Sharing is encouraged

Introduction to Vine Copulas

Judith Claassen

The MYRIAD-EU project has received funding from the European Union's Horizon 2020 research and innovation programme call H2020-LC-CLA-2018-2019-2020 under grant agreement number 101003276

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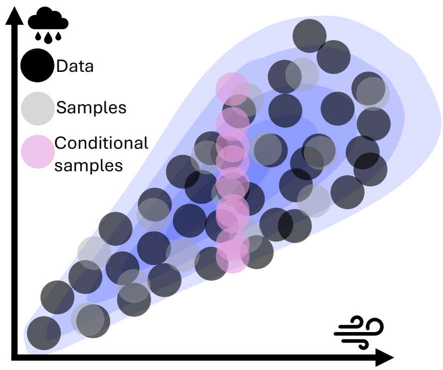

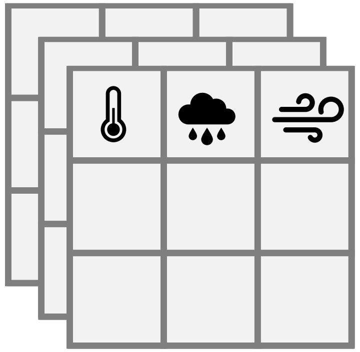

Introduction

The VineCopulas Python Package

Example how VineCopulas can be used in research

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