# CREST

## A Continuous, REactive SysTems DSL

Stefan Klikovits, Université de Genéve

@stklik

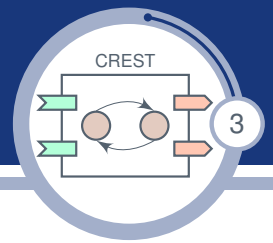
2018 CUSO Winter School

# Growing plants

# Growing plants

(c) Debra Roby
https://www.flickr.com/photos/darinhercules/

# The Language

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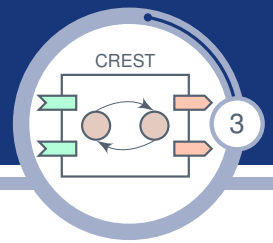


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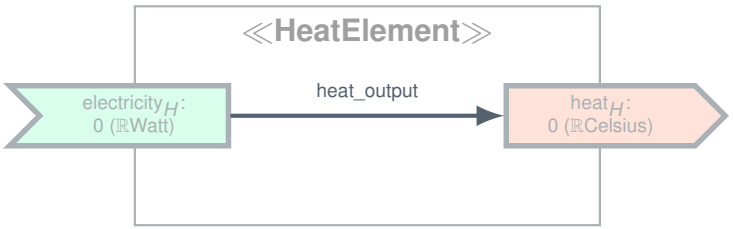

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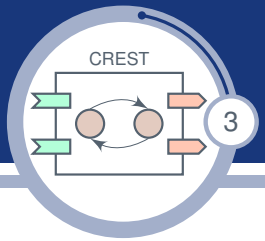


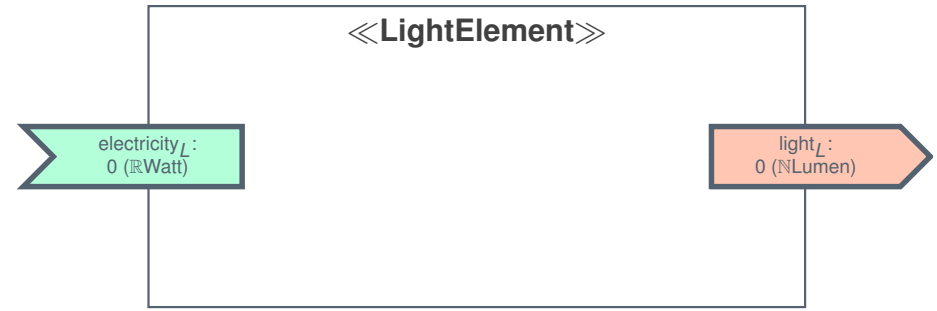


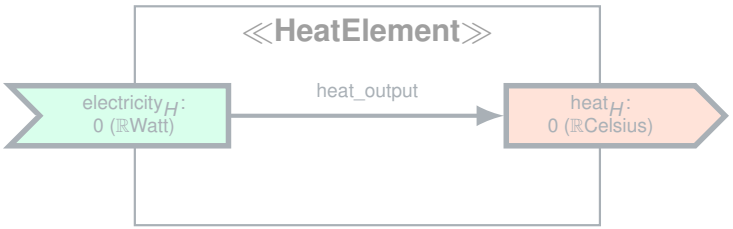

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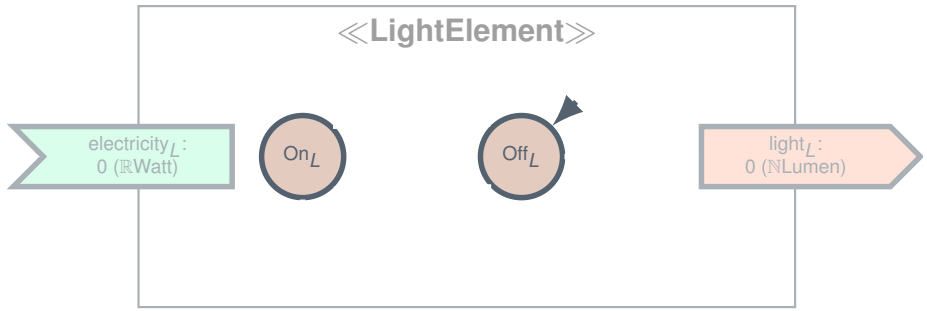


