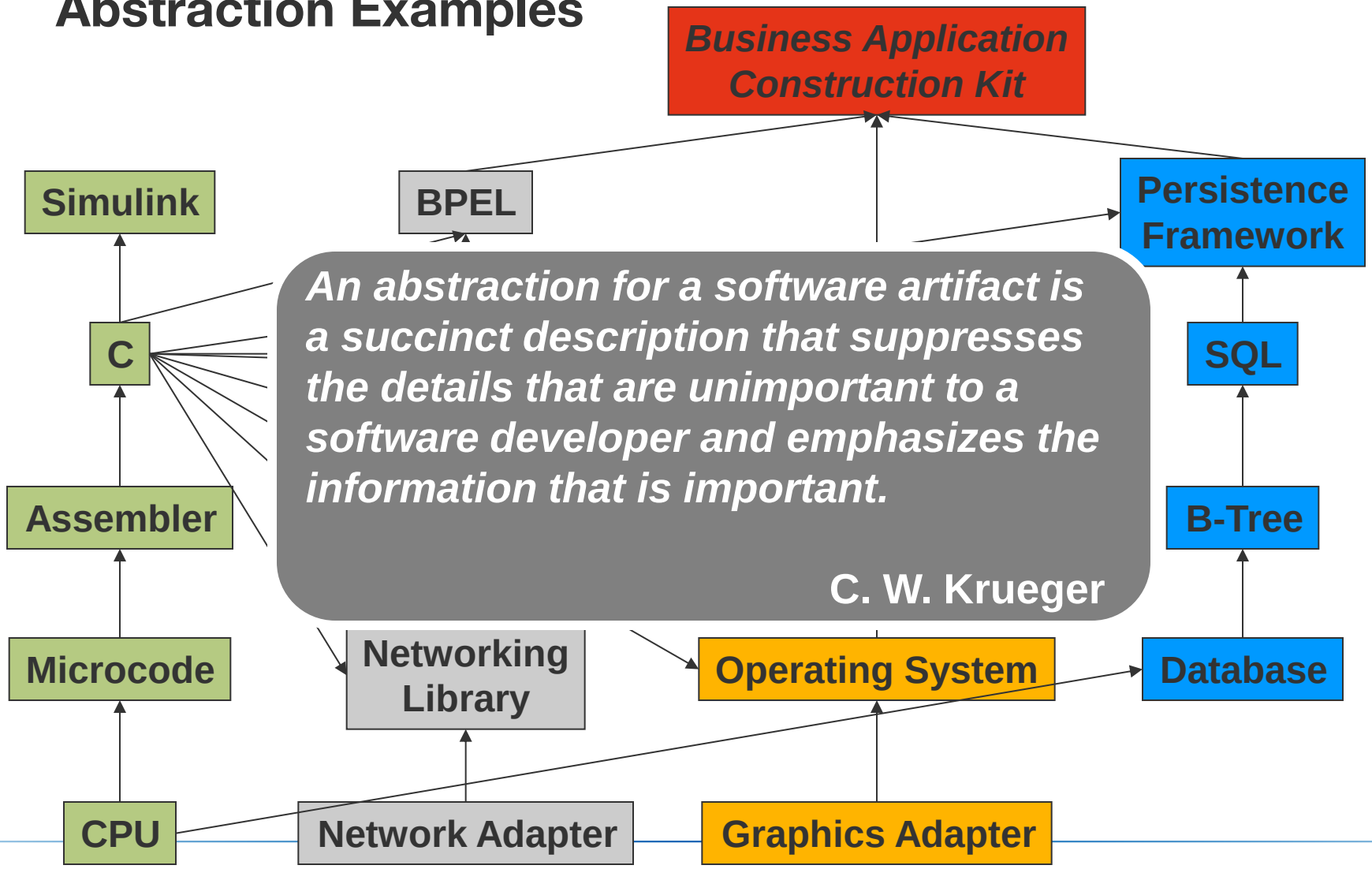
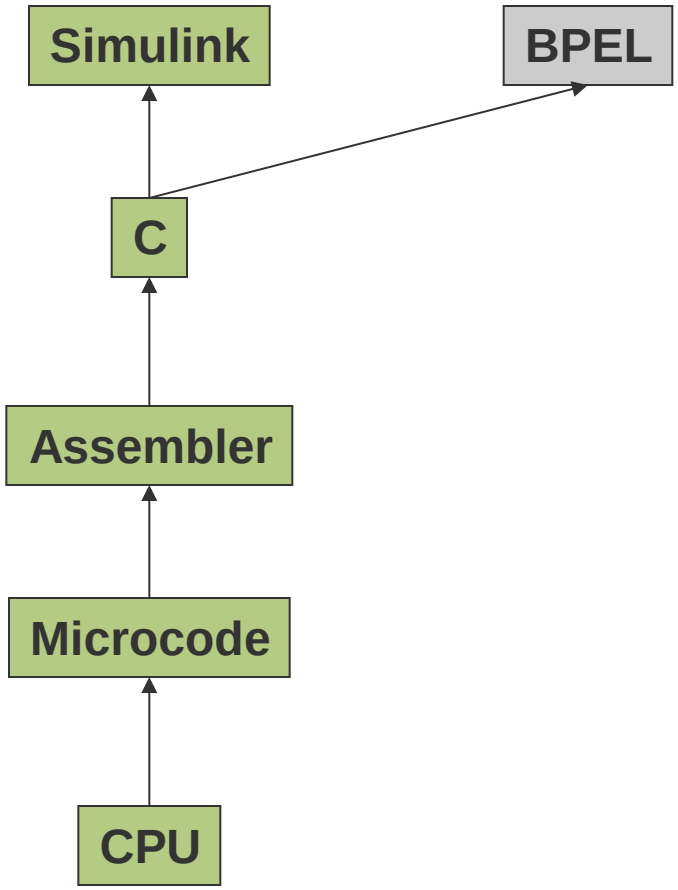


