Dynamic Kernel Adaptation

A case study in a component-based infectious disease simulator

CBHPC'09

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Presentation Outline

- **Motivation**
- **Compositional Adaptation**
- **Application: Infectious Disease Simulation**
  - Agent-based Simulation
  - SEIR model
  - Simulation Kernels
- **The best of both worlds**
- **Componentized Adaptive Simulator**
- **Forward path**

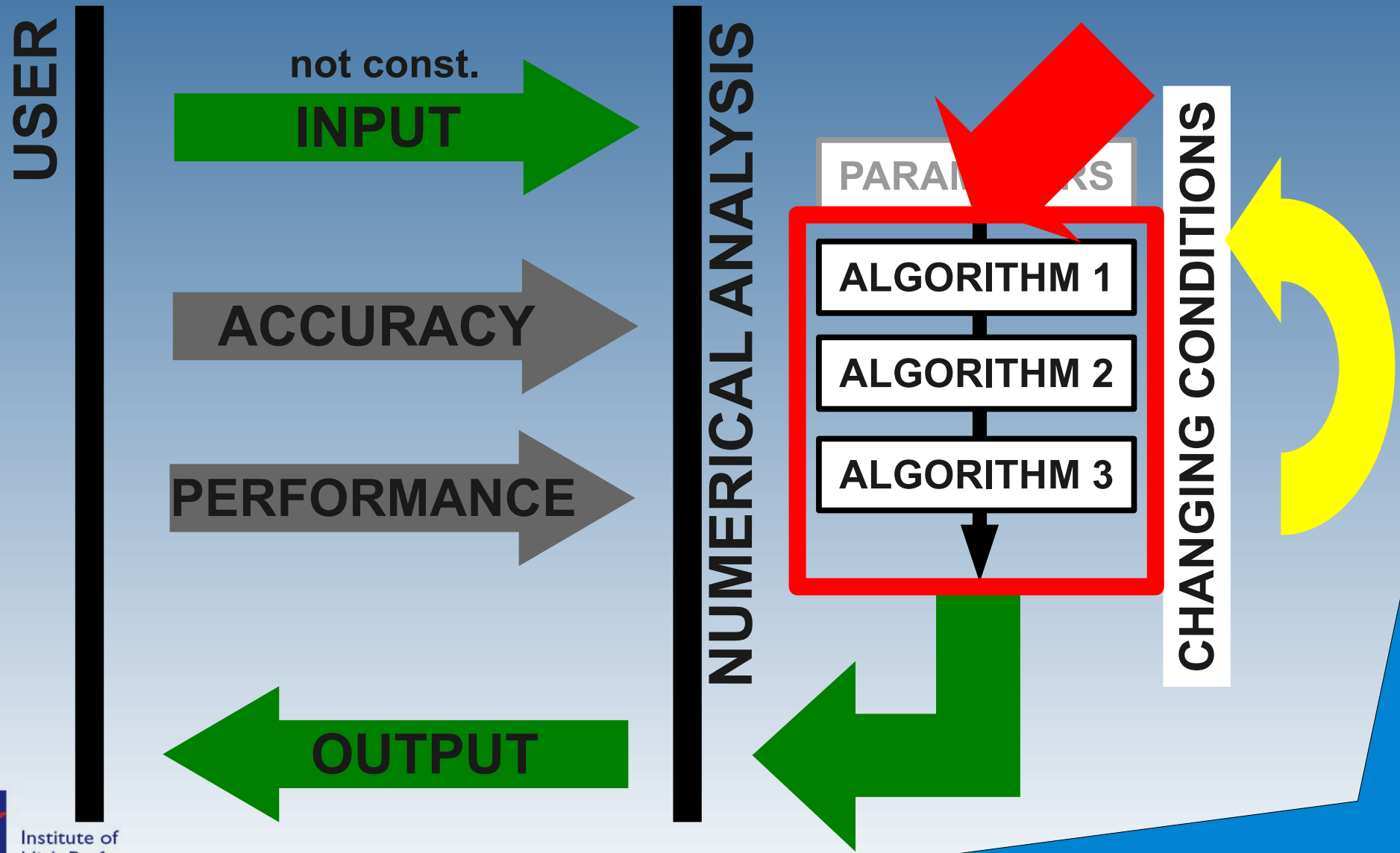
Motivation

- The goal of computational science is to find a solution to a scientific problem.
- Often, there are many ways of computing the same solution and they are all equally valid.
- What is the fastest (shortest path) to the solution?

Compositional Adaptation

- Different algorithms can arrive at equivalent solutions and have different resource requirements.
- Often researchers strives to find the “optimal” implementation on a case by case bases.
- Alternative: Have all implementations available and switch at runtime.

Runtime Optimization



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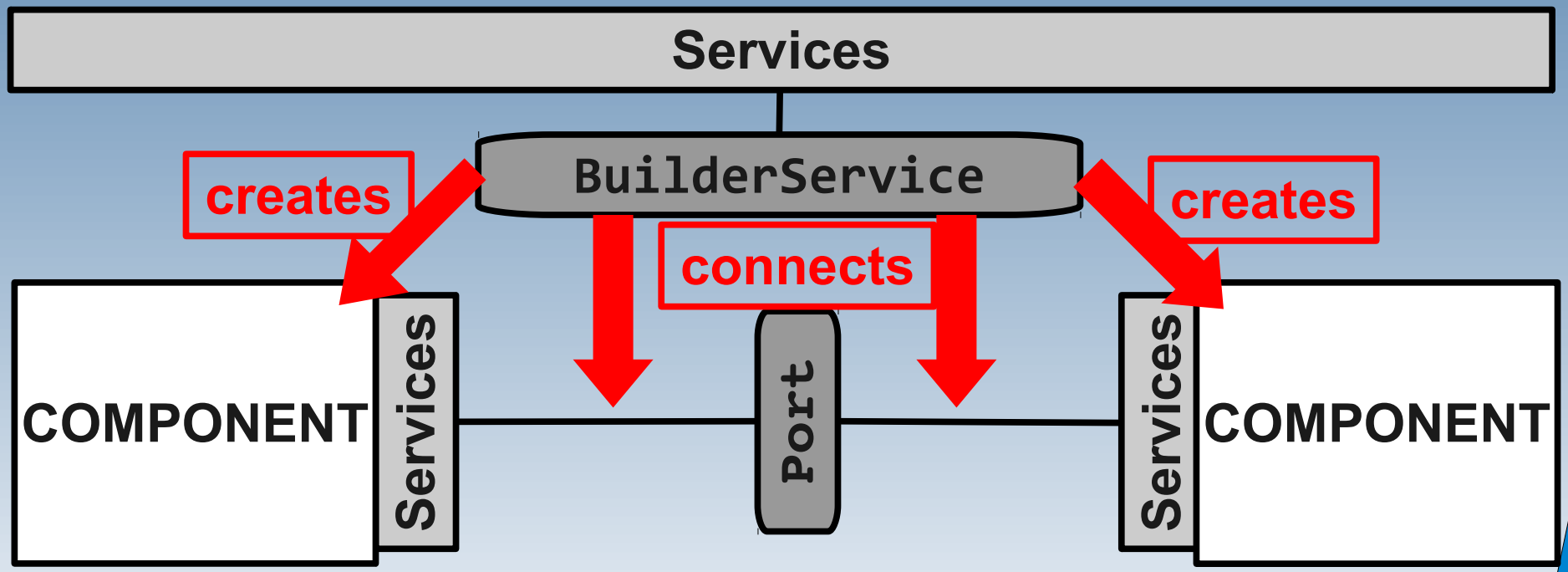
Requirement for CA