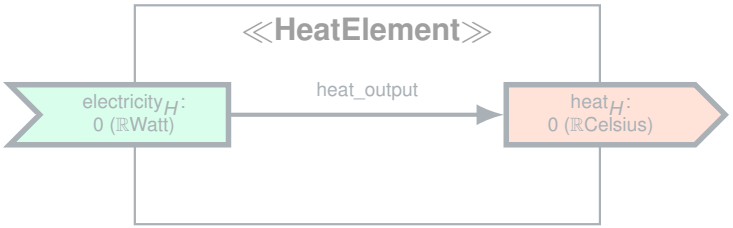

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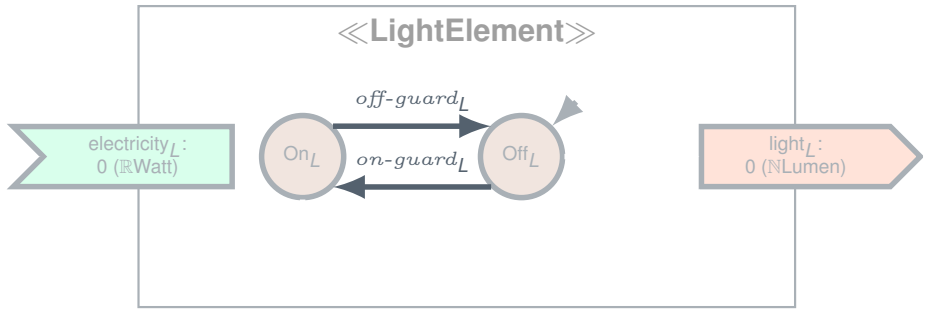


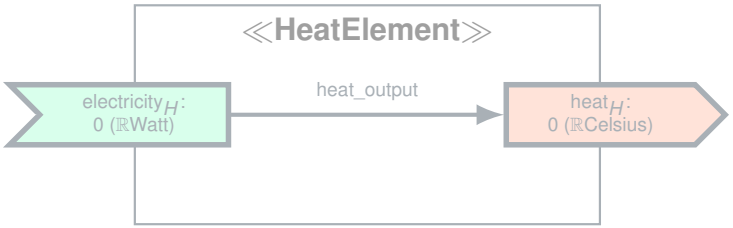

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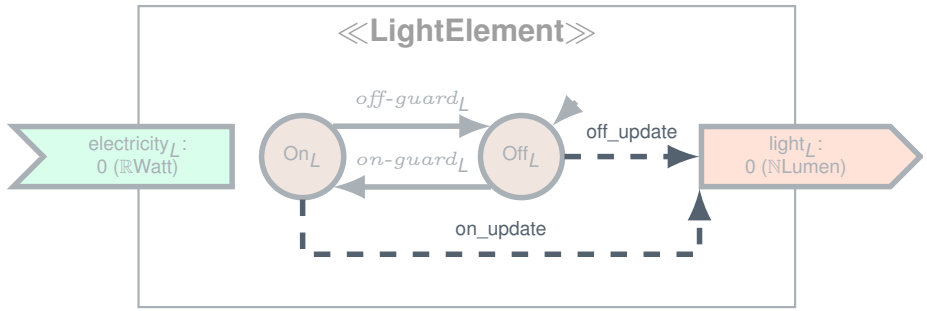


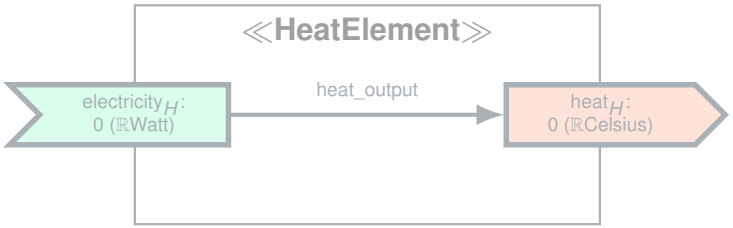

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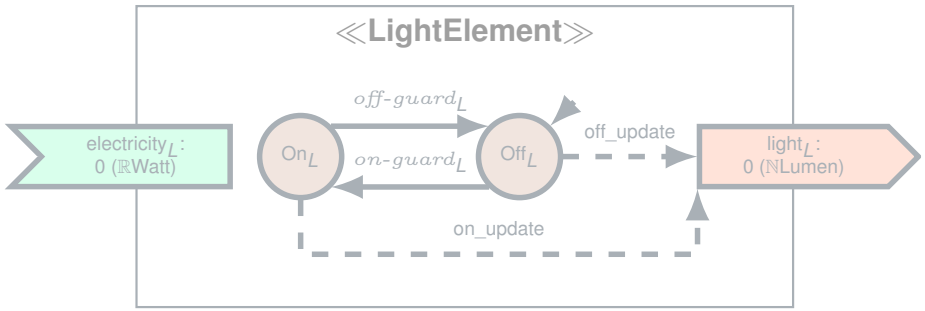