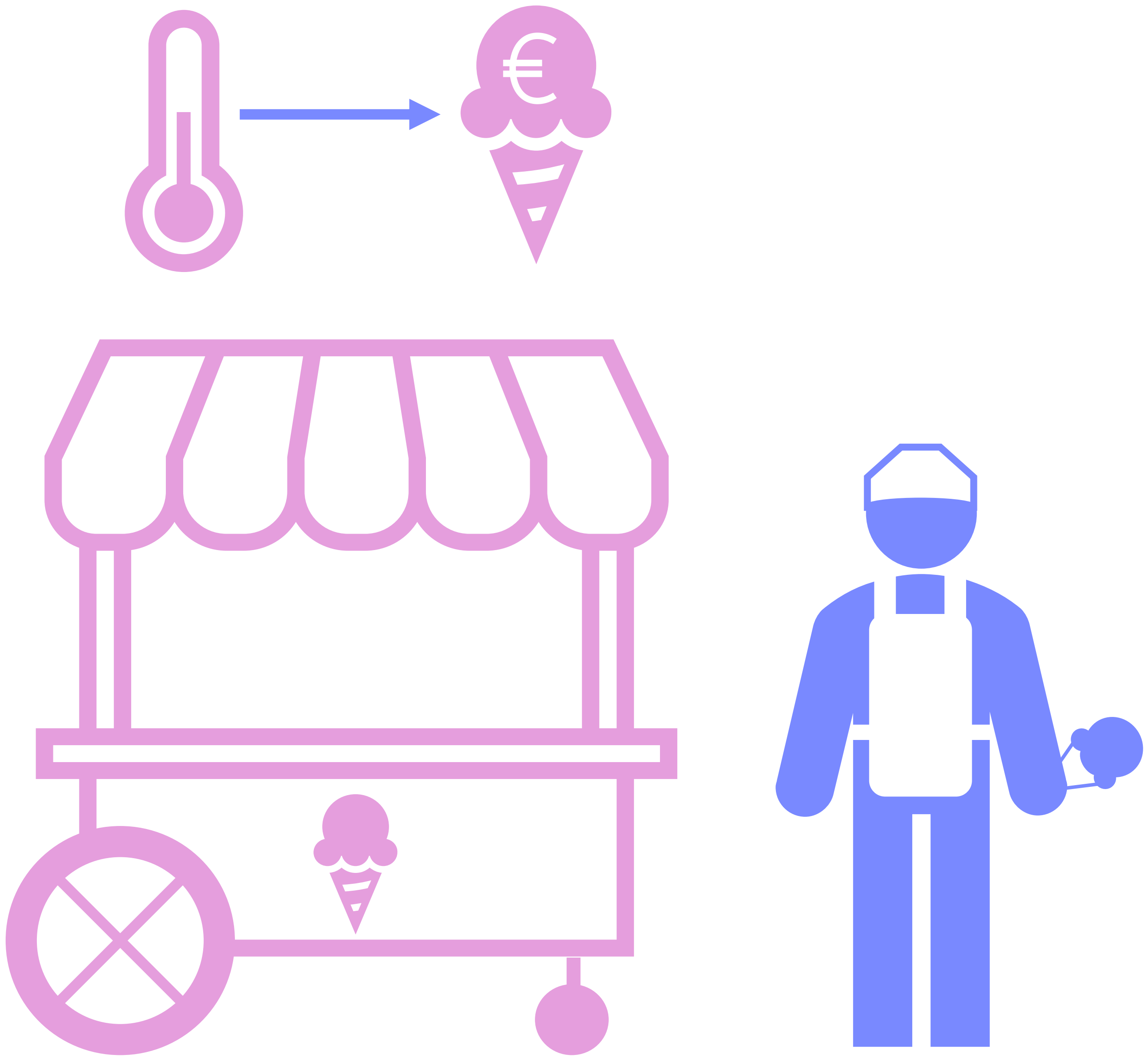
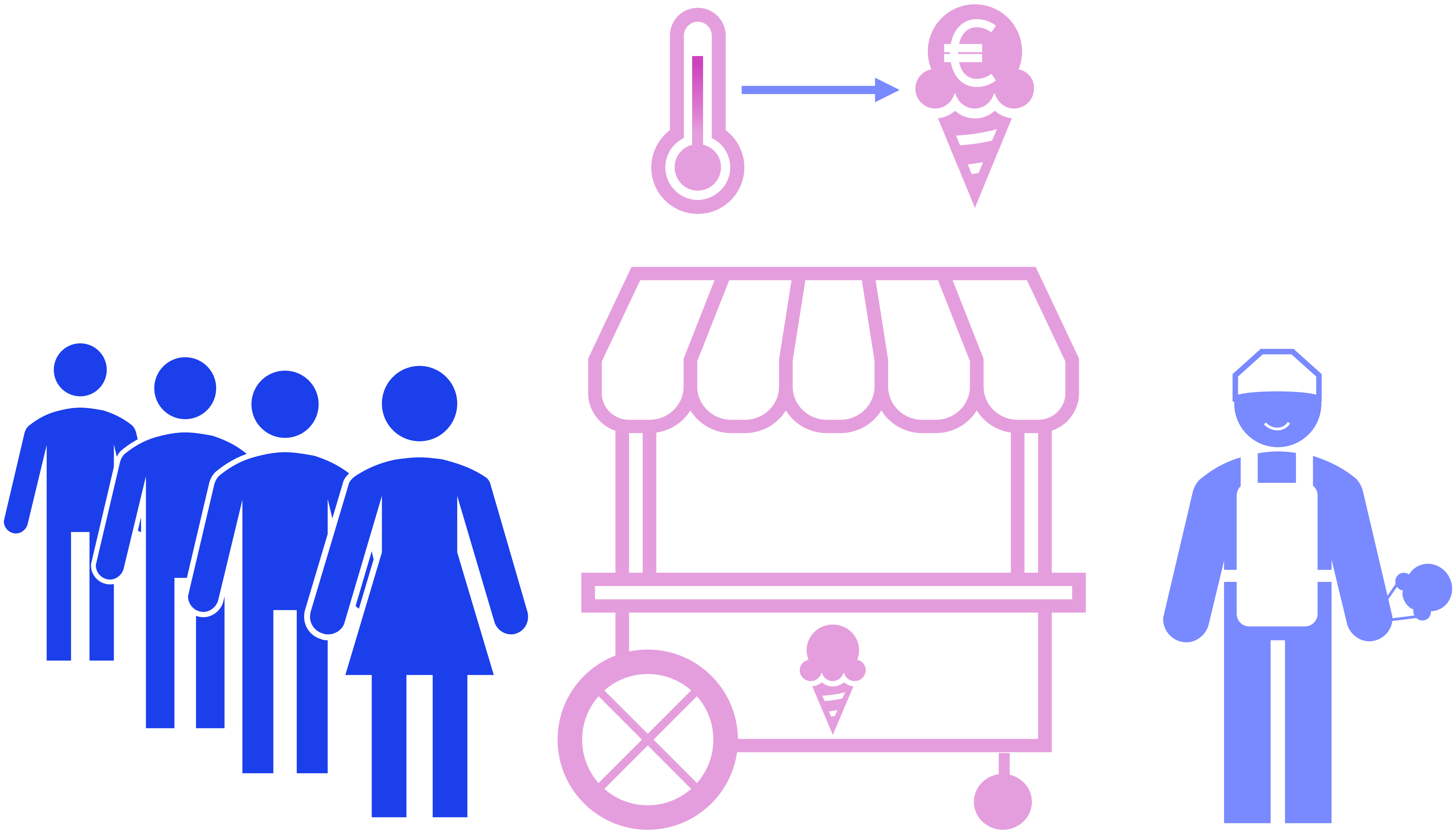
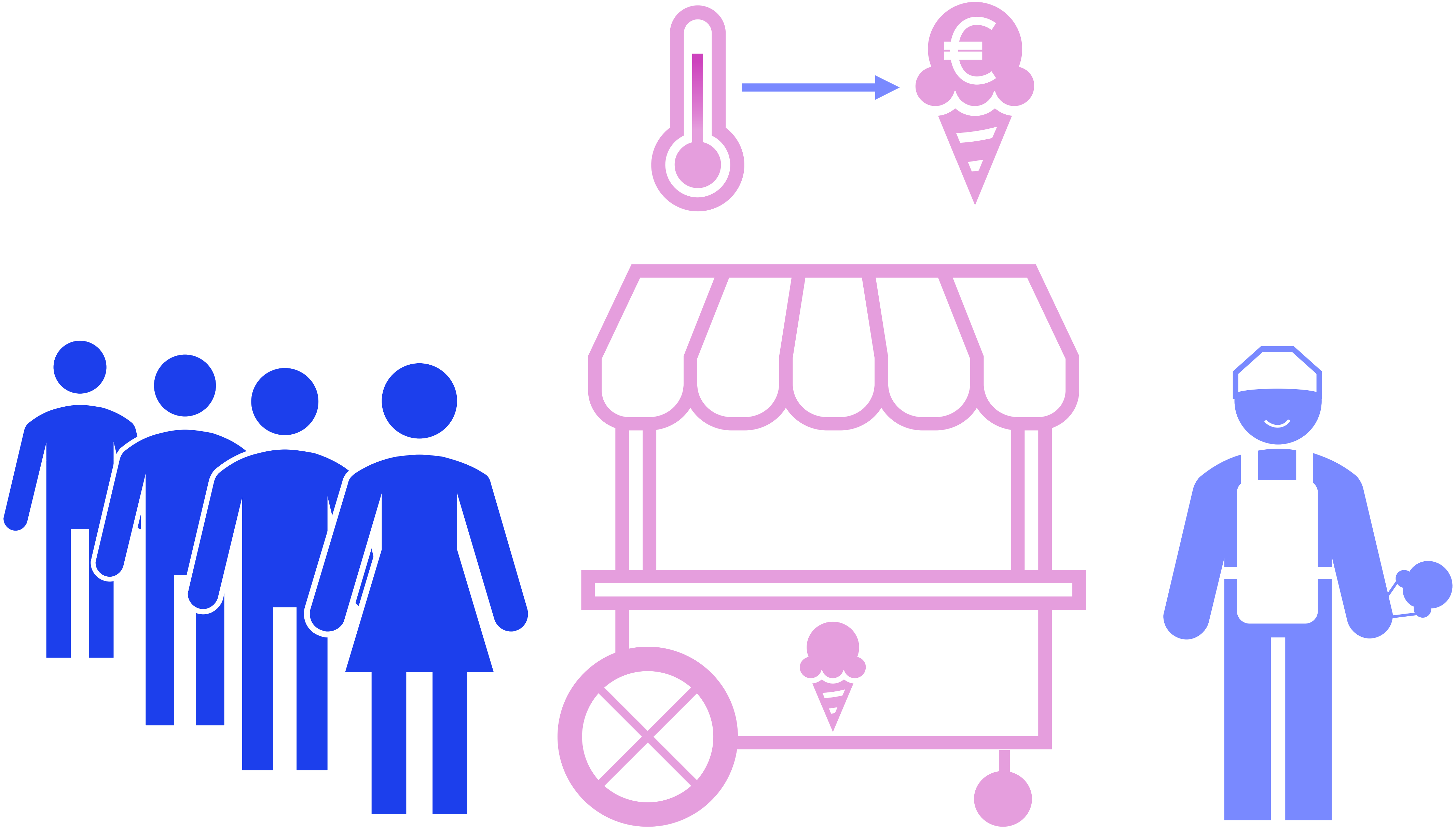
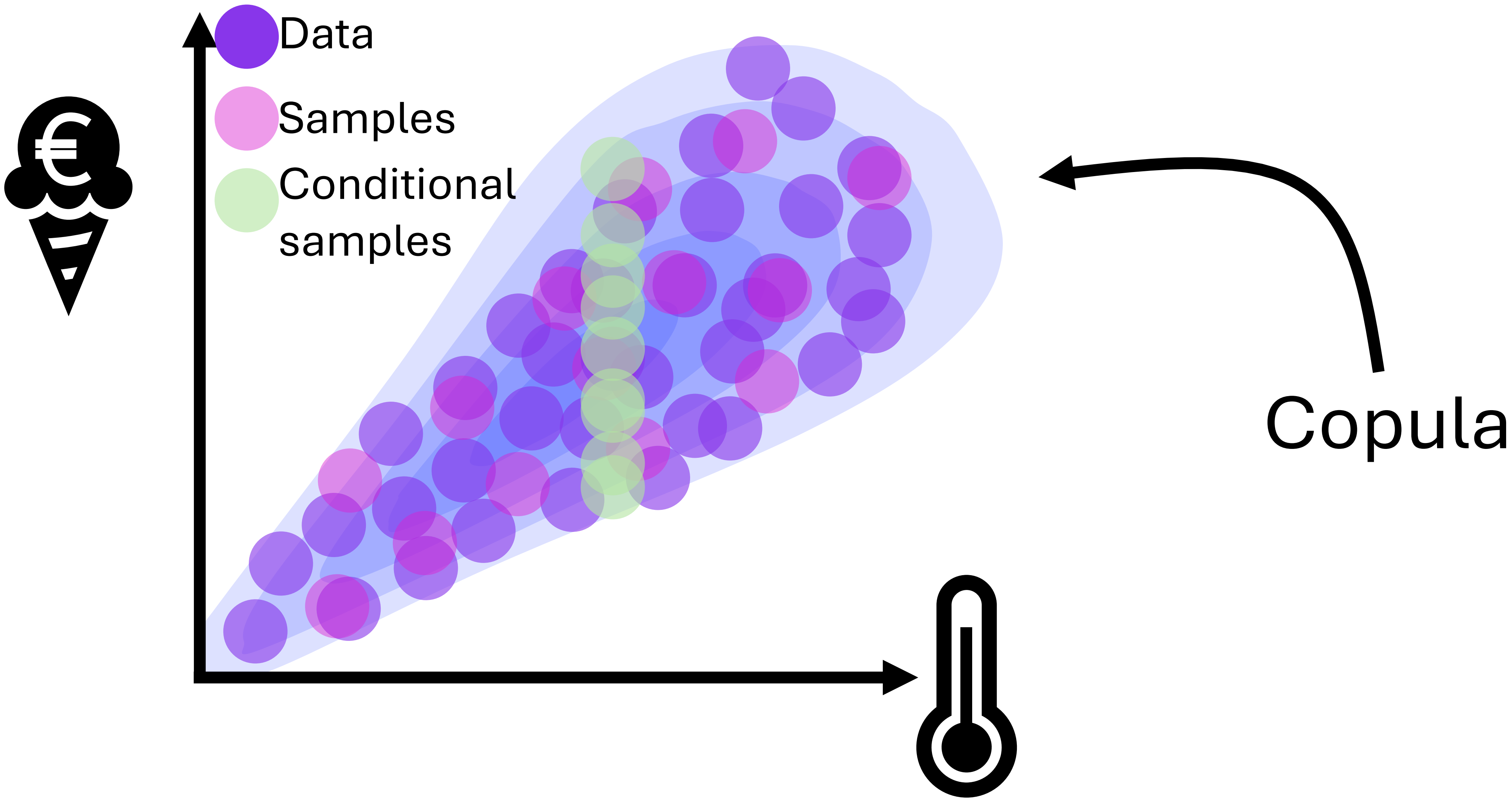