- Separation of Concerns
  - e.g. Separating QoS requirement from Functional behaviour
- **Component-Based Design**
  - Provides consistent interface for component level replacement
- **Computational Reflection**
  - Allows a program to observe its own behaviour and alter accordingly.
- Middleware

CCA Framework

- We use the BuidService service provided by the ccafeine framework to change the composition.



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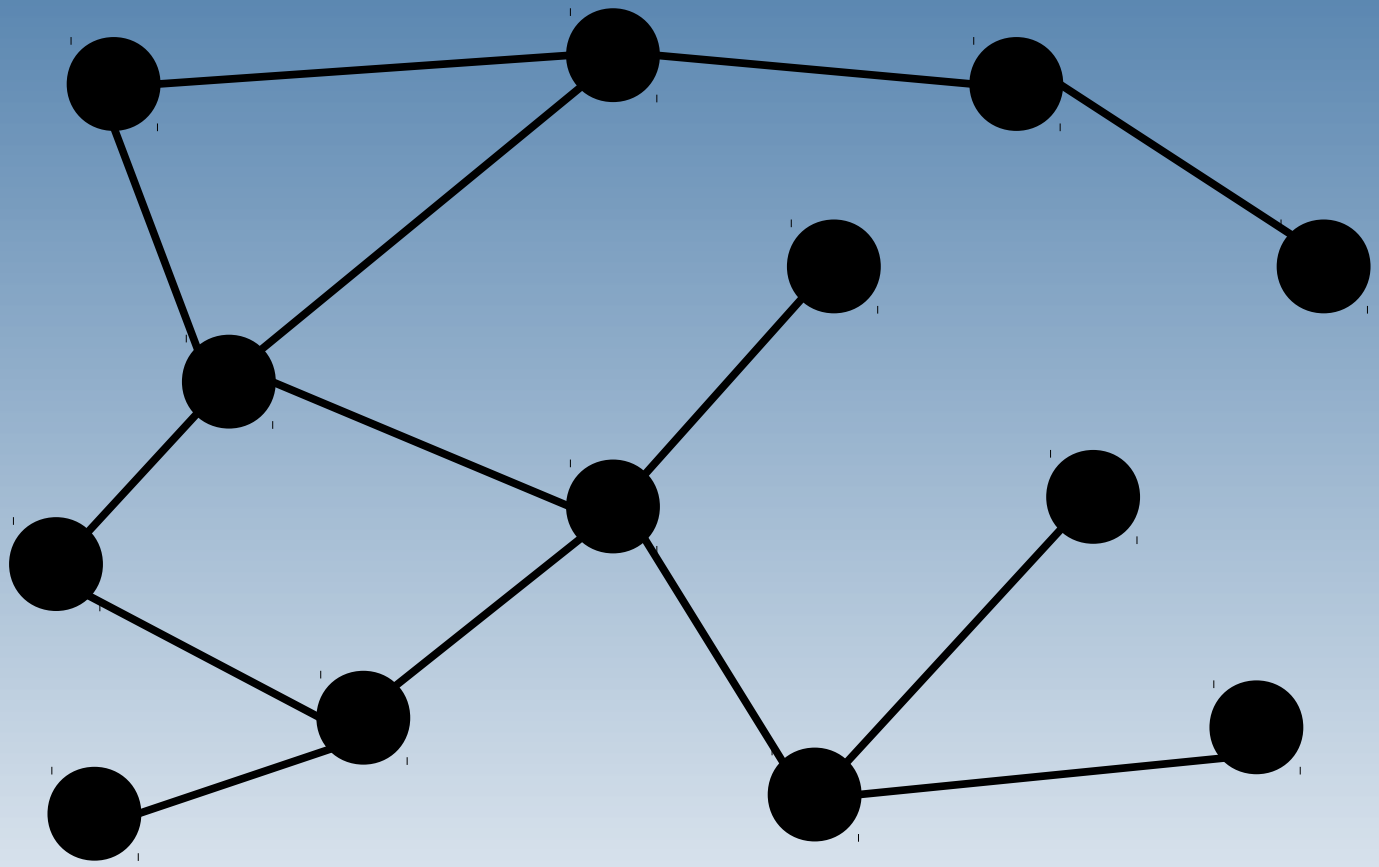
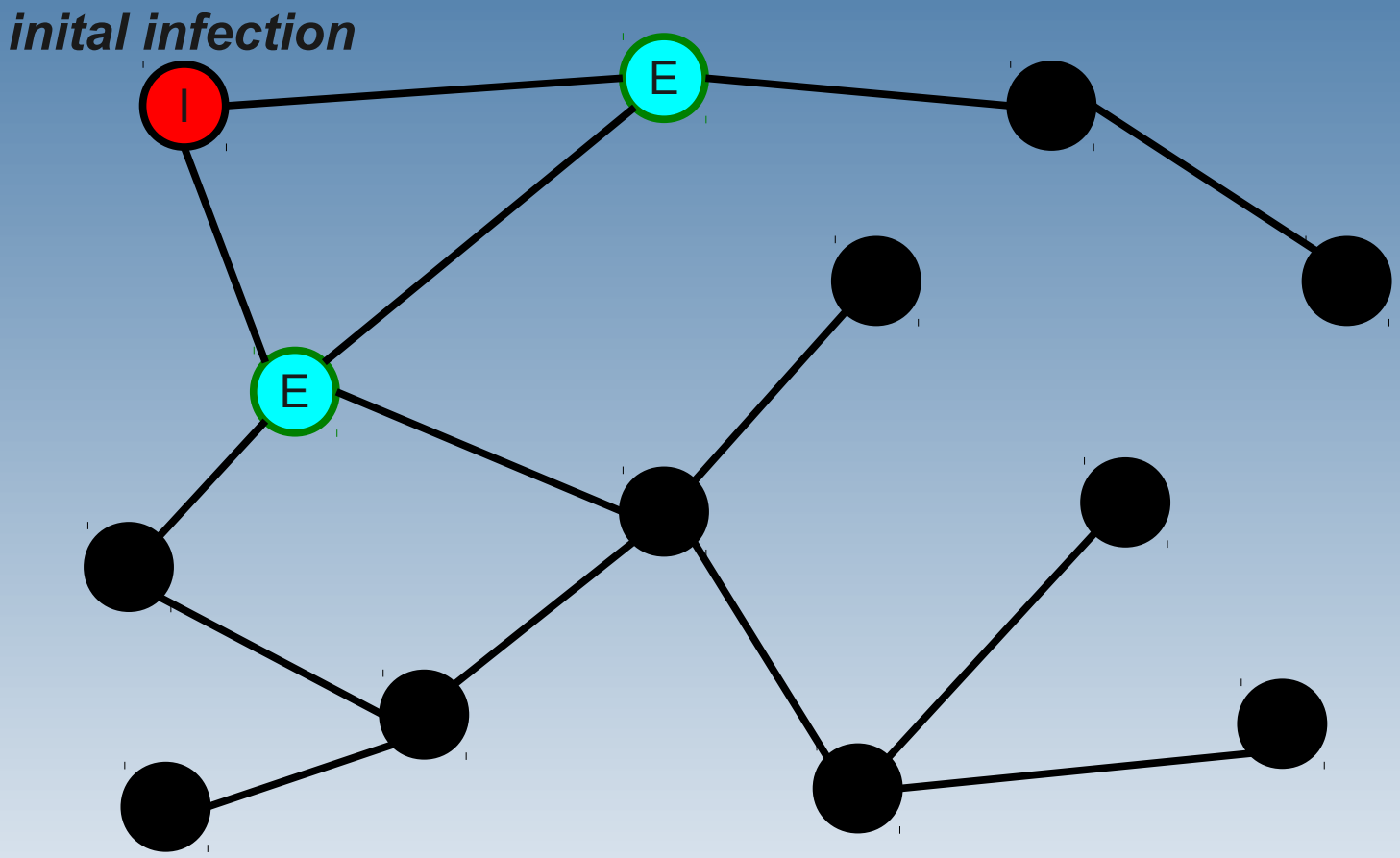
Case Study:
Infections Disease Simulation

