TECHNISCHE UNIVERSITÄT WIEN

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

MODEL-BASED, MUTATION-DRIVEN TEST CASE GENERATION VIA HEURISTIC-GUIDED BRANCHING SEARCH

Andreas Fellner

FMCAD Student Forum
Wien, October 4th 2017

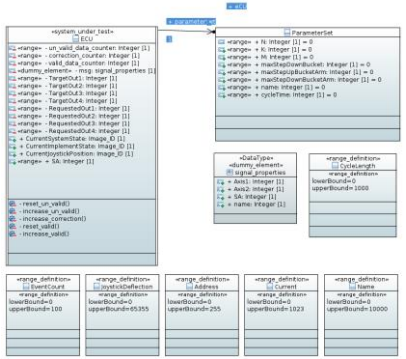
TEST CASE GENERATION WITH MoMuT

Andreas Fellner

TEST CASE GENERATION WITH MoMuT

Abstract Model

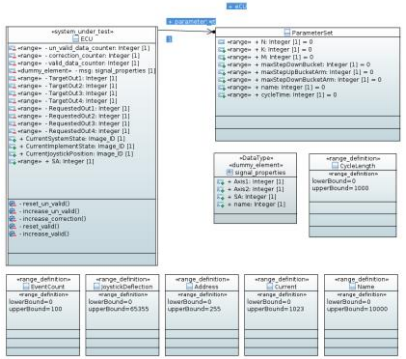
UML / Event-B



TEST CASE GENERATION WITH MoMuT

Abstract Model

UML / Event-B



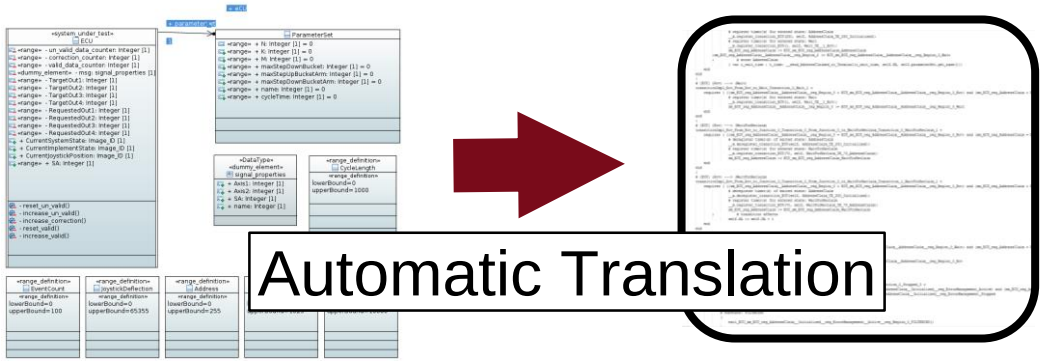
Executable Model

Action System

TEST CASE GENERATION WITH MoMuT

Abstract Model
UML / Event-B

Executable Model
Action System



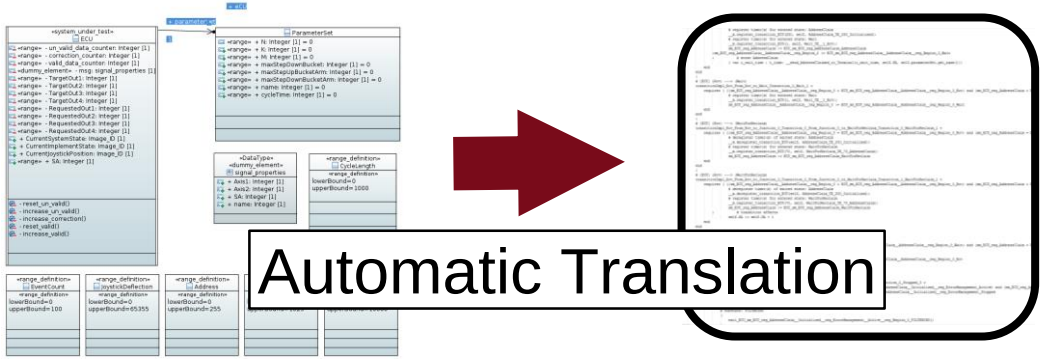
TEST CASE GENERATION WITH MoMuT

Abstract Model

UML / Event-B

Executable Model

Action System

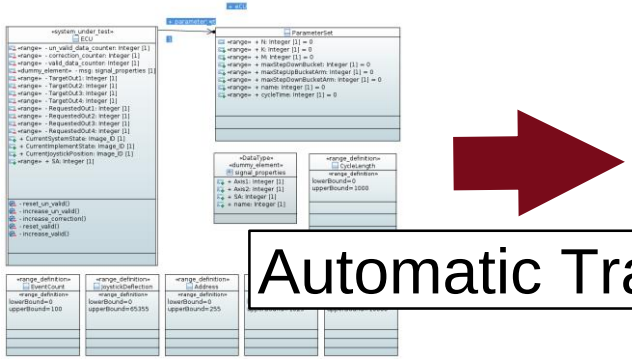


Mutated Action Systems

TEST CASE GENERATION WITH MoMuT

Abstract Model

UML / Event-B

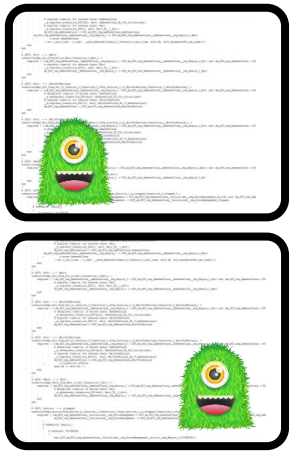


Automatic Translation

Executable Model

Action System

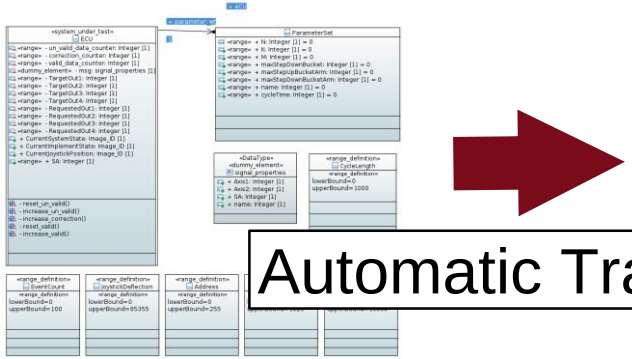
Mutated Action Systems



TEST CASE GENERATION WITH MoMuT

Abstract Model

UML / Event-B

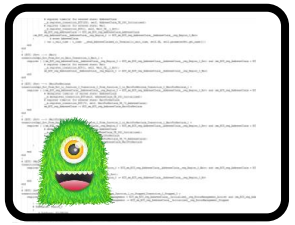


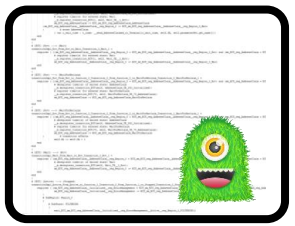
Automatic Translation

Executable Model

Action System

Mutated Action Systems





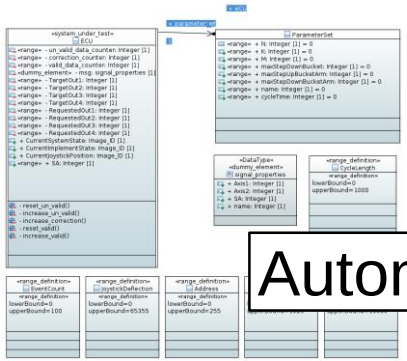
Original: `c := c + 1`

Mutation: `c := c`

TEST CASE GENERATION WITH MoMuT

Abstract Model

UML / Event-B



Automatic Translation

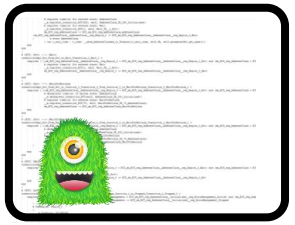
Executable Model

Action System

Mutated Action Systems

Original: `c := c + 1`

Mutation: `c := c`

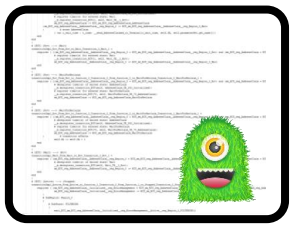


Original: `if signal > 100`

…

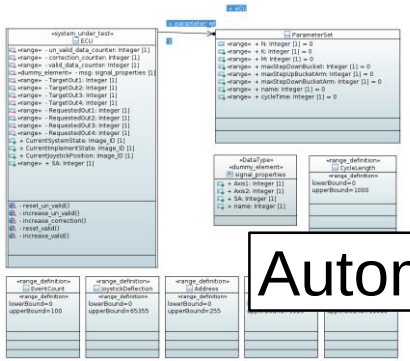
Mutation: `if false`

…



TEST CASE GENERATION WITH MoMuT

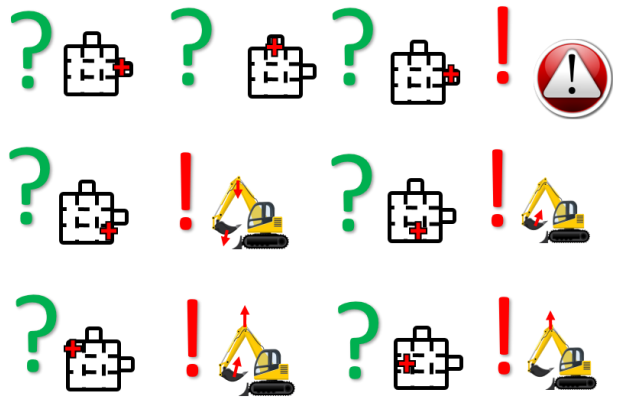
Abstract Model
UML / Event-B



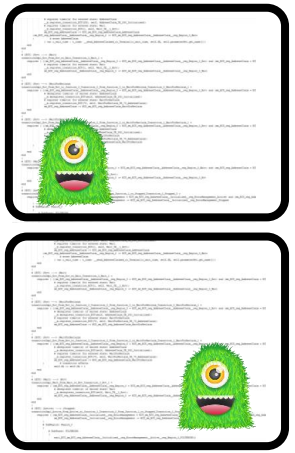
Automatic Translation

Executable Model
Action System

Test Cases



Mutated Action Systems



Original: `c := c + 1`

Mutation: `c := c`

