

Open Challenges in Mutation Testing

Panel Discussion

Objectives



“In 2000, I thought we were finished with mutation.”

Objectives

- Why is mutation testing not done in industry? (Or is it?)
- Where is research leading to?
- Where *should* research be leading to?

Panelists



Panelists



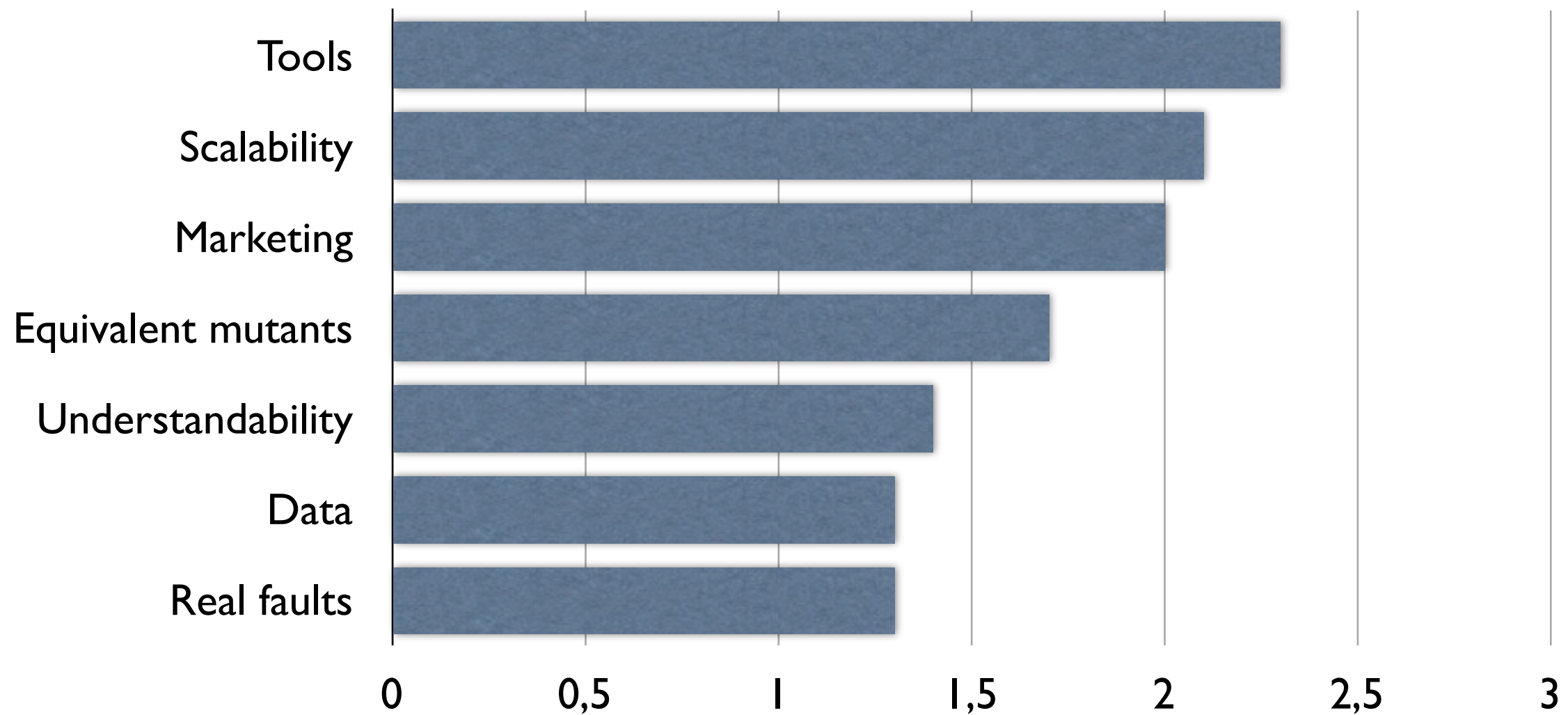
4th Order Mutants?

Survey Results

Mutation testing in practice

- Mutation is mainly used for research experiments
- Equivalent mutants are not ignored
- Equivalent mutants are mainly detected manually
- Mutation researchers like their own tools?

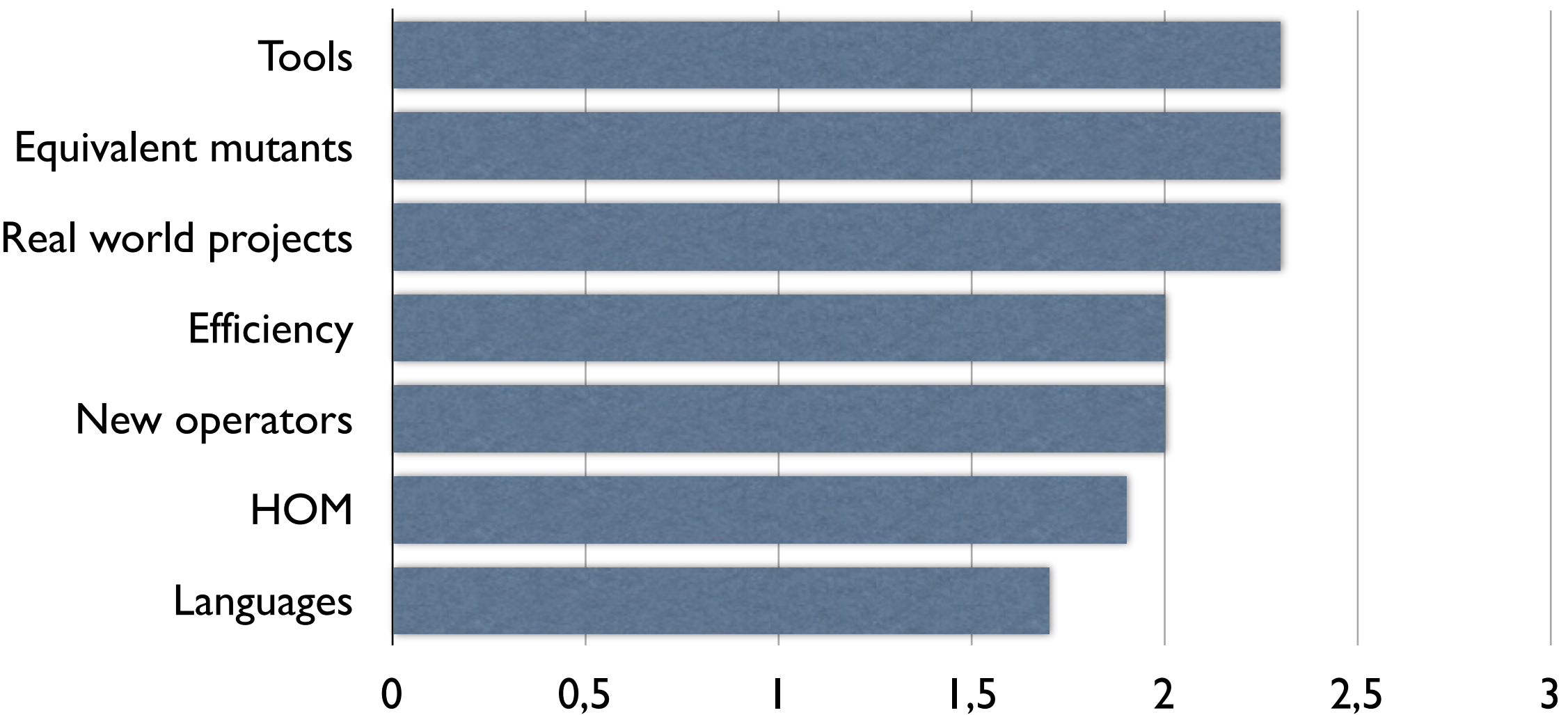
Industry Acceptance



Industry Acceptance

- Lack of automatic test data generation
- Lack of cooperation between industry and academia
- Industry has many pressing problems
- Huge effort and costs compared to other techniques
- Benefits unclear for evolving systems

Research Challenges



Research Challenges

- Test (data) generation
- Use mutation for other purposes such as repairing faults, automatic patching
- Developers don't care how tests are built - they just want good tests
- Handle larger code with various features (databases, network, ...)