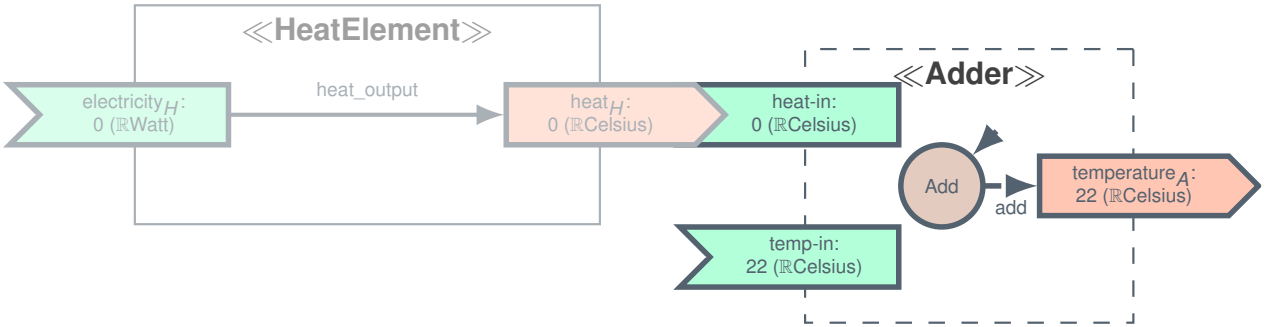

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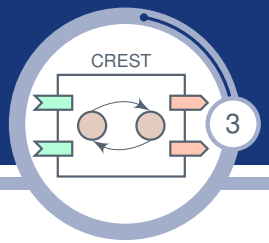