An abstraction for a software artifact is a succinct description that suppresses the details that are unimportant to a software developer and emphasizes the information that is important.

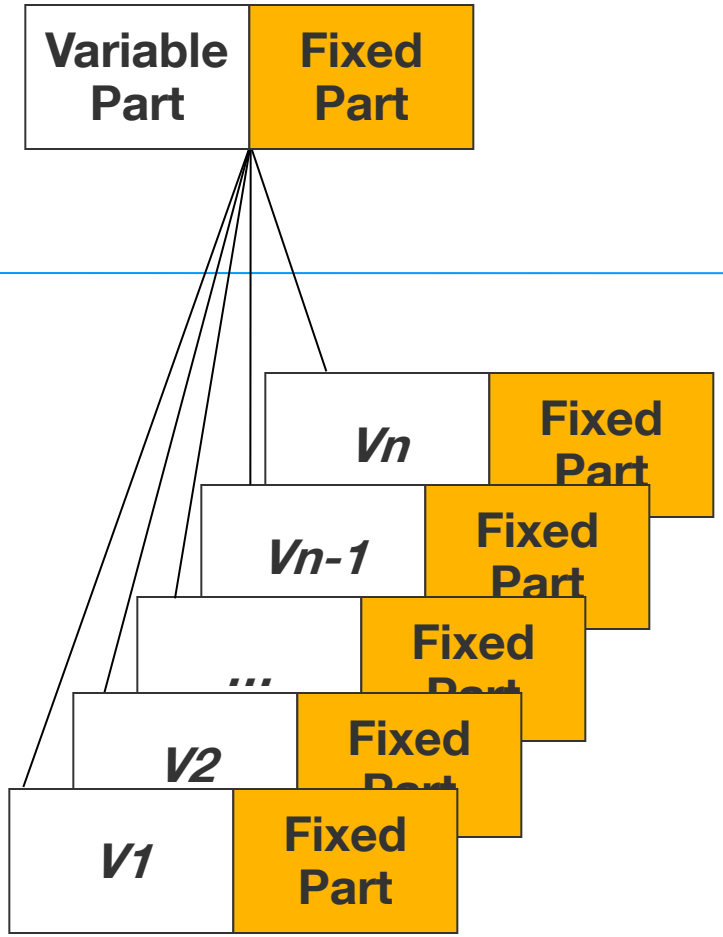
C. W. Krueger

Problem Statement

- Abstraction is of paramount importance for software development.
- What are the implications on specificity?
- What are the implications on complexity?
- What are the implications and trade-offs in abstractions?
- How to design and use abstractions?



