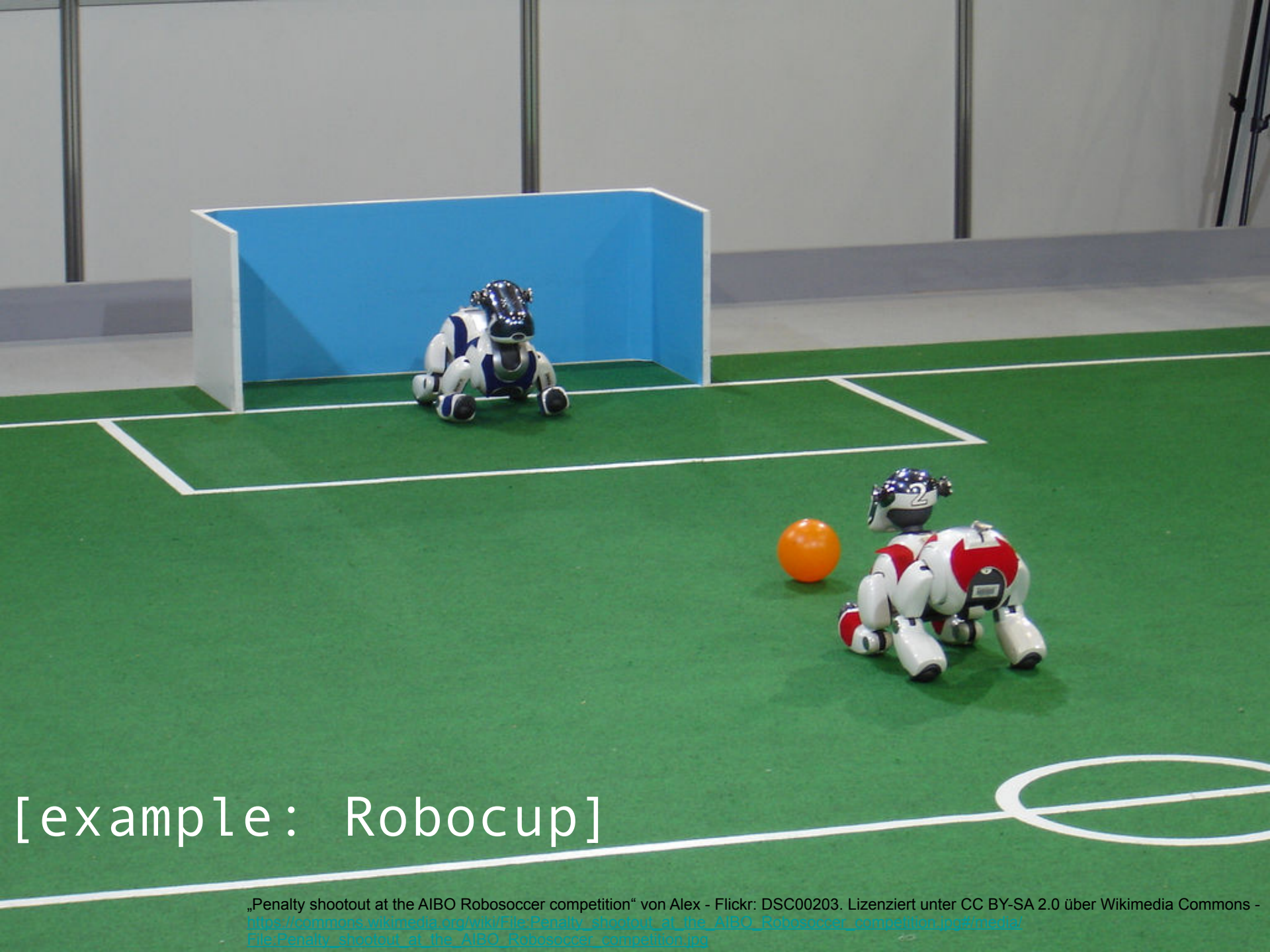
Anthony Anjorin

MODELLING REACTIVE / EVENT-DRIVEN SYSTEMS WITH STATE MACHINES



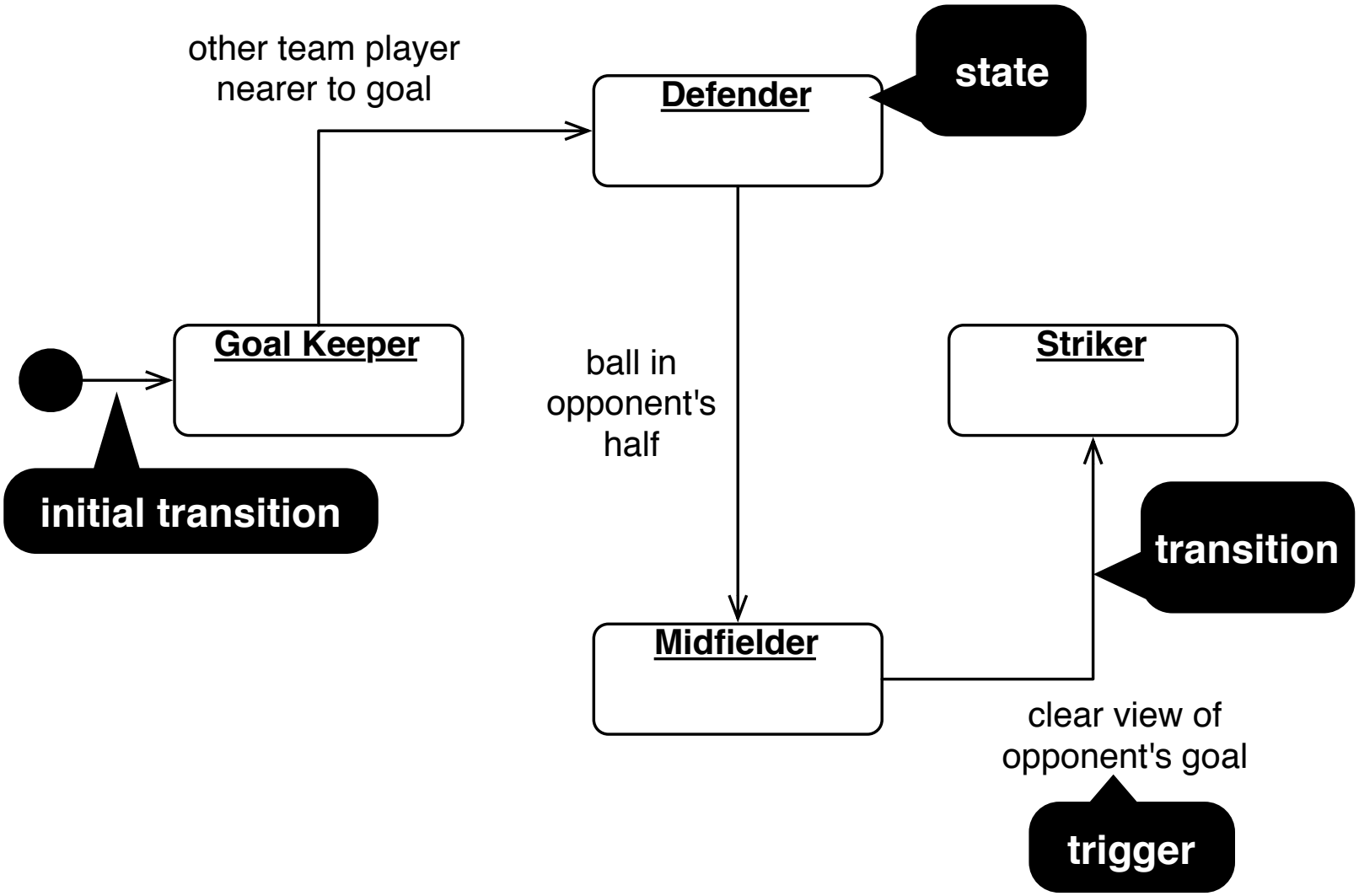
Reactive / Event-Driven System

current role (or “state”)

