Università
della
Svizzera
italiana

Faculty
of Informatics

Understanding the Redundancy of Software Systems

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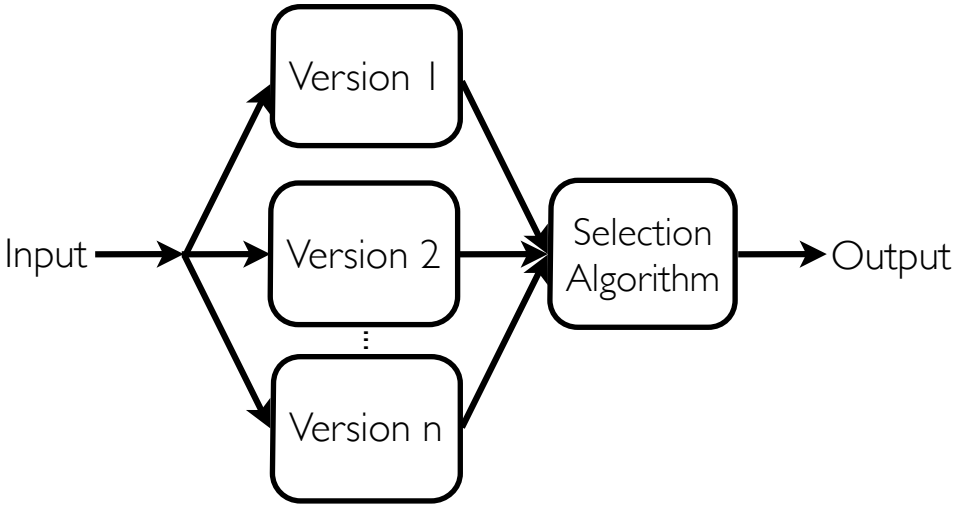
Research Co-Advisor: Prof. Antonio Carzaniga

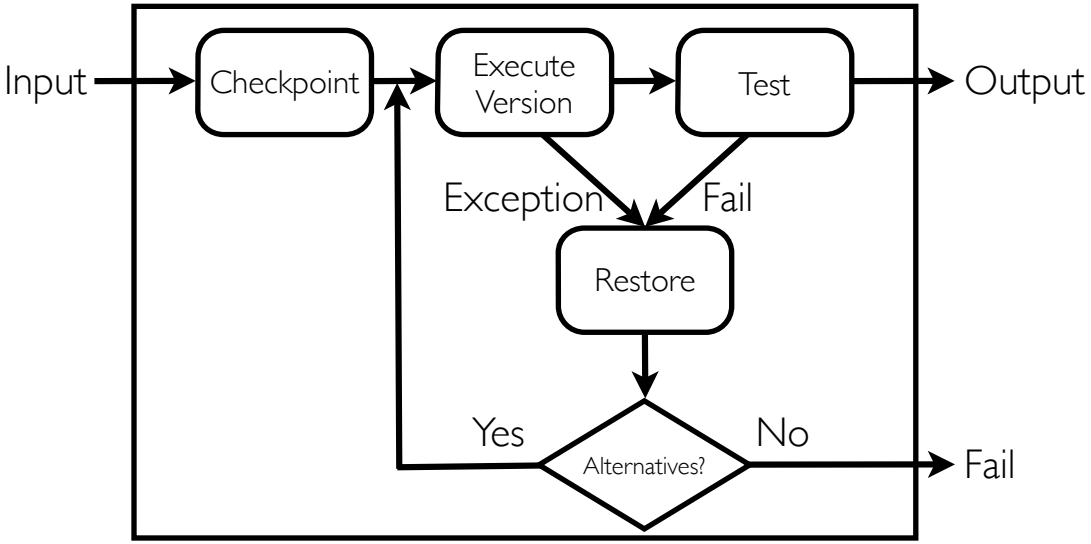
Redundancy

> Informally, a system is redundant when it is able to perform the **same functionality** by executing **different code**.