Mark Hampton

previously CTO & co-founder at Certess

Certess developed a Mutation Analysis tool.

Languages supported: VHDL, Verilog, SystemVerilog, C, C++

Company grew from 3 to 25 in 5 years

Sold to a much larger company in early 2009

Major clients: CISCO, Intel, Sony, Toshiba, Bosch etc

Open Challenges in Mutation Testing

Some common assumptions need to be questioned
(5 in this presentation)

To be adopted MA needs to offer a convincing
story regarding ROI

Assumption #1

Don't assume test checking is based on golden results that are manually checked

Lets assume the test environment is automated

an oracle exists

e.g. model based testing

Assumption #2

- Killing a mutant should require a failing testcase
- If we change assumption #1 then this means the testcase includes an oracle and code for checking the expected results

This means redefining strong mutation

To include propagation through the test environment until the indication of a passing/failing testcase

Assumption #3

- Lets redefine the mutation analysis process to include humans interacting with the results
 - no need to collect all the mutants status before using the information
 - the order of the mutants is important
 - the process for results analysis is important

Assumption #4

- Weak mutation is not a good solution to the performance issue

the principle value of the Certess product is in finding mutants that are “weak” dead

mutation is complimentary to coverage information

focus on the strengths of mutation compared to code coverage – *finding problems in the propagation and detection of bugs*

Assumption #5

- A mutation analysis metric, based on sampling, can be many orders of magnitude faster than the published results

The Certess product provides a metric in a reasonable runtime even for large systems (100's of CPUs days of testcase execution)

ROI 1/2

- Can an ROI perspective help with the adoption of MA in industry

are we marketing the technology well ?

which niche should be the entry point for software testing ?

where is the most pain ?

ROI 2/2

- Is mutation highlighting a more fundamental issue that industry is ignoring ?

measuring the quality of testing should be a separate discipline from testing

in the same way measuring that quality of the design has been specialized into testing

should there be "qualifiers" in the same way we have coders and testers ?

Mark Harman

**King's College and
University College London**

New challenges

- Finding faults is **easy**;
- ... there are too many to count ...

- So we need to
 - Take fault severity into account
 - Develop test cases
 - Develop fixes

HOM Testing

- First order mutants are **not** necessarily realistic
- We need tailored adaptive higher order mutation
- We need to take account of fault models
- We need non functional mutants

Jeff Offutt

George Mason University

Jeff Offutt

George Mason University

- Hampton – ROI
- Harman – HOM

Jeff Offutt

George Mason University

- Hampton – ROI
- Harman – HOM
- Offutt – YAMGG

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What ????

What does that mean?

We can't even pronounce "YAMGG"!

Research into Mutation Operators

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Mutation 2000

Research into Mutation Operators

Mutation 2000



Here is the path to build a commercial mutation system.

Jeff

Research into Mutation Operators

Mutation 2000



Here is the path to build a commercial mutation system.

I quit.

Jeff

Research into Mutation Operators

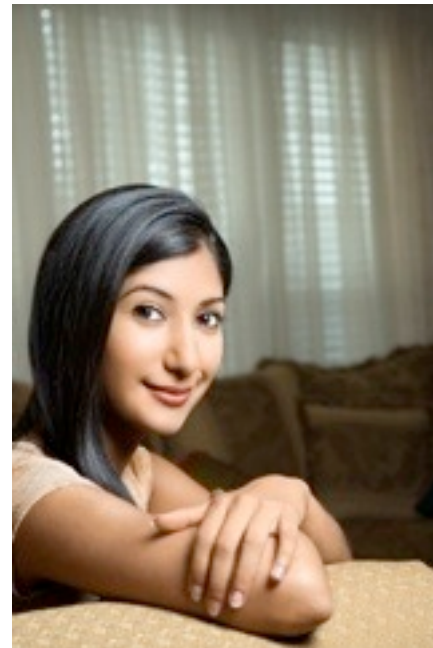
Mutation 2000



Jeff

Here is the path to build a commercial mutation system.

I quit.



Yu-Seung Ma

Research into Mutation Operators

Mutation 2000

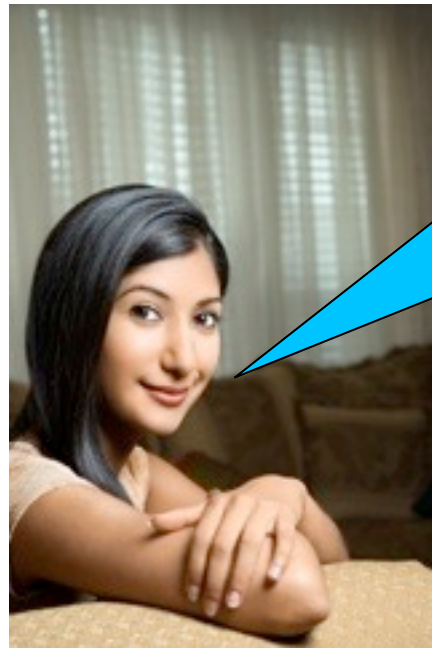


Jeff

Here is the path to build a commercial mutation system.

I quit.

I have an idea!
OO mutation operators ...
muJava



Yu-Seung Ma

Last Decade of Mutation Operators

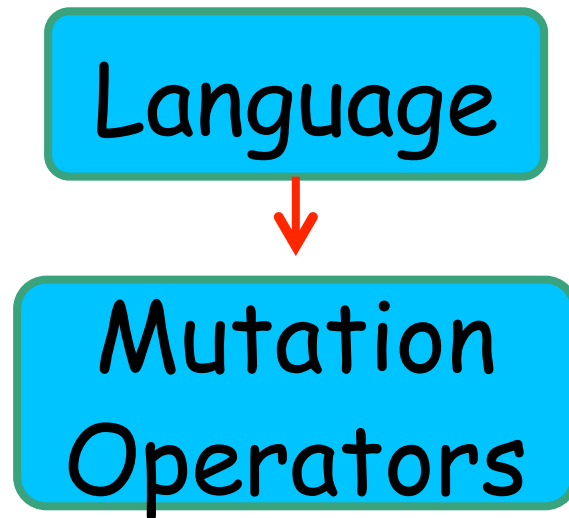
- Since then, we have had a veritable explosion in languages we can mutate
- We needed mutation operators for each language
 - Java OO, XML, JSPs, HTML, SQL, XML, PHP, inter-class, statecharts, dynamic typing, WS-BPEL, Agents, Actors, ...
 - Most of today's papers present new mutation operators
- And we need a mutation engine for each language!