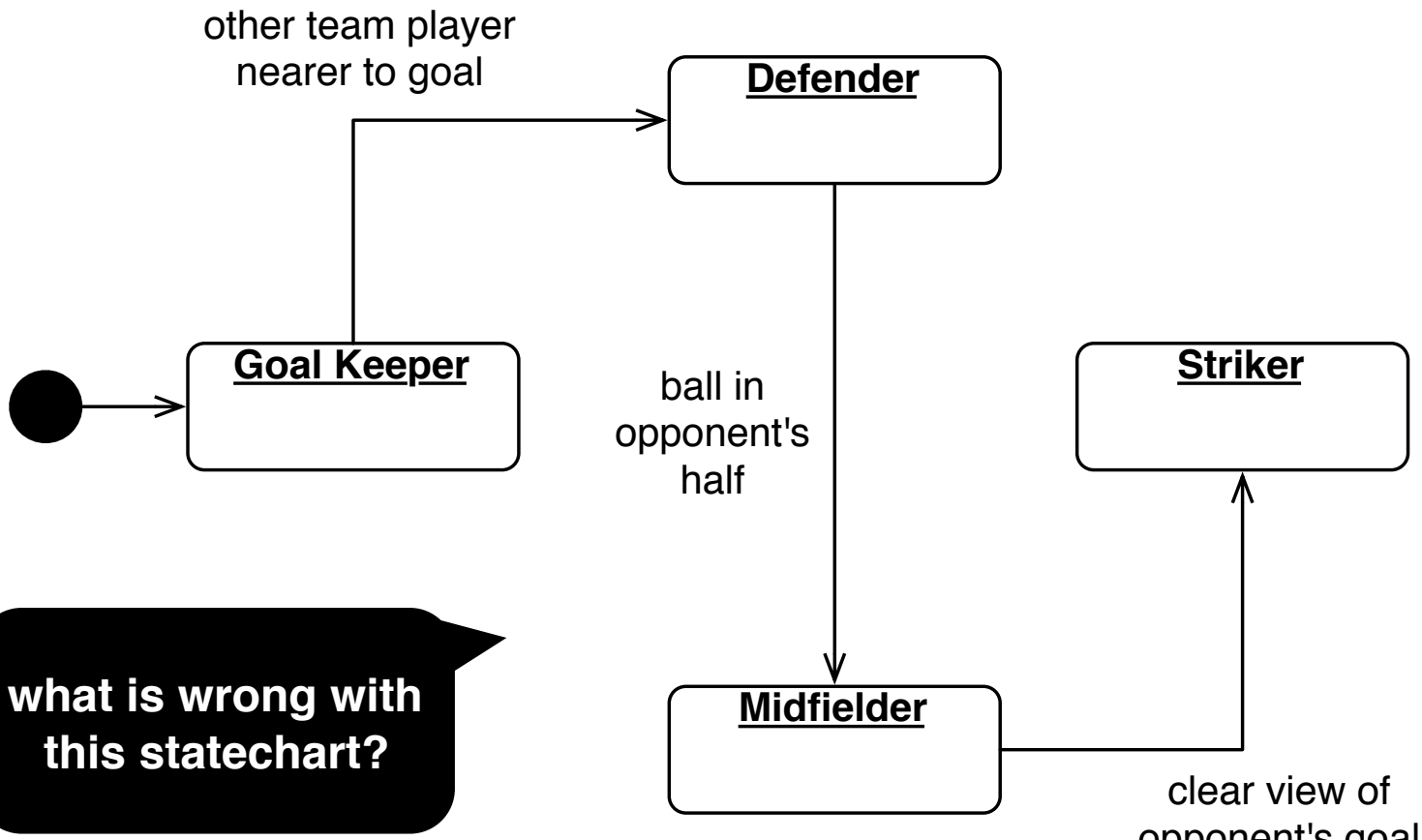
event	Goal Keeper	Defender	Striker	…
got the ball	clear with a long shot	pass	dribble	
lost the ball	intercept shot	chase	wait for pass	
clear view of opponents goal	…	…	score!	
ball in opponents half	…	…	chase	
…	…		…	

how can this be implemented?

UML Statecharts



Hierarchical States



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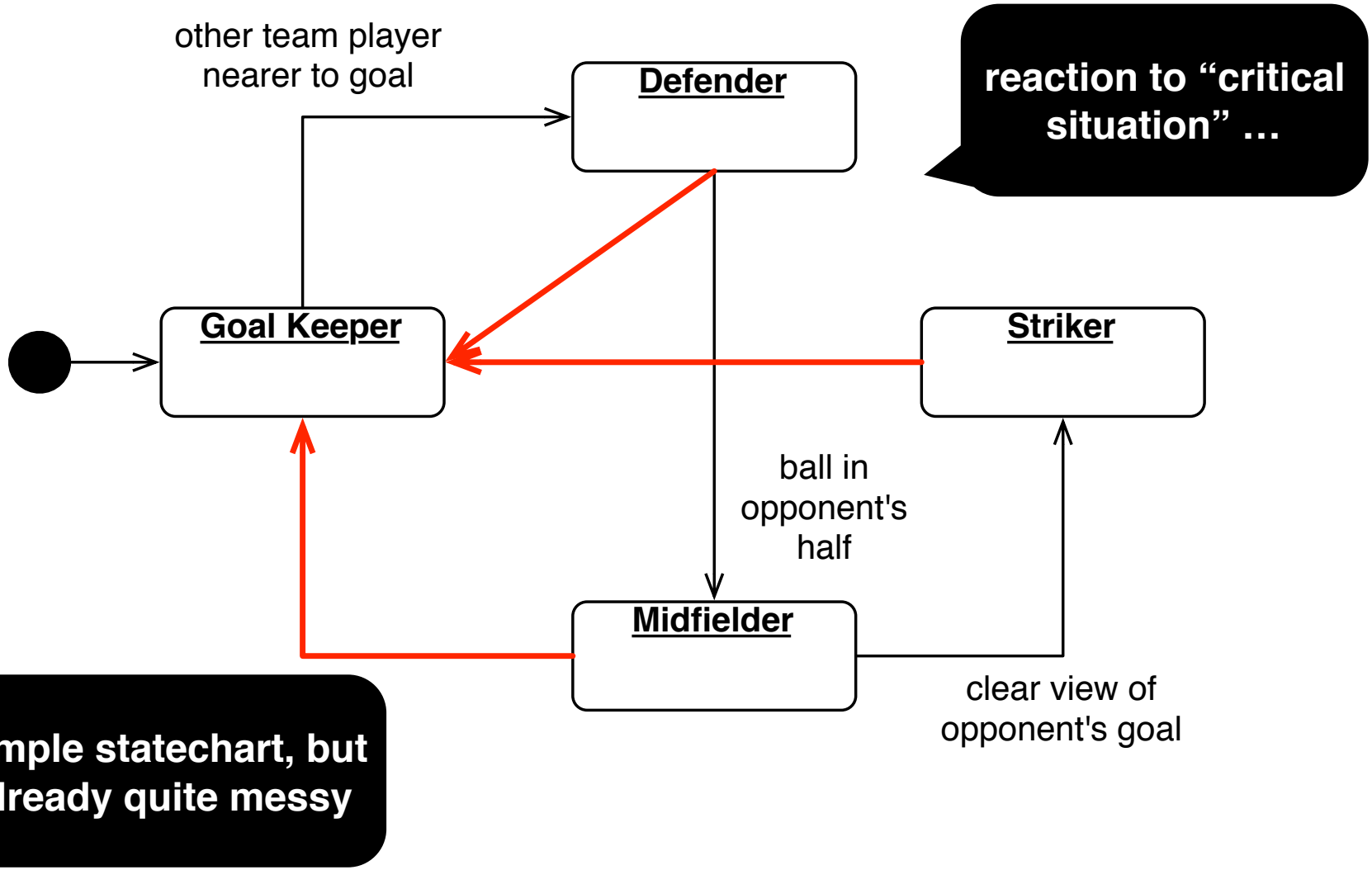