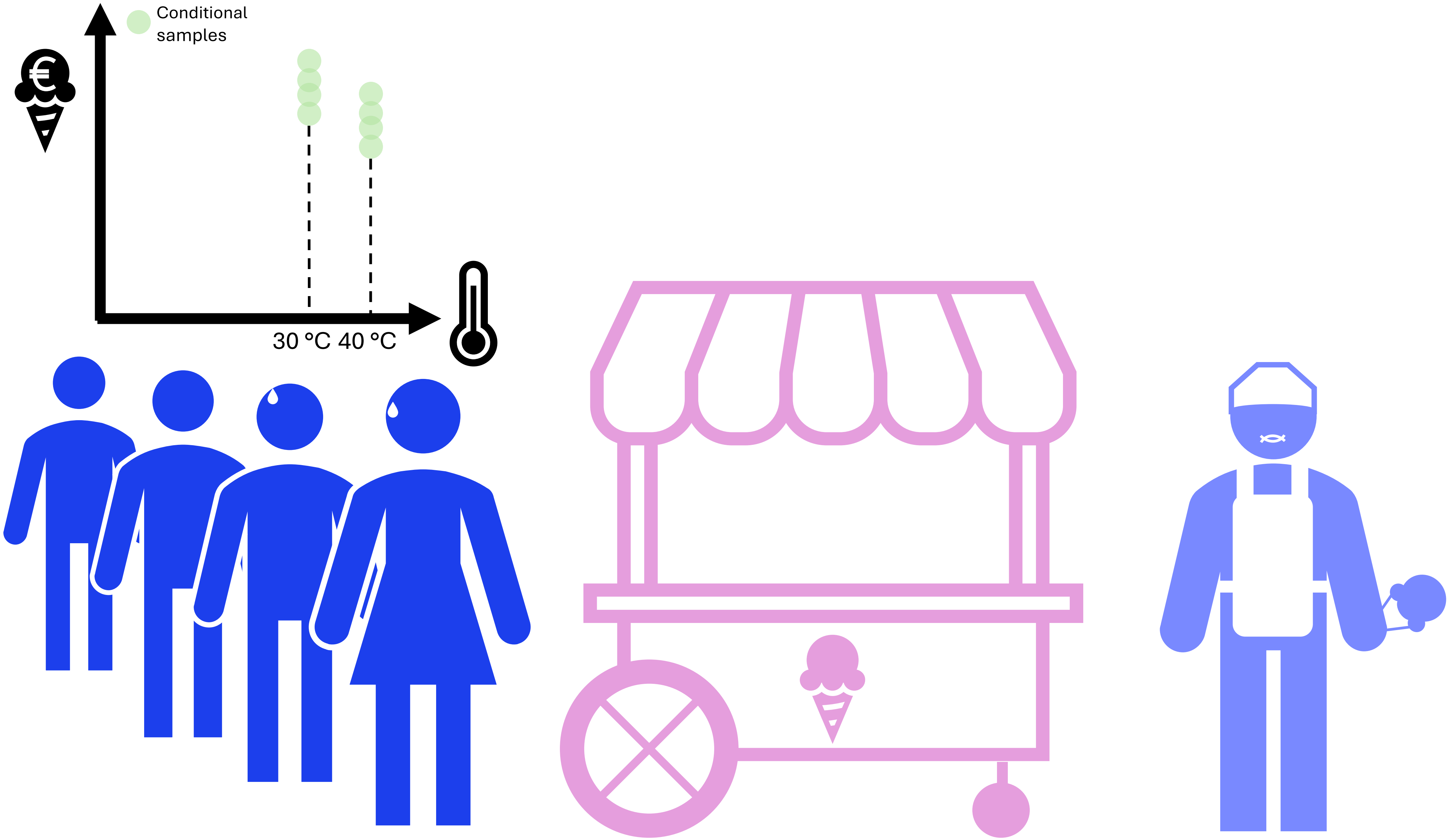
Reducing risks together

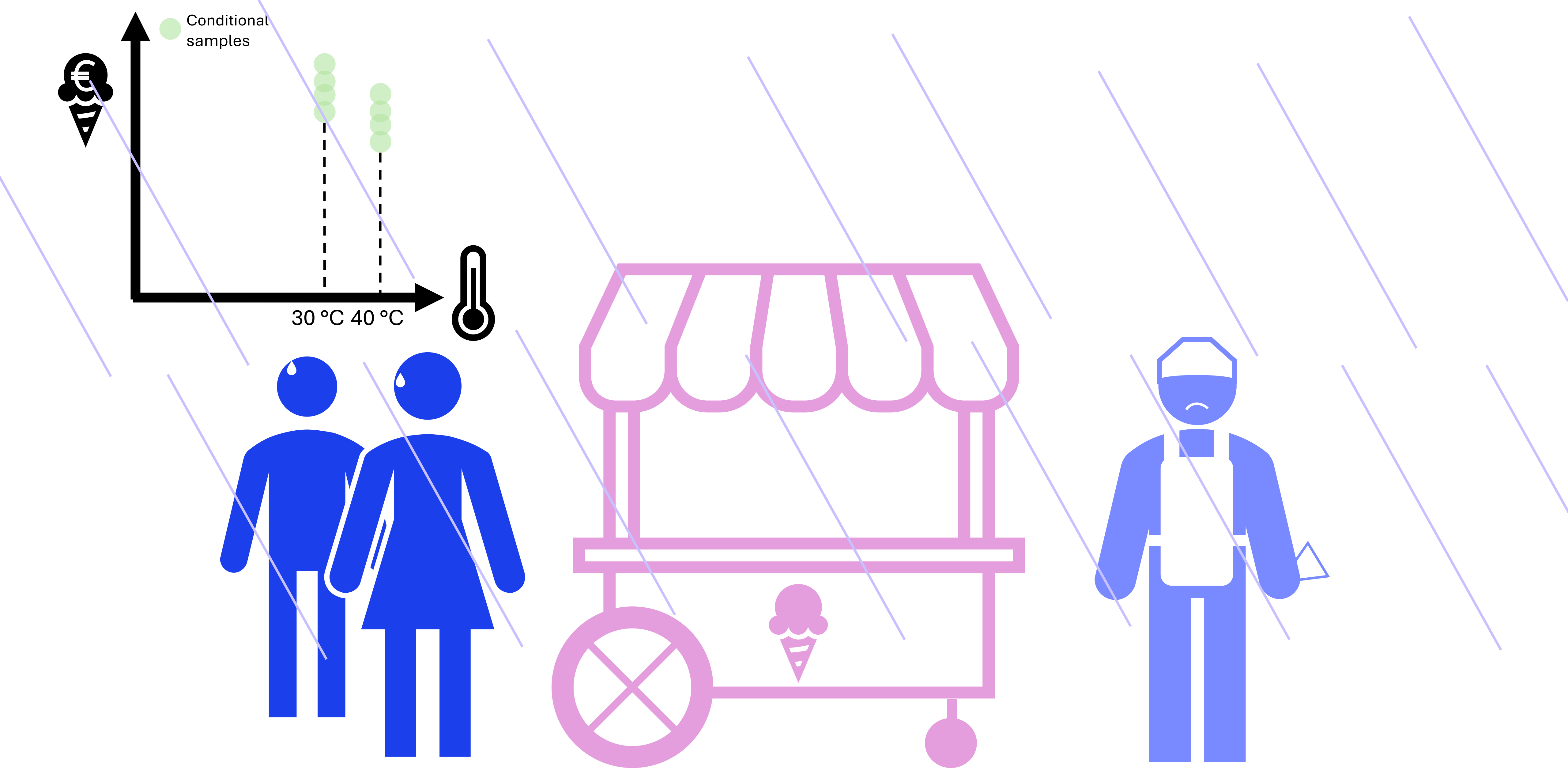







Data