Two Levels of Abstraction

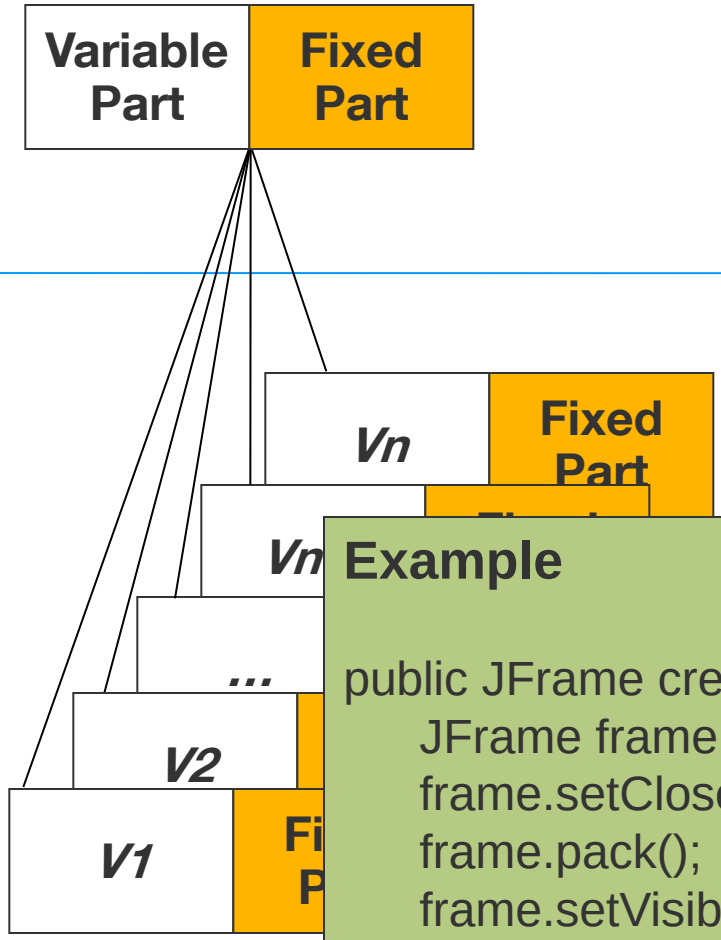


Abstraction Specification

Abstraction Realization

[C. W. Krueger. Software Reuse. 1992]

Two Levels of Abstraction



Example

```
public JFrame createWindow(String title) {
    JFrame frame = new JFrame(title);
    frame.setCloseOp(EXIT_ON_CLOSE);
    frame.pack();
    frame.setVisible(true);
    return frame;
}
```

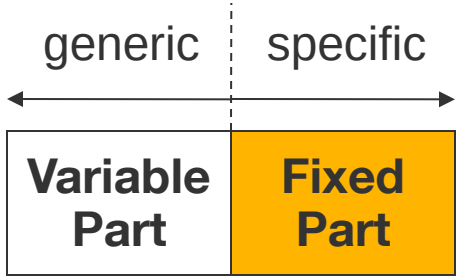
Abstractness & Specificity

Abstractness

- Abstraction means information loss
- Remove explicit detail ⇨ model building
- Defined by amount of variable information

Specificity

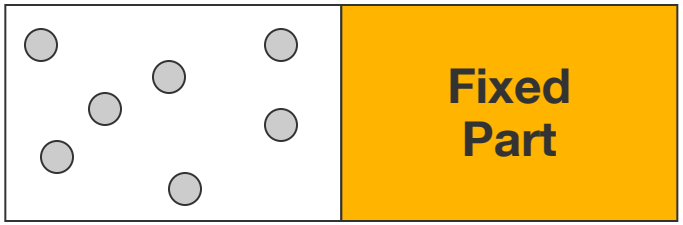
- Defined by the number of contexts it can be used in
- The larger the variable part, the more generic
- The larger the fixed part, the more specific



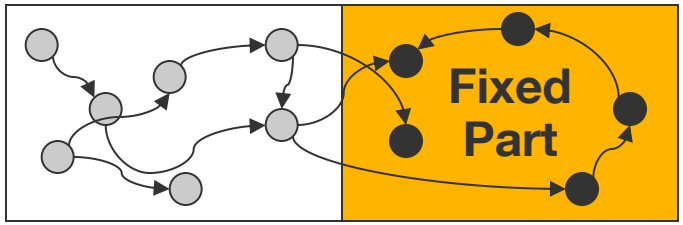
Complexity

- Complexity reduction is a main goal of abstraction
- Various definitions (even philosophy has not a unique one)
- Detail complexity*: Number of parts
- Dynamic complexity*: Cause and effect relationships

Detail Complexity

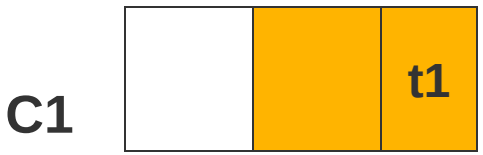


Dynamic Complexity



* [Peter M. Senge. The Fifth Discipline. 1990]