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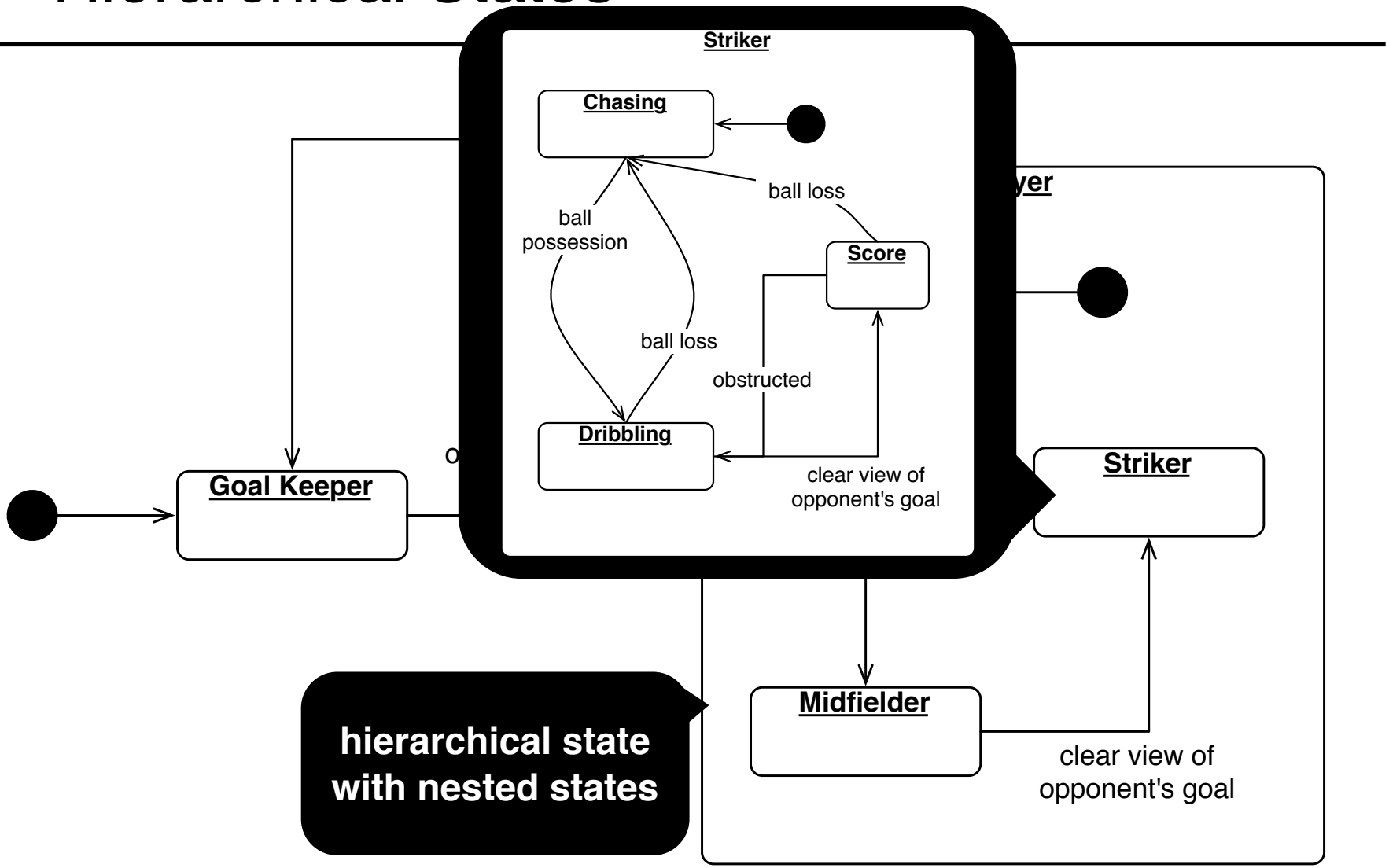
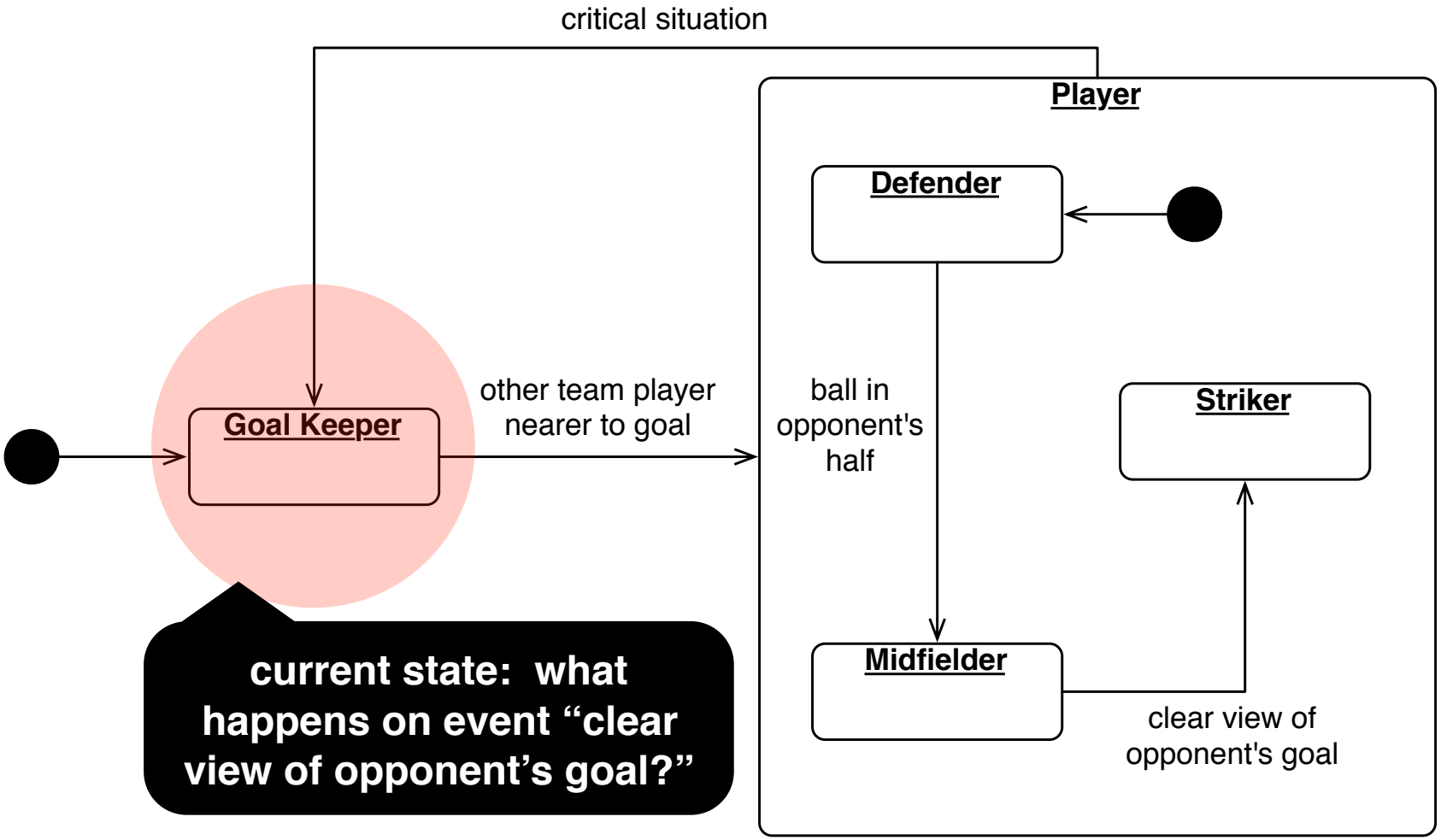


SEMANTICS

“Missing” Transitions?



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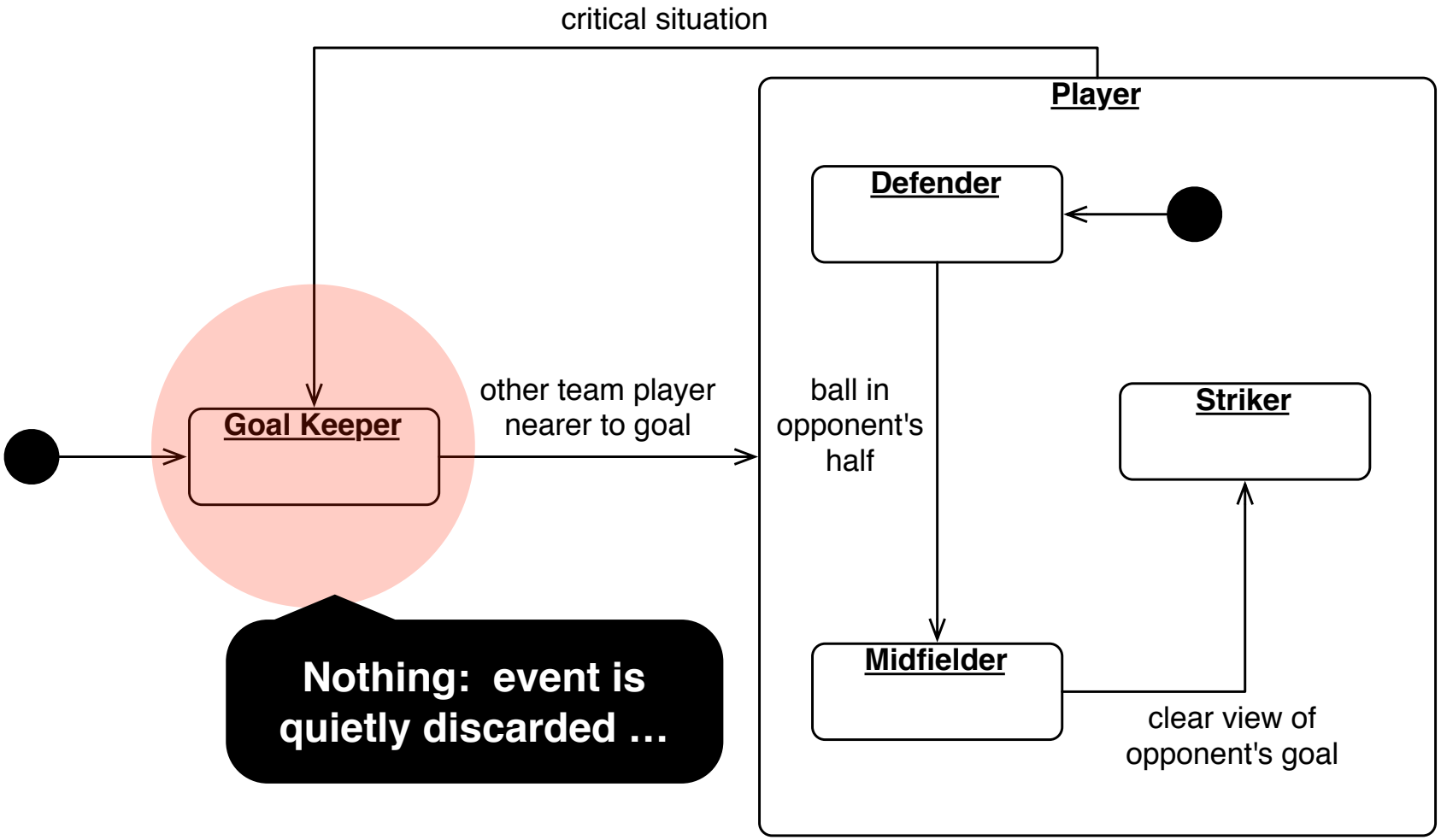

