UNIVERSITÄT ZU LÜBECK
INSTITUTE FOR SOFTWARE ENGINEERING
AND PROGRAMMING LANGUAGES

HØGSKOLEN
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# Integration of Runtime Verification into Metamodeling

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28th Nordic Workshop on Programming Theory (NWPT'16), Denmark

# Why Runtime Verification?

- DSML do not shield the software from design errors
- Runtime Verification checks the execution of real system
  - Consider environmental influences
  - React to failures
- Testing is seldom exhaustive
- Model Checking can not always gurantee the correctness of executing system

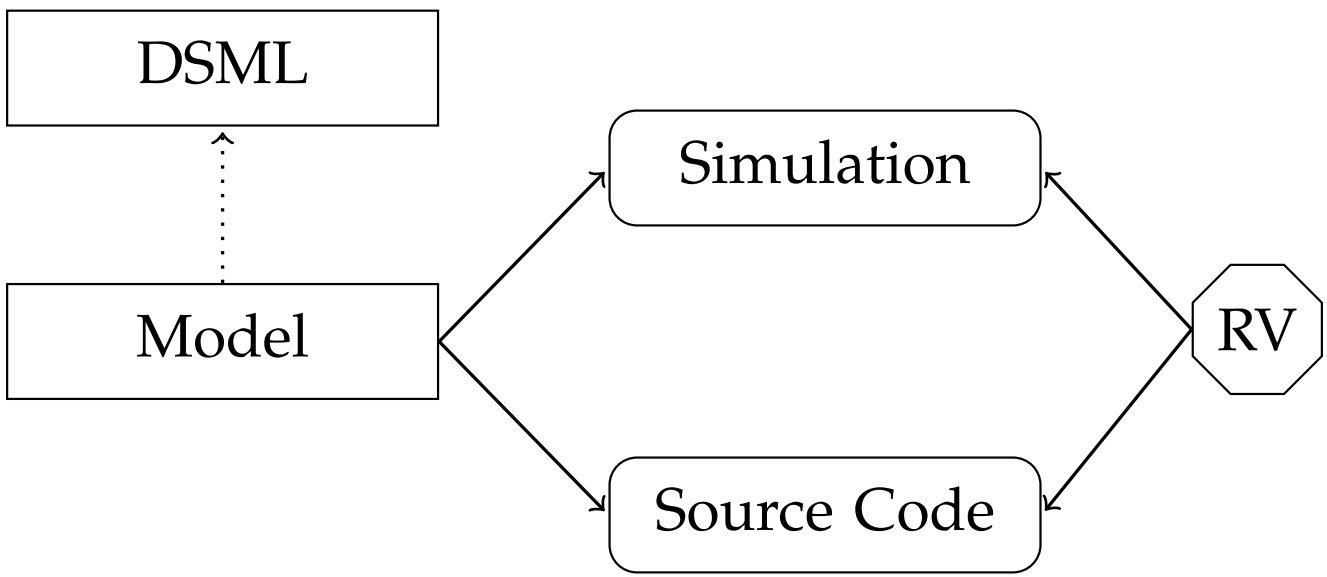
# Runtime Verification

- Use runtime monitors to observe the run of systems
- Check whether the current execution of such systems violates given correctness properties
- Such correctness properties can be formulated in linear-time temporal logic, LTL

