LUE tutorial

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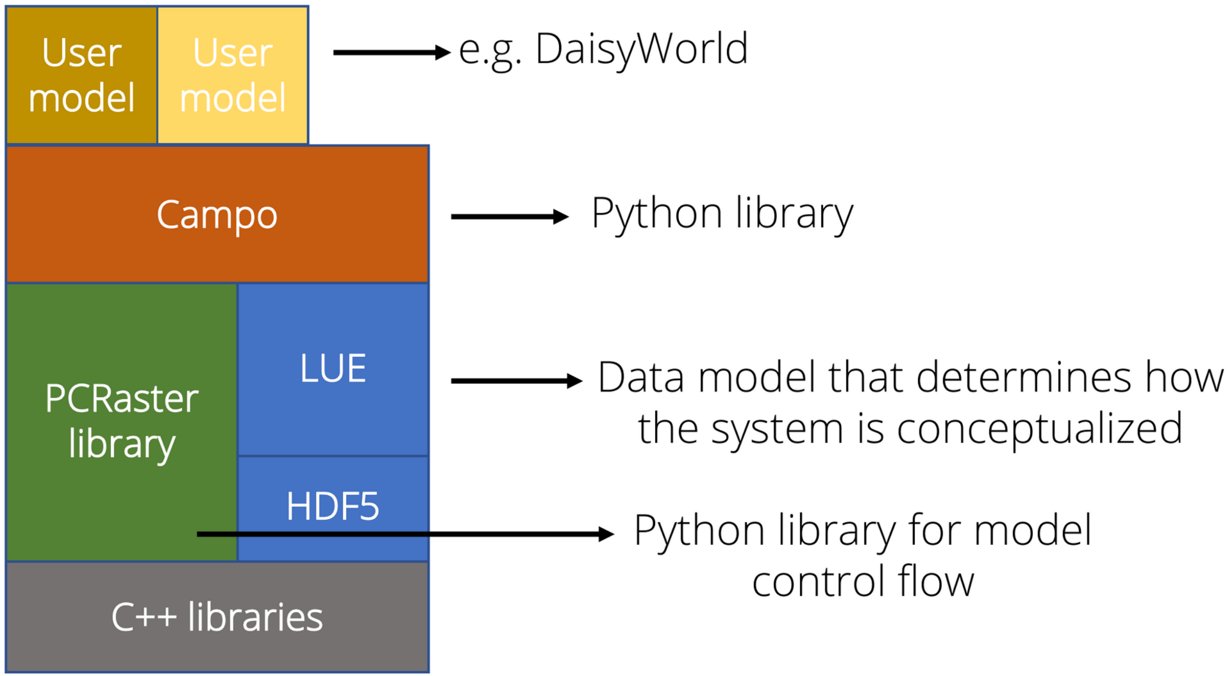
LUE


User model
User model
e.g. DaisyWorld
Campo
Python library
PCRaster library
LUE
HDF5
Data model that determines how the system is conceptualized
Python library for model control flow
C++ libraries

LUE

Modelling framework for simulating large geographical systems of agents and fields

- Modelling framework
  - Usable by software developers
  - Usable by model developers
- Large
  - No arbitrary limits
  - Model size → data set size & number of computations
  - Scalable over CPU cores and cluster nodes
- Systems of agents and fields
  - Integration of agent-based and field-based modelling
  - Single data model