Mutant Generators

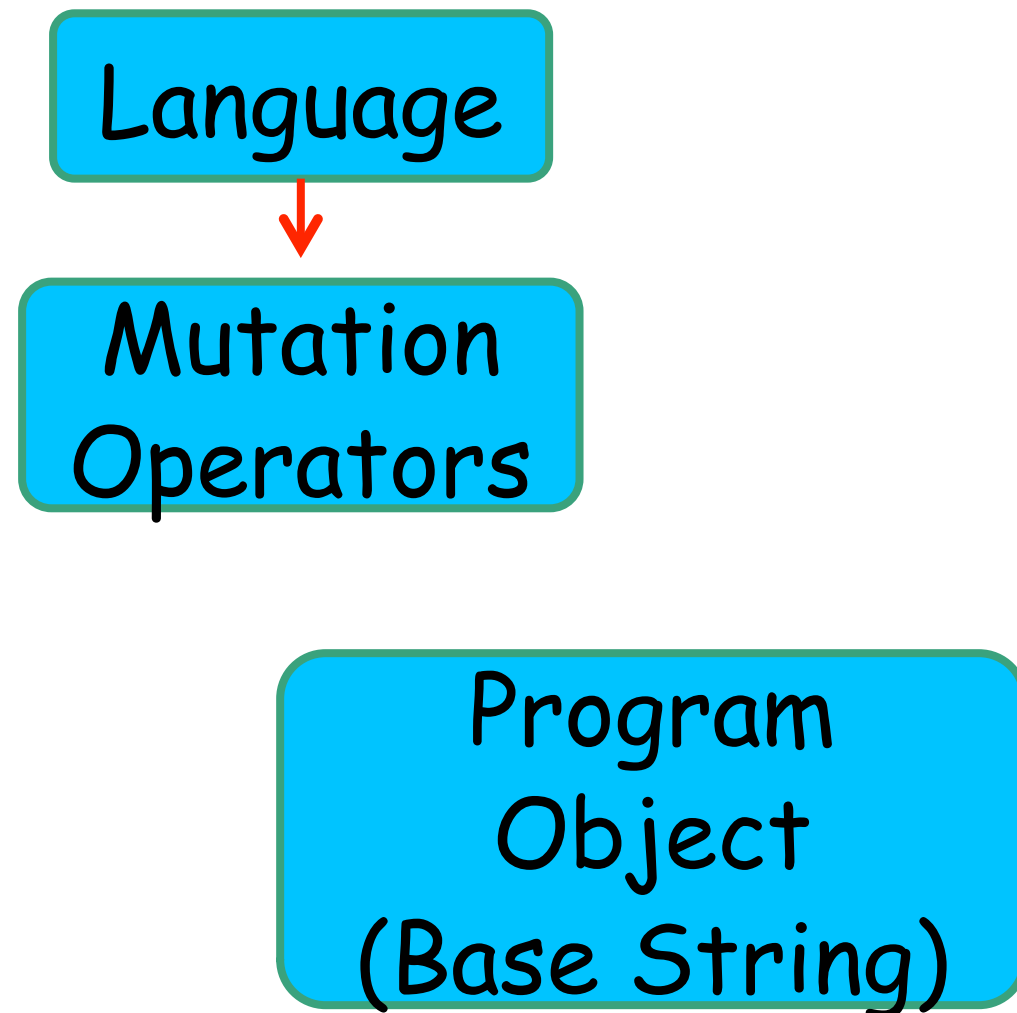
Mutant Generators

Language

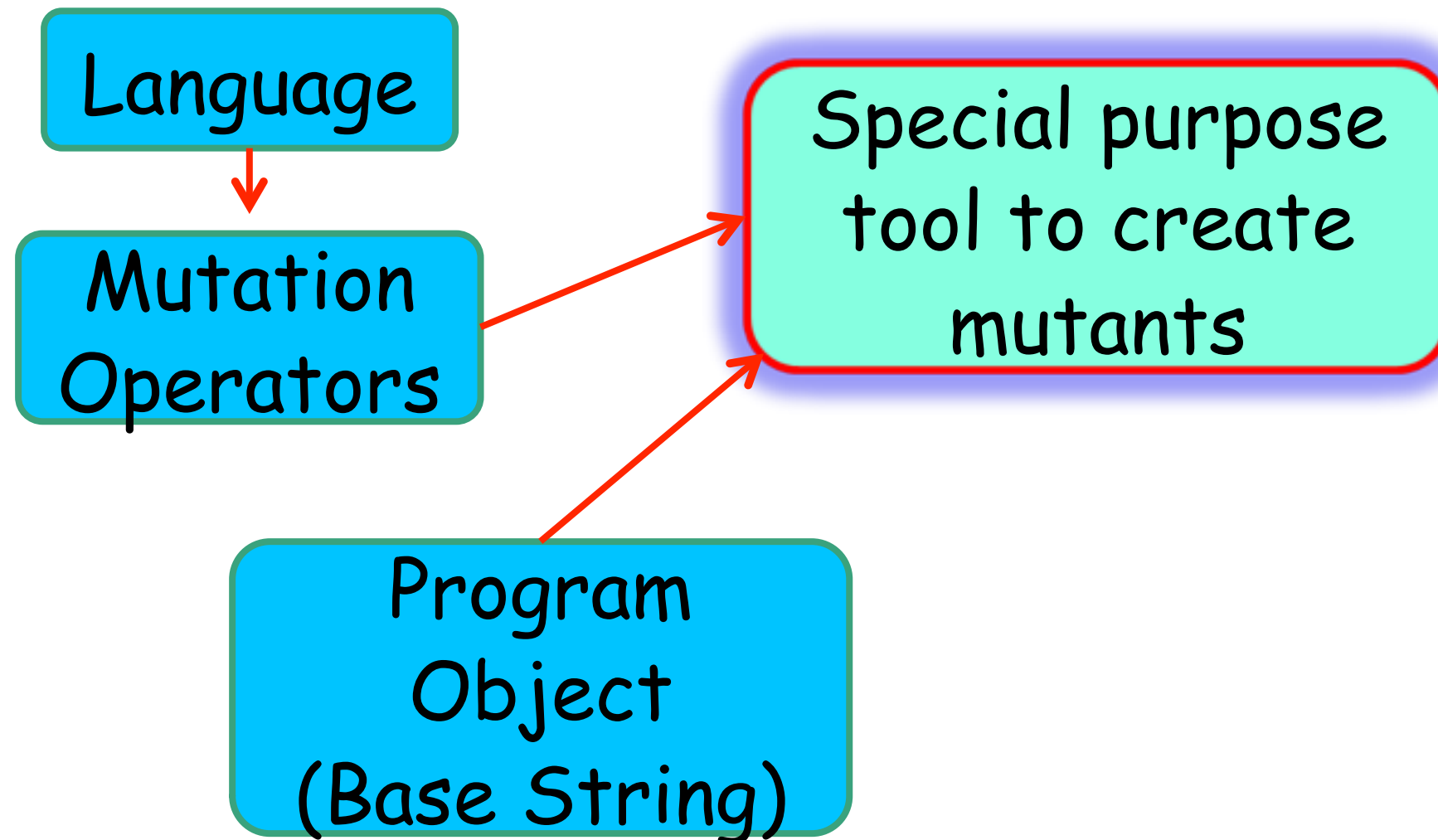
Mutant Generators