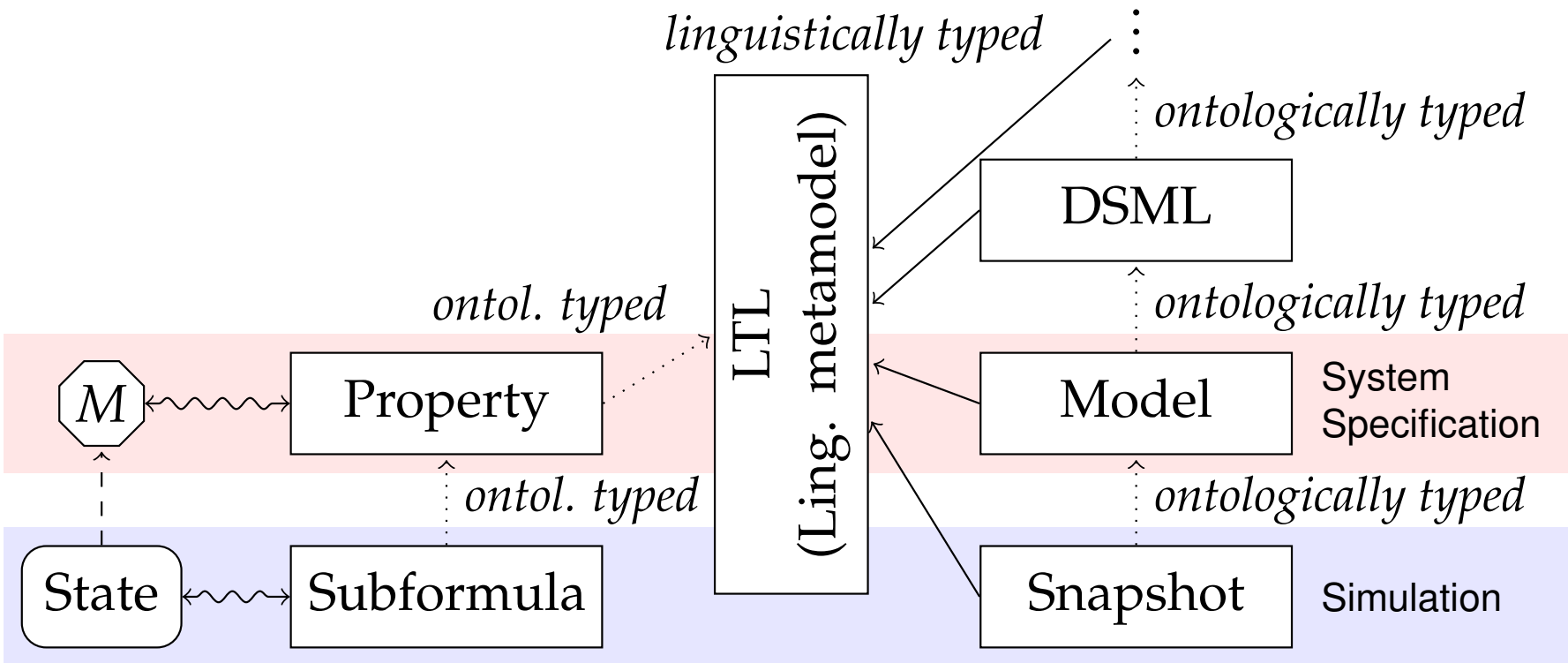
# Integrating RV into Modeling

## Goal

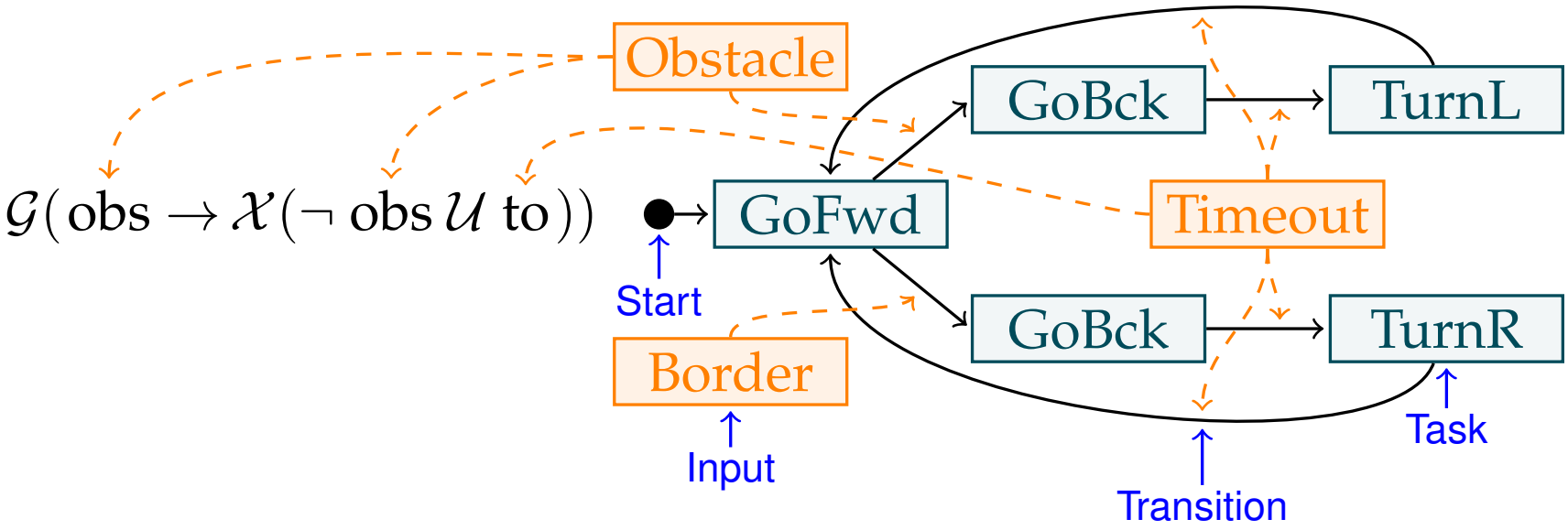
⇒ Integrate RV into software engineering process
⇒ Domain experts and verification engineers use same model