Types of Abstraction

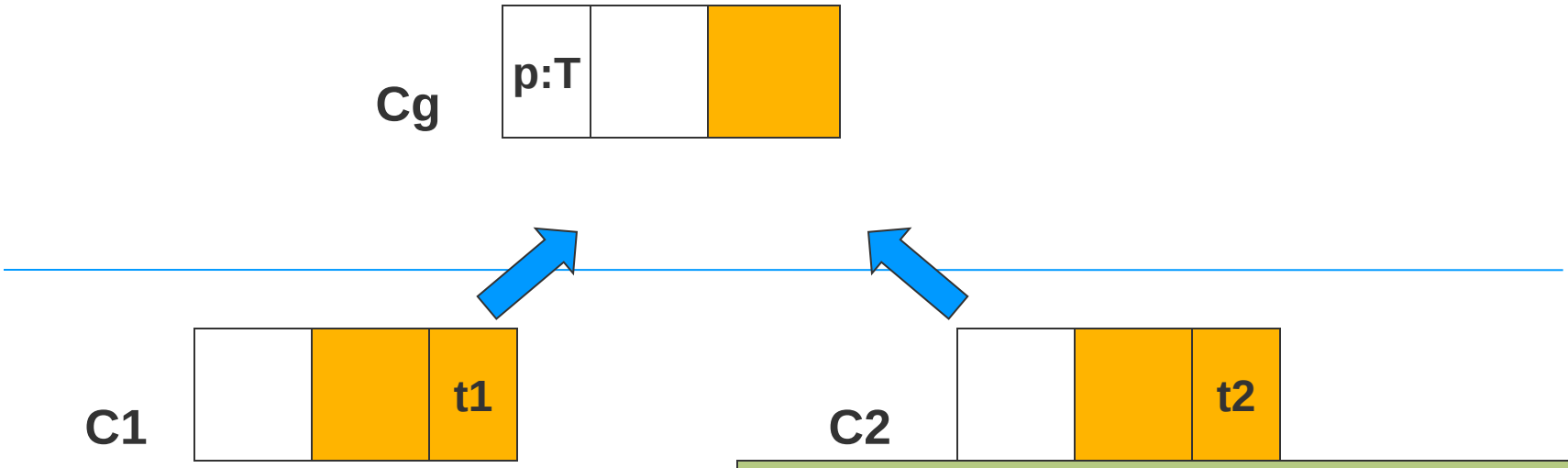


Types of Abstraction


```
JFrame f = new JFrame("Choose Source Fil
f.setCloseOp(EXIT_ON_CLOSE);
…
```

```
JFrame f = new JFrame("Choose Target File");
f.setCloseOp(EXIT_ON_CLOSE);
…
```

Types of Abstraction

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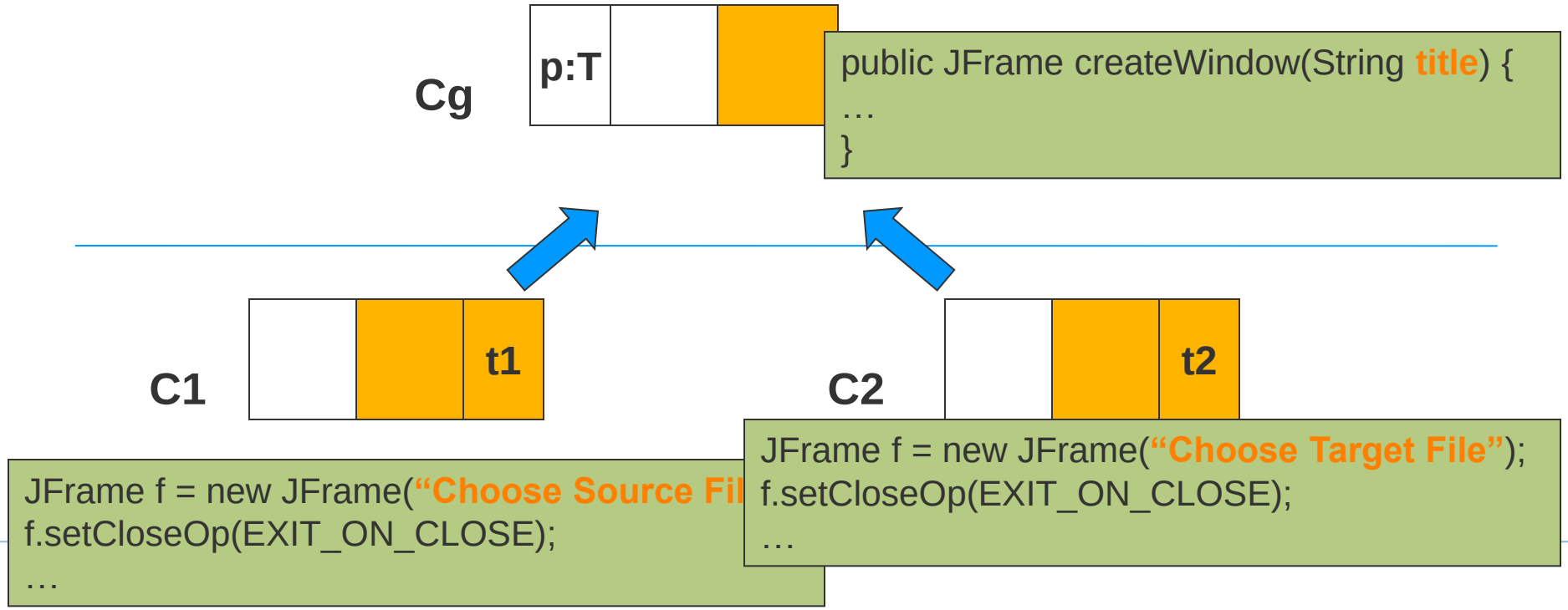