Original: `if signal > 100`

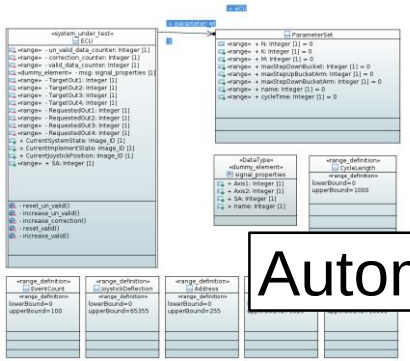
…

Mutation: `if false`

…

TEST CASE GENERATION WITH MoMuT

Abstract Model
UML / Event-B

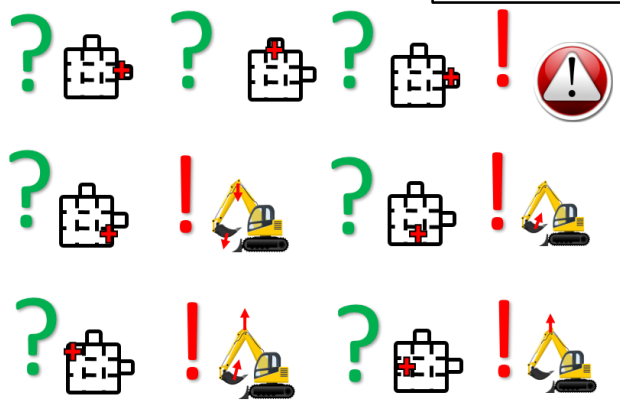


Executable Model
Action System

Automatic Translation

Test Cases

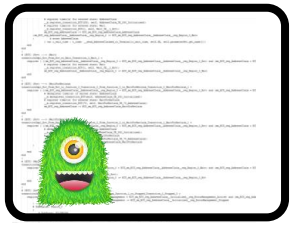
Input/Output Sequence



Mutated Action Systems

Original: `c := c + 1`

Mutation: `c := c`

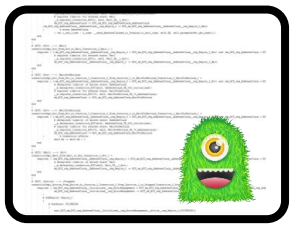


Original: `if signal > 100`

…

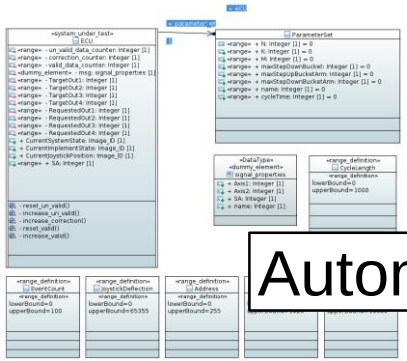
Mutation: `if false`

…



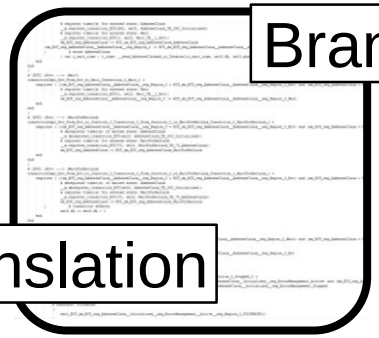
TEST CASE GENERATION WITH MoMuT

Abstract Model
UML / Event-B



Automatic Translation

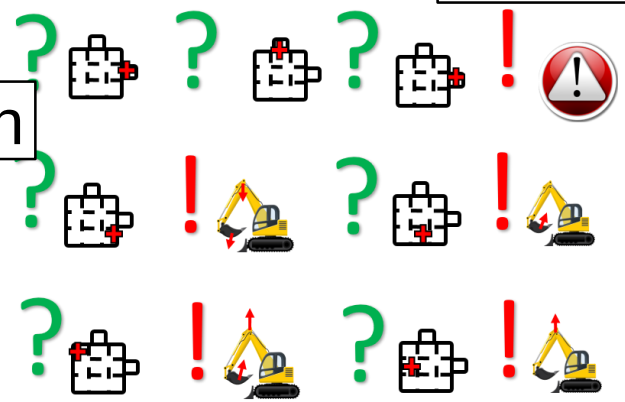
Executable Model
Action System



Branching Search

Test Cases

Input/Output Sequence



Mutated Action Systems

Original: `c := c + 1`

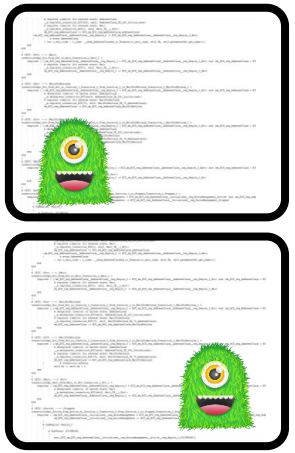
Mutation: `c := c`

Original: `if signal > 100`

…

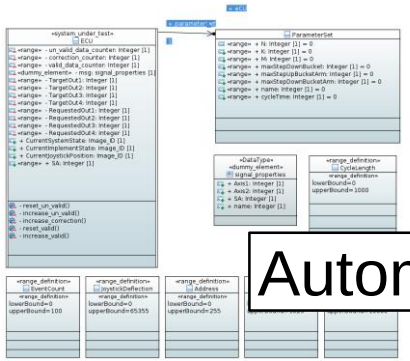
Mutation: `if false`

…



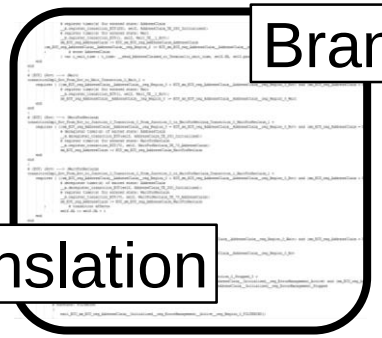
TEST CASE GENERATION WITH MoMuT

Abstract Model
UML / Event-B



Automatic Translation

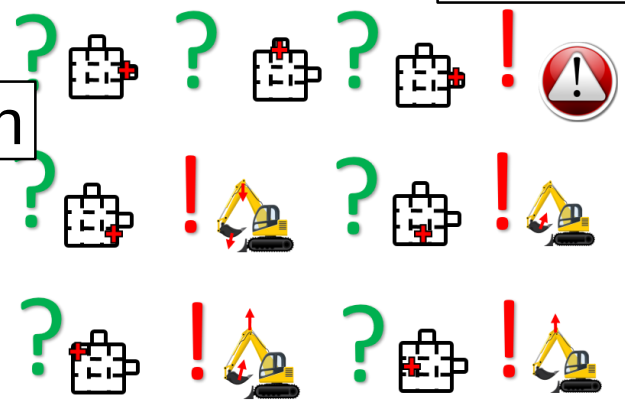
Executable Model
Action System



Branching Search

Test Cases

Input/Output Sequence



Mutated Action Systems

Original: `c := c + 1`

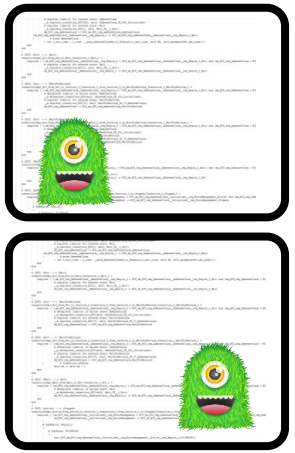
Mutation: `c := c`

Original: `if signal > 100`

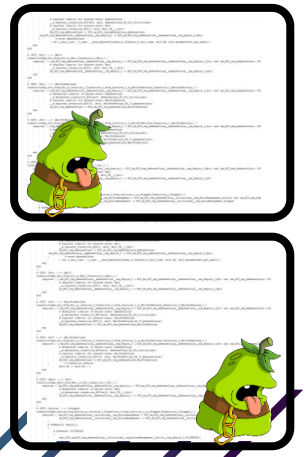
…

Mutation: `if false`

…

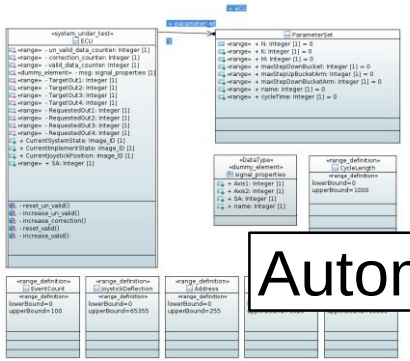


Mutants killed / alive / equivalent?



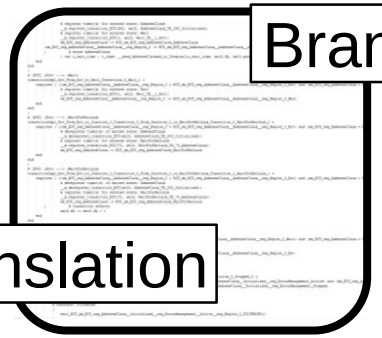
TEST CASE GENERATION WITH MoMuT

Abstract Model
UML / Event-B



Automatic Translation

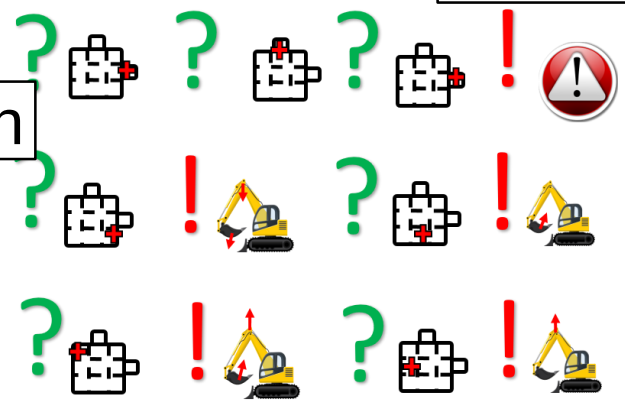
Executable Model
Action System



Branching Search

Test Cases

Input/Output Sequence



Mutated Action Systems

Original: `c := c + 1`

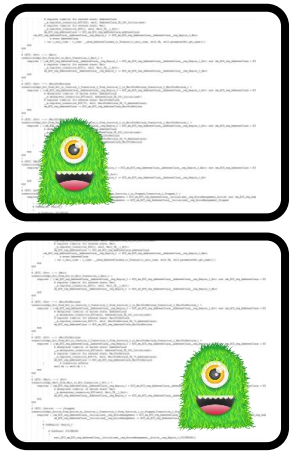
Mutation: `c := c`

Original: `if signal > 100`

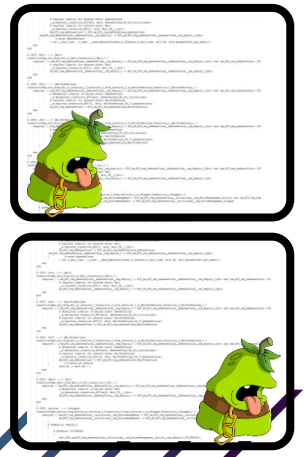
…

Mutation: `if false`

…



Mutants killed / alive / equivalent?