# Multilevel Metamodeling

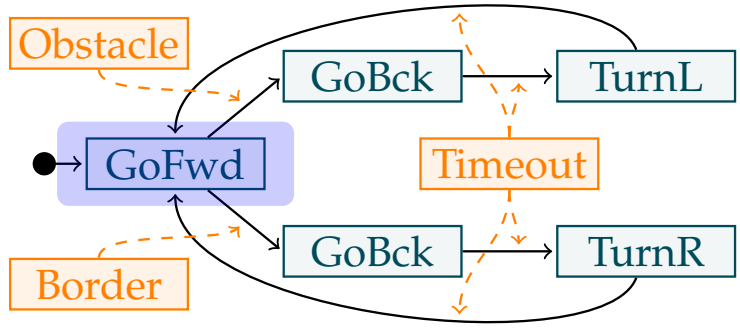


# Example Scenario




- Generate Python code for the robot and monitor

# Example Execution

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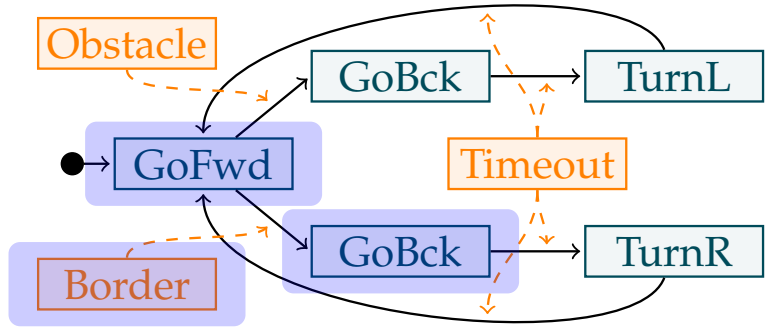
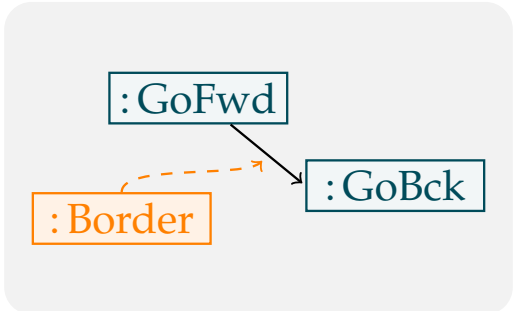
# Example Execution







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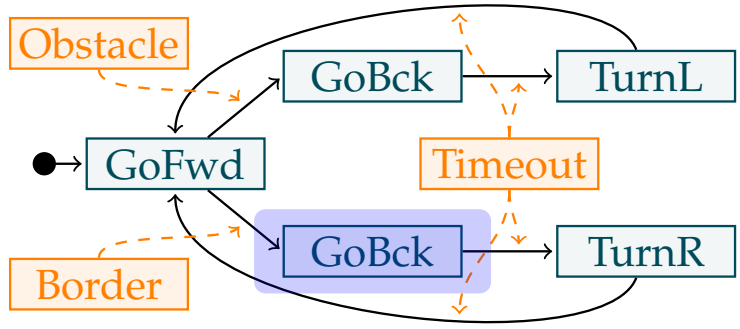



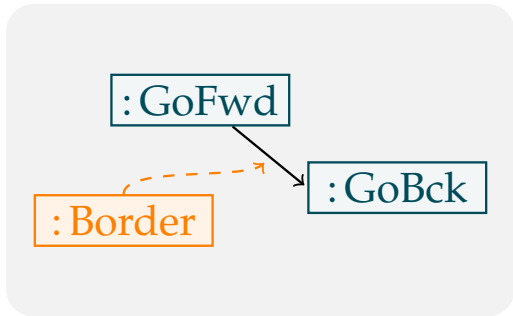


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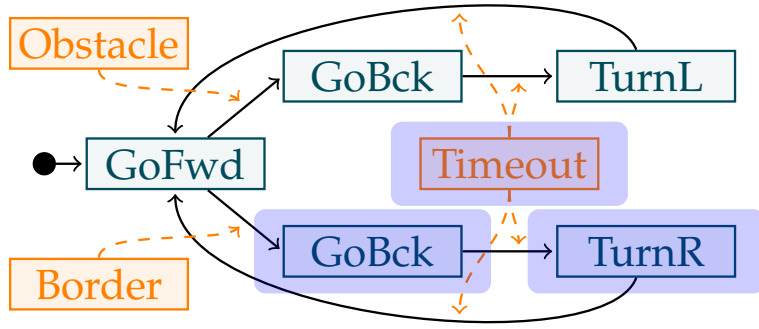