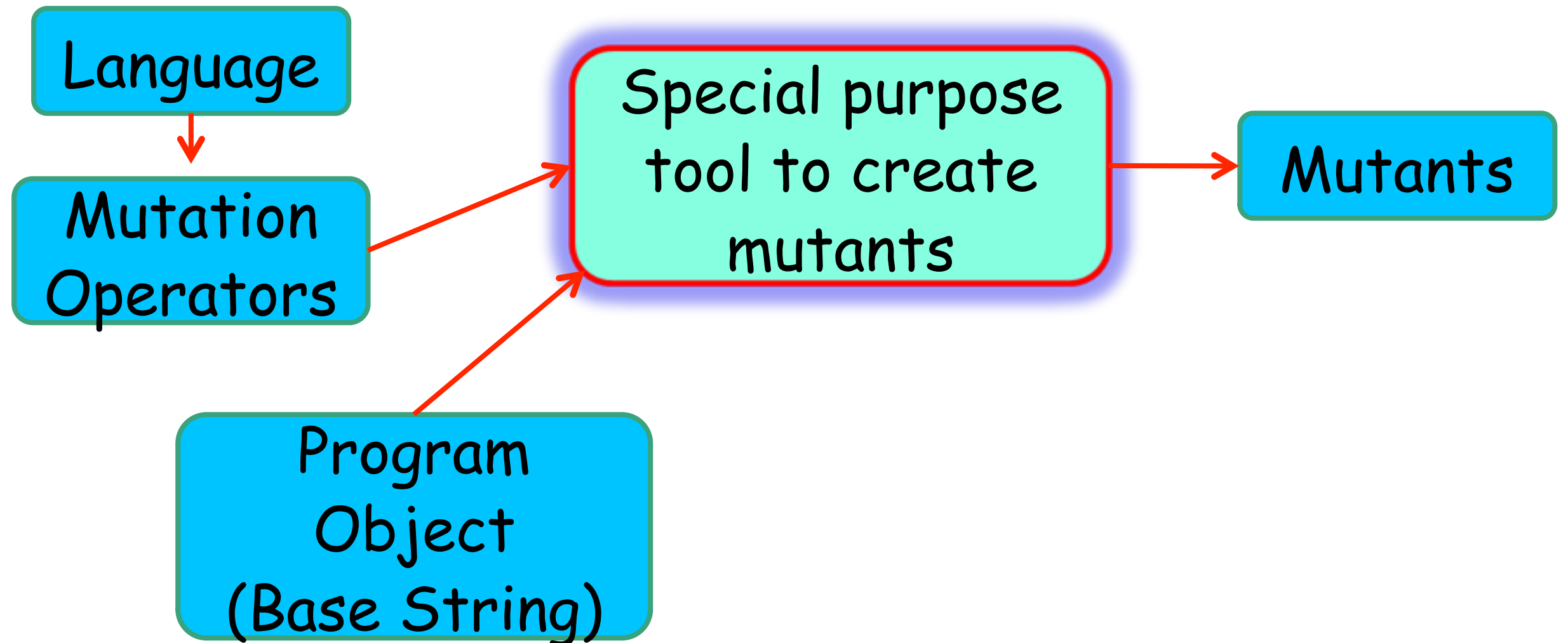
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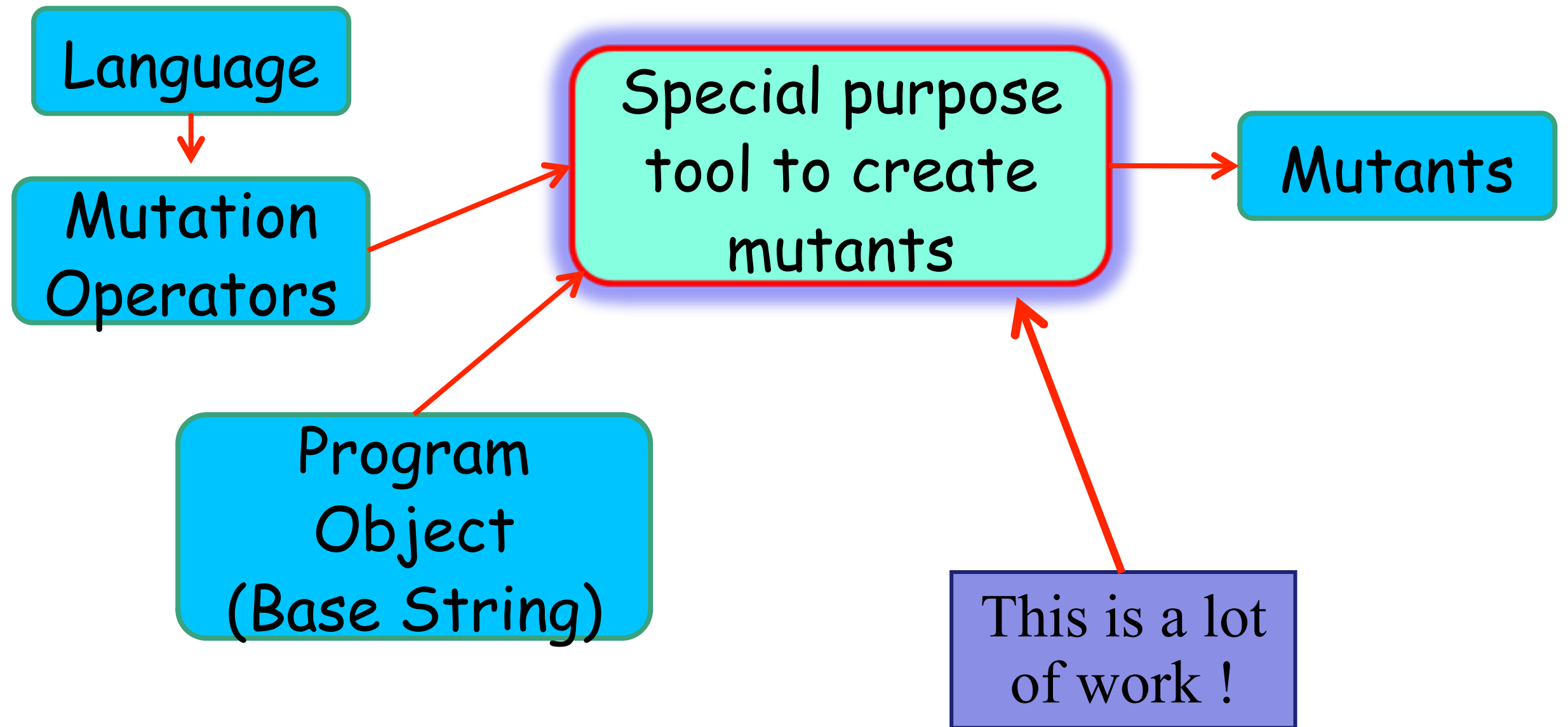
Mutant Generators