Mutant Killed:
- Same Input
- Different Output

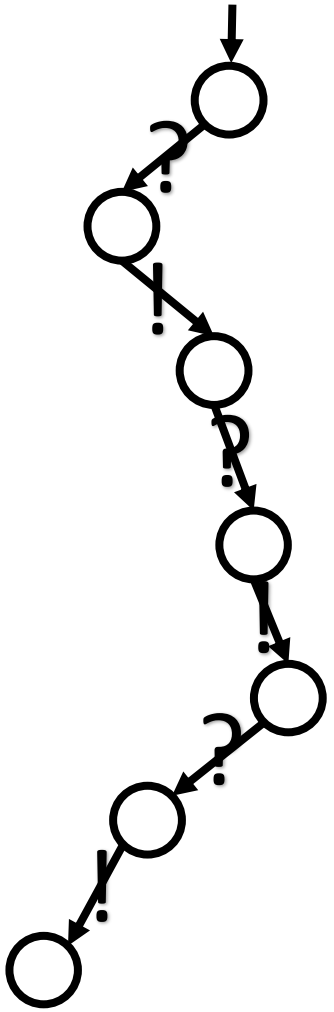
BRANCHING SEARCH AND MUTATION KILLING

BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches

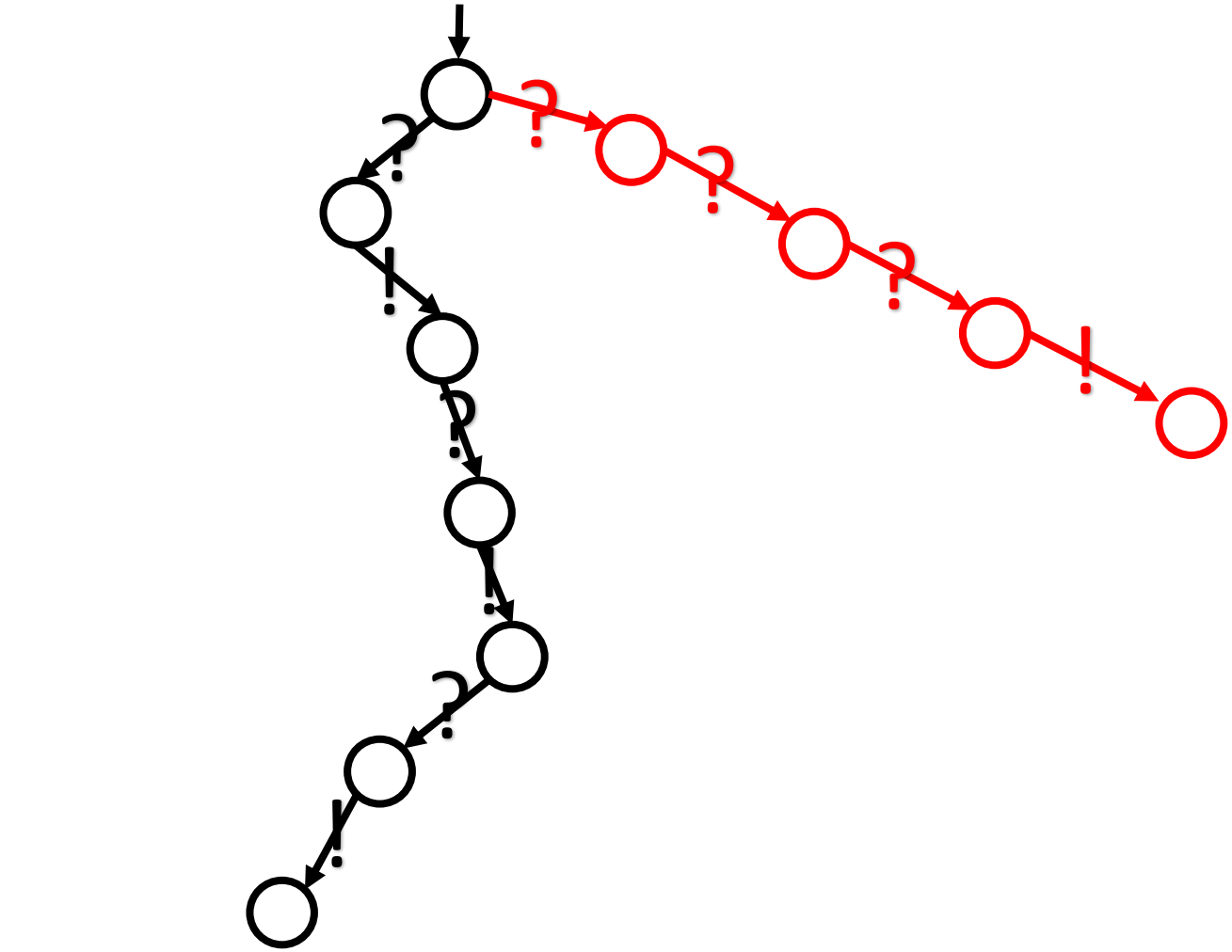
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches



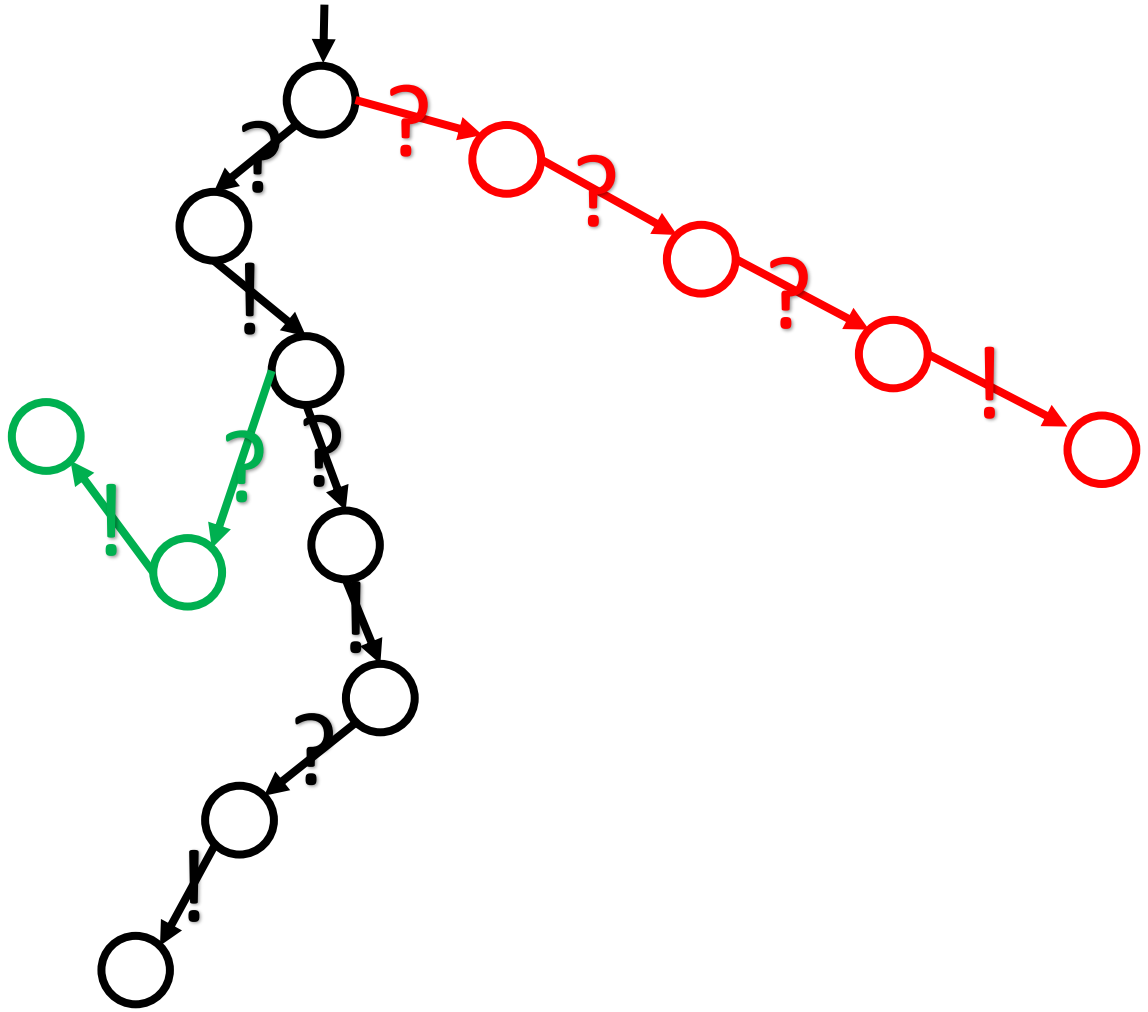
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches



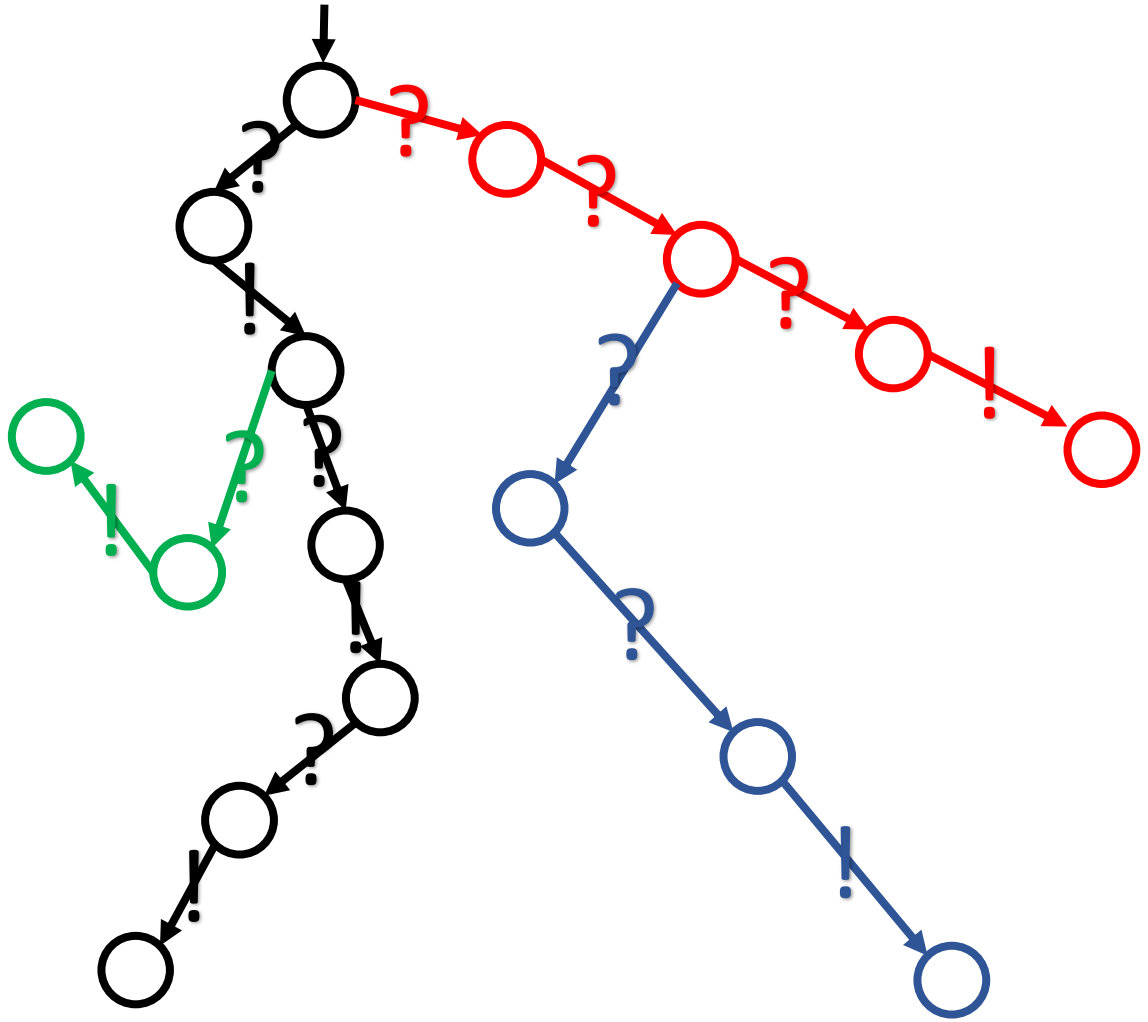
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches



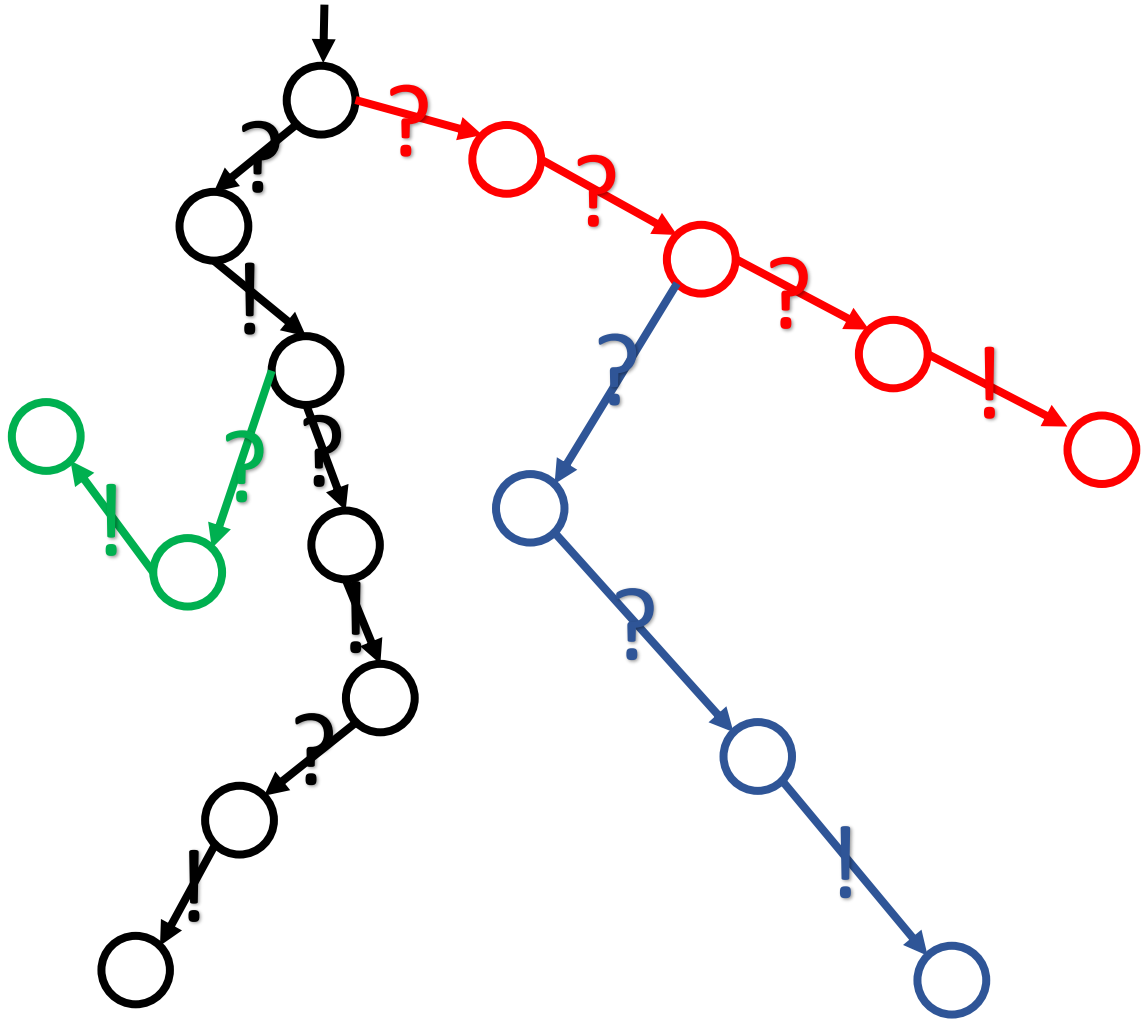
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches



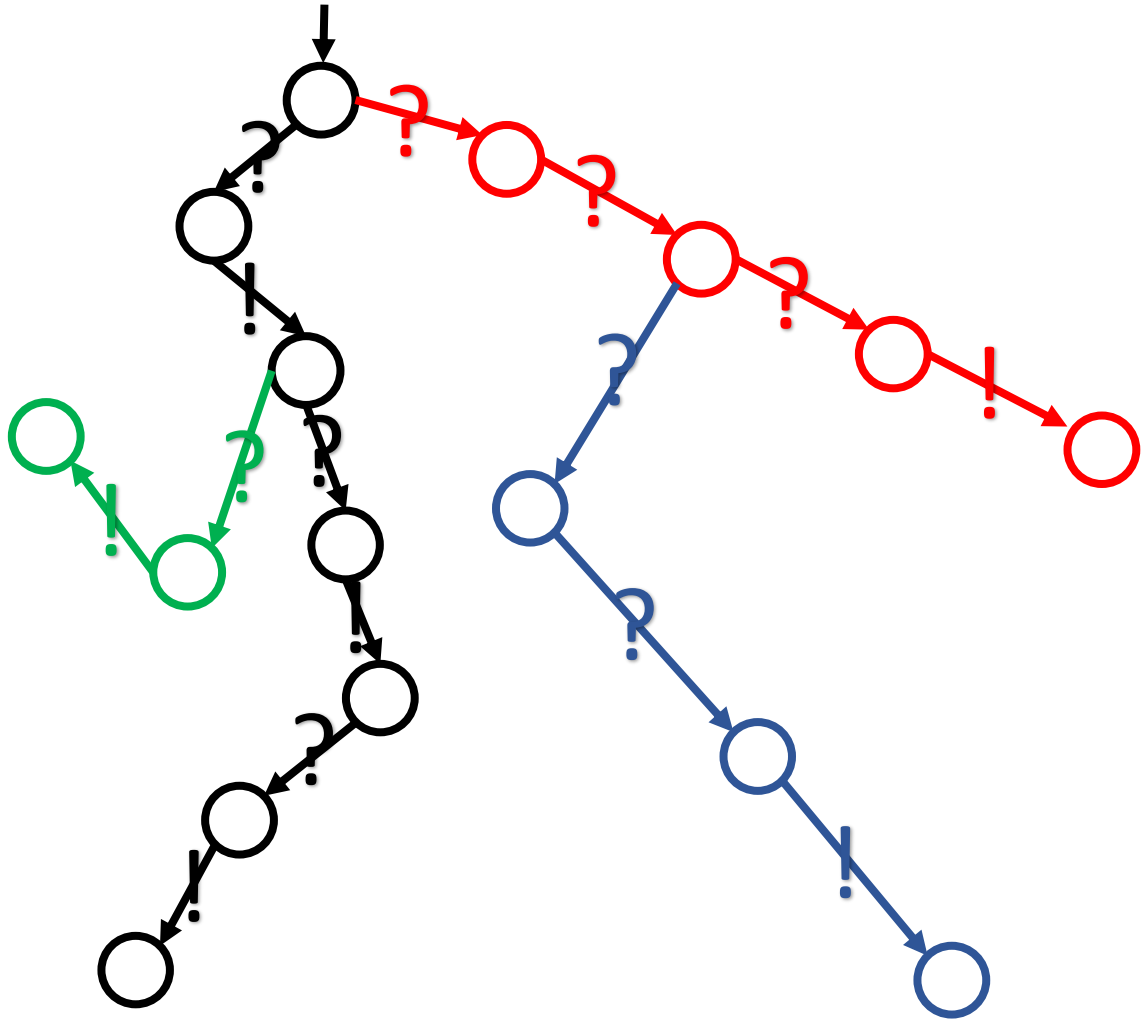
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel



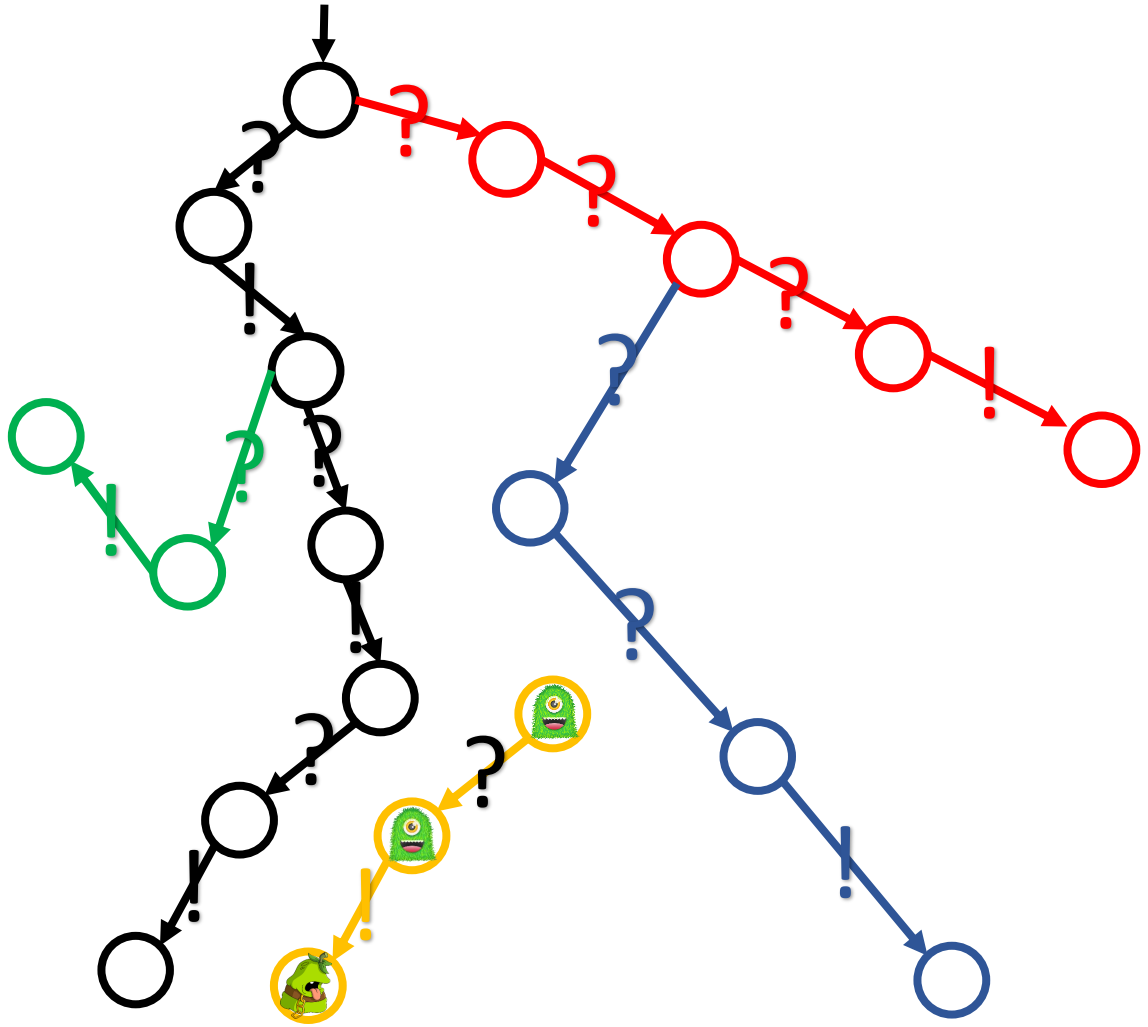
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel



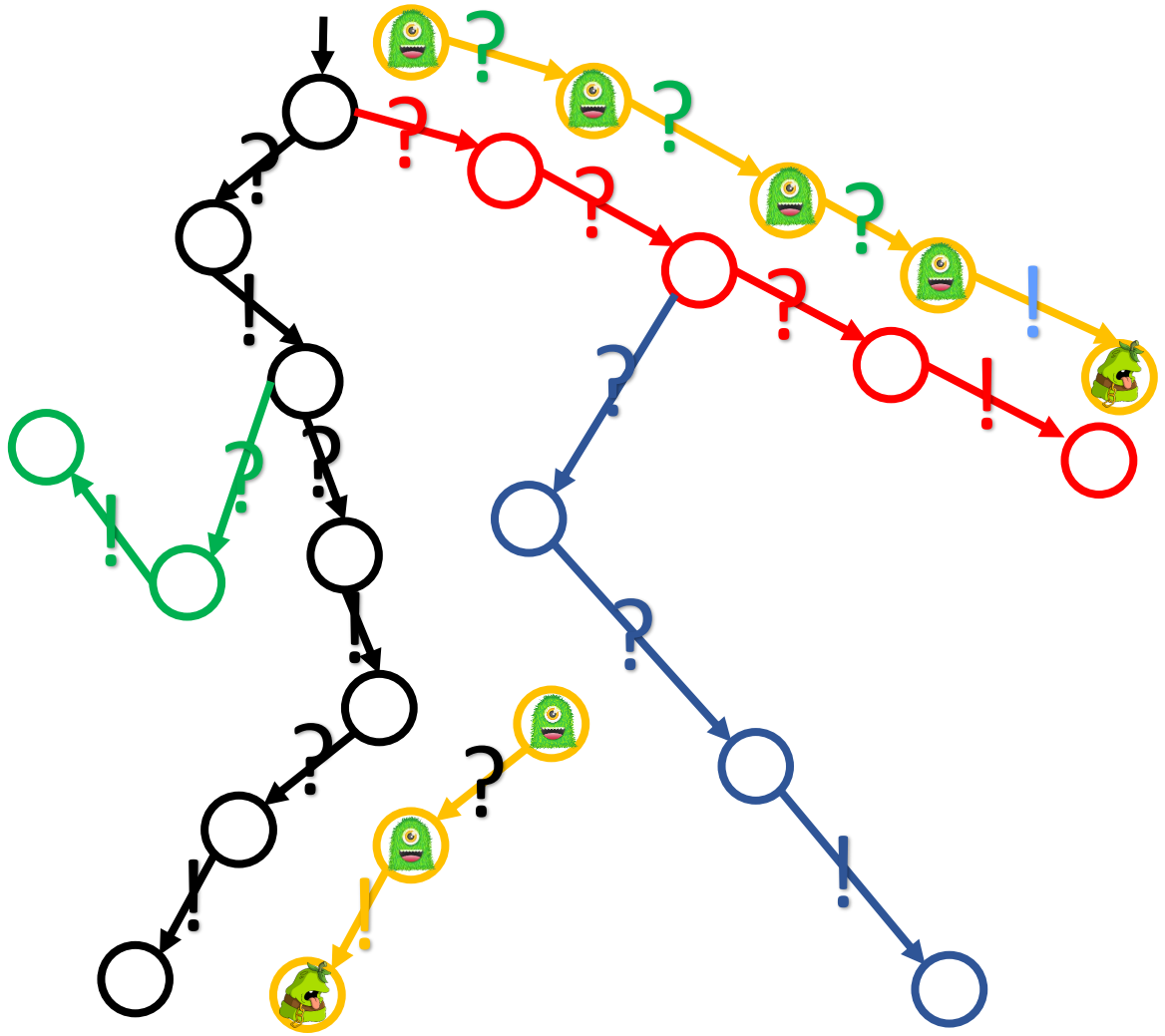
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel



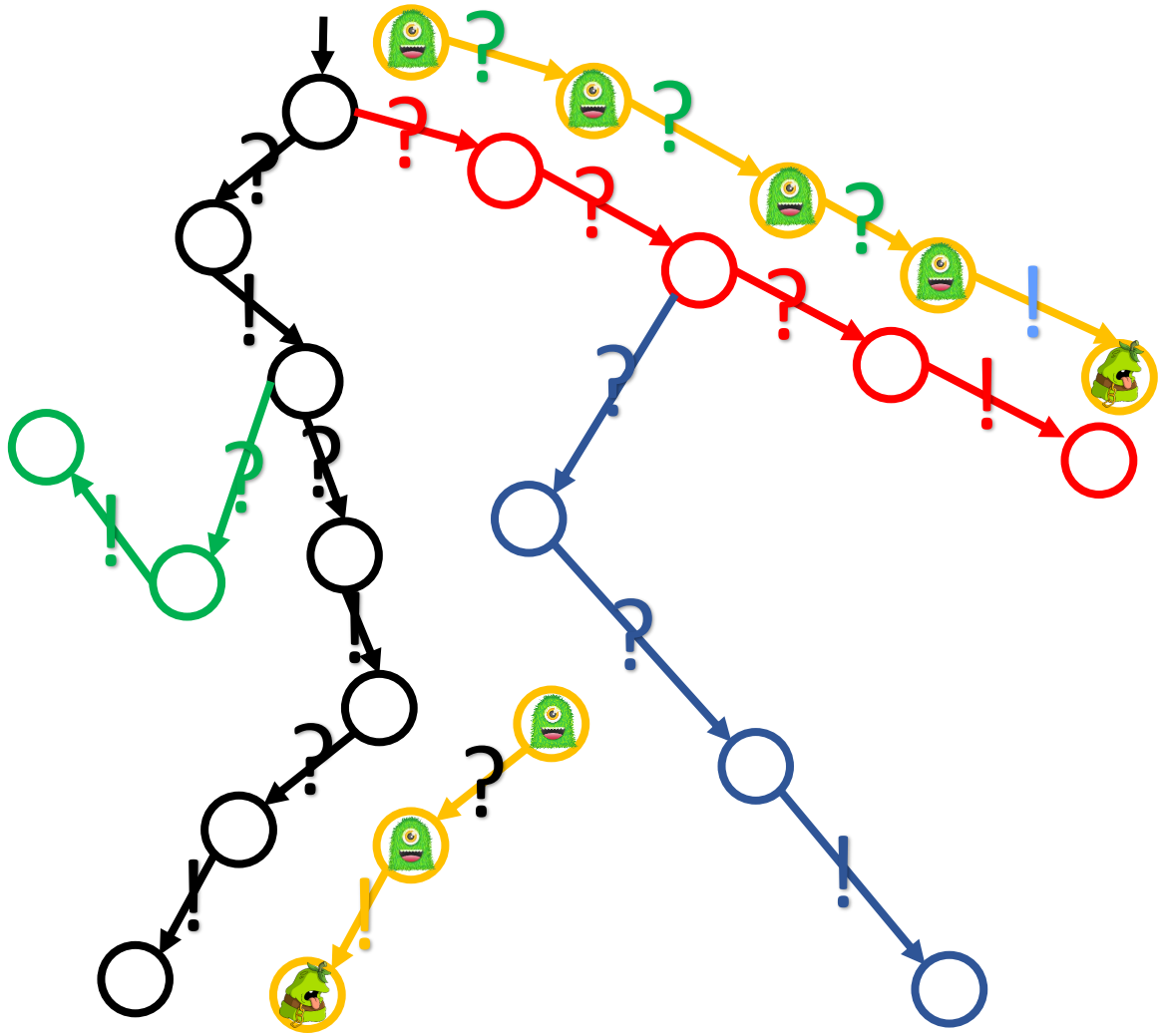
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel



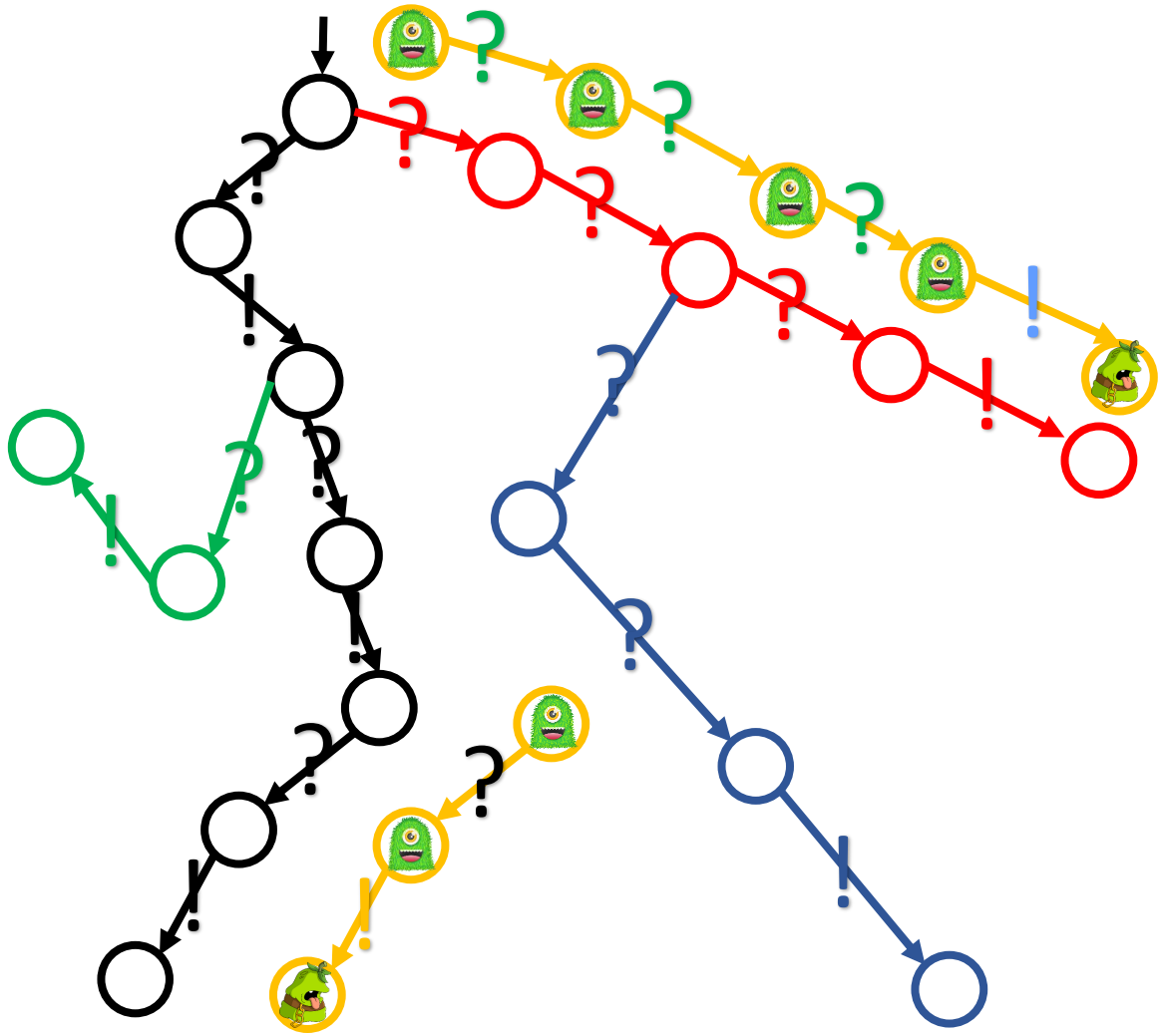
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts



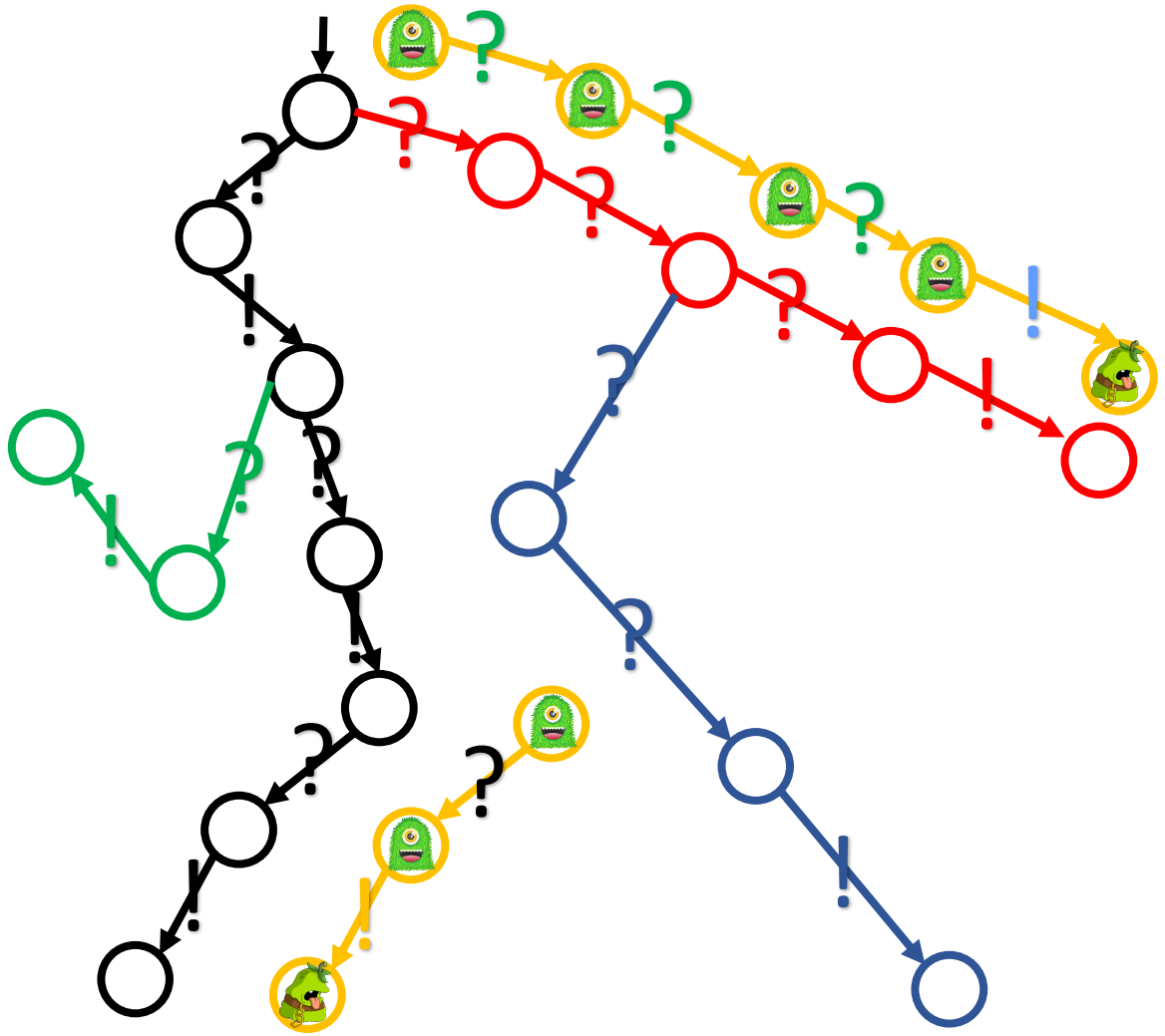
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts
- Set of heuristics guiding branching search