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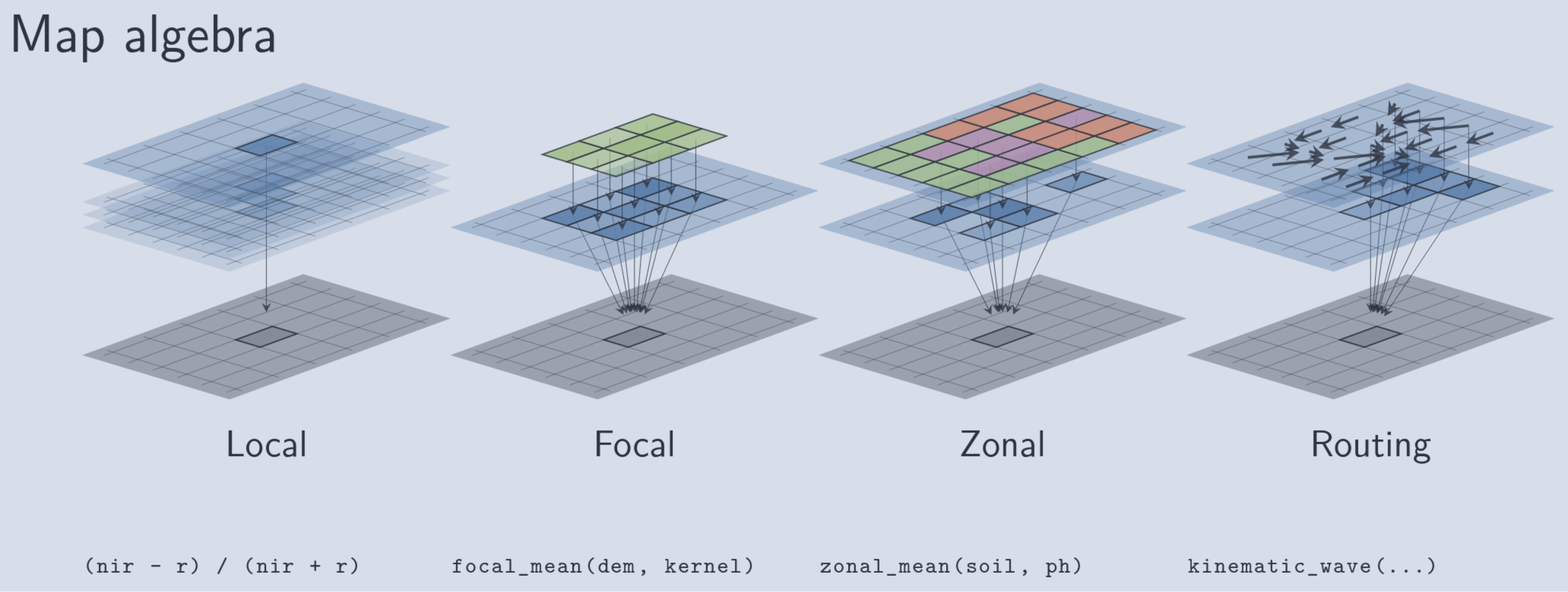
- Field based modelling



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- Asynchronous many-tasks (AMT) approach:
  - Task: work to be executed on a CPU core
  - Sufficient amount of work
  - Independent order of execution

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Possible order of execution:

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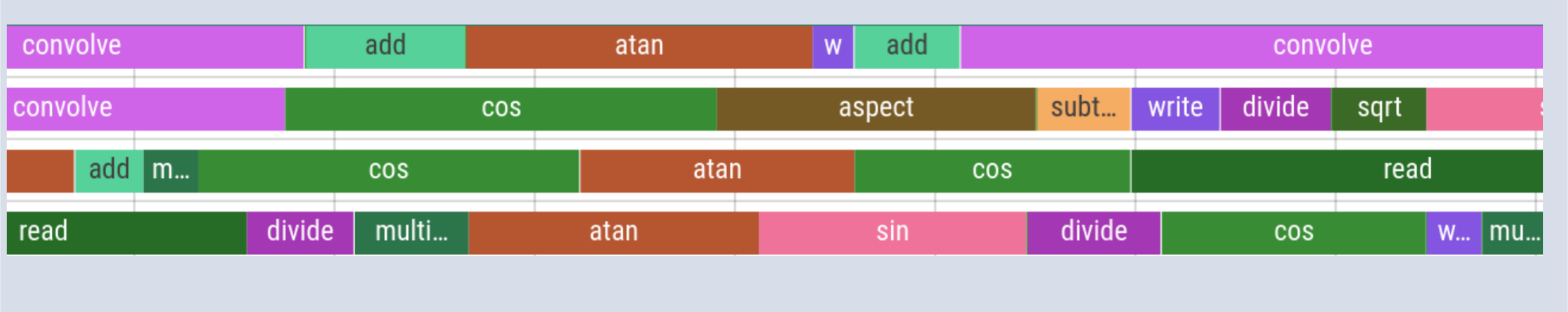
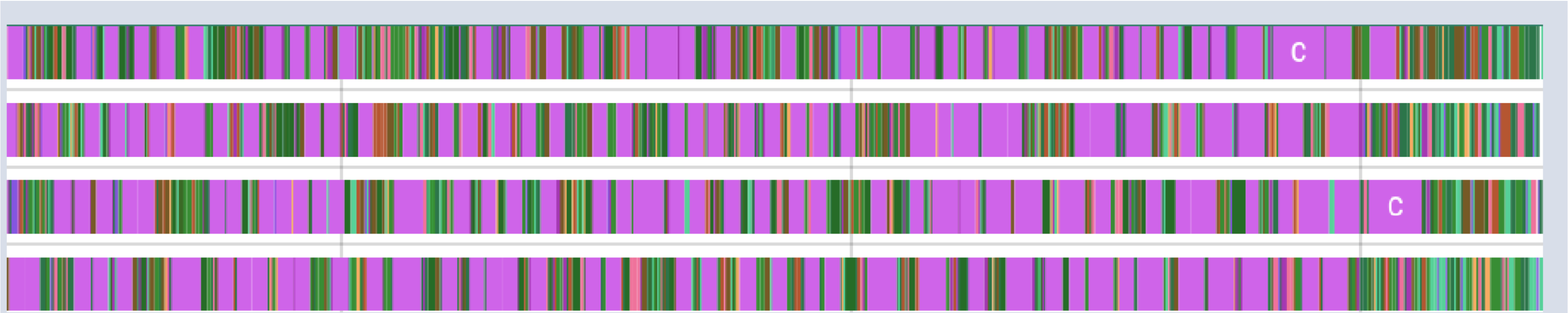
Possible execution order:





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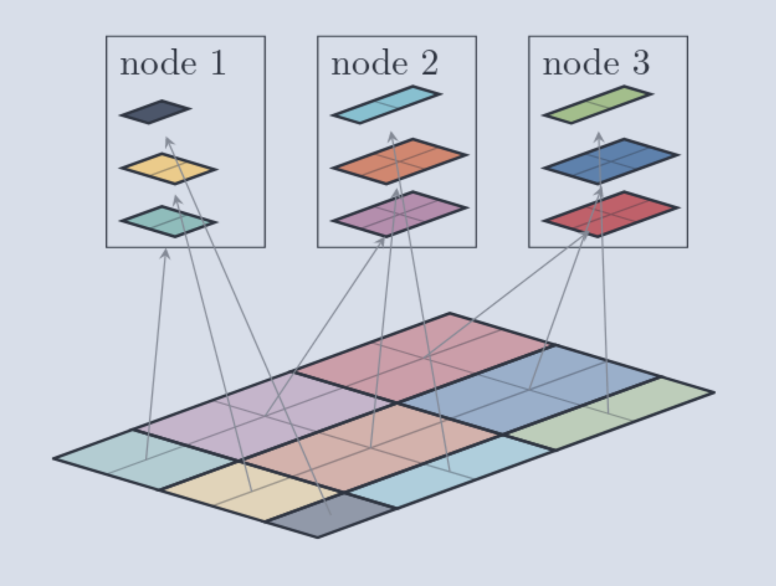
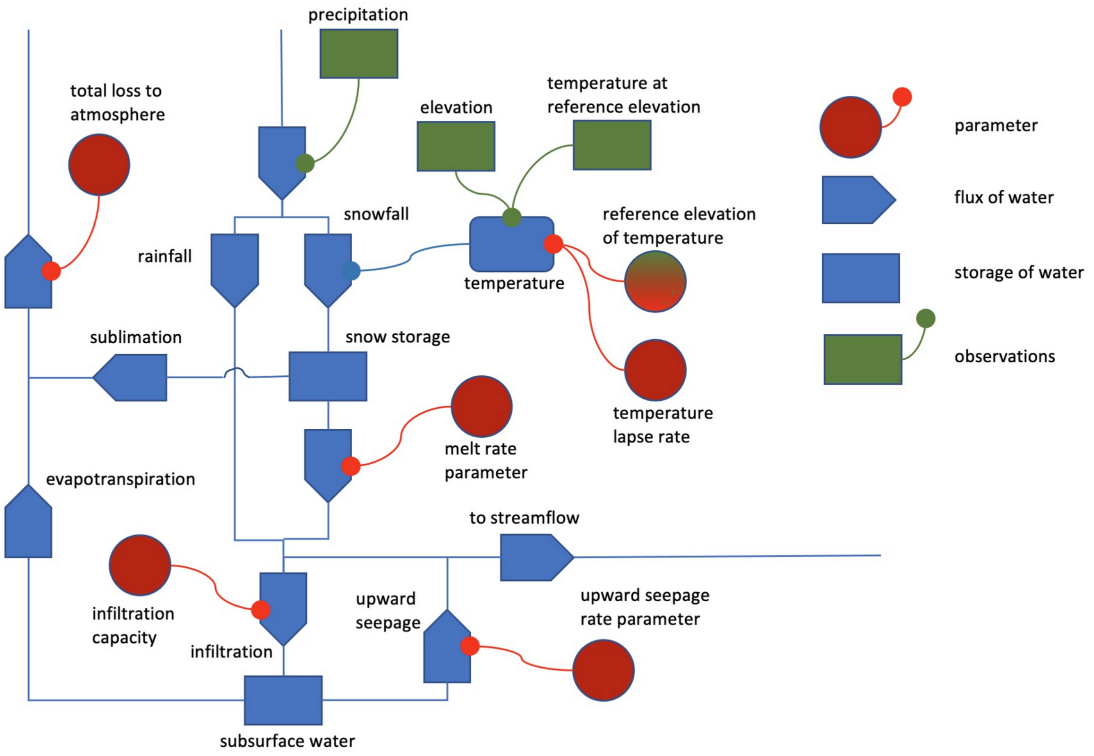
- Large computations:
  - Distribute work over CPU cores
  - Distribute work over cluster nodes



LUE

- Benefits:
  - Use a high-level API to define models (C++, Python)
  - Execute models faster
  - Execute larger models
  - No need to do the spatial domain partitioning yourself
  - No need to write parallel algorithms yourself
  - Open source, free to use, installable on all major platforms

A hydroLUEgical model



Air temperature:

$$t = t_{obs} - l(e - e_{obs})$$

Potential infiltration:

$$a = m(\max(t, 0)) + s$$

A hydroLUEgical model

```
def simulate(self, timestep):
    precipitation = self.precipitation[timestep - 1]
    observed_temperature = self.observed_temperature[timestep - 1]
    temperature = observed_temperature - self.temperature_correction

    freezing = temperature < 0.0
    snowfall = lfr.where(freezing, precipitation, 0.0)
    rainfall = lfr.where(~freezing, precipitation, 0.0)

    self.snow = self.snow + snowfall

    potential_melt = lfr.where(
        ~freezing, temperature * self.melt_rate_parameter, 0.0
    )
    actual_melt = minimum(self.snow, potential_melt)

    self.snow = self.snow - actual_melt

    # Sublimate first from atmospheric loss
    sublimation = minimum(self.snow, self.atmospheric_loss)
    self.snow = self.snow - sublimation

    # Potential evapotranspiration from subsurface water (m/day)
    potential_evapotranspiration = maximum(self.atmospheric_loss - sublimation, 0.0)

    # Actual evapotranspiration from subsurface water (m/day)
    evapotranspiration = minimum(
        self.subsurface_water, potential_evapotranspiration
    )
```

$$t = t_{obs} - l(e - e_{obs})$$

A hydroLUEgical model

```python
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```

Same script for

- Notebook
- Workstation
- HPC

A hydroLUEgical model

Demo

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- Current emphasis is on field-based operations
- Will replace PCRaster in Campo
- Research on agent-based operations