Mutant Generators

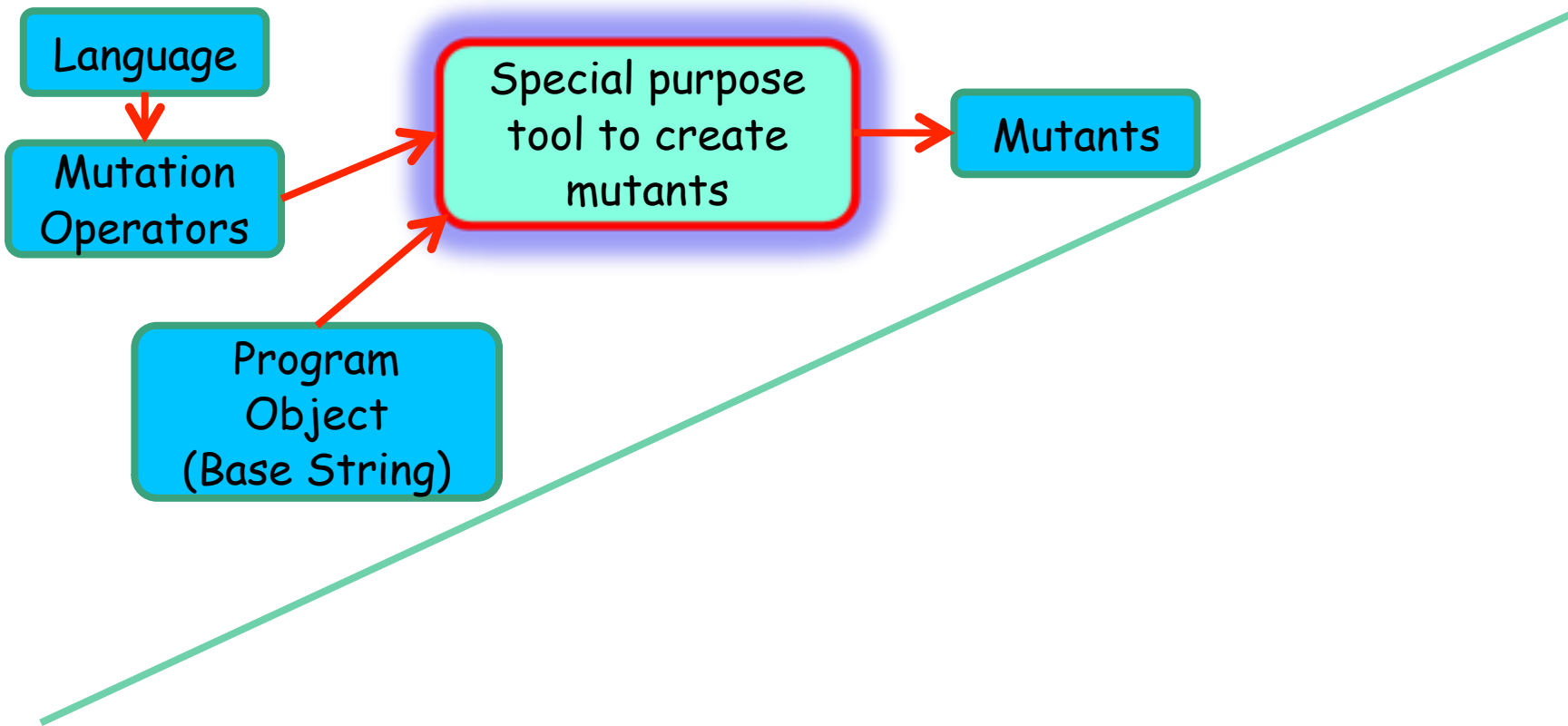


Mutant Generators

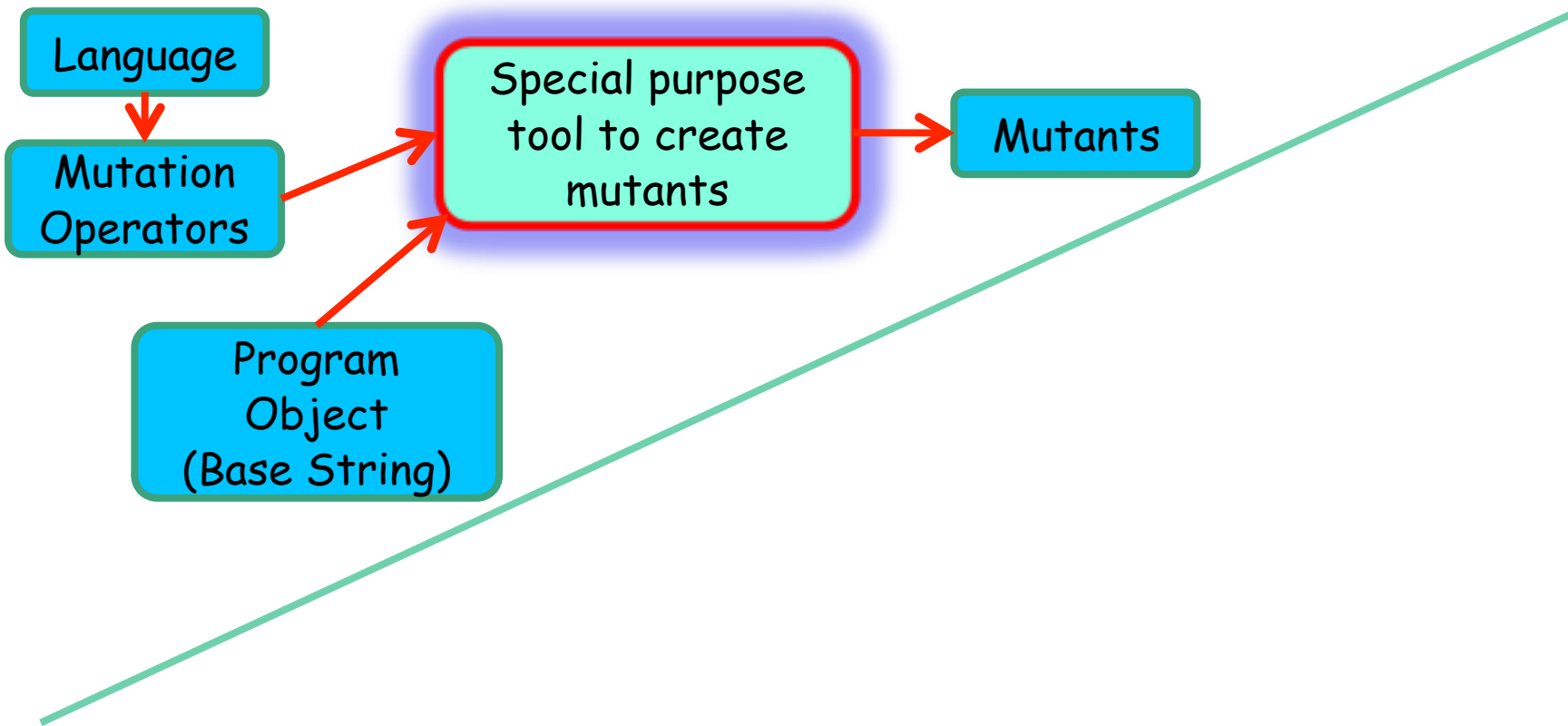


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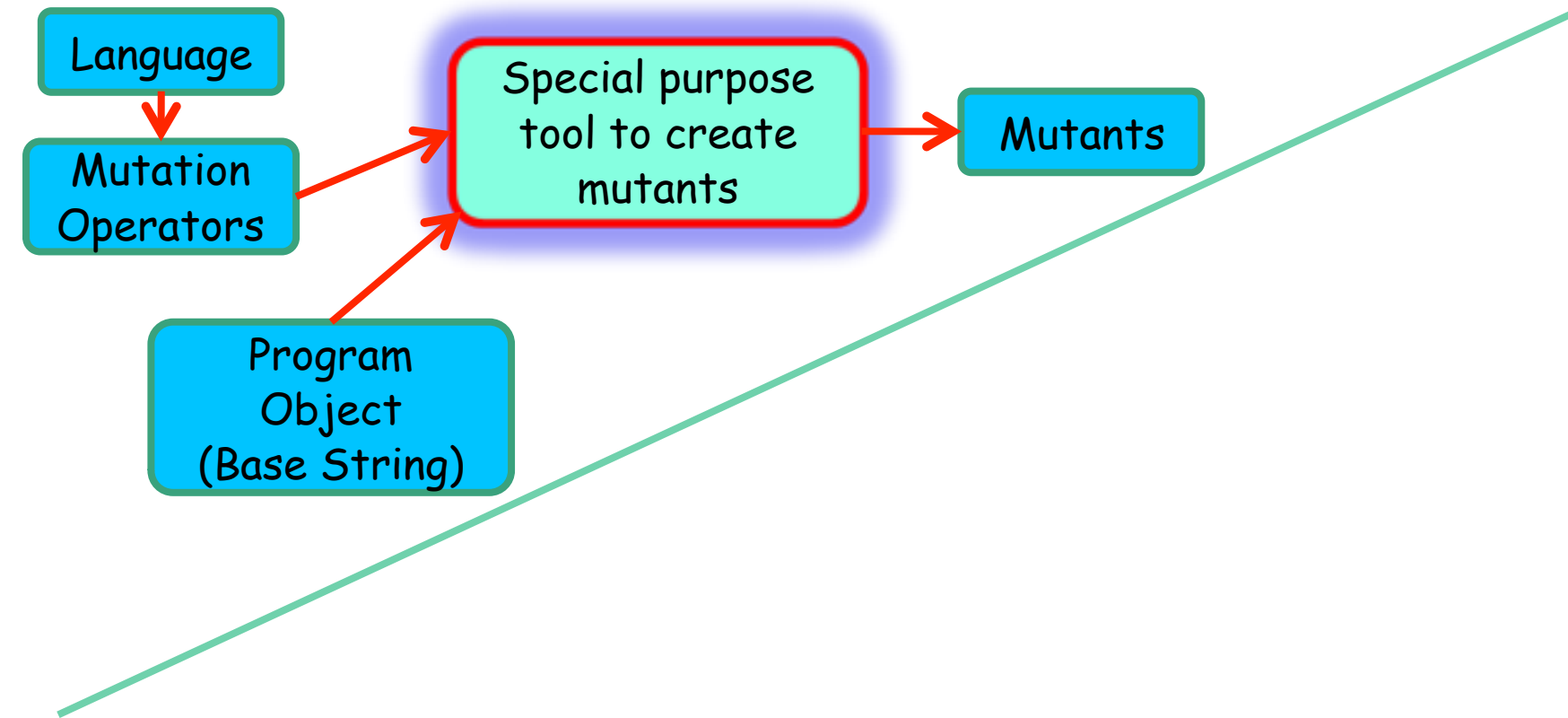