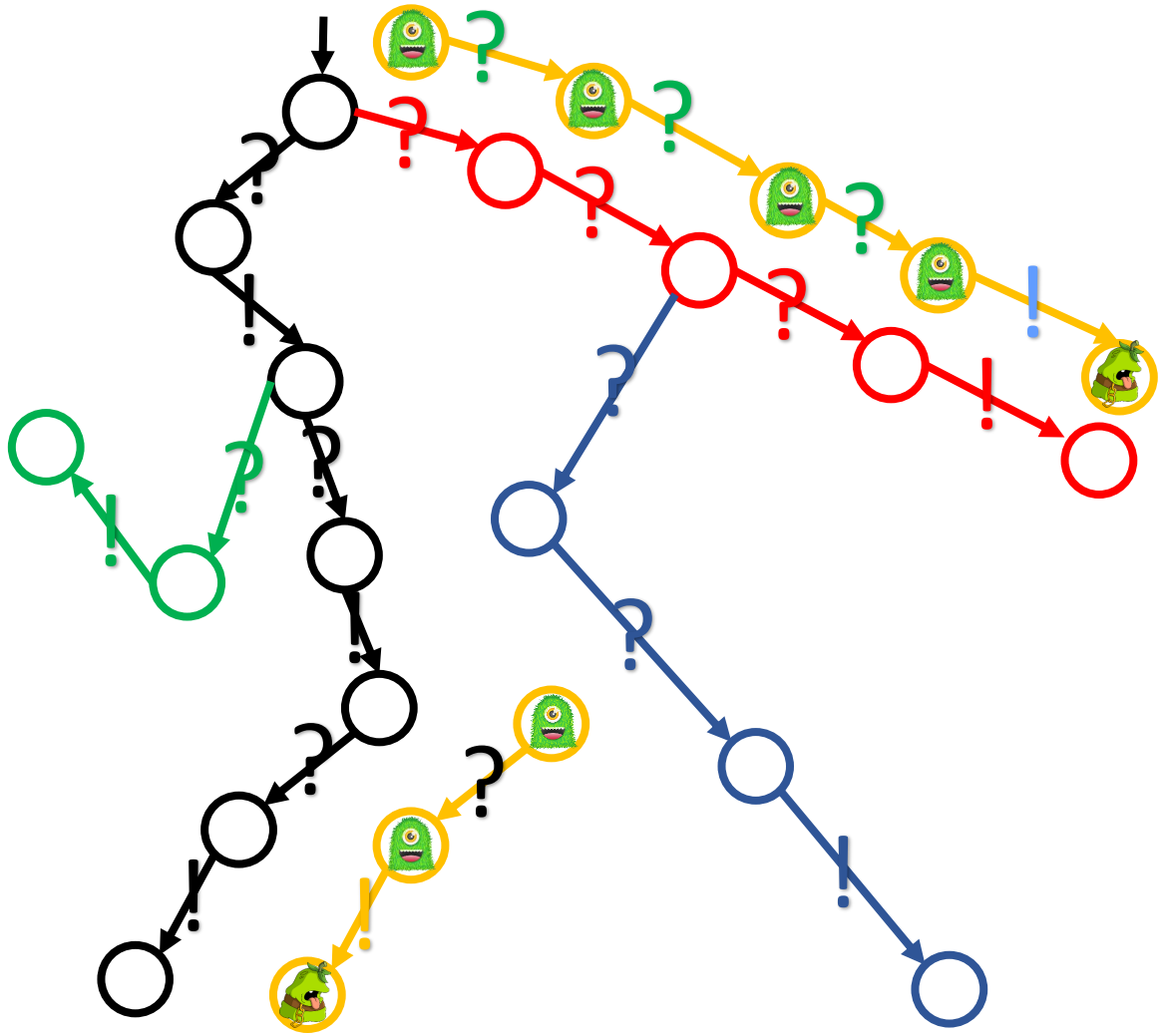
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts
- Set of heuristics guiding branching search
  - Where to start new branches
  - How to expand branches



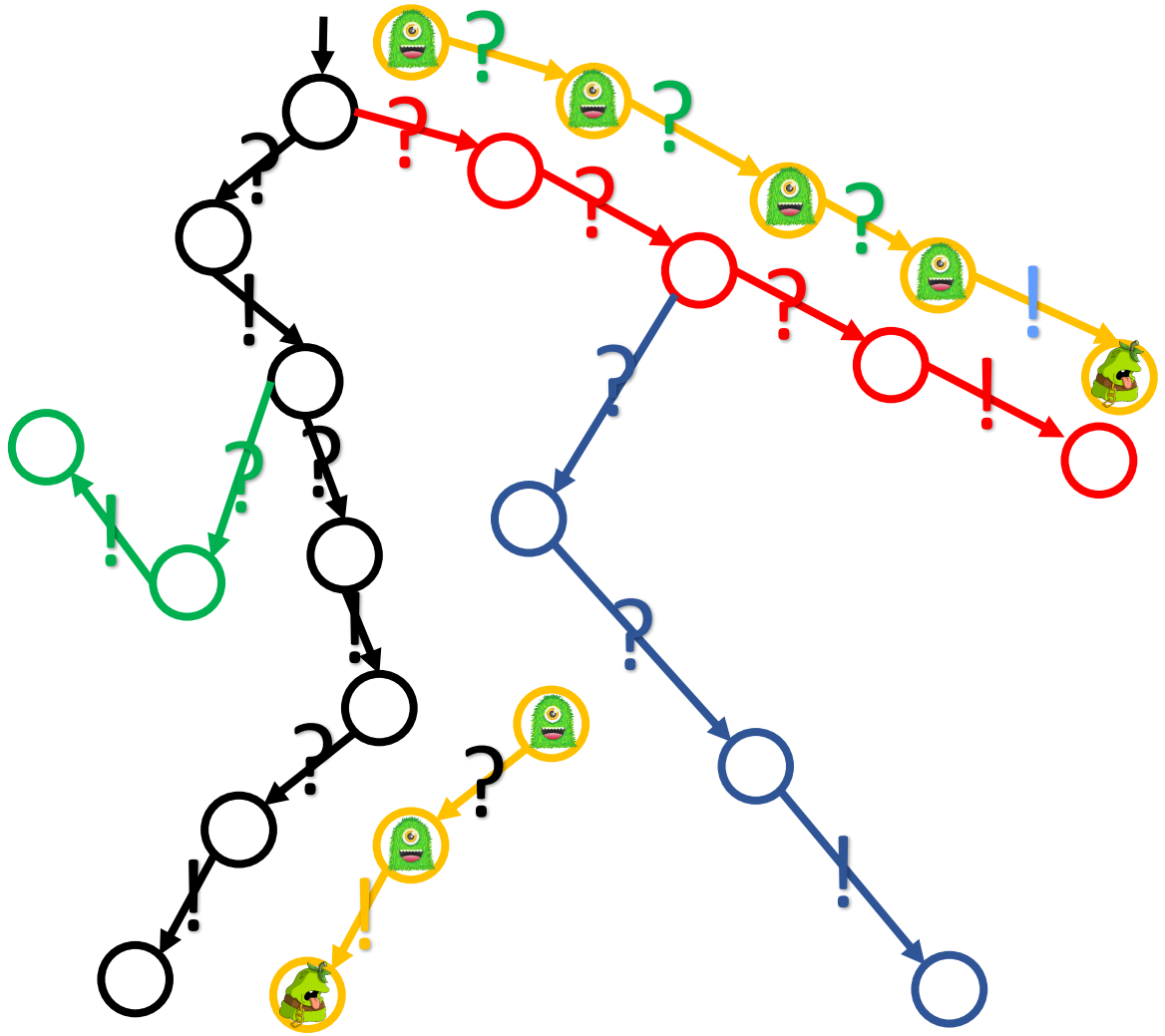
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts
- Set of heuristics guiding branching search
  - Where to start new branches
  - How to expand branches
- Construct test cases from exploration graph



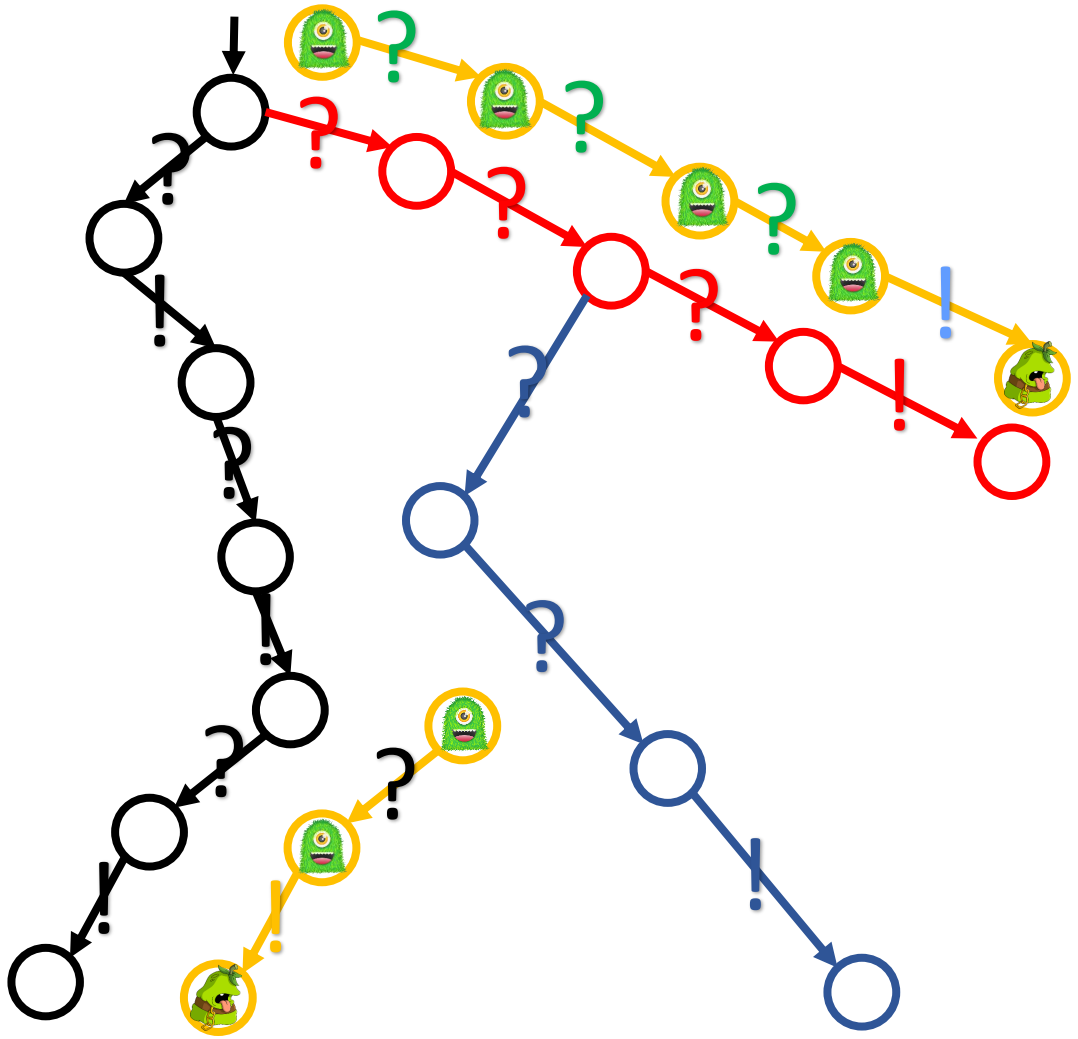
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts
- Set of heuristics guiding branching search
  - Where to start new branches
  - How to expand branches
- Construct test cases from exploration graph
  - Prune irrelevant exploration steps