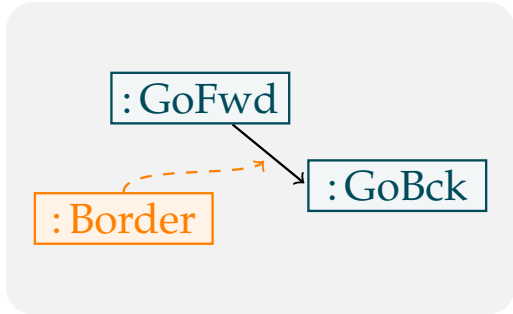



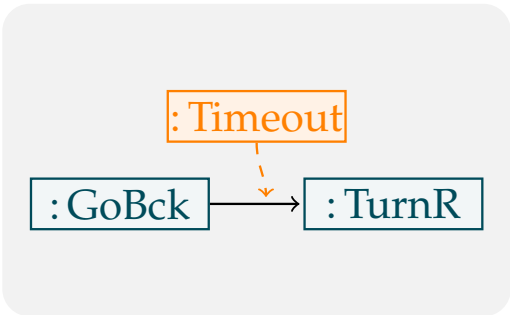

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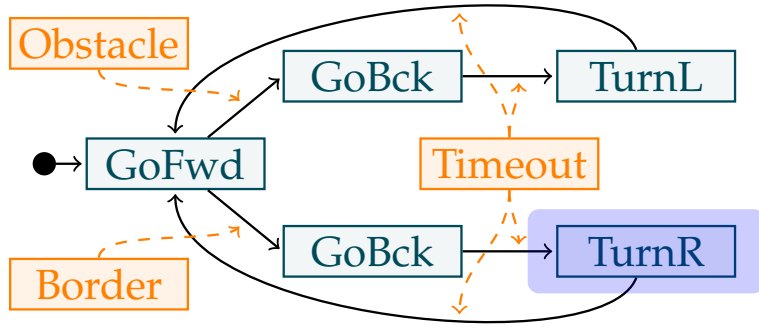



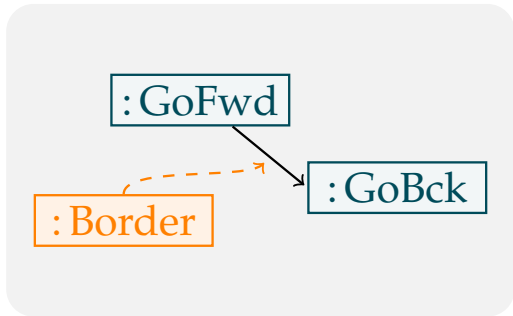



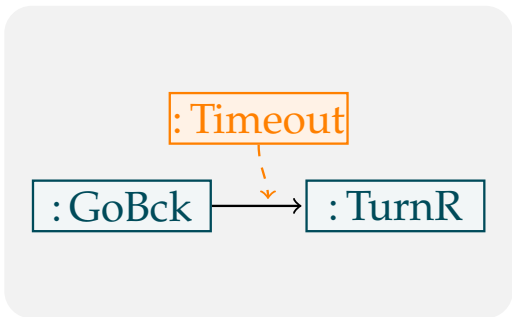


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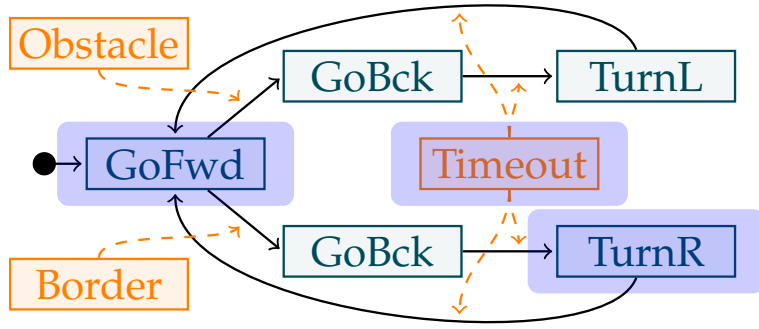