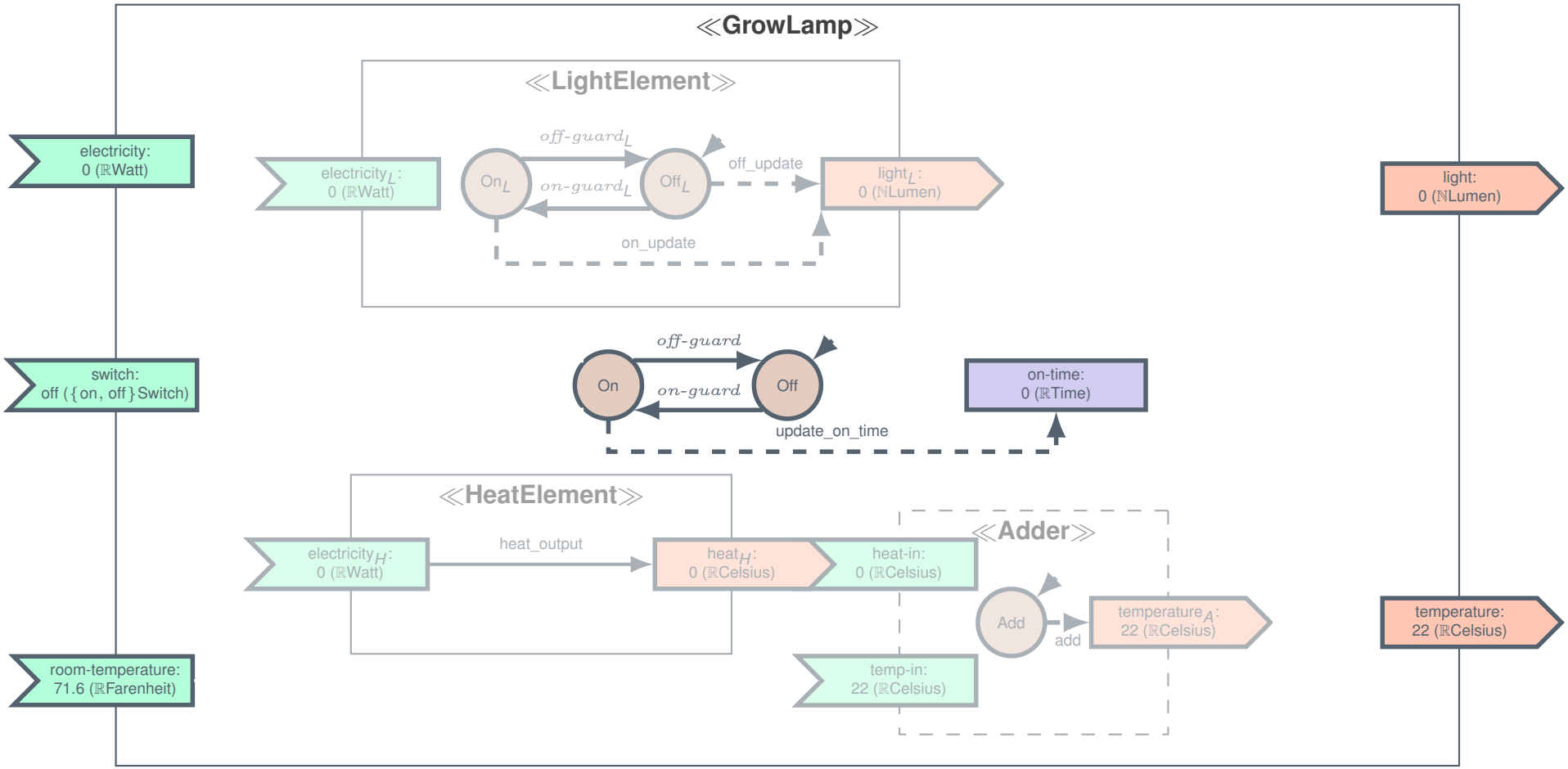

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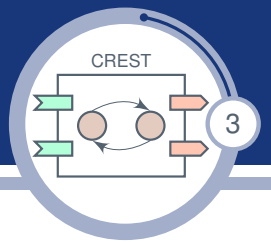
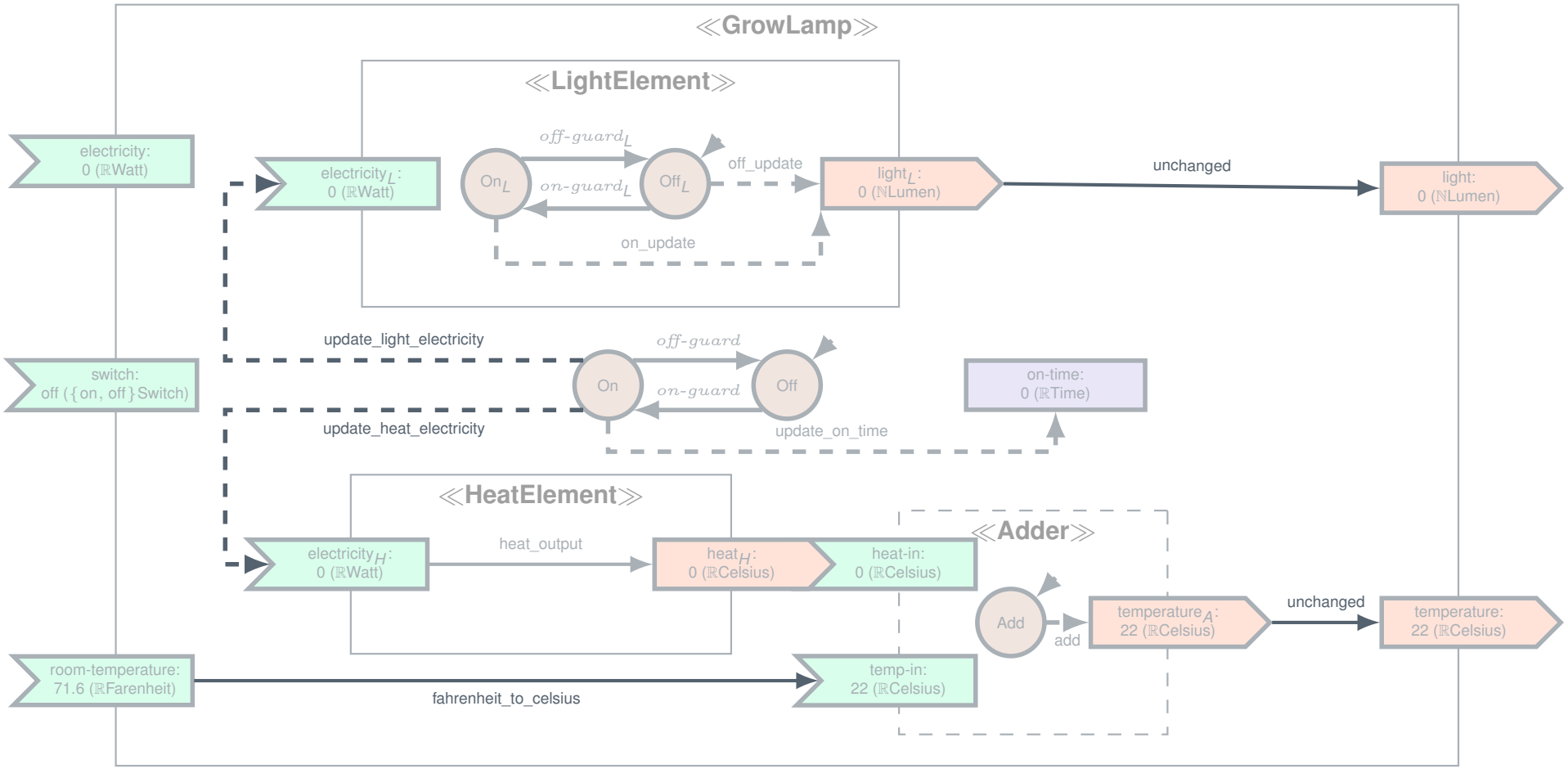
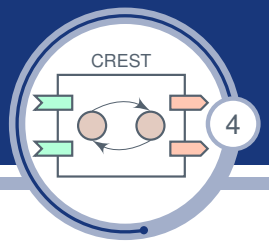