Model of Disease Spread



Model of Disease Spread



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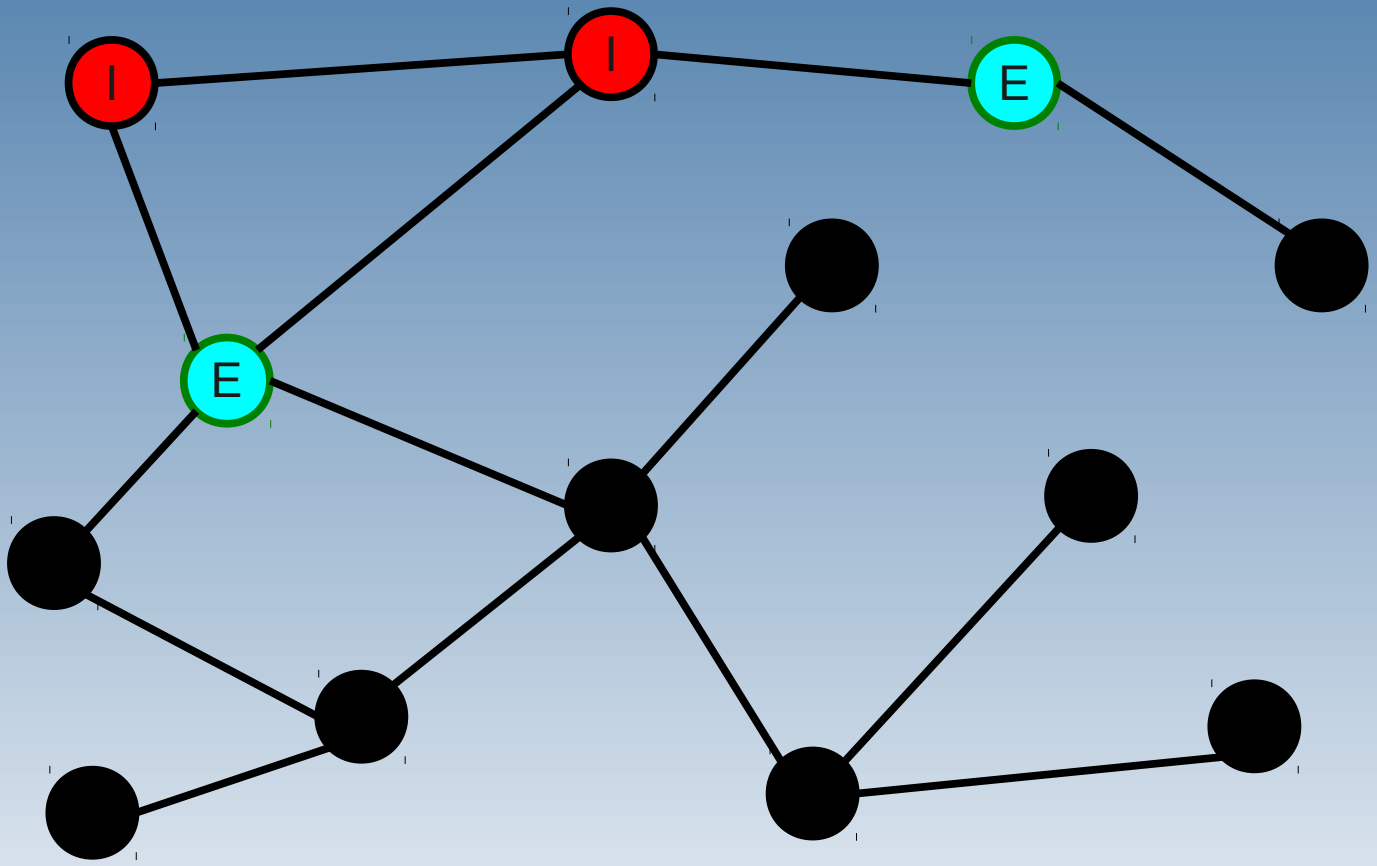
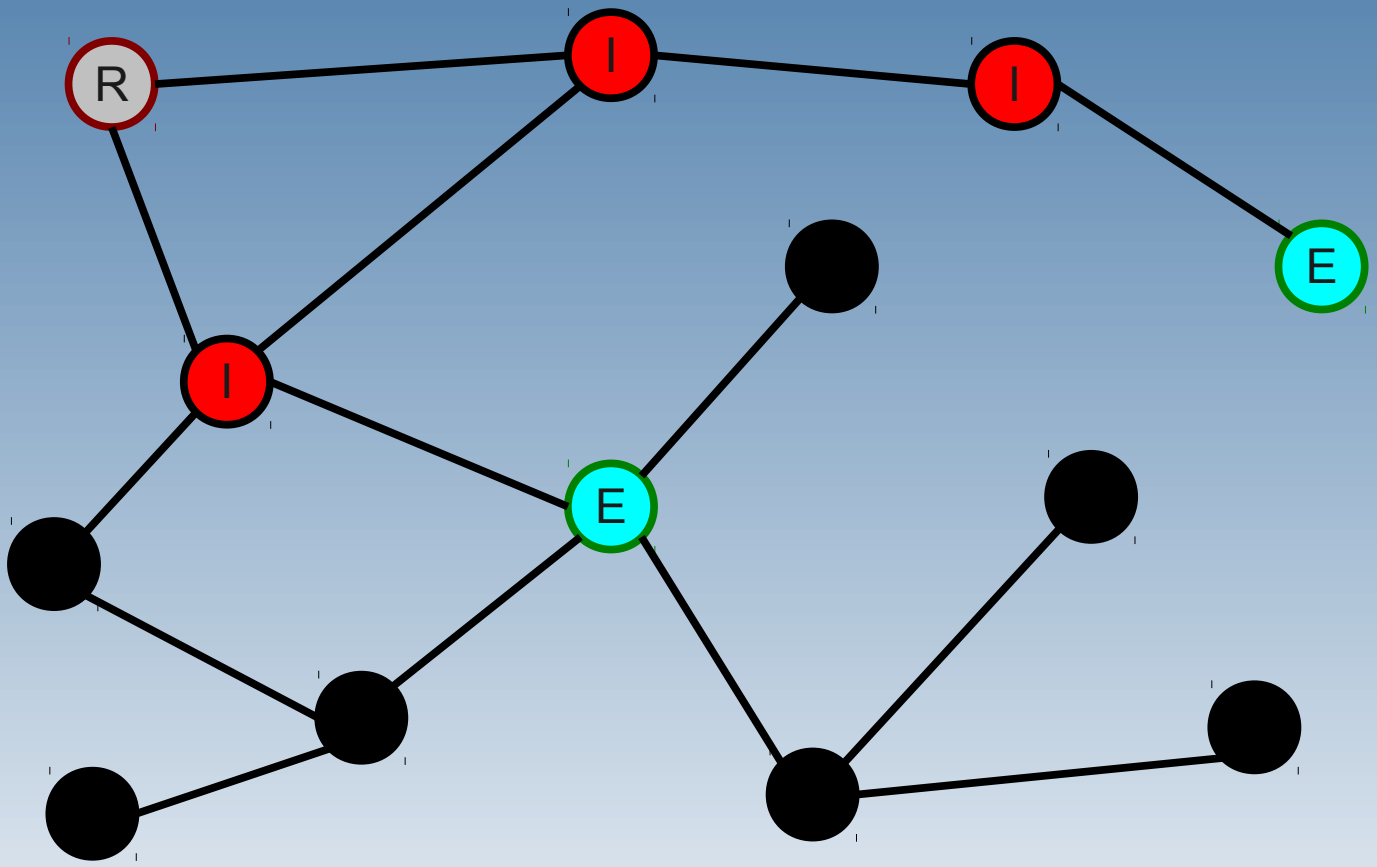