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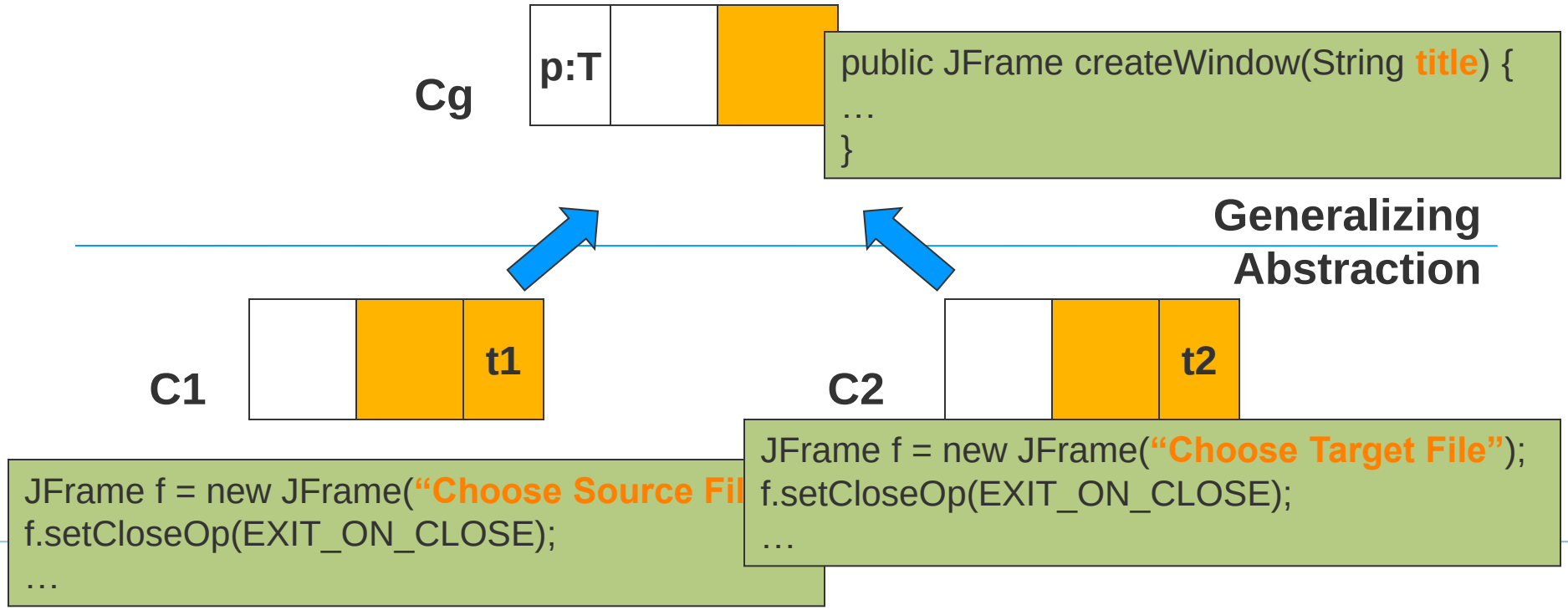