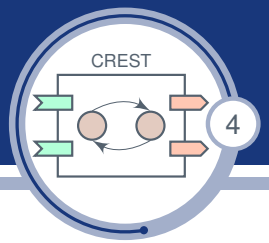



# Language Realization




```
class LightElement(Entity):
```

# Language Realization




```
class LightElement(Entity):

  electricity = Input(resource=Watt, value=0)
  light       = Output(resource=Lumen, value=0)
```

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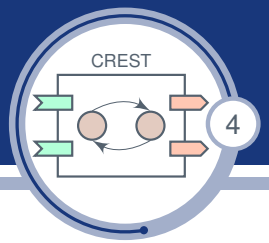


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class LightElement(Entity):

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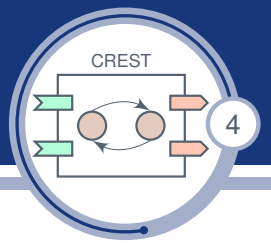


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  off_to_on = Transition(source=off, target=on,
        guard=(lambda self: self.switch.value == "on" and
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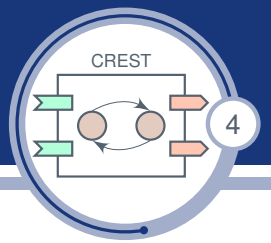


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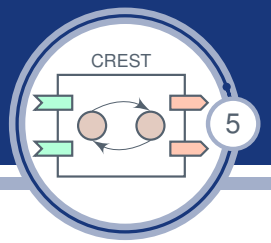
  off_to_on = Transition(source=off, target=on,
        guard=(lambda self: self.switch.value == "on" and
                            self.electricity.value >= 100)
  )