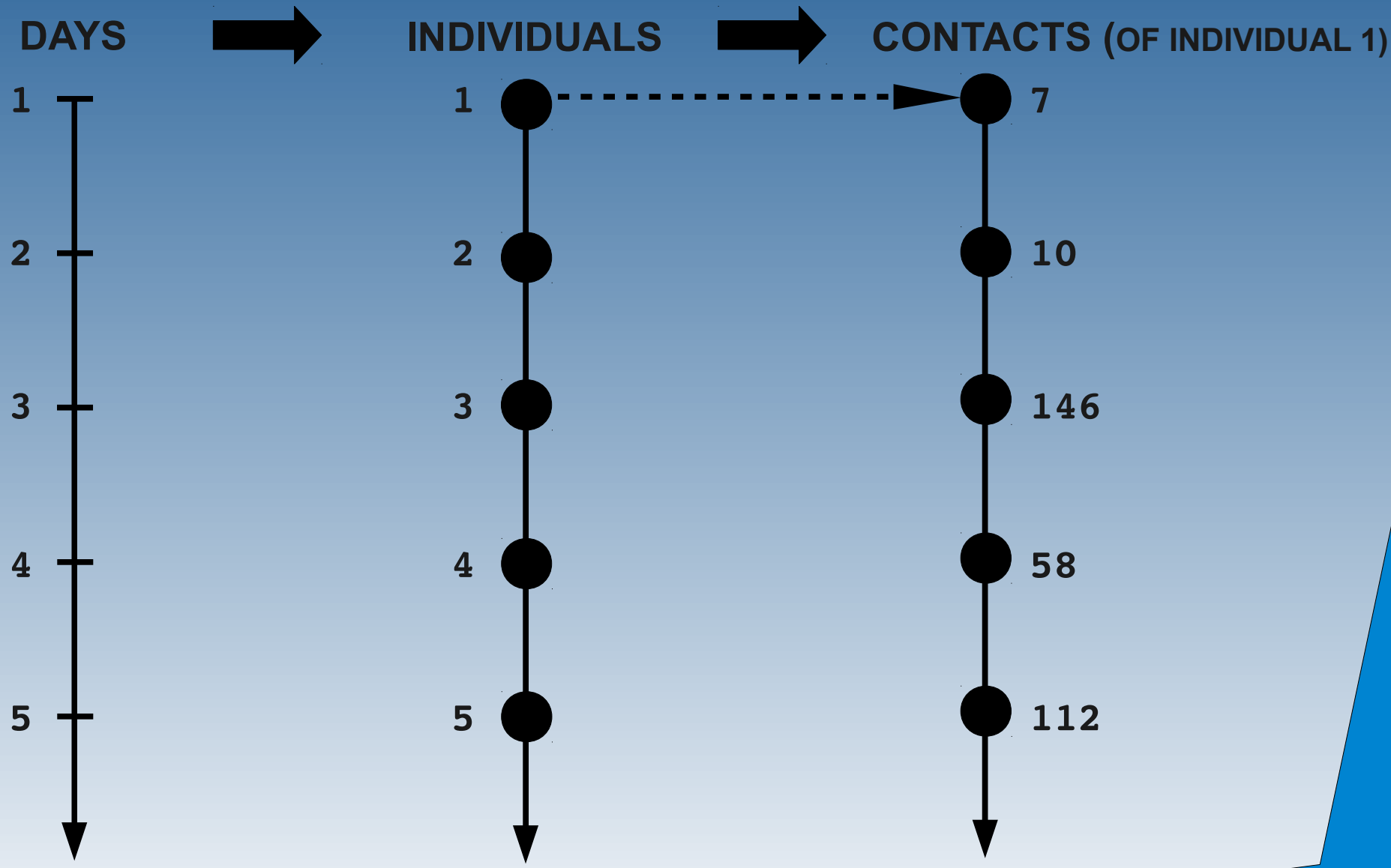
Model of Disease Spread



Observation

- Individuals can be modelled as a state machine
  - SEIR model
- Some state transitions are **automatic**
- Some state transition are **probabilistic**
  - Once an individual is in the exposed state, the movement to the infected state is probabilistic but independent of the network.
- Some state transition are **network dependent**
  - i.e. an individual going to the exposed state

Infectious Disease Simulator



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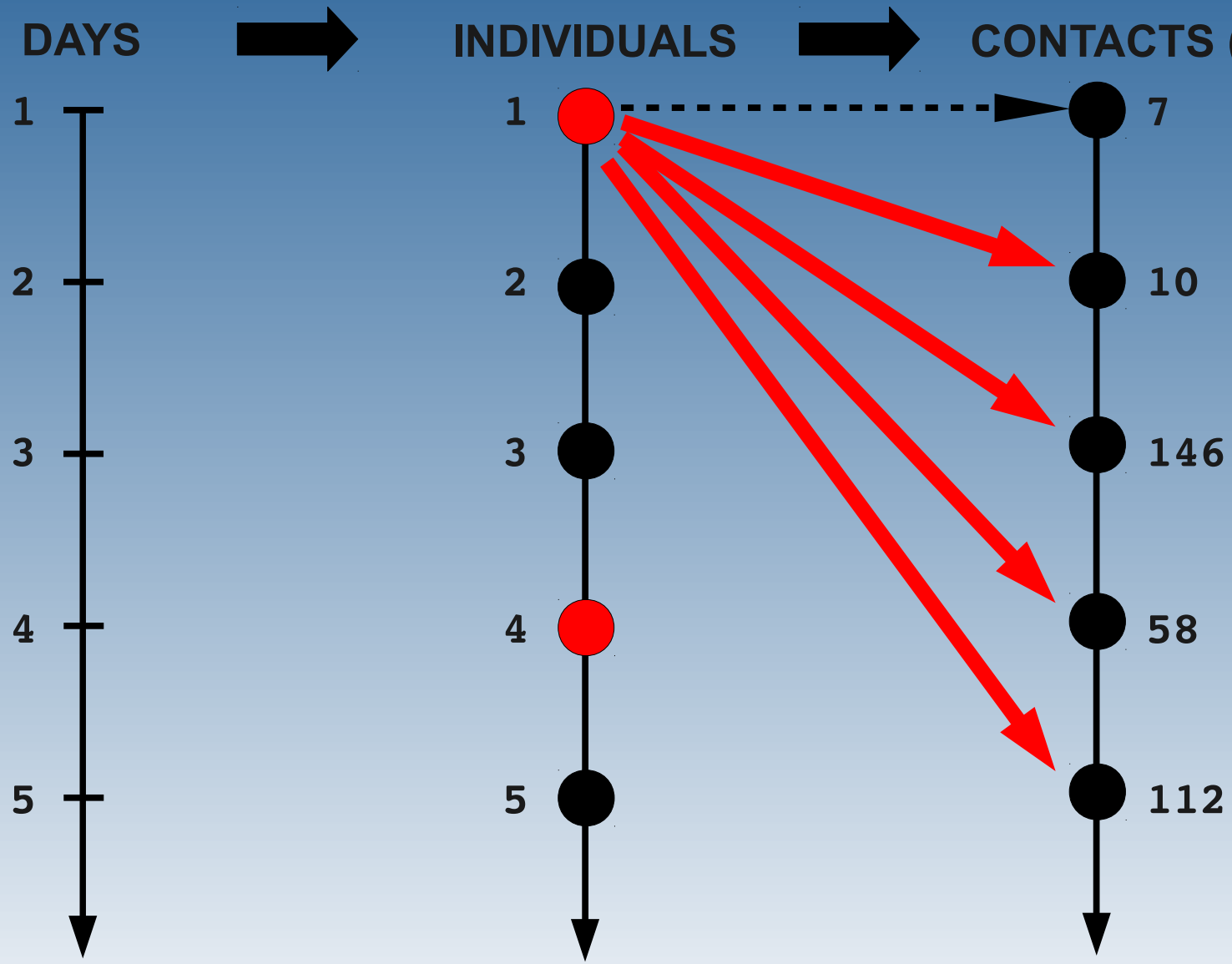
Infectious Disease Simulator