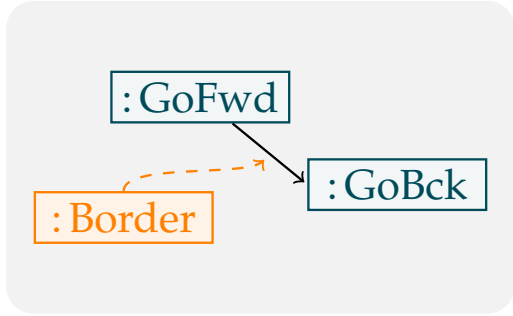



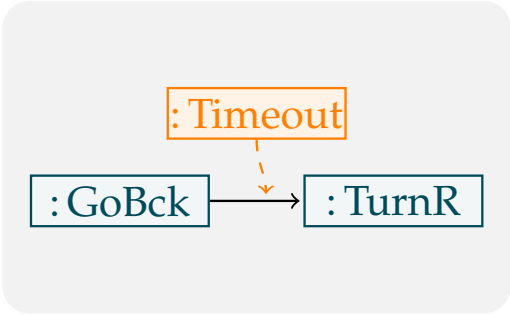



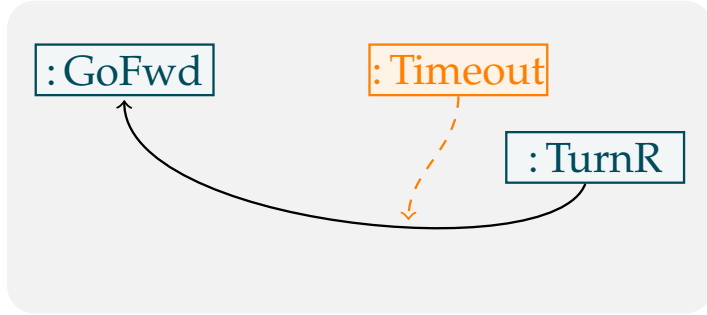

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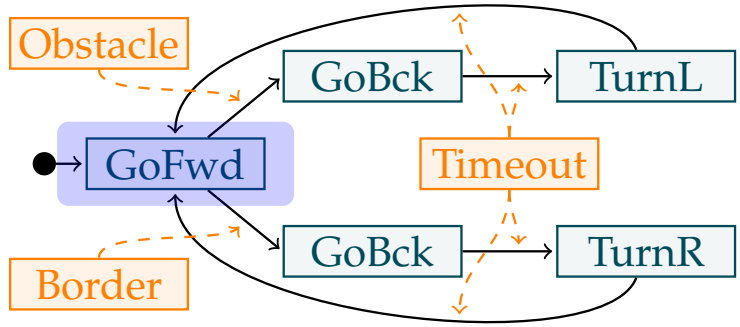


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$\mathcal{G}(\text{obs} \rightarrow \mathcal{X}(\neg\, \text{obs}\, \mathcal{U}\, \text{to}))$

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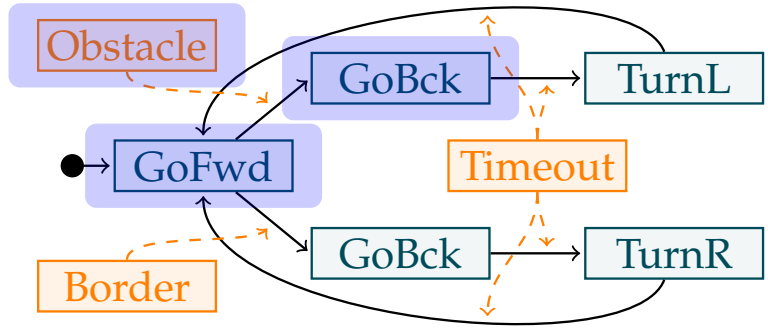



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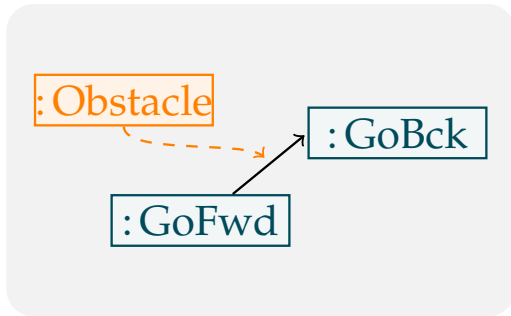


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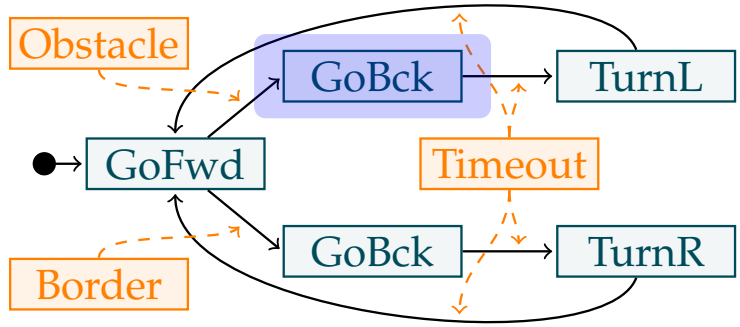



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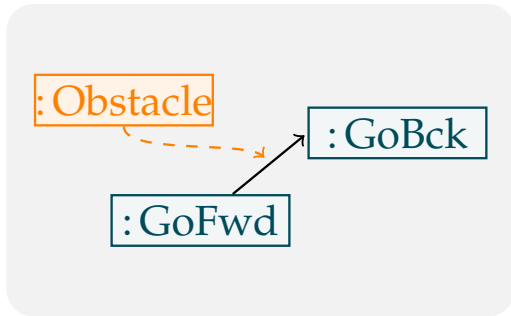


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$\neg\, \text{obs}\, \mathcal{U}\, \text{to}$

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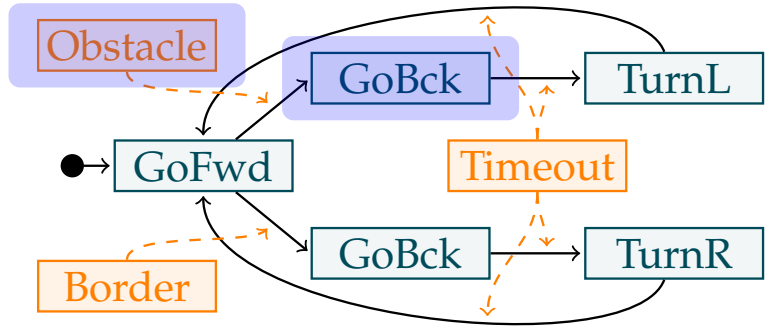