  @update(state=on, target=light)
  def set_light_on(self, dt=0):
      return 800
```

# Why not «formalism-XYZ»?

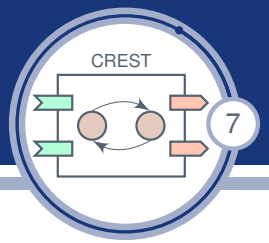



- powerful, but complex
- too generic
- feature workarounds
- architecture and behaviour

# One DSL to rule them all?

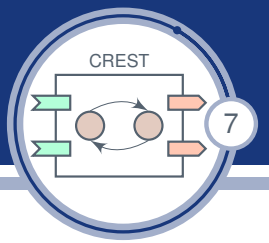


# CREST Formalization




*Domains*, *Units*

# CREST Formalization

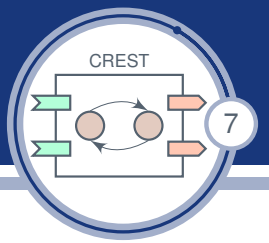



$$Domains \times Units = Types$$

$$\text{values} = \{\langle v, unit \rangle \mid v \in domain, \langle domain, unit \rangle \in Types\}$$

where

# CREST Formalization

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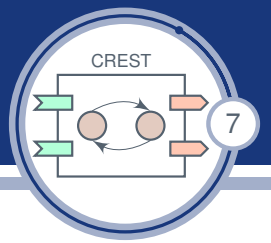


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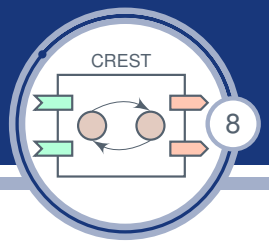
where

...

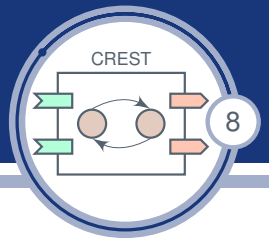
it's in the paper

# How to design a simulator




- advance time in constant steps?
- transition time calculation
- generate CREST diagrams

# How to design a simulator

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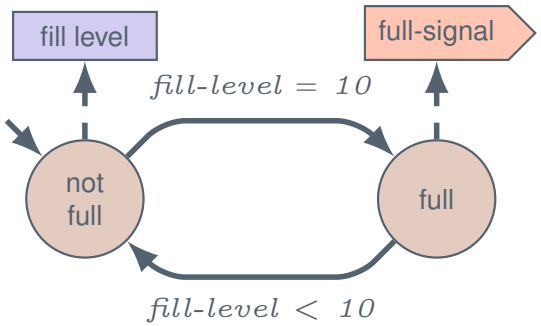