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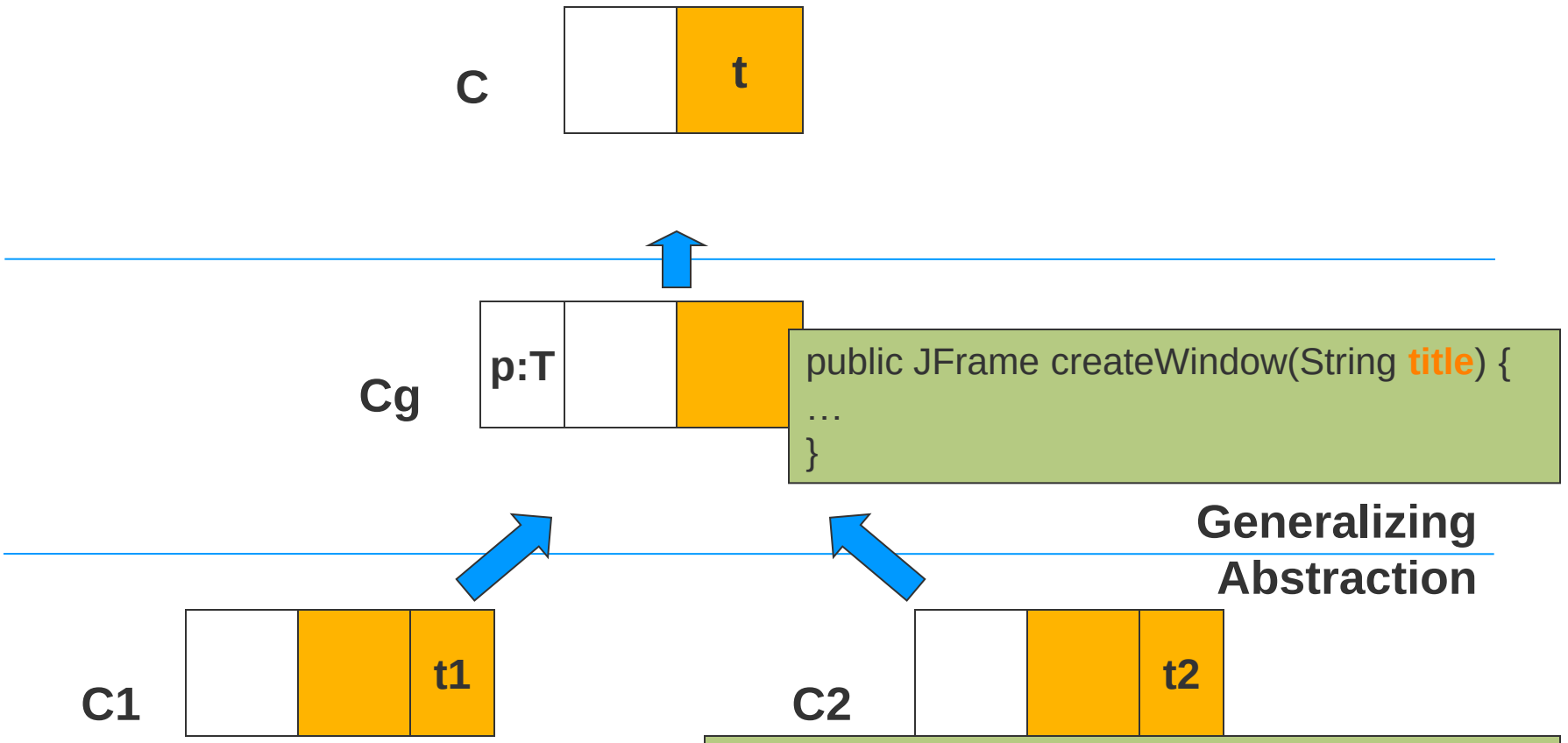