Software Redundancy

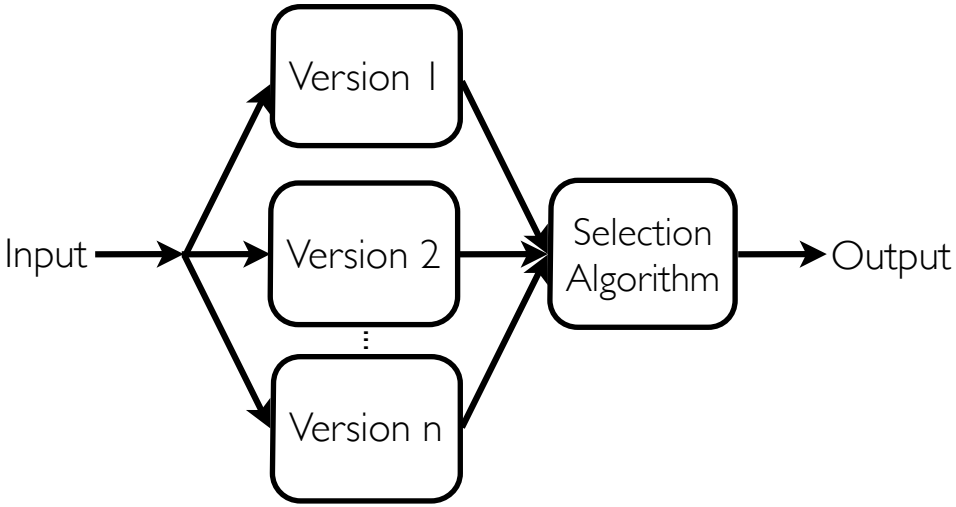


N-version



Recovery Blocks

Deliberate Redundancy



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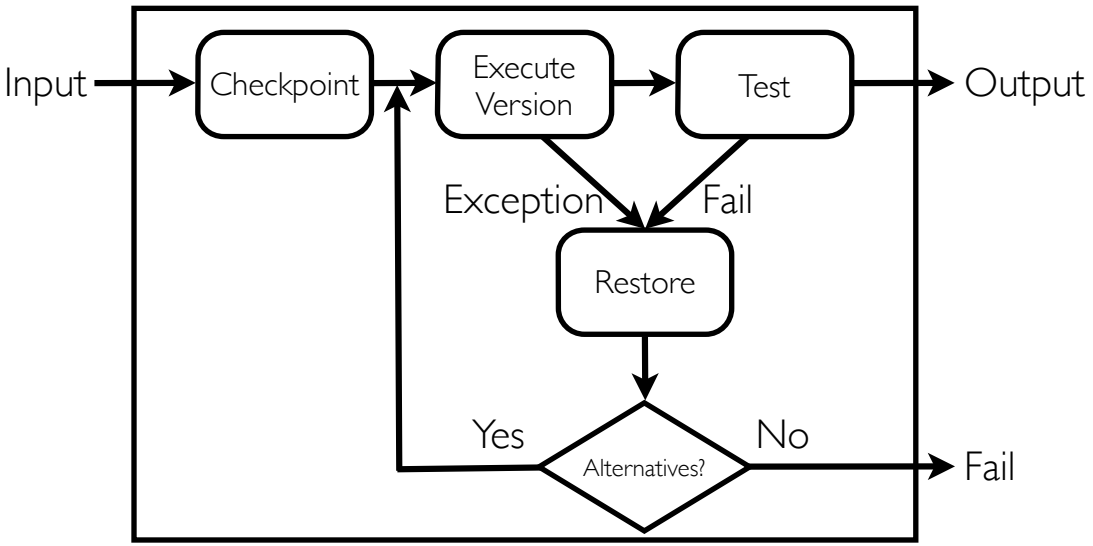

Recovery Blocks

Intrinsic Redundancy

> Modern software systems contain a form of redundancy that is indeed **intrinsically** present.

Intrinsic Redundancy: Examples

Joda-Time

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DateTime t = new DateTime();
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//get the beginning of the day for time t
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2 LOC (~0.1%)

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Using Intrinsic Redundancy

Self-healing

Test oracles

Automatic repair

Security

Studying Intrinsic Redundancy

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Studying Intrinsic Redundancy

What is its essence?

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What Is Its Essence?