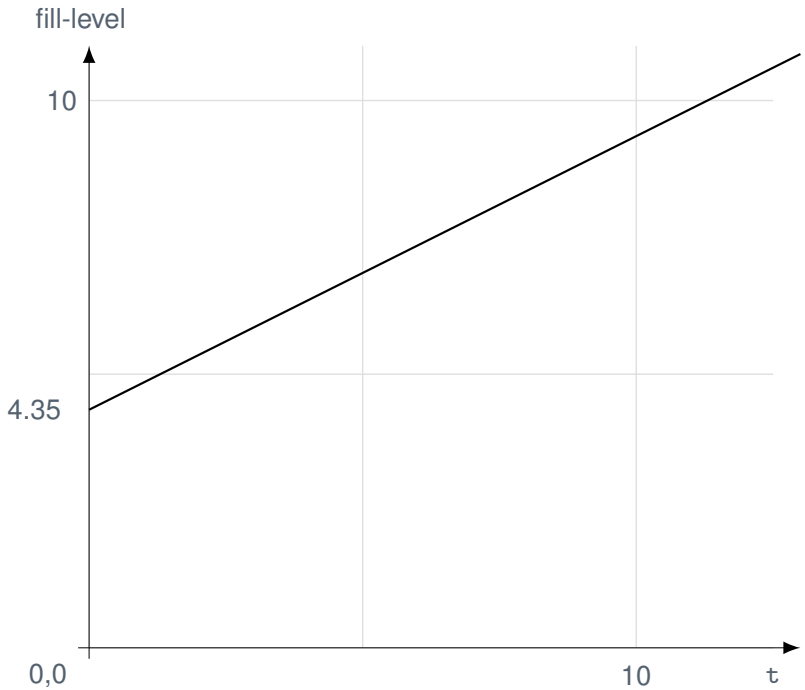



*flow-rate: 0.5 per time step*



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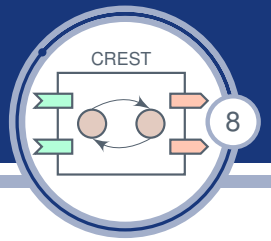


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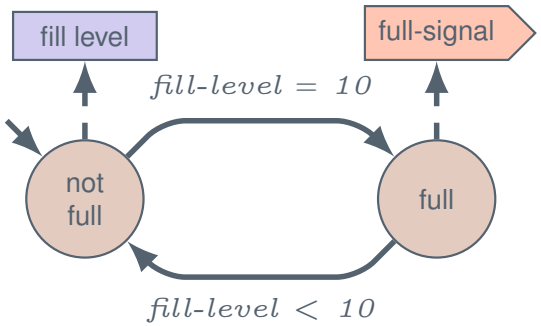


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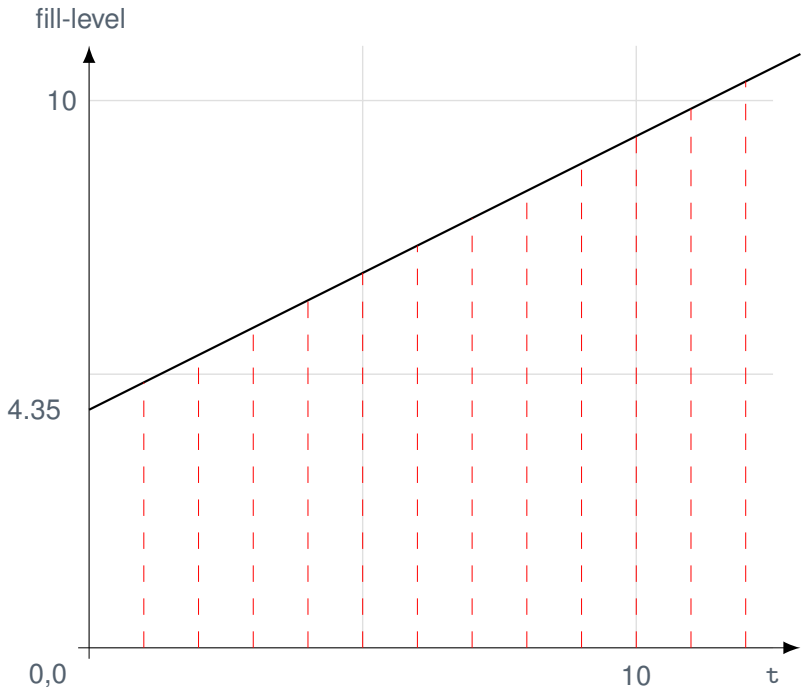

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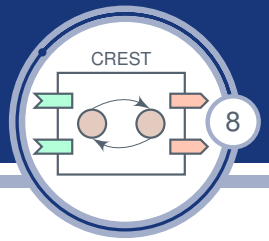


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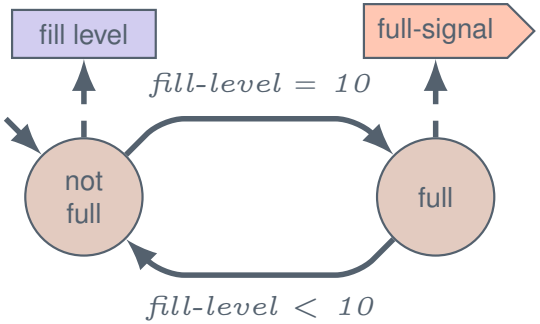


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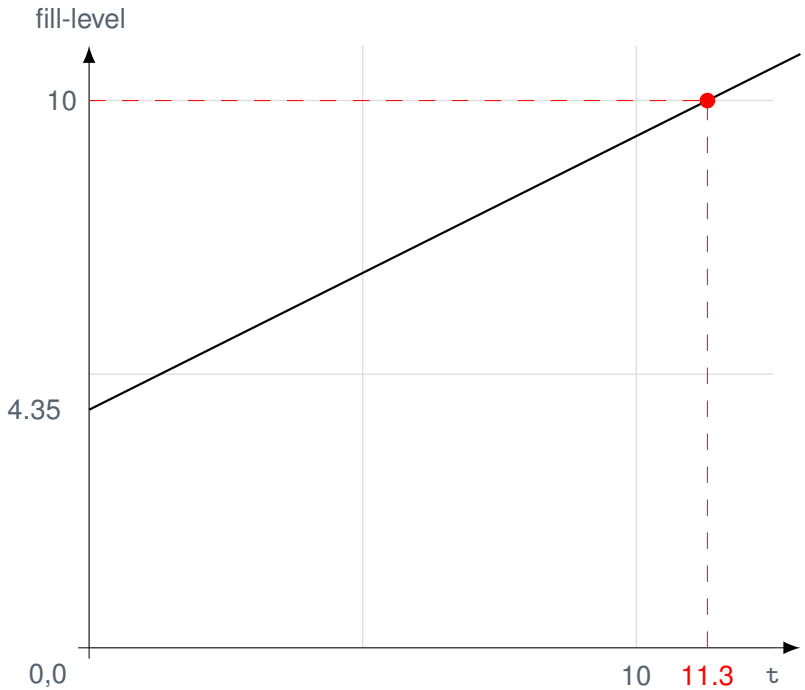
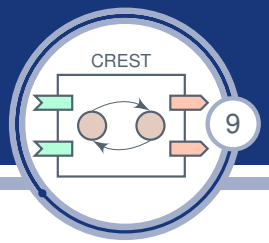


# Advanced



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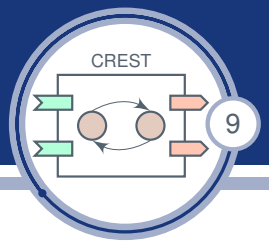
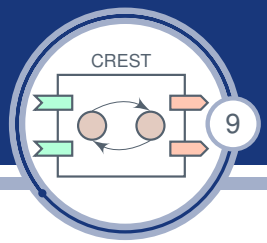


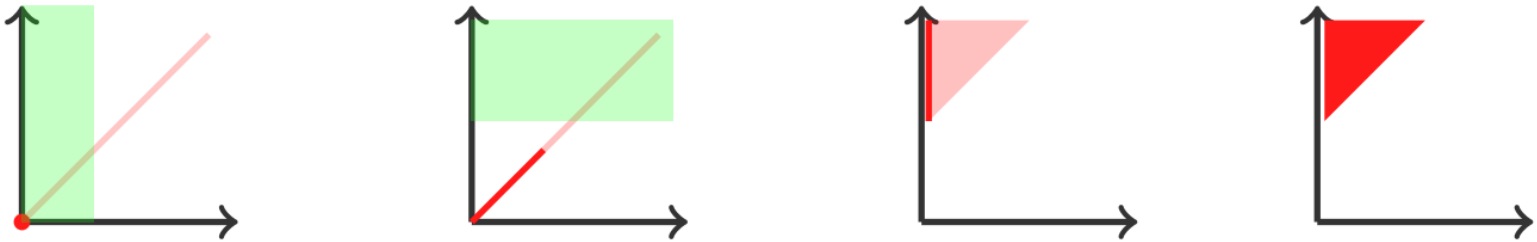

## Verification

# Advanced



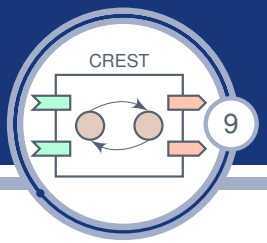

## Verification

- state space exploration
- zone/region-based verification



http://www-i2.informatik.rwth-aachen.de/ sri/Slides/sri-zonebased.pdf