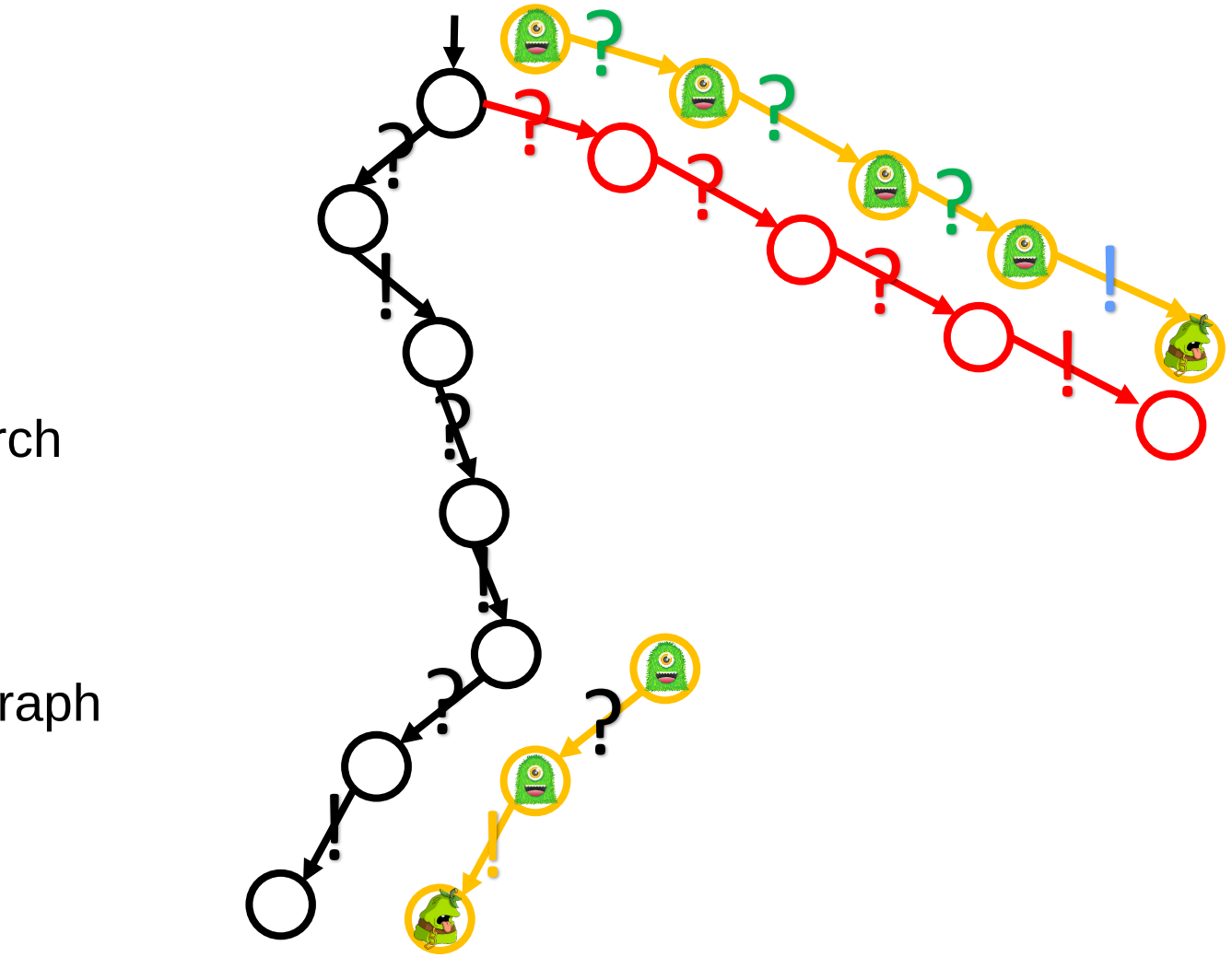
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts
- Set of heuristics guiding branching search
  - Where to start new branches
  - How to expand branches
- Construct test cases from exploration graph
  - Prune irrelevant exploration steps



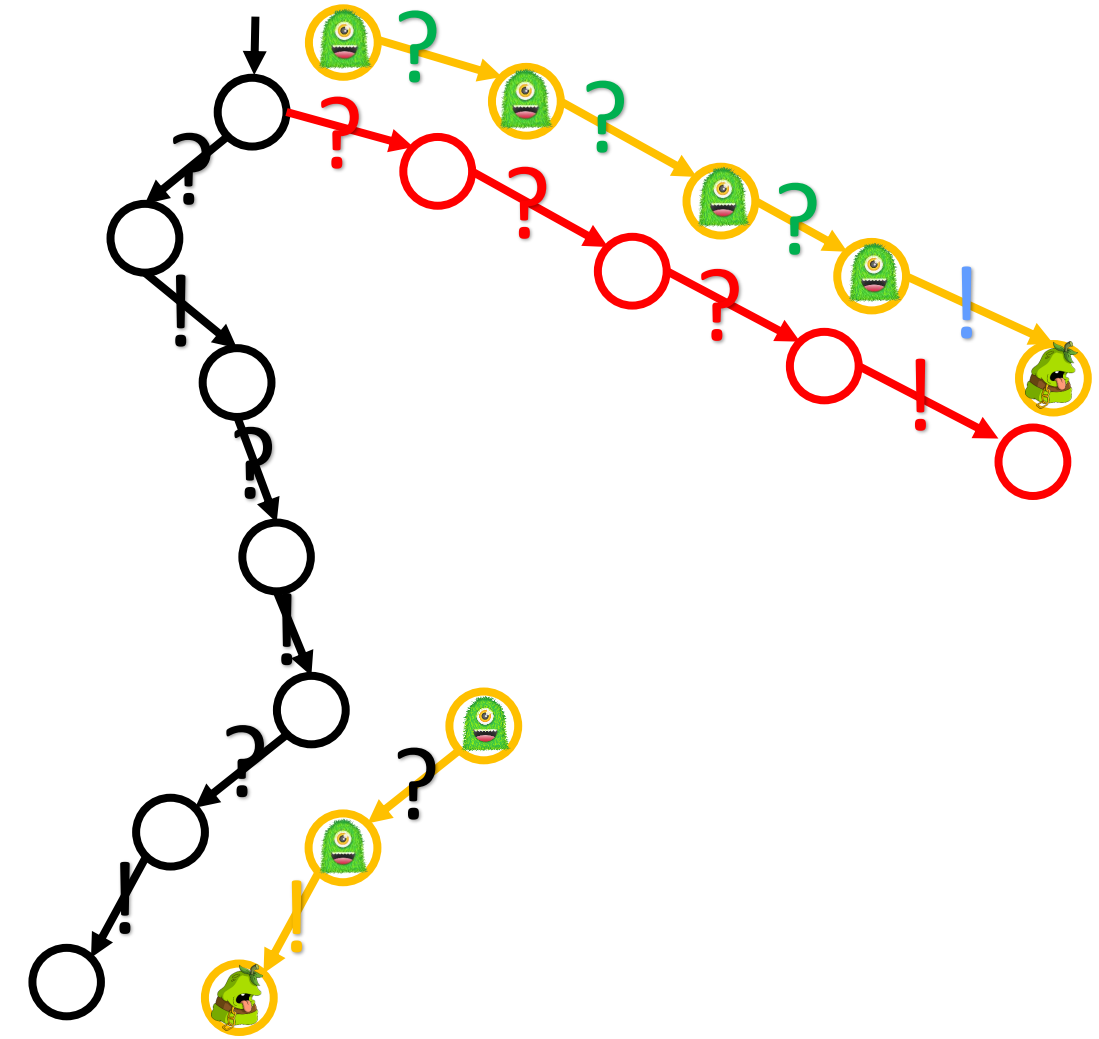
BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts
- Set of heuristics guiding branching search
  - Where to start new branches
  - How to expand branches
- Construct test cases from exploration graph
  - Prune irrelevant exploration steps



BRANCHING SEARCH AND MUTATION KILLING

- Explore model in branches
  - Each branch is explored in parallel
- Explore mutated models in parallel
  - Only explore relevant parts
- Set of heuristics guiding branching search
  - Where to start new branches
  - How to expand branches
- Construct test cases from exploration graph
  - Prune irrelevant exploration steps
  - Map test cases to mutant kills



SUMMARY

- Model based testing
  - Test high level behavior based on abstract description of the system
- Mutation testing
  - Connect tests to faults
  - Prune irrelevant test steps

- Demanding models from industrial context, thus emphasis on scalability

- Branching Search
  - Fully leverage parallelism
  - Flexibility through set of heuristics
  - Shorter and more effective tests

FUTURE WORK

- Distance metric based on mutant constraints
- Designated strong killing algorithm
- Semi symbolic methods
  - Dynamic symbolic execution
- Unfoldings, Partial Orders & Petri Nets
- Static analysis
  - Better estimation of state space
  - Eliminate equivalent mutants