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redundancy

=

functional equivalence

+

execution diversity

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redundancy

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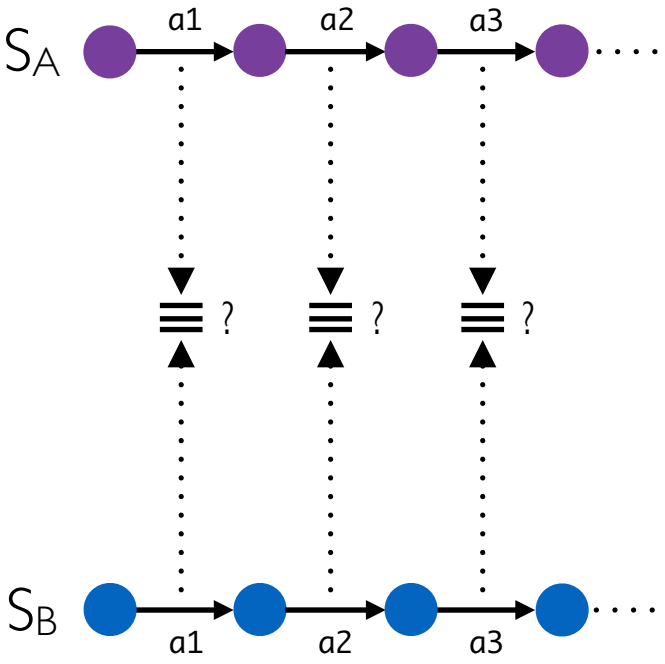
functional equivalence

+

execution diversity



Observational Equivalence
[Hennessy et al.]

What Is Its Essence?

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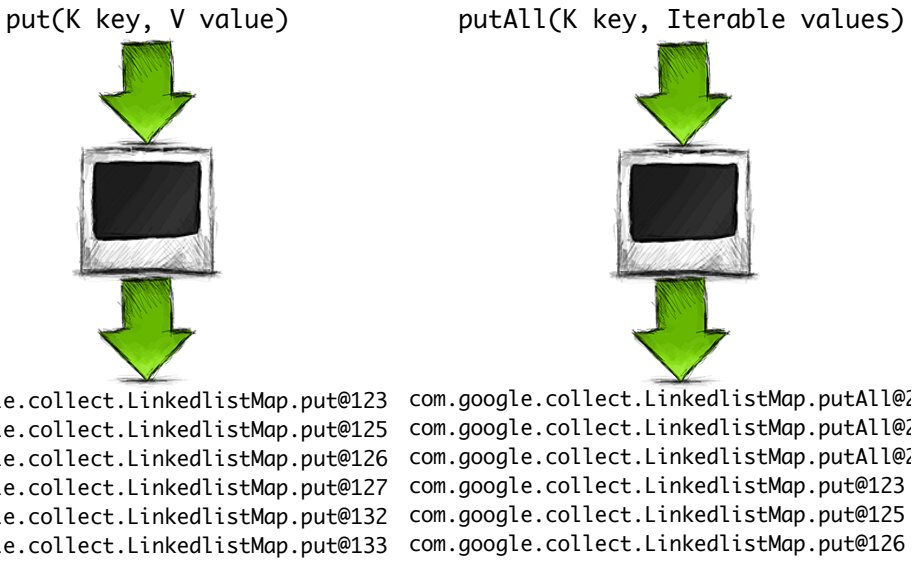

How Pervasive Is It?

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Joda-Time

SWT

GraphStream

How Pervasive Is It?

Joda-Time

SWT

4700+

equivalent method sequences

GraphStream

Intrinsic redundancy

What Is Its Essence?

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functional equivalence

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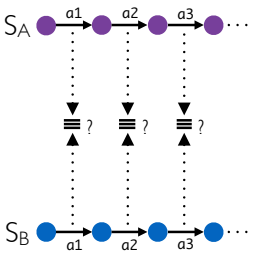
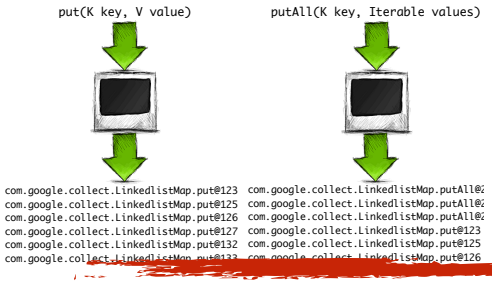
execution diversity