# Advanced

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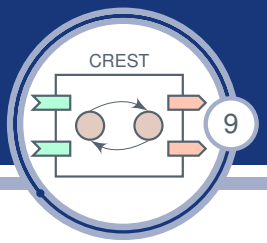


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## Controller synthesis

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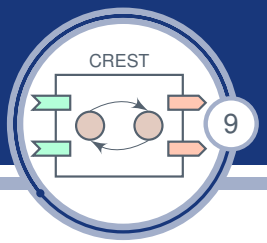


## Verification

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## Controller synthesis

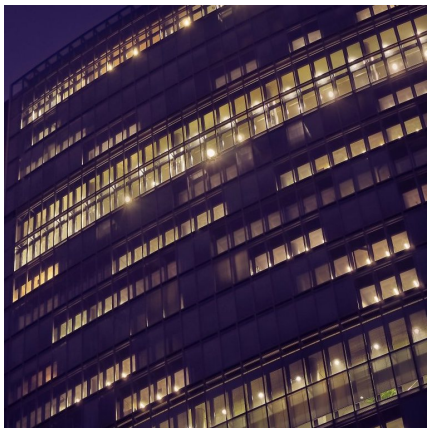
- planning + optimization + simulation
- changing parameters
- changing (sub-)systems

# Applications

plant growing

home automation

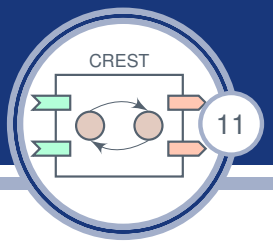
job scheduling



office automation

https://cs.wikipedia.org/wiki/Roomba#/media/File:IRobot_Roomba_780.jpg

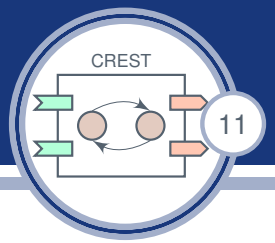
# Conclusion




CREST

- architecture & behaviour
- continuous & reactive
- formal basis

# Conclusion

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`https://mybinder.org/v2/gh/stklik/CREST/binder`

# CREST

## A Continuous, REactive SysTems DSL

Stefan Klikovits, Université de Genéve

@stklik

2018 CUSO Winter School