I-LOOP

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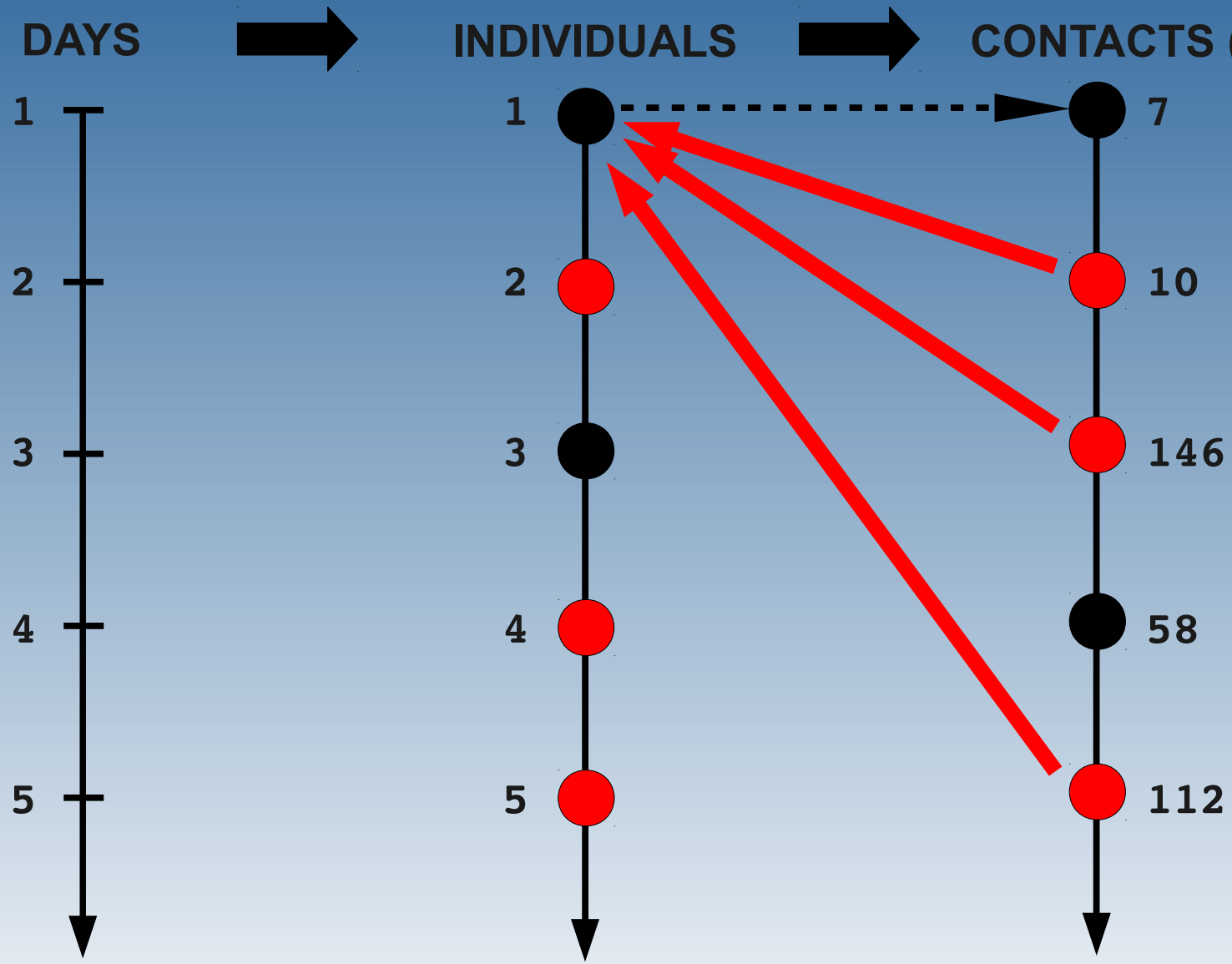
Infectious Disease Simulator



S-LOOP

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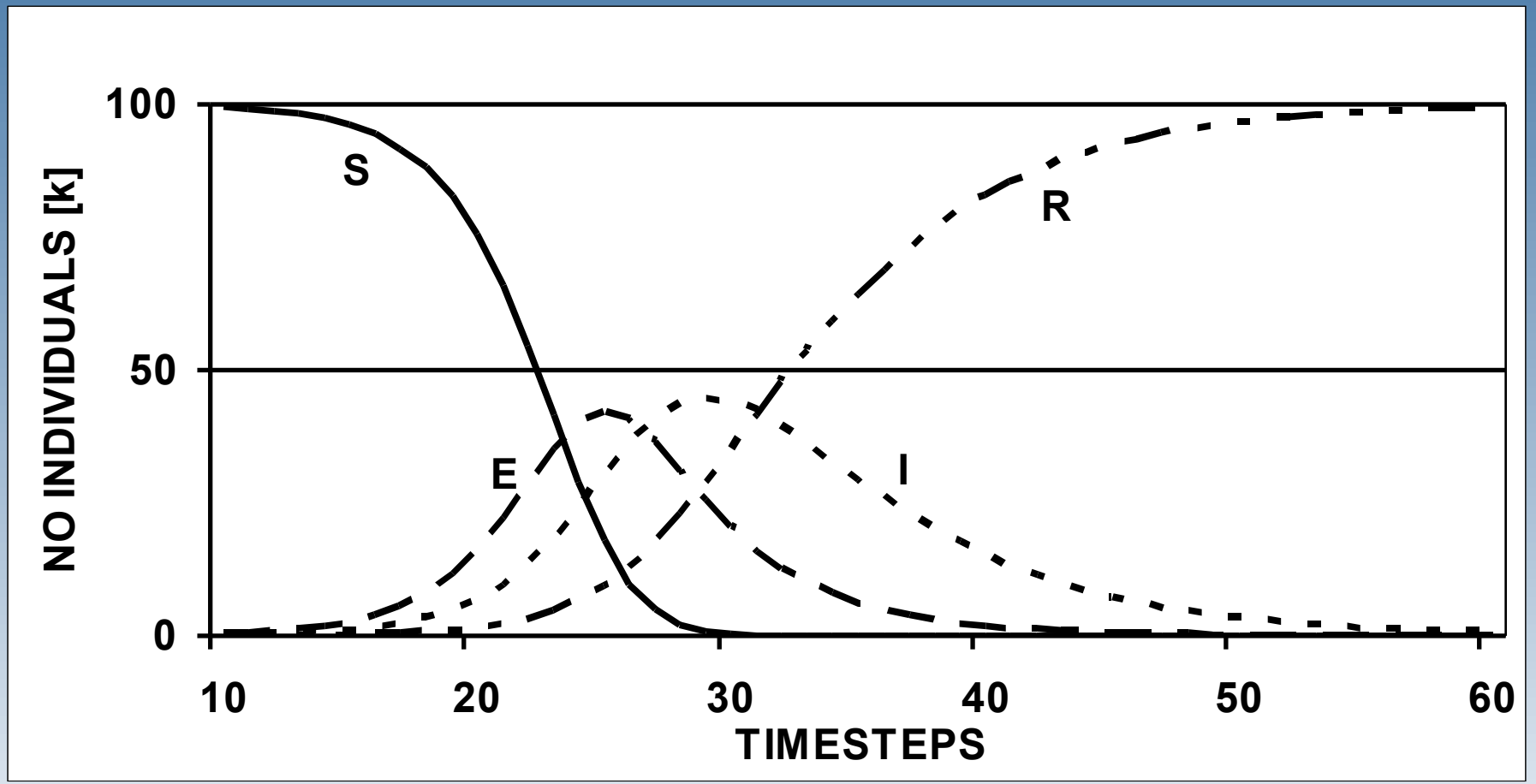
Infectious Disease Simulator