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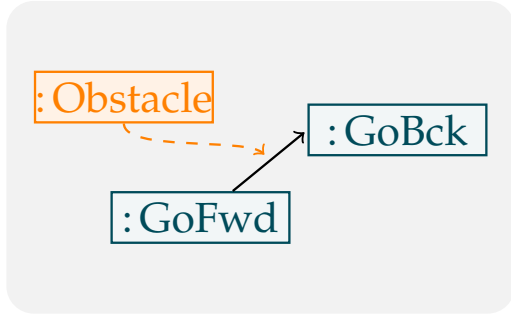


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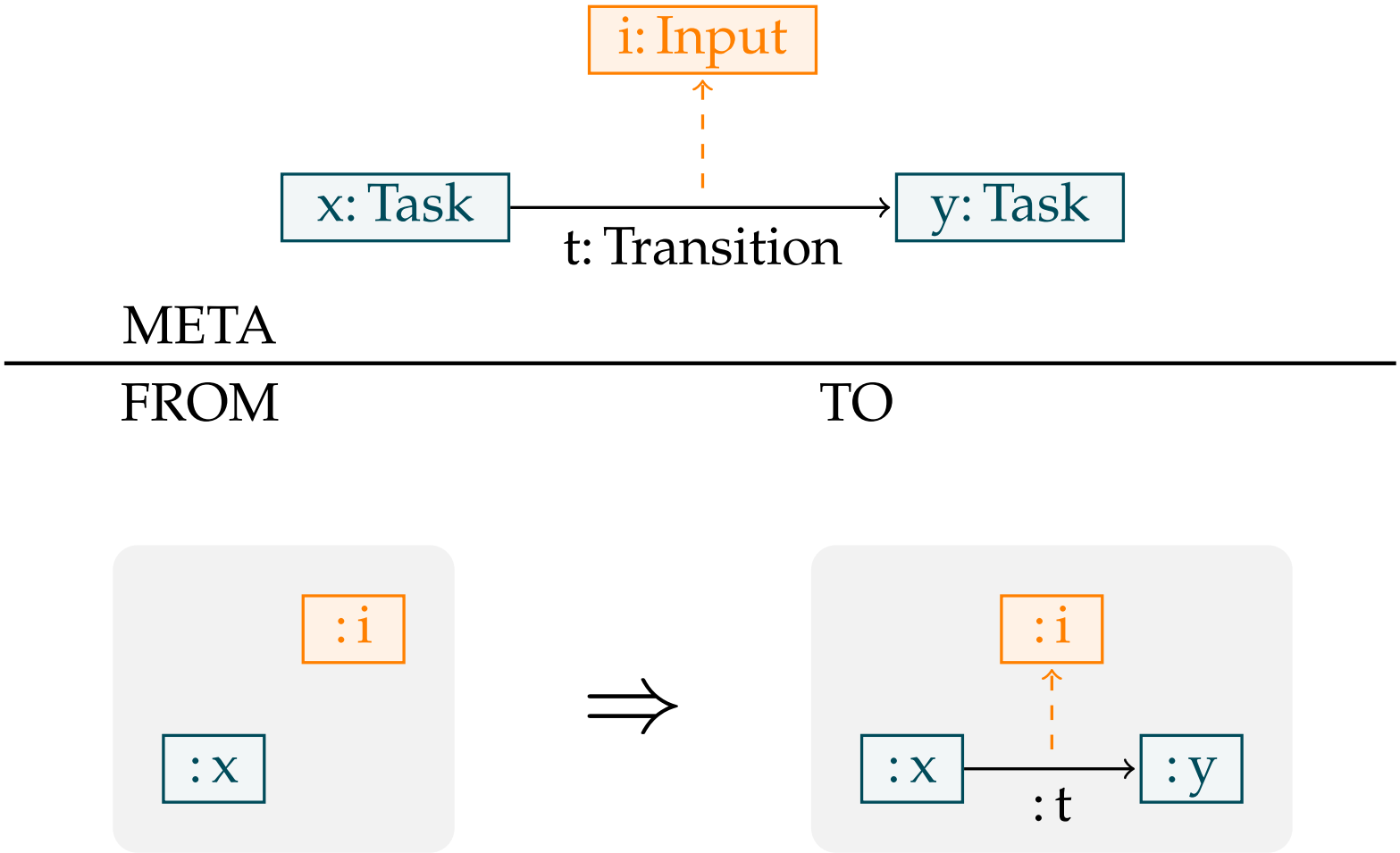
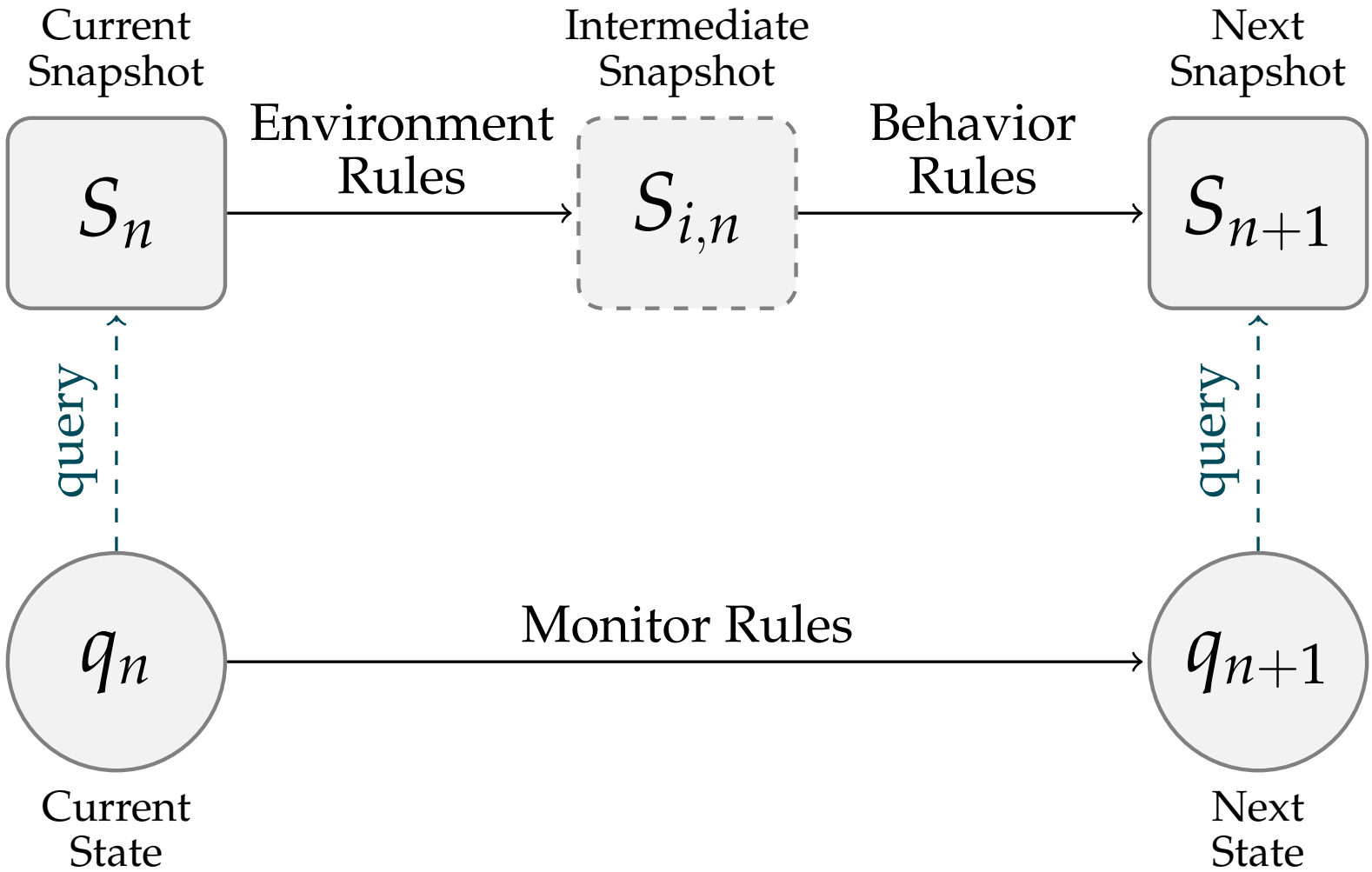
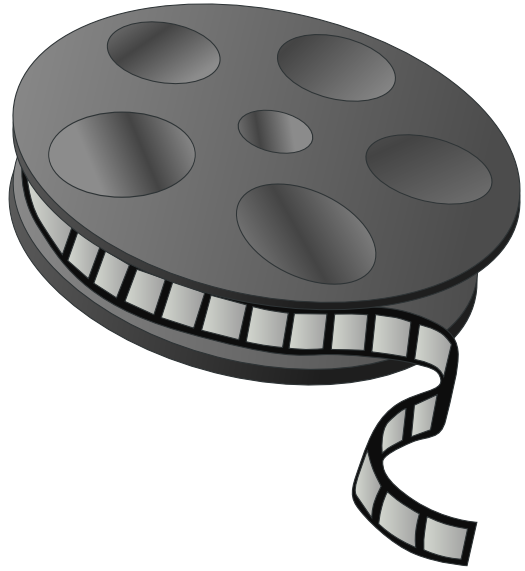
# Coupled Model Transformation Rules