Intrinsic redundancy

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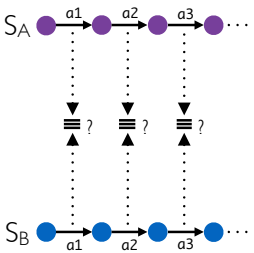
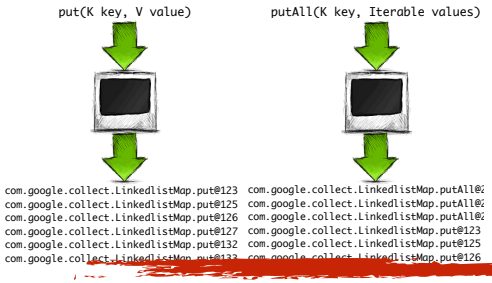
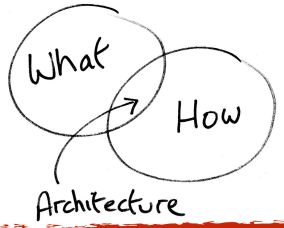
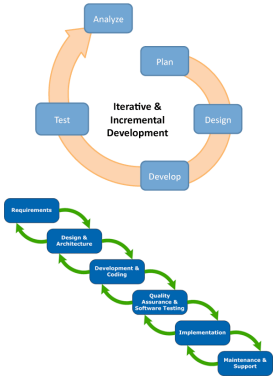






How Pervasive Is It?



Intrinsic redundancy

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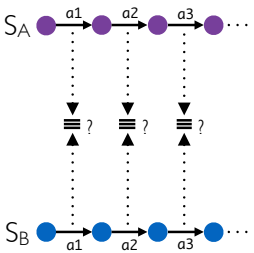

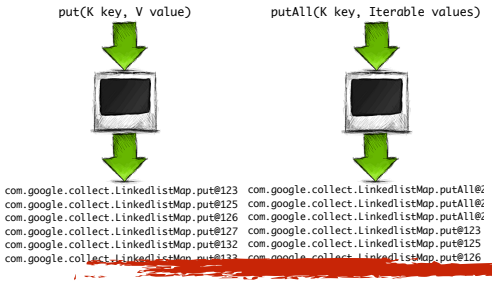

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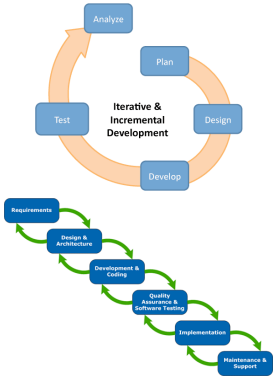
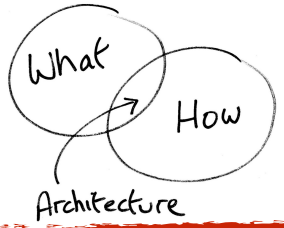
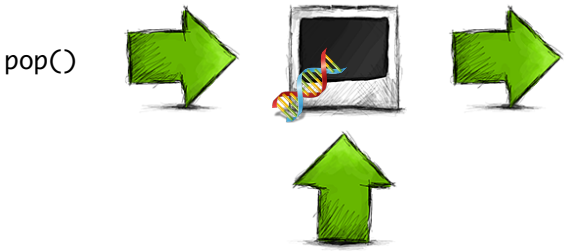




Intrinsic redundancy

How to Identify It?