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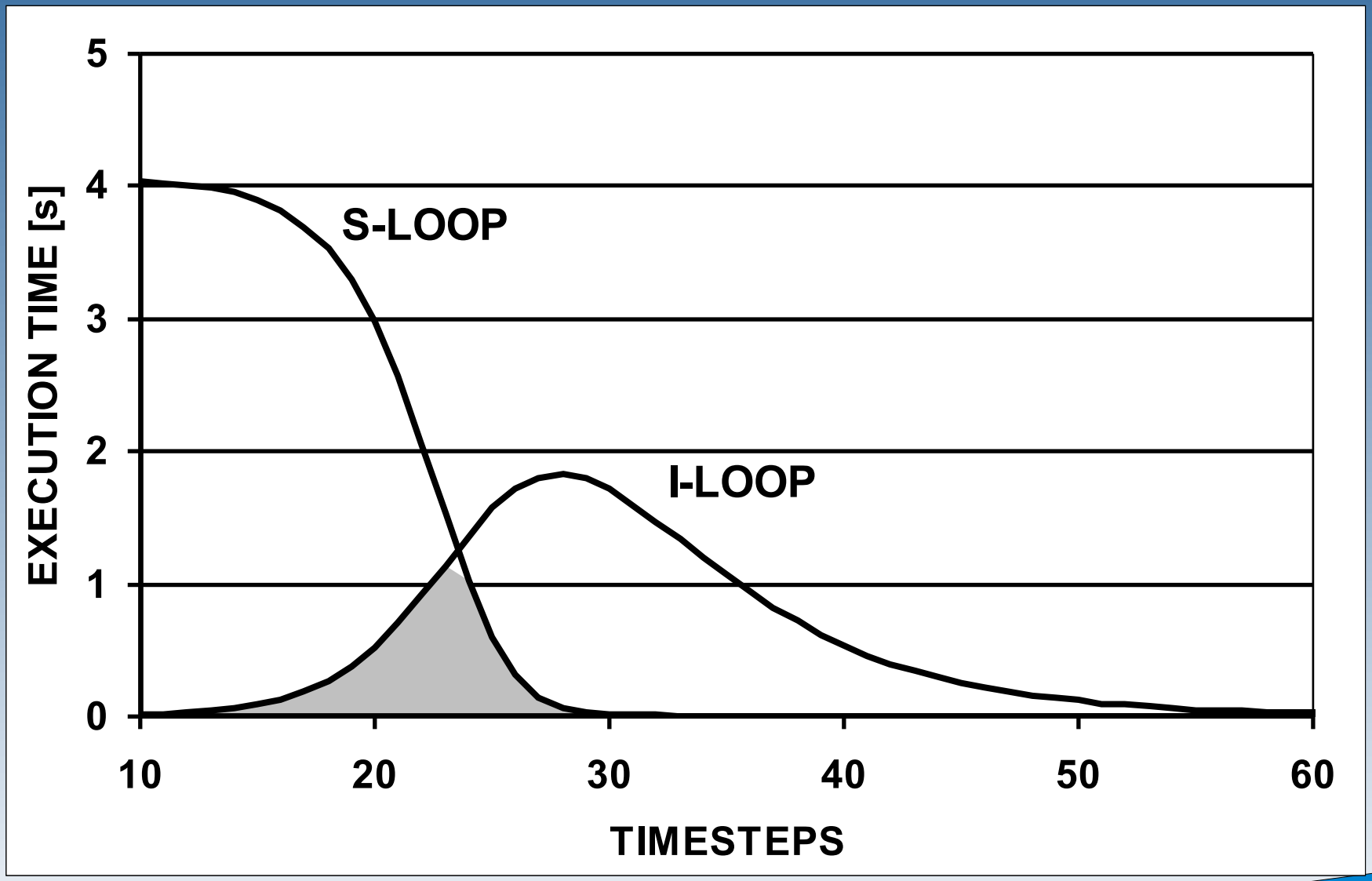
The best of Both World