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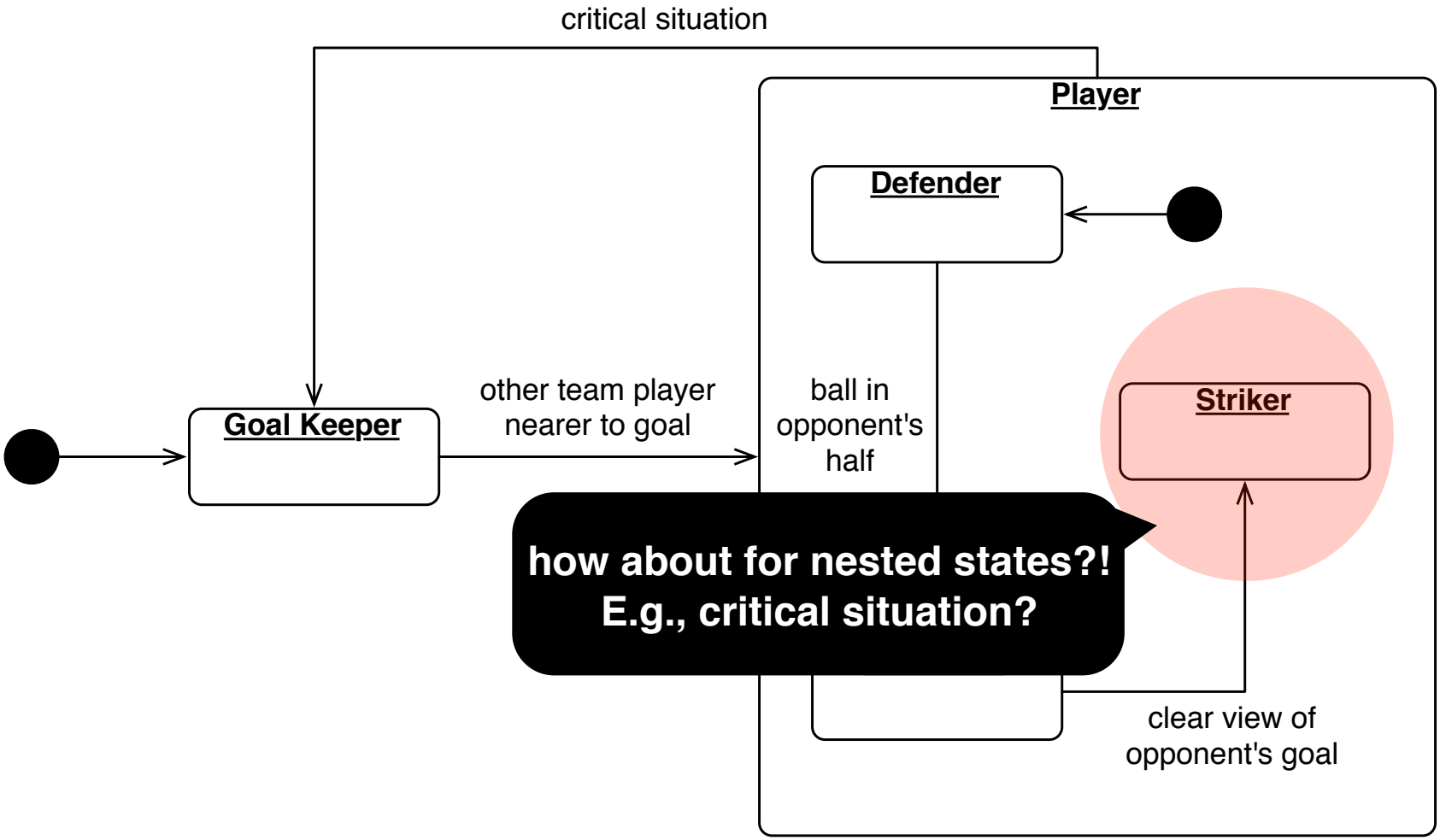

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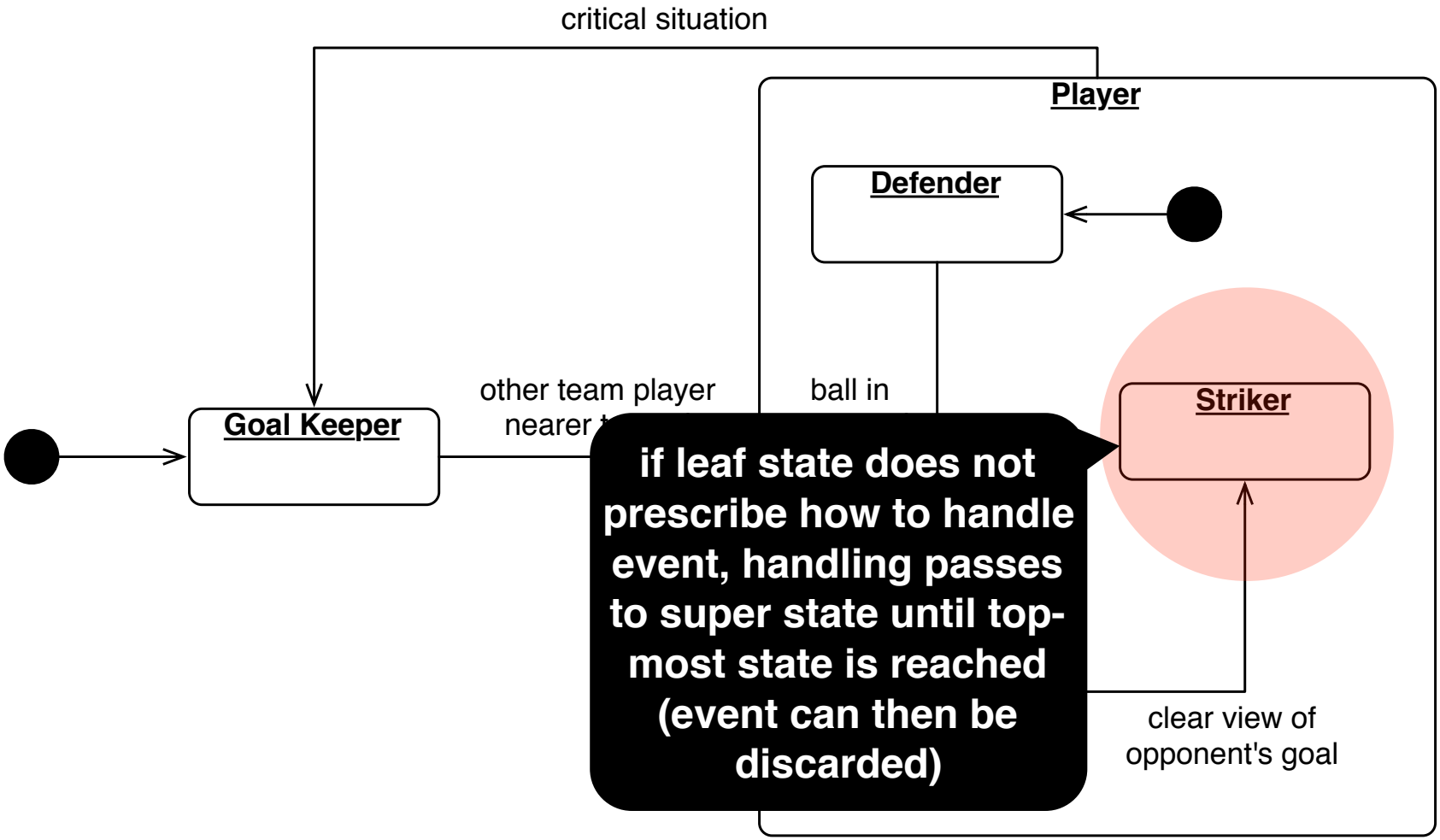