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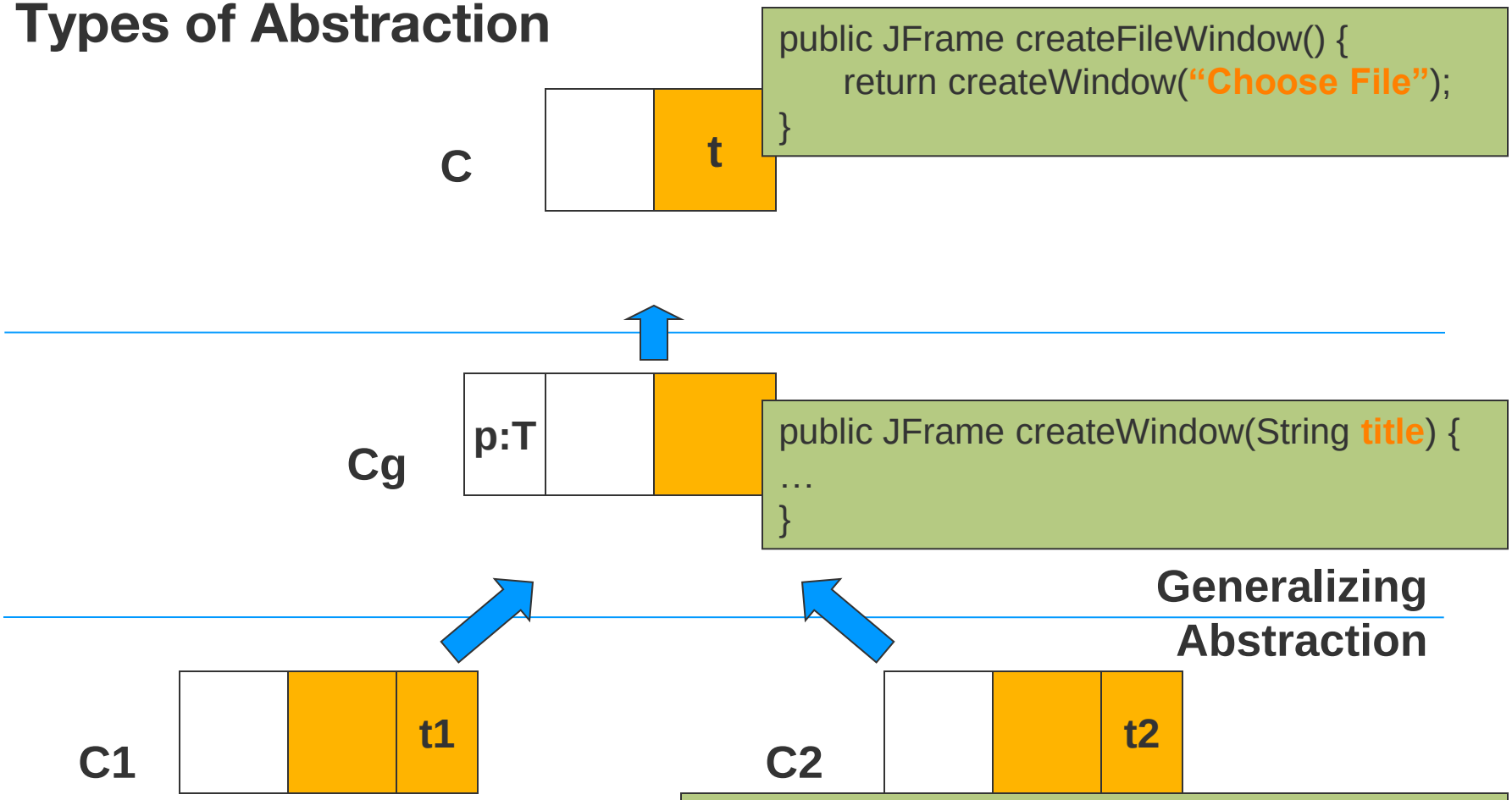