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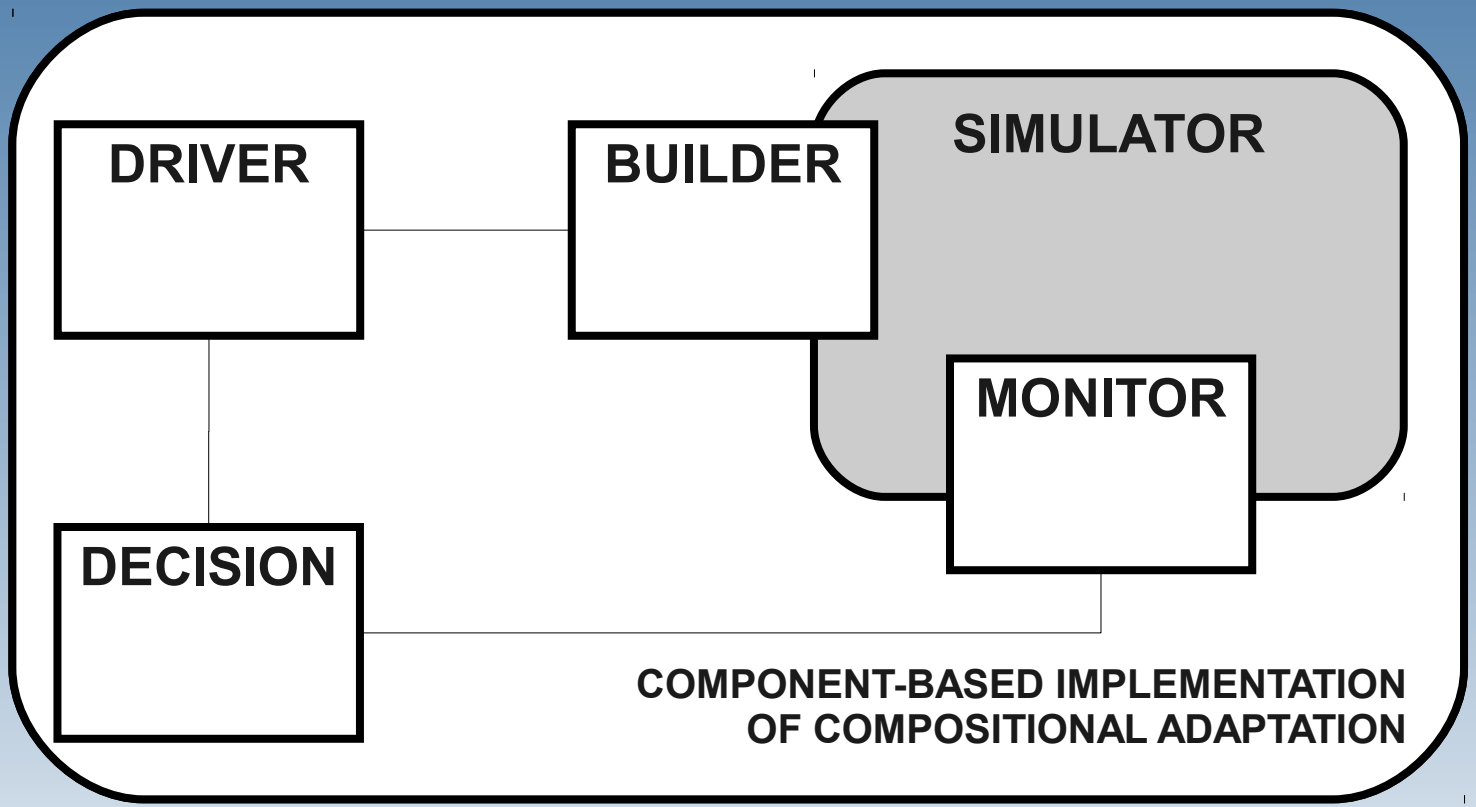
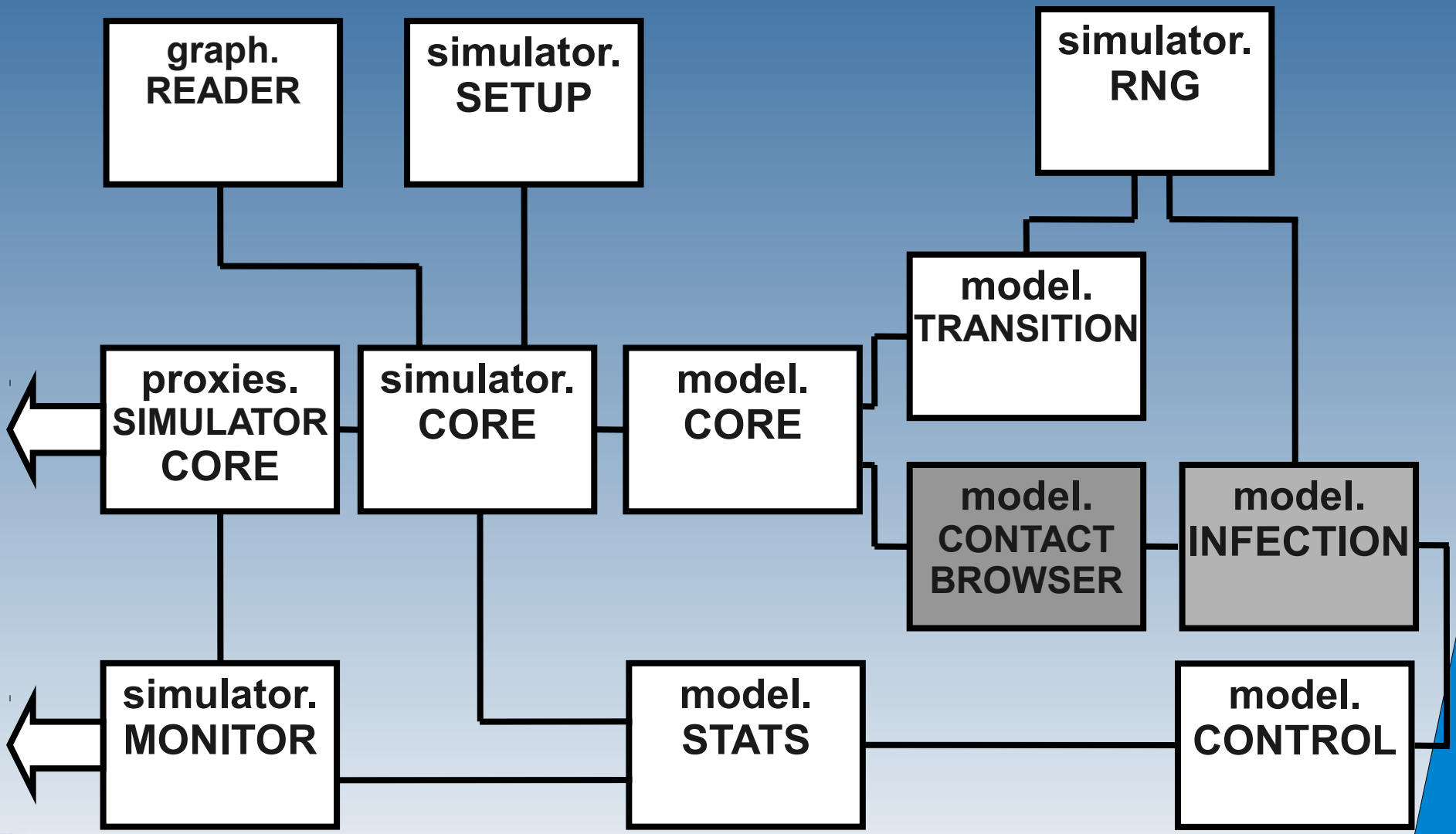
Adaptive Composition Framework



Infectious Disease Simulator



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Conclusion

- Summary
  - There is no single best algorithm that wins all the time.
  - Dramatic performance improvement can be gained with an “open mind.”
- Forward Path
  - Explore compositional adaptation with multiple substitutable components(+Control).
  - More work is required to generalise the decision component (GA ?).
  - More applications, and also older codes.