# Model Transformation Rules



# Example Video



# Communication

**Goal**

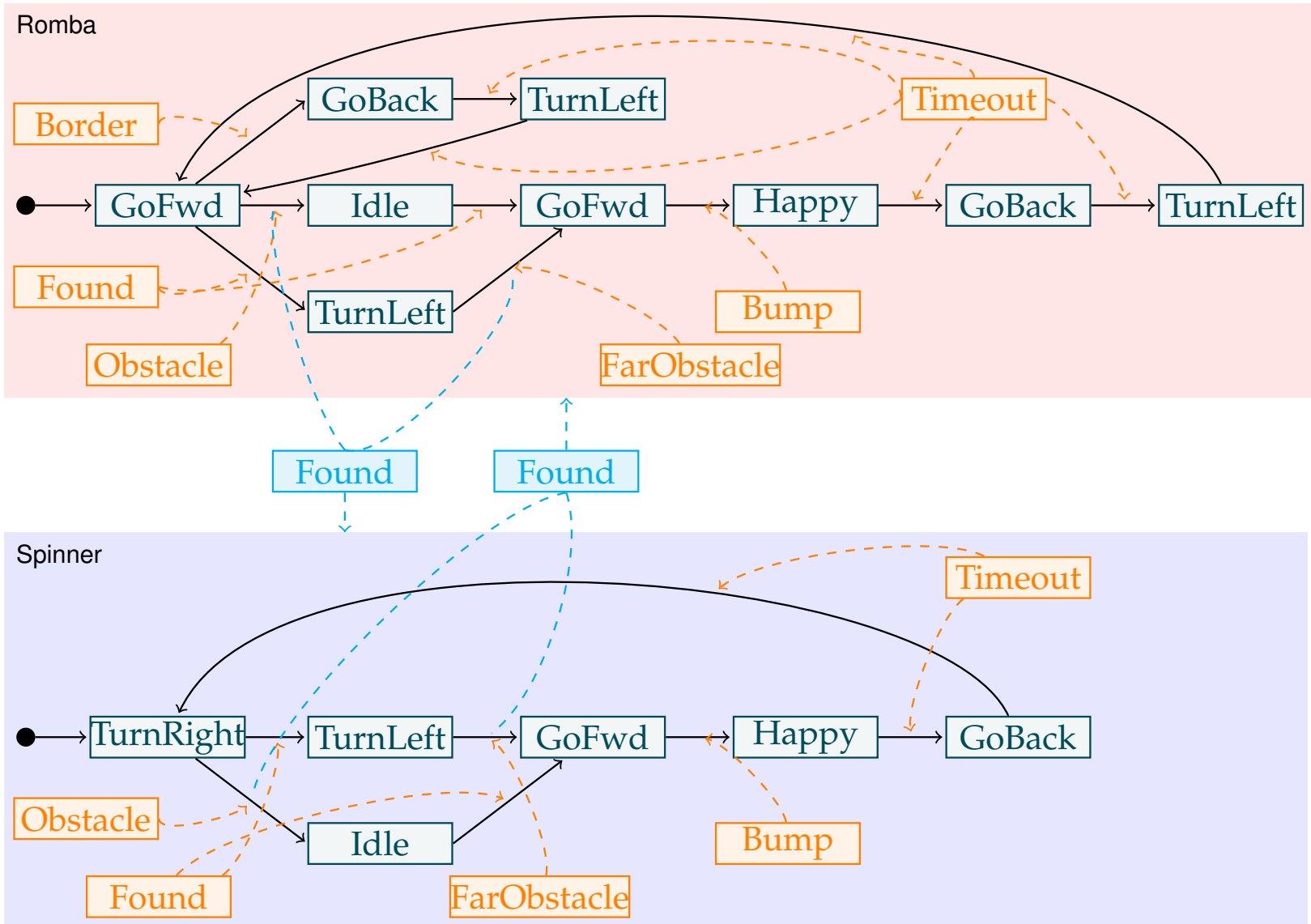
$\Rightarrow$ Model distributed systems

- Current scenario: two robots meet
- Client/Server Model
- Sockets - send and receive data
- UDP (The User Datagram Protocol)
  - No handshaking dialogues
  - No guarantee of delivery, ordering, or duplicate protection
  - Suitable for purposes where error checking and correction are performed in the application
  - Broadcasting information

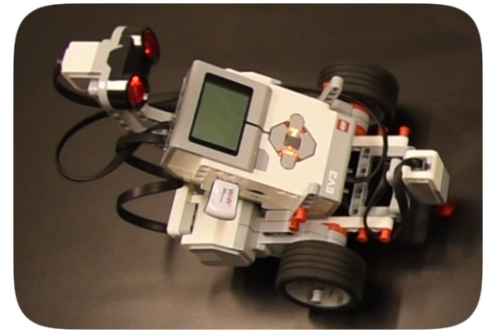
# Broadcast

- Romba/Spinner simple "Found" message
- More advanced messages for robots explore area and share updates to a common map
- Broadcast Hello messages (ID, timestamp and data)
- The number of retransmission, reTx, is counted
- Maximum number of transmissions: MaxReTx

# Example Scenario for communication



# Conclusion and outlook



- Present a metamodel that captures a wider range of aspects of the robots
  - Sensors
  - Motors
  - Communication
- Integrate runtime verification into the whole software engineering process
  - Design
  - Simulation
  - Code generation for the robot and monitor
- Allow the design of distributed systems in the future
  - Distribution can be modeled through replication of existing instances on the modeling level
- Use models for Model-based testing