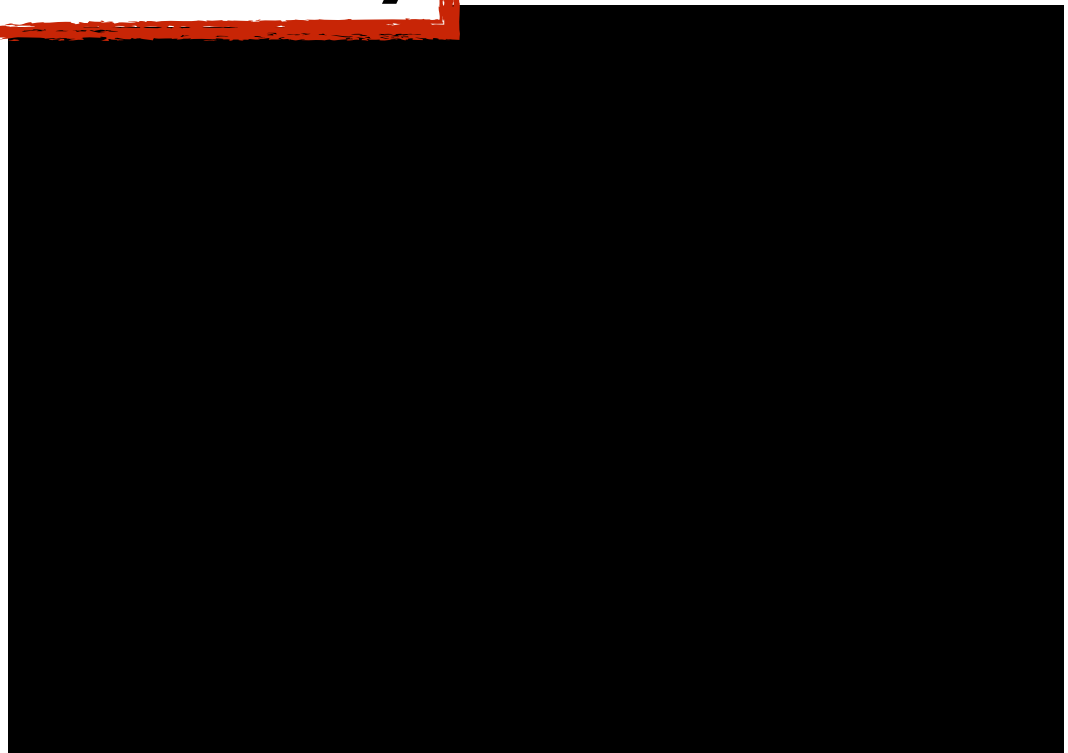



```
Object o = s.peek();
int index = s.size();
index = index - 1;
s.remove(index);
return o;
```

```
Stack s = new Stack();
s.push(0);
s.push(1);

Stack s = new Stack();
s.push(-174);
```

Execution Scenarios



What Is Its Essence?

redundancy

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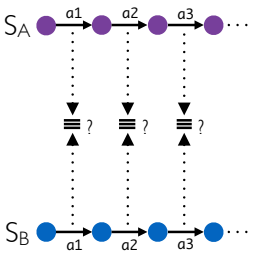
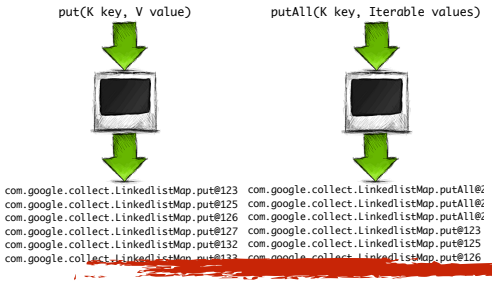
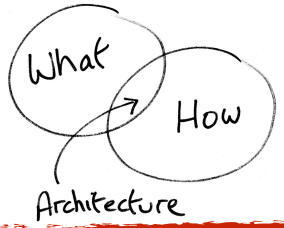
functional equivalence + execution diversity







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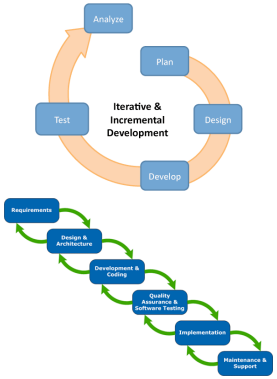

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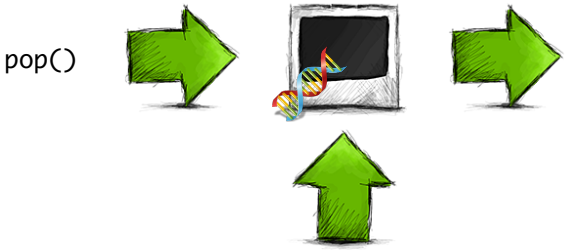


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Execution Scenarios

Why?

Design for reusability

Non-functional requirements

Replicated Functionalities

Backward compatibility