Mutant Generators



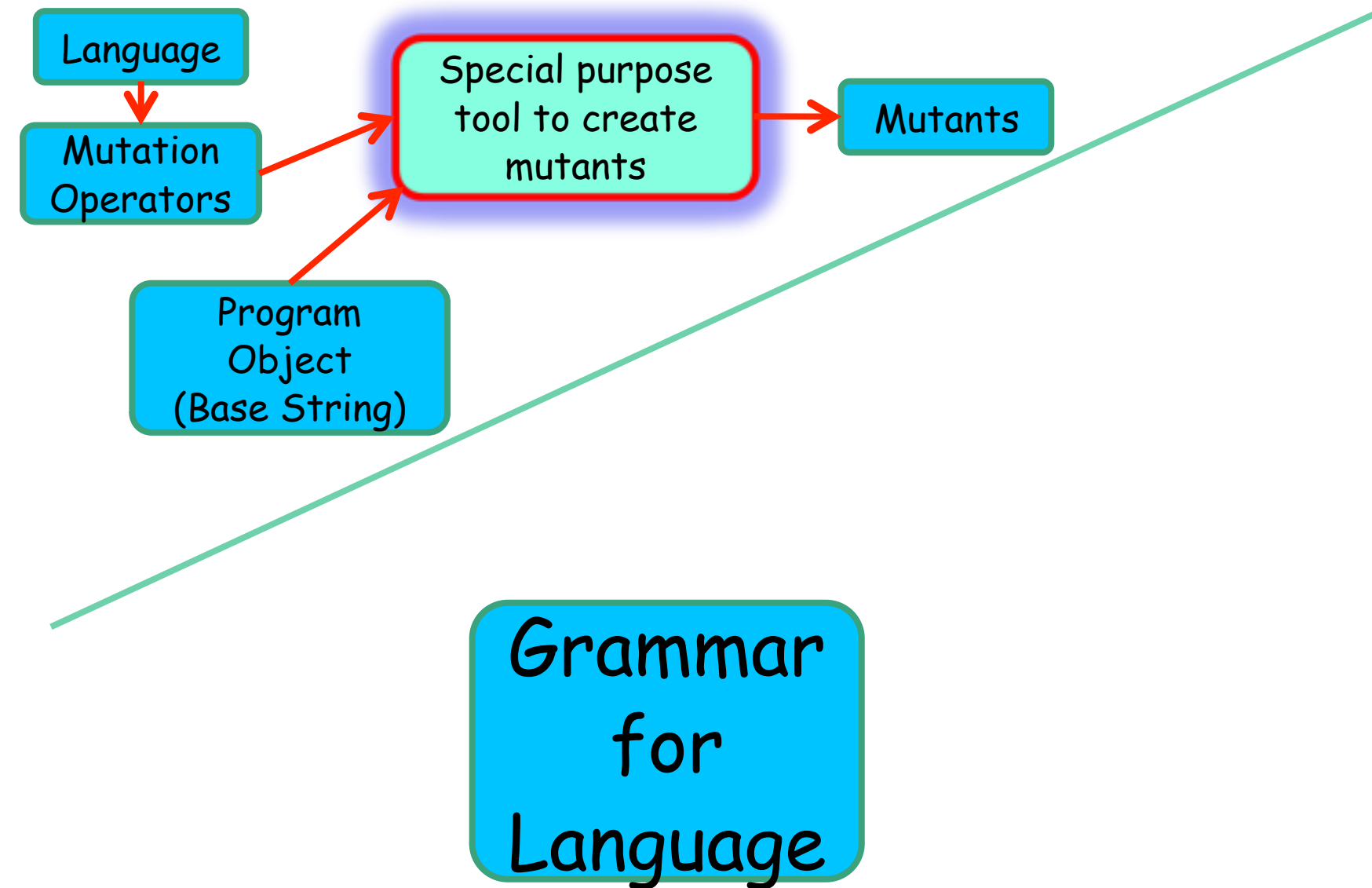
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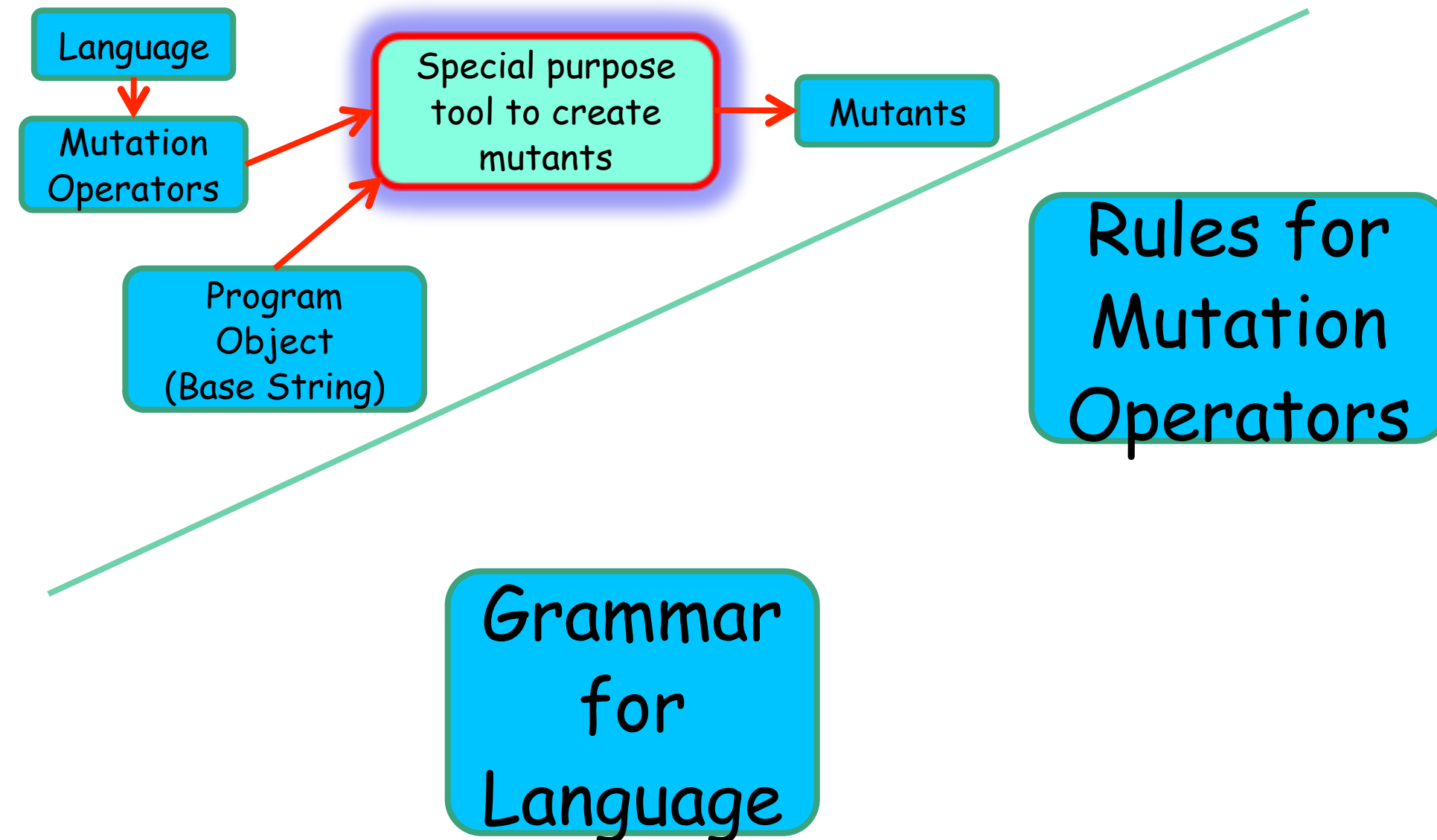
Yet Another Mutant Generator Generator