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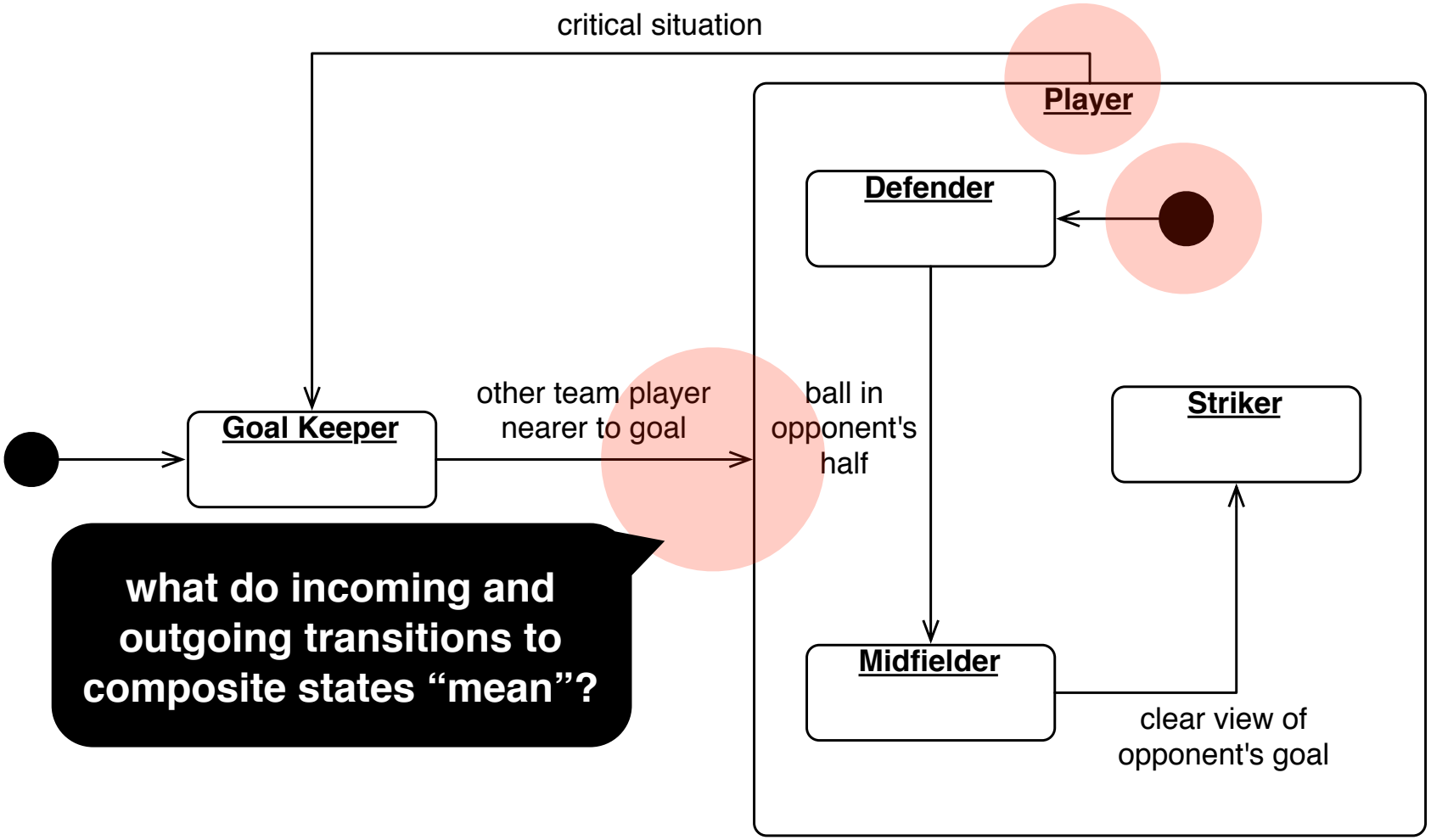

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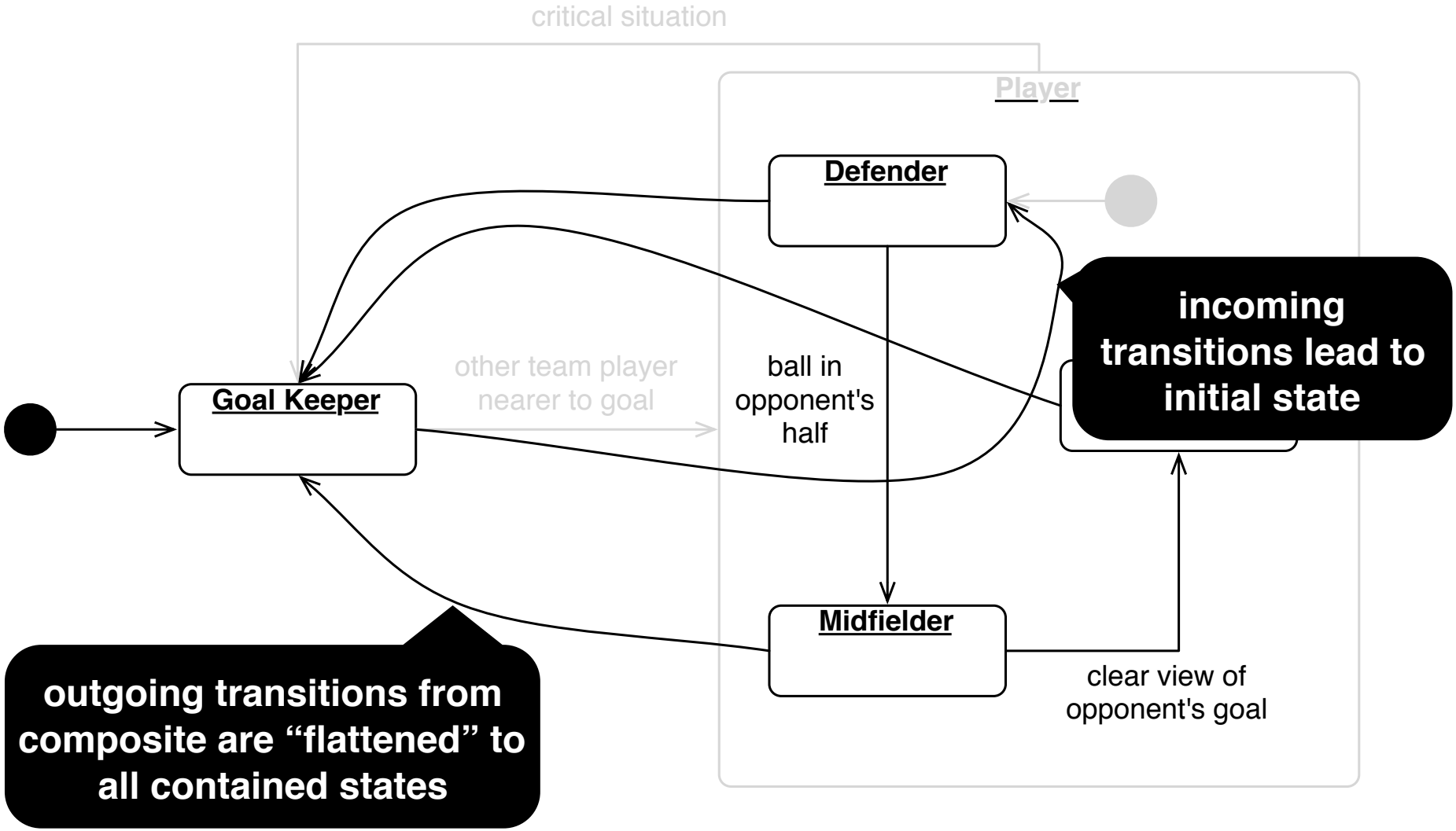