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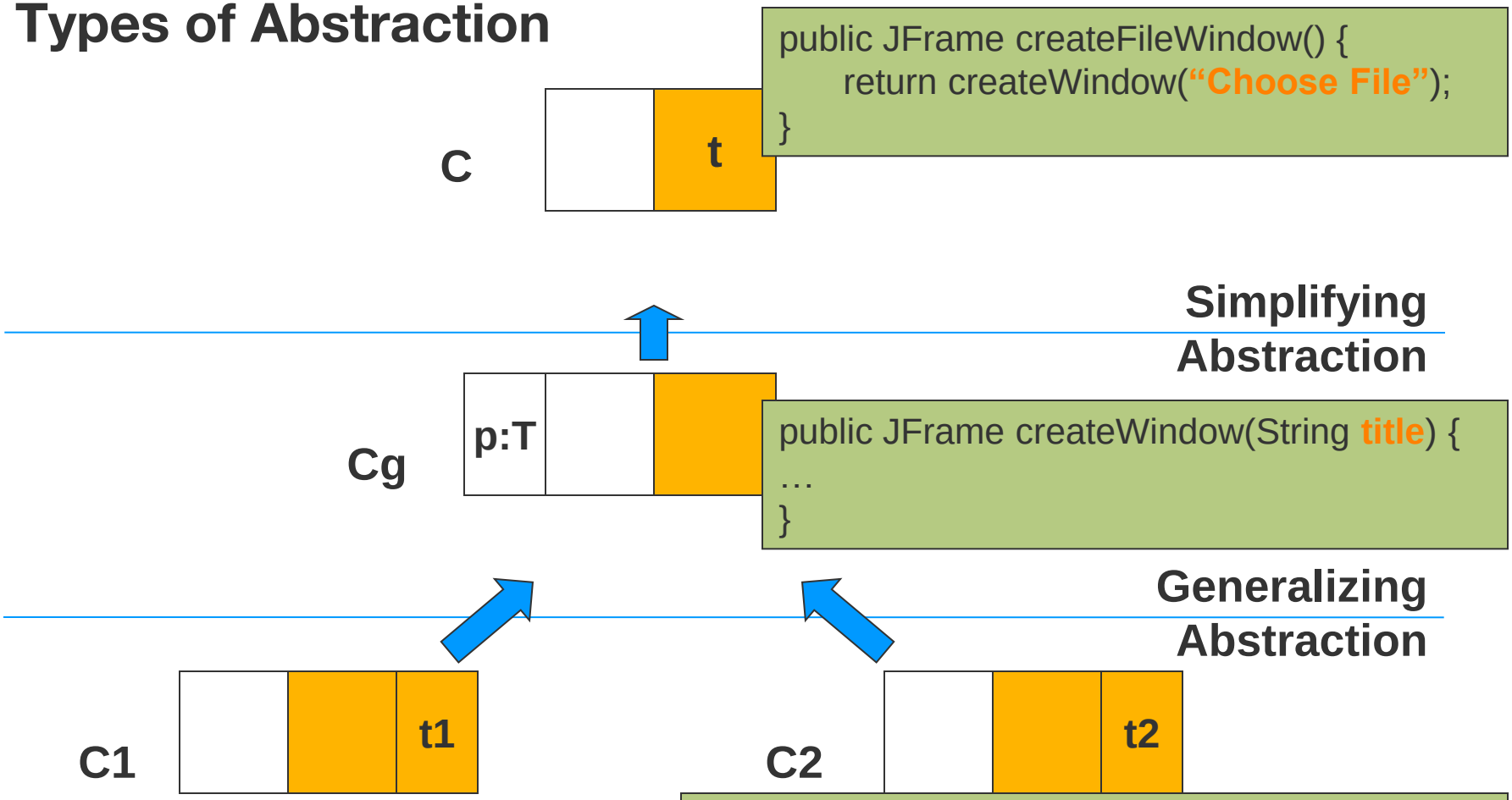
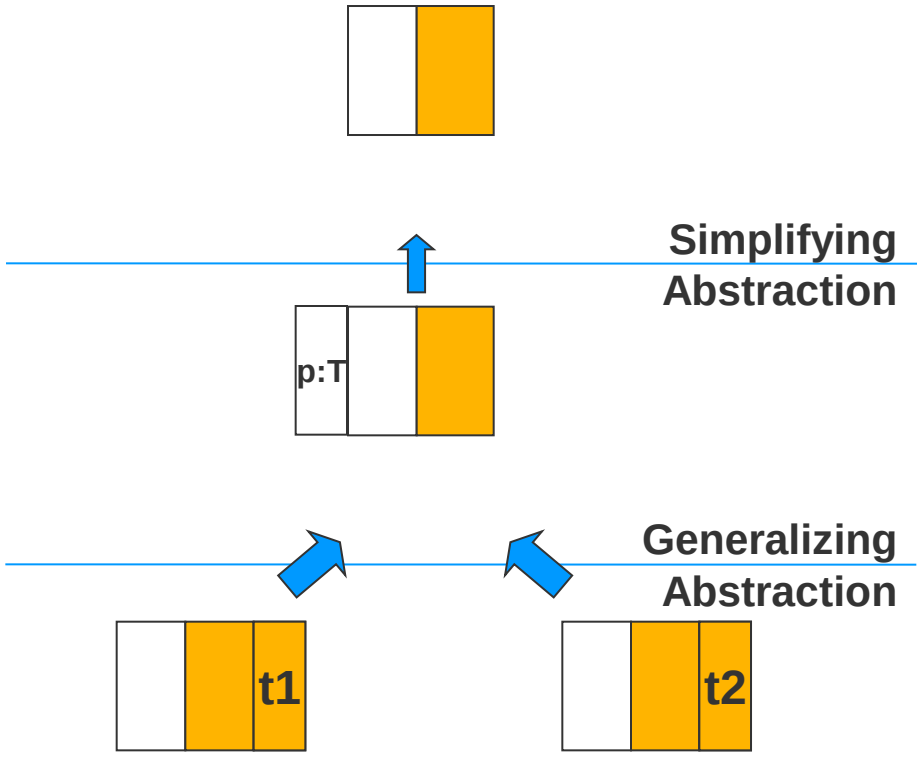


The Influences of Abstraction

Type	Specificity	Detail Complexity	Dynamic Complexity
Genera-lizing	-	0/-	+
Simpli-fying	+	-	+/-



Consequences

1. Generalizing abstraction increases dynamic complexity
2. Simplifying abstraction increases specificity
3. To manage complexity, design specific and generic

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1. **Generalizing abstraction increases dynamic complexity**
2. **Simplifying abstraction increases specificity**
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Example
Swing JFrame can be used by setting only one of its > 65 parameters.

Conclusions

- Motivation
  - Abstraction is an essential activity in software engineering
  - Used to increase comprehensibility and reuse
  - Effects are rarely discussed and not well understood
- Contribution
  - Two basic types of abstraction: simplifying and generalizing
  - Influences on specificity and complexity
- Future work
  - Developing more examples
  - Formal framework
  - Relation to redundancy?