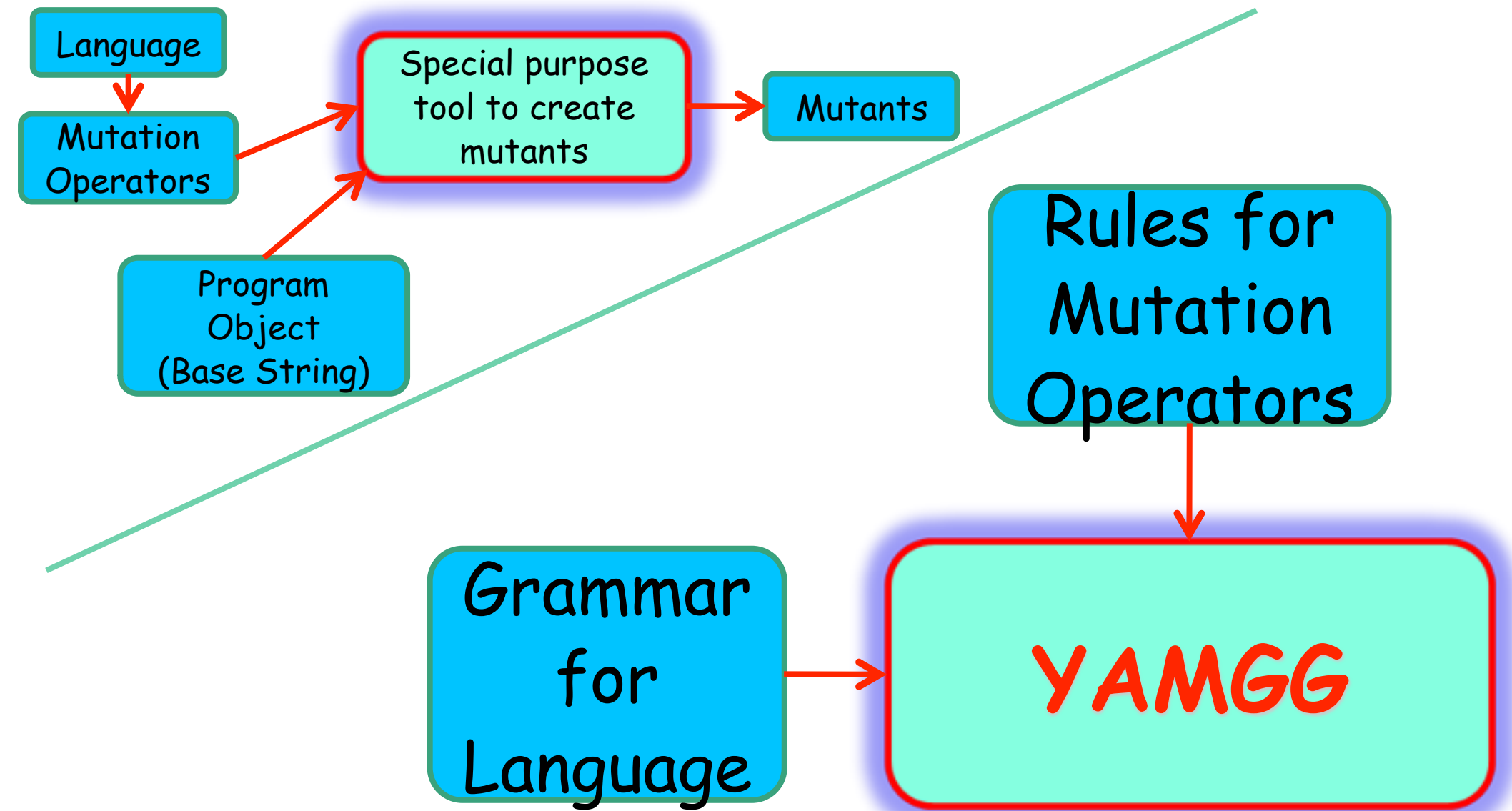
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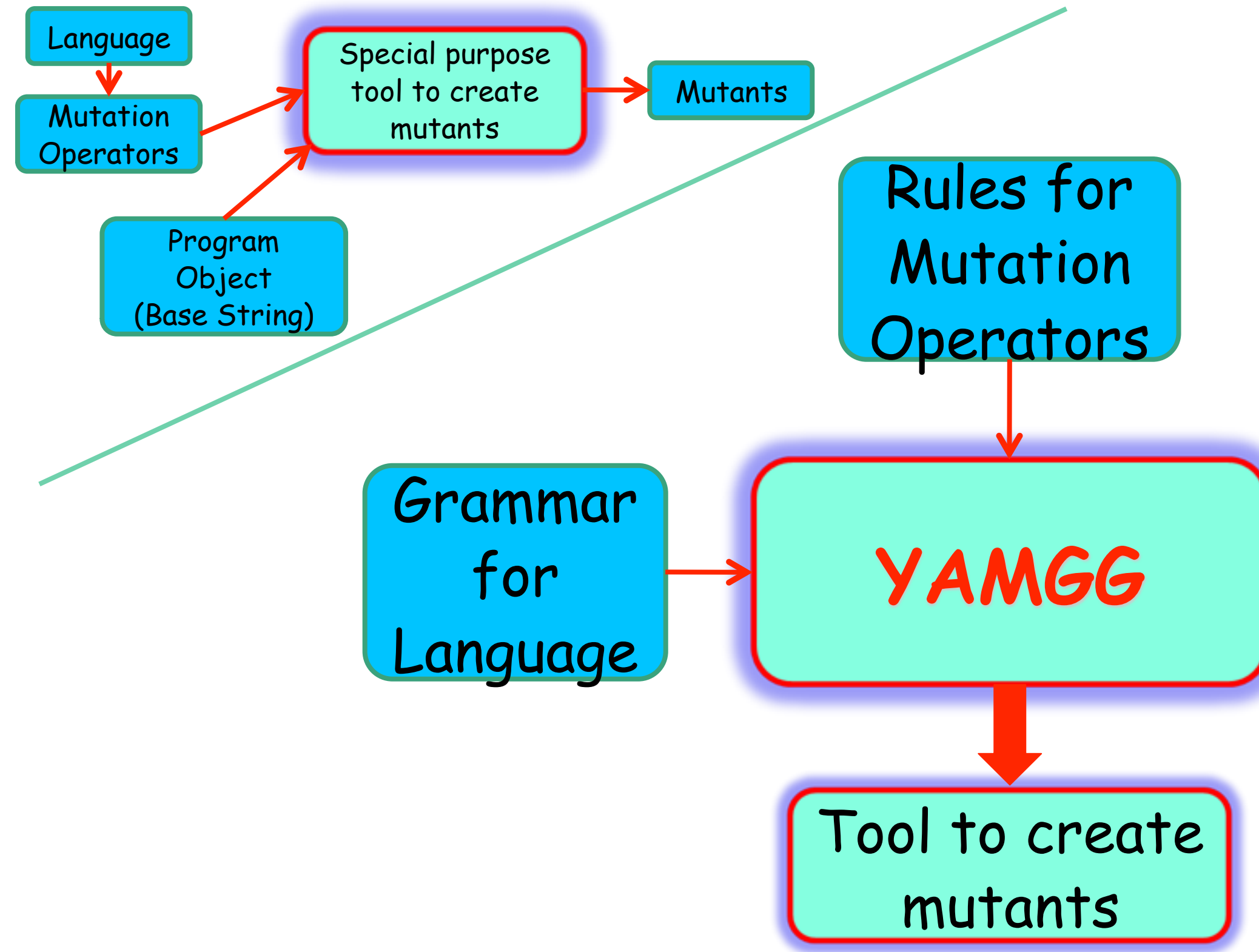
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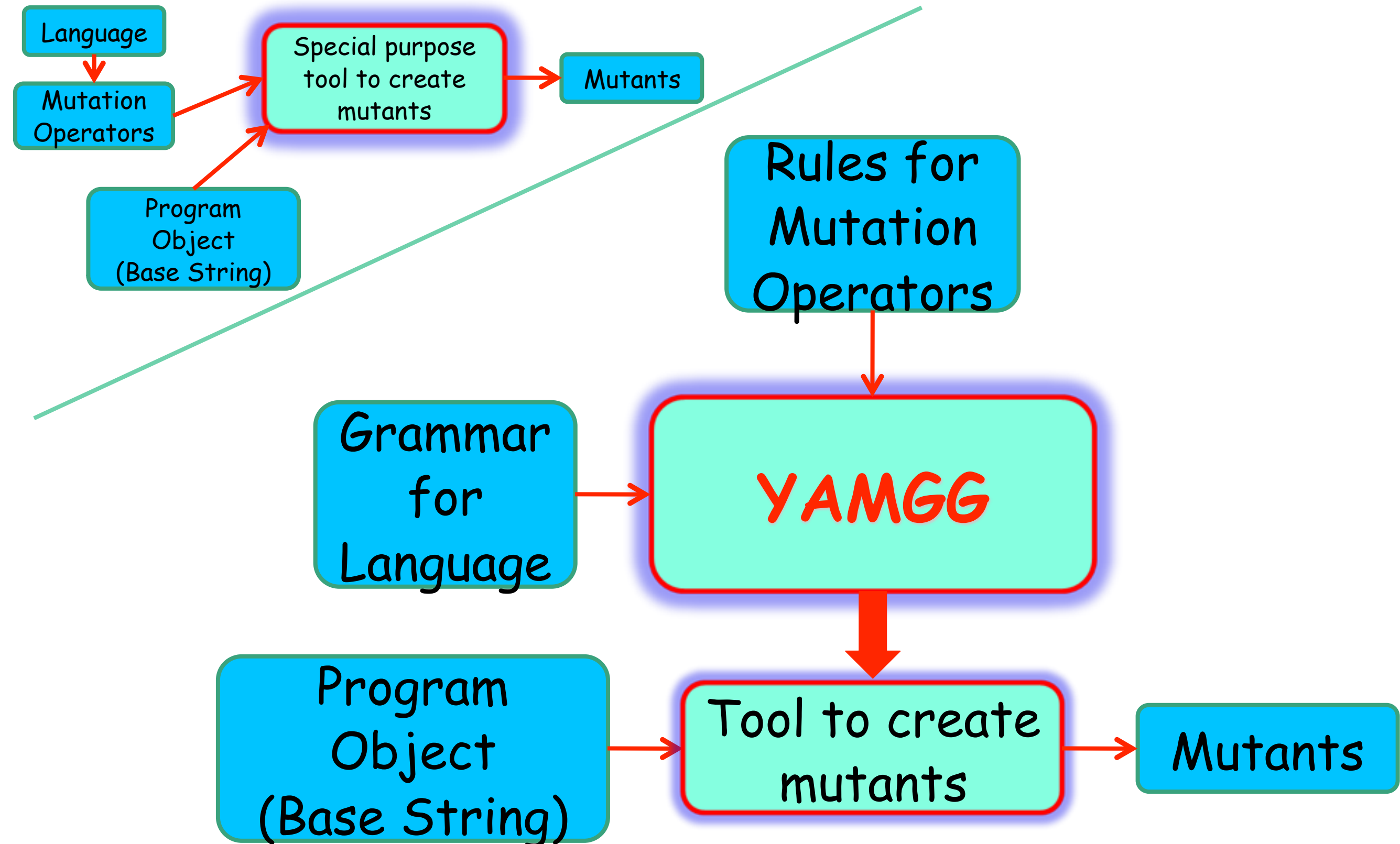
Yet Another Mutant Generator Generator



Yet Another Mutant Generator Generator



Yet Another Mutant Generator Generator



Open Challenges in Mutation Testing

- **Hampton – ROI**
- **Harman – HOM**
- **Offutt – YAMGG**

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Your turn !!