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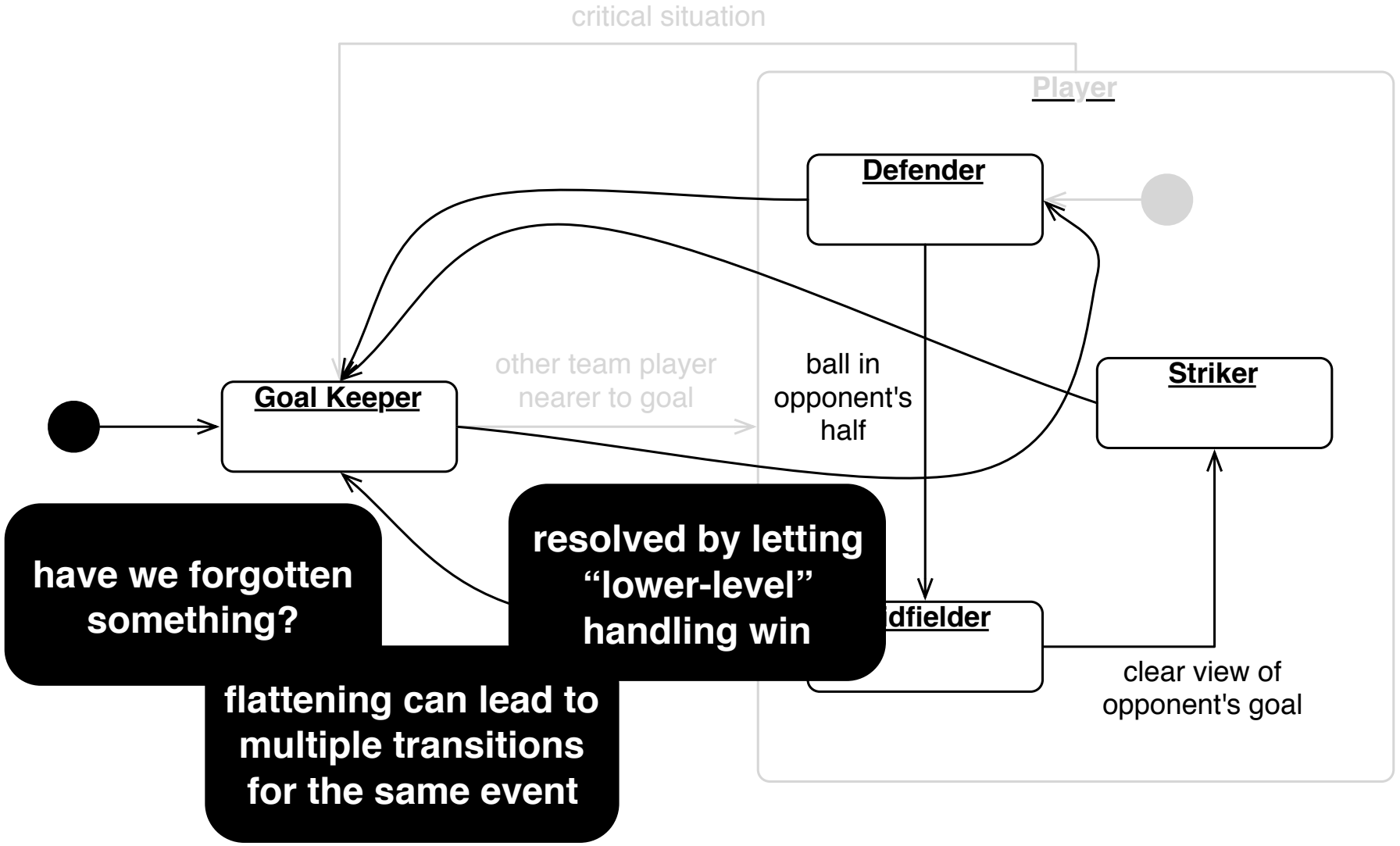
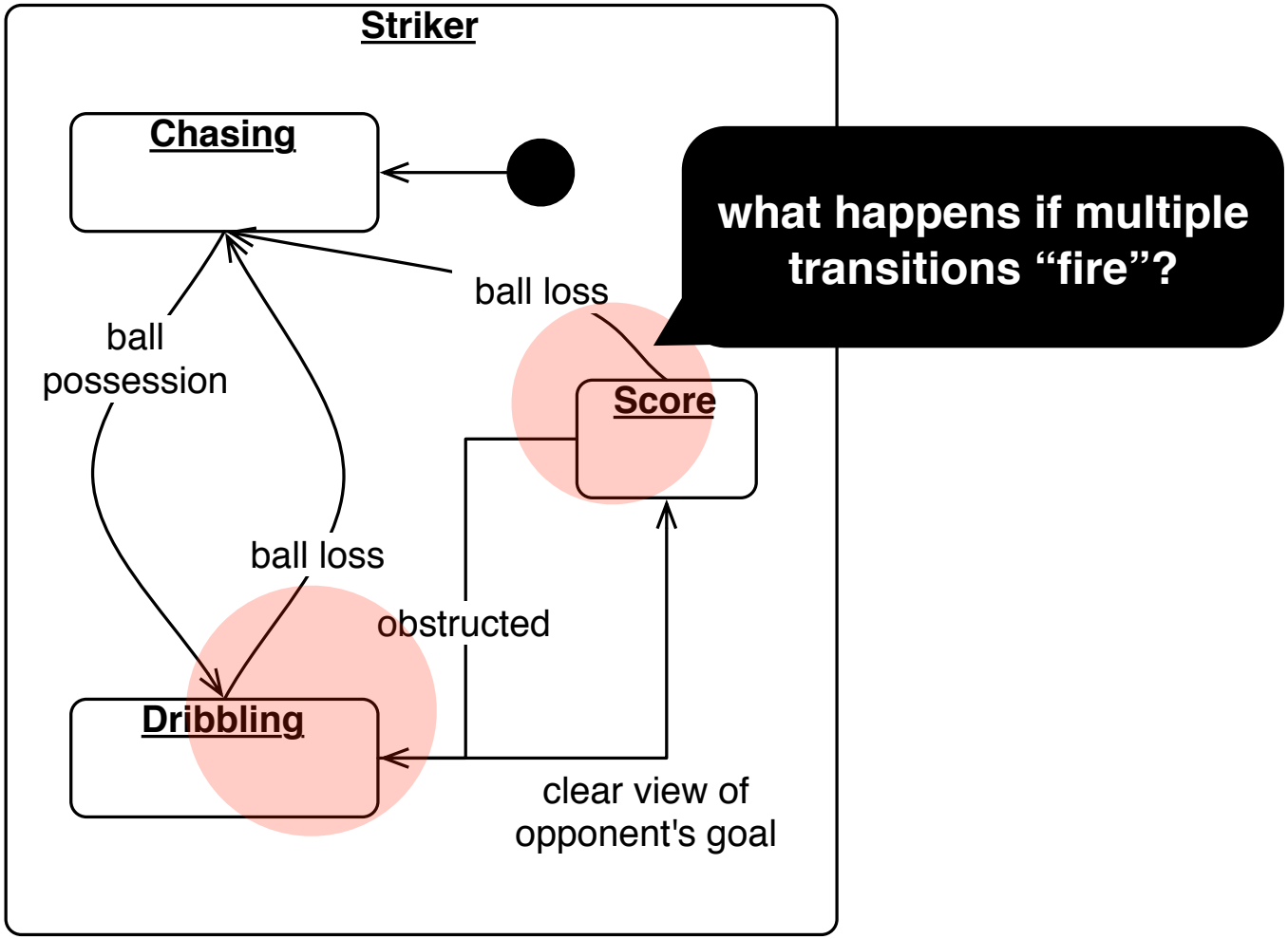
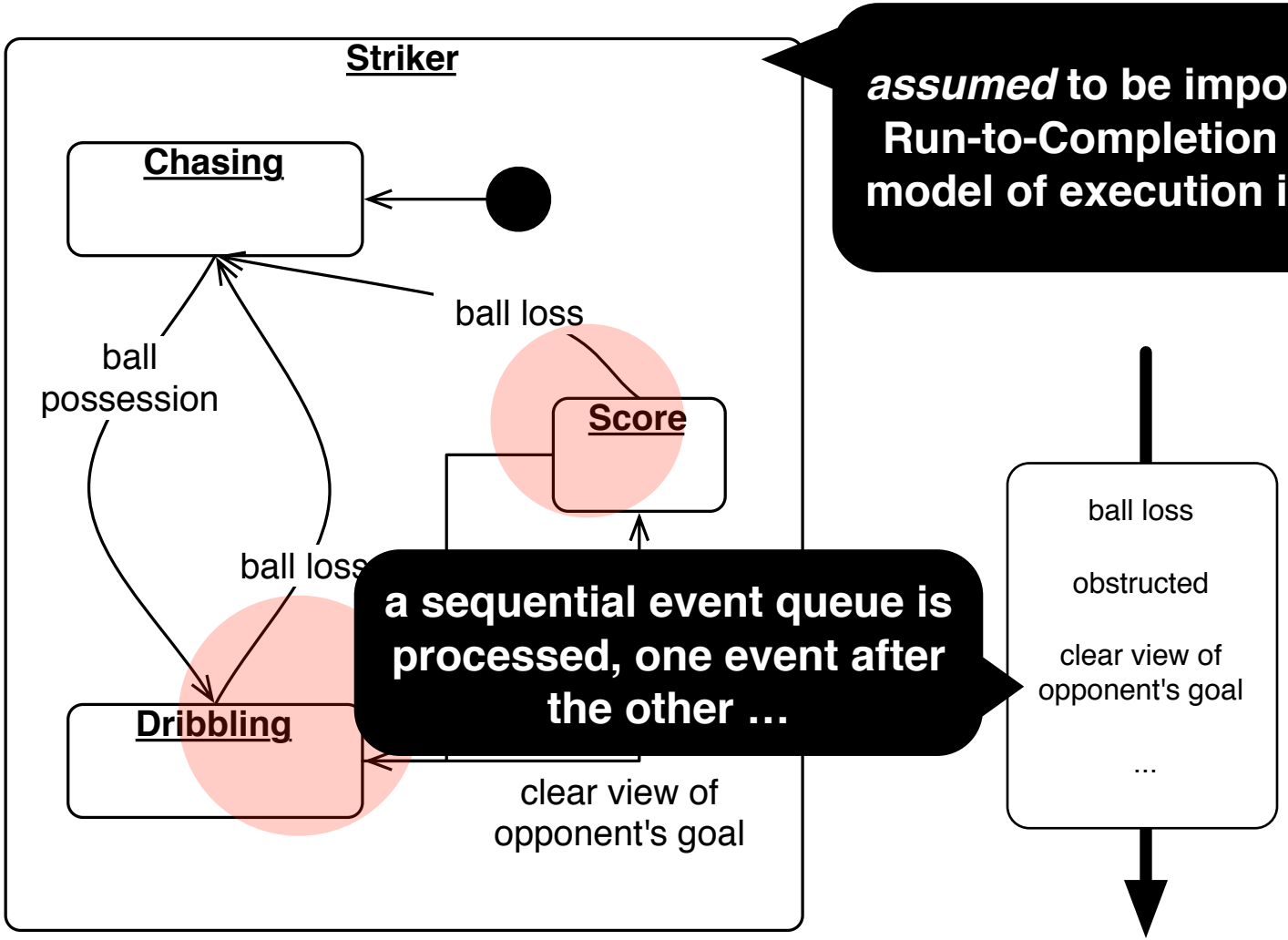


Multiple Events?



Multiple Events?



Other Language Features

- Actions on transitions: TRIGGER / ACTION
- Actions on entry or exit of states

- Usage of variables (extended states)
- Guards on transitions: TRIGGER [GUARD] / ACTION
- Simple control flow (branching on variable values)

- Orthogonal regions (and vs. or decomposition)
- Internal vs. external vs. local transitions

- Networks of communicating state machines
- …

non-trivial (perhaps even unclear) semantics in some cases, can easily lead to “spaghetti code”!

APPLICATIONS OF STATE MACHINES

Modelling, Programming and Verification

The Boost Statechart Library

nblumhardt / **stateless**

Rubygem state_machine

oxo42 / **stateless4j**

some libraries for using state machines directly in your favourite programming language

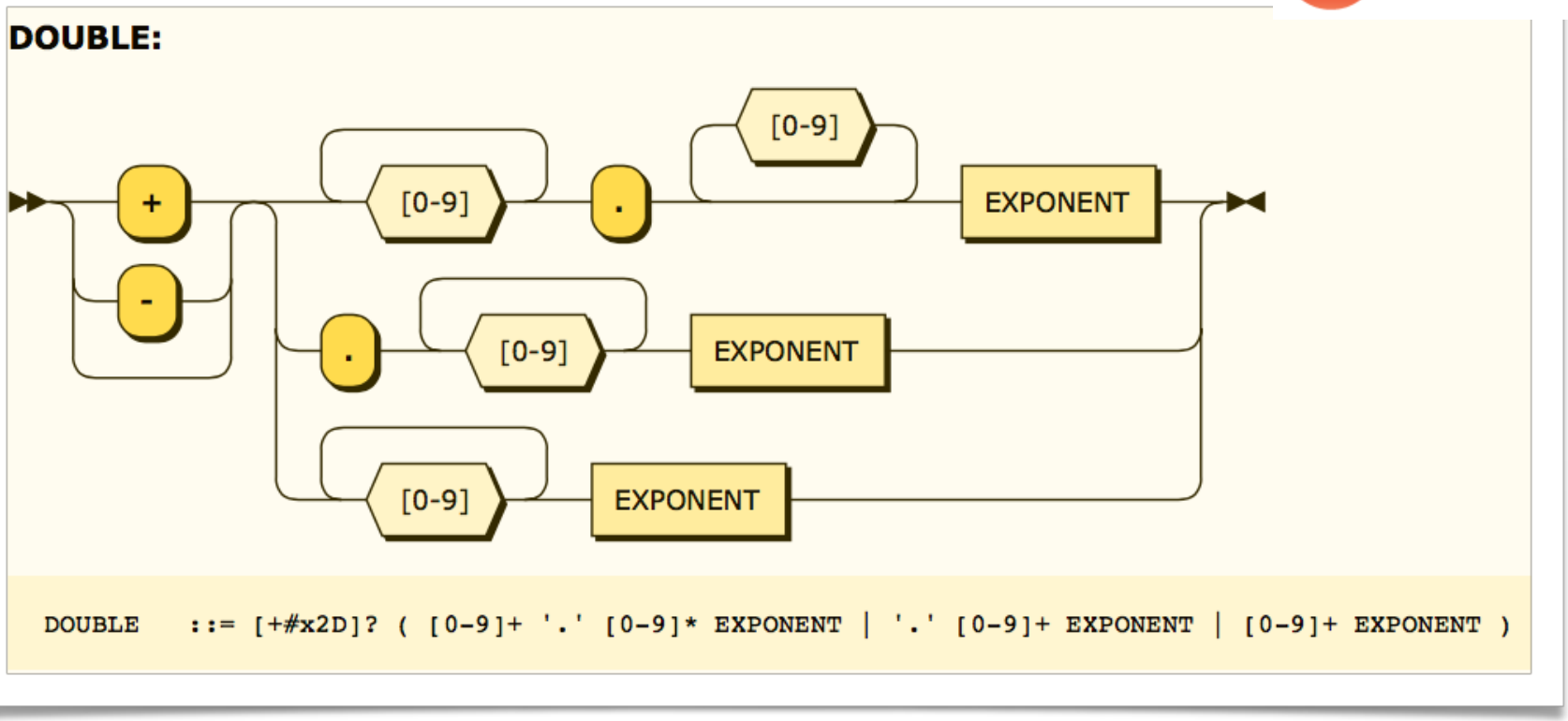
mbeddr

seamless extension of C with (amongst other things) verifiable state machines

UPPAAL

verification of real-time systems modelled as networks of timed automata

Language Recognition



Model-Based Testing

Are the test cases “good”?
Are they redundant?
Are they enough?
Are they up-to-date?

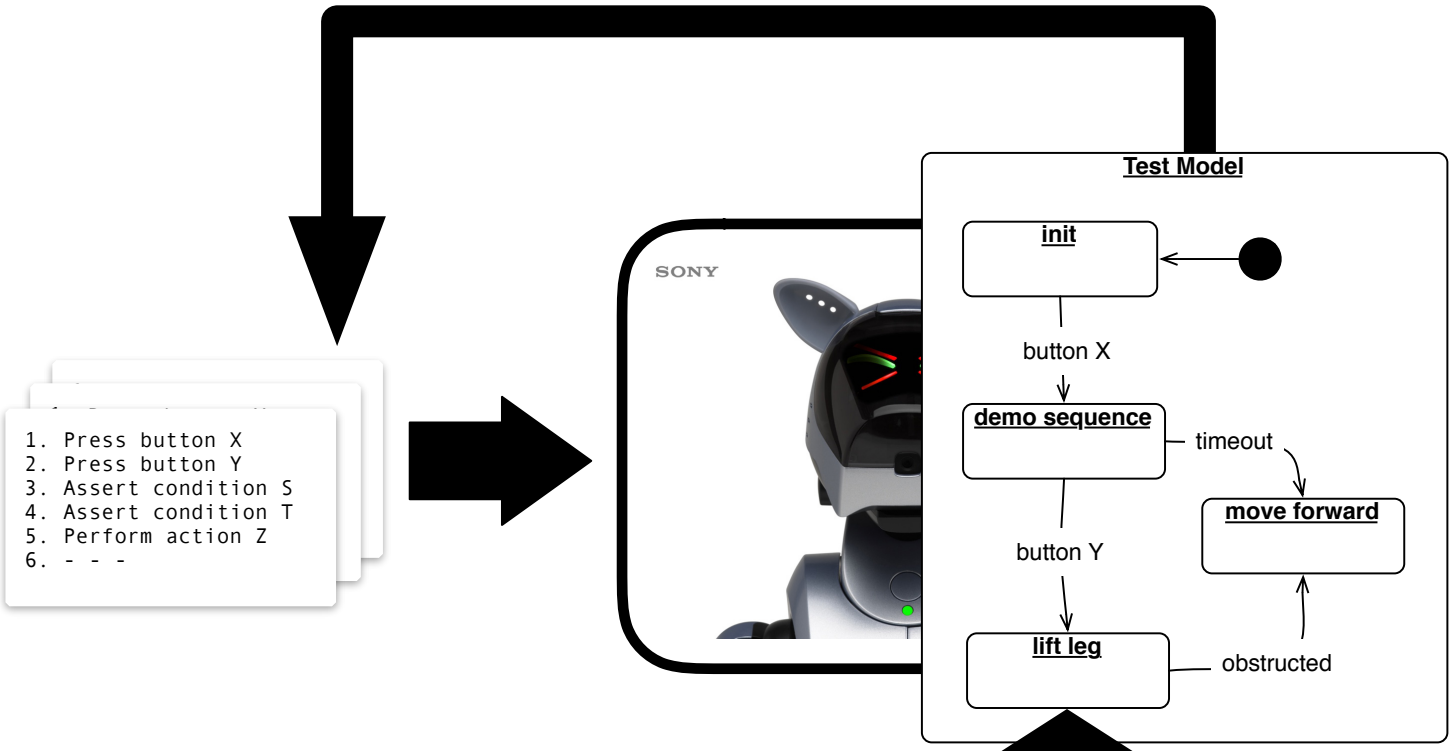
Test Cases for the SUT

```
1. Press button X
2. Press button Y
3. Assert condition S
4. Assert condition T
5. Perform action Z
6. - - -
```

System Under Test (SUT)

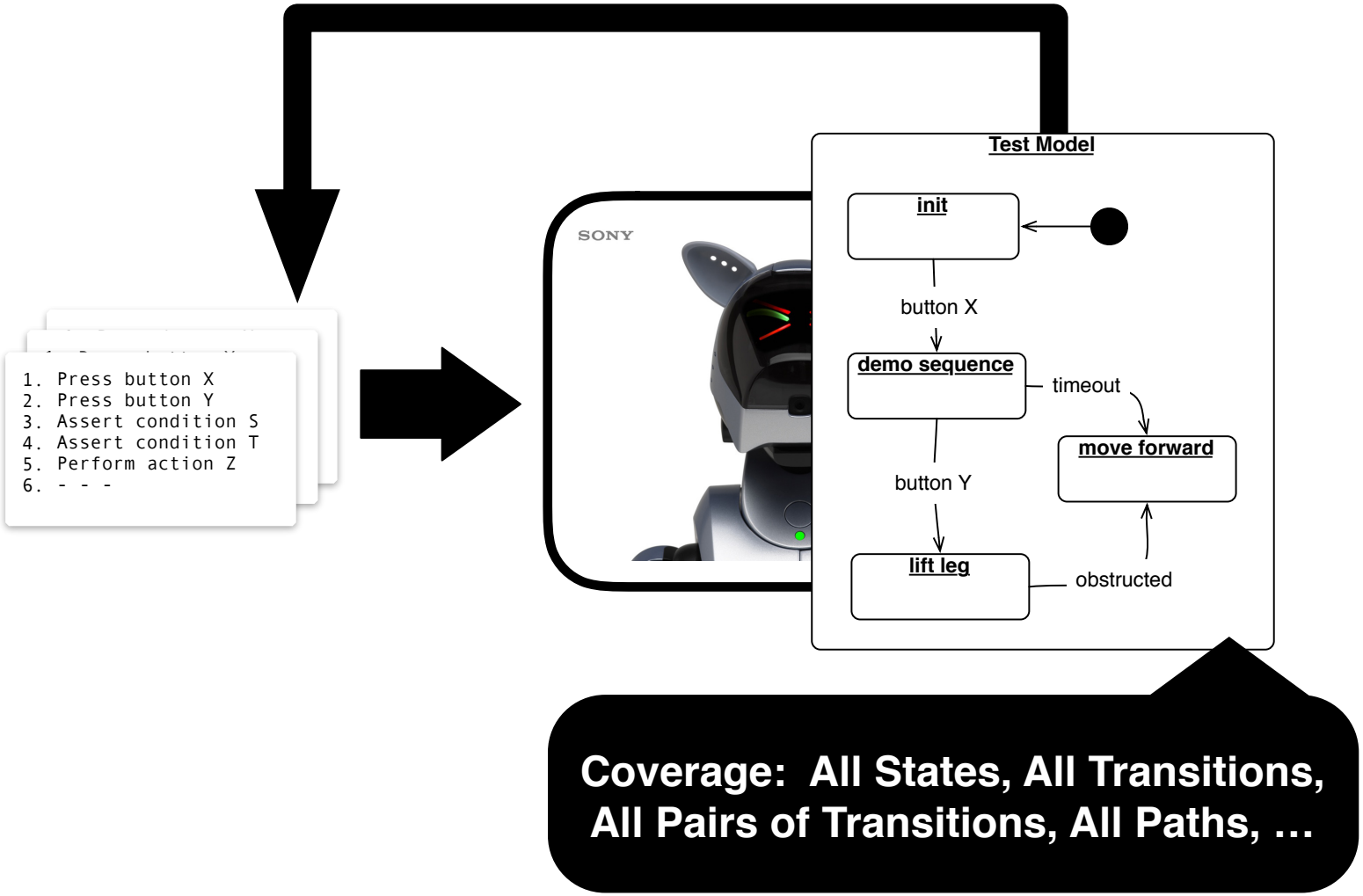
Model-Based Testing

use test model to generate tests
(and/or answer all our questions)



specify **expected** behaviour of
system as a state machine
(Test Model)

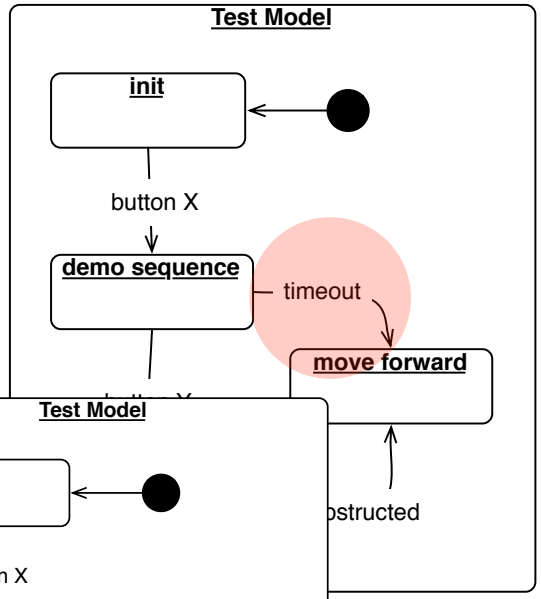
Model-Based Testing: Coverage

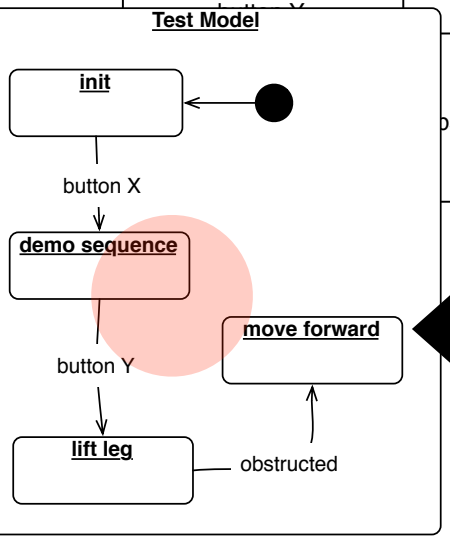


Model-Based Testing: Mutation Analysis

1. Run the tests on the test model, they should of course pass

```
1. Press button X
2. Press button Y
3. Assert condition S
4. Assert condition T
5. Perform action Z
6. - - -
```





2. Mutate the test model, systematically introducing faults (representing possible faults in the SUT)

3. A test is “good”, if it fails on (kills) as many mutants as possible

GO FORTH AND APPLY (STATE MACHINES)!