Samples
Conditional samples
Copula


Conditional samples
30 °C 40 °C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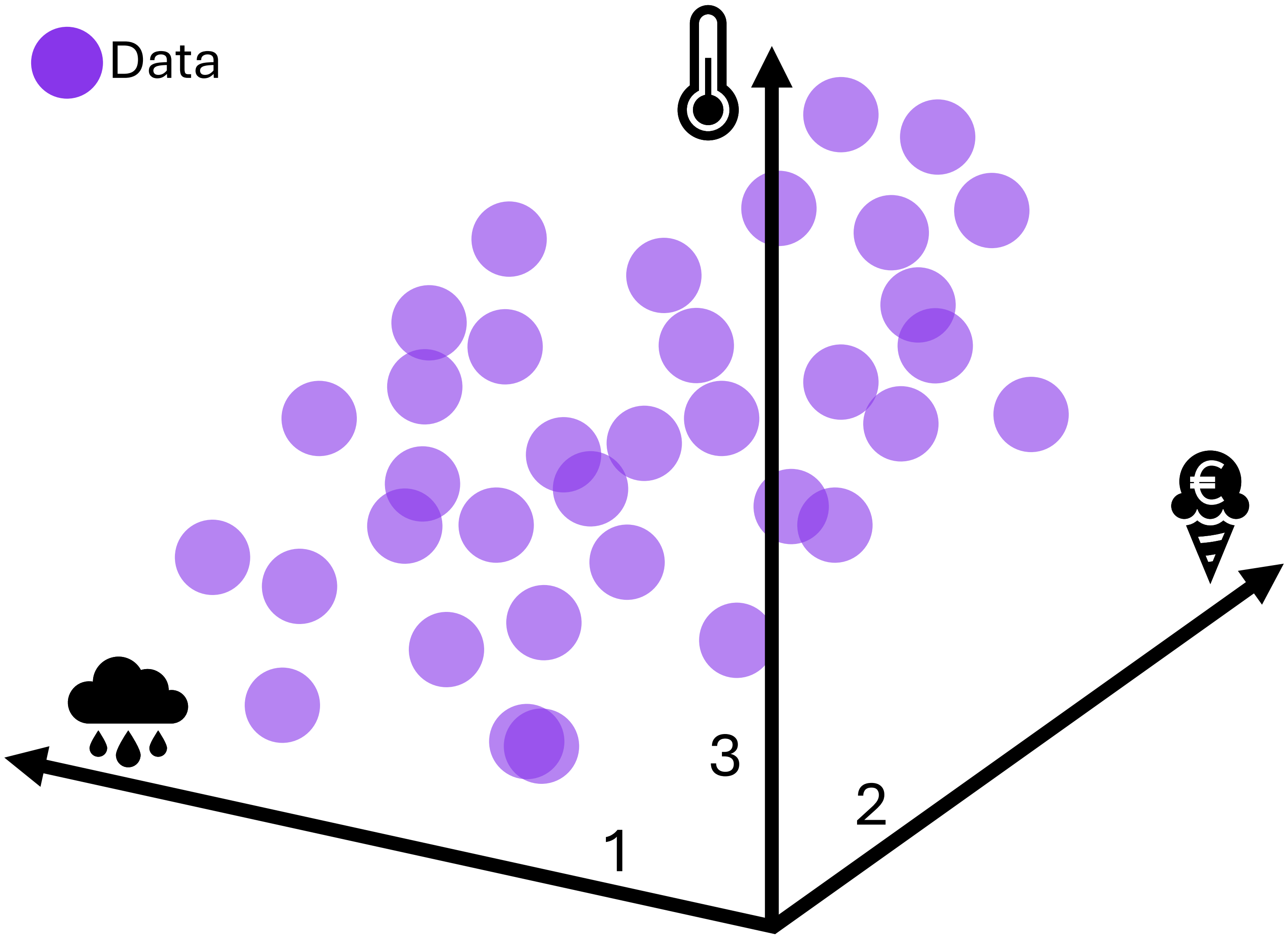
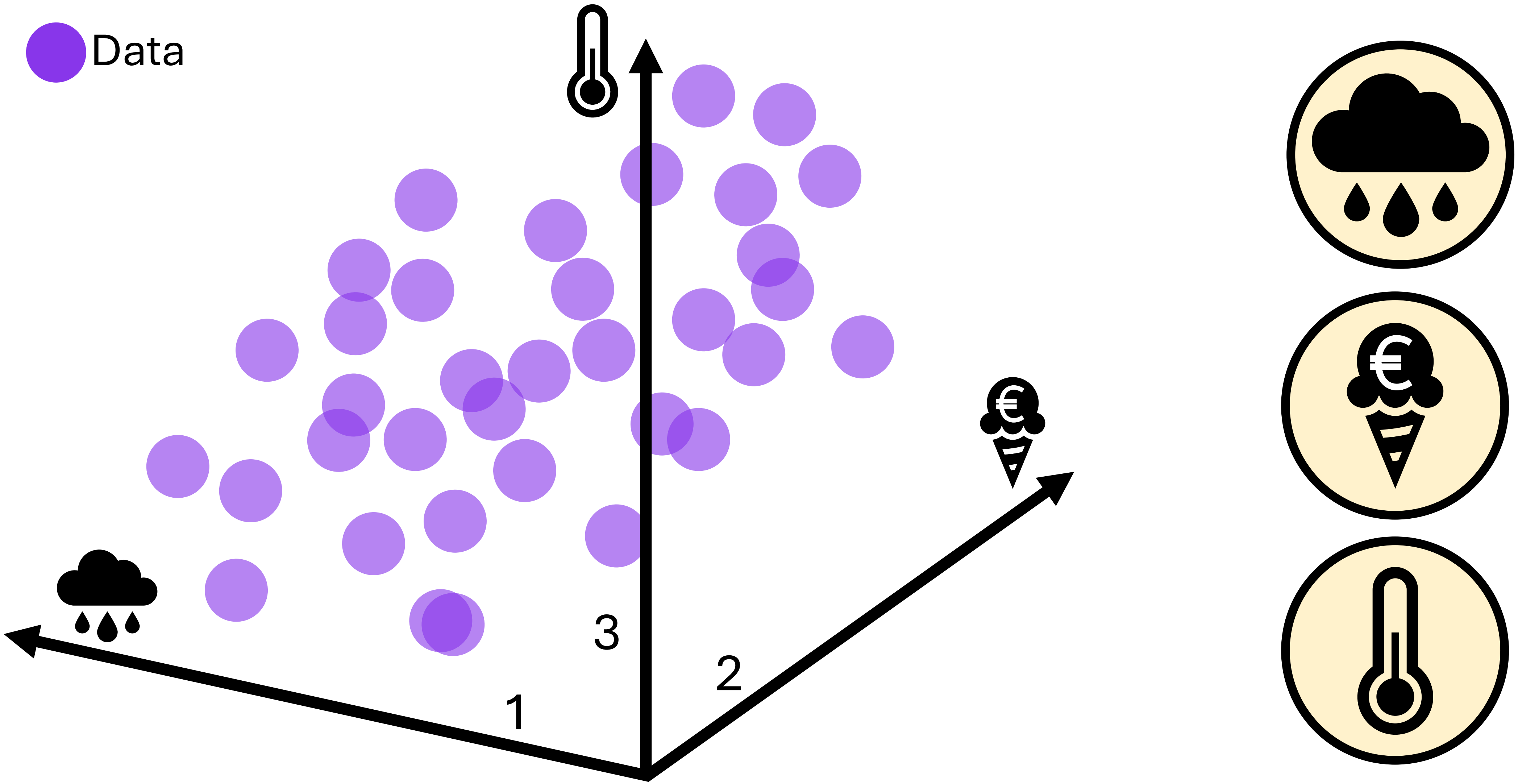

Data
3
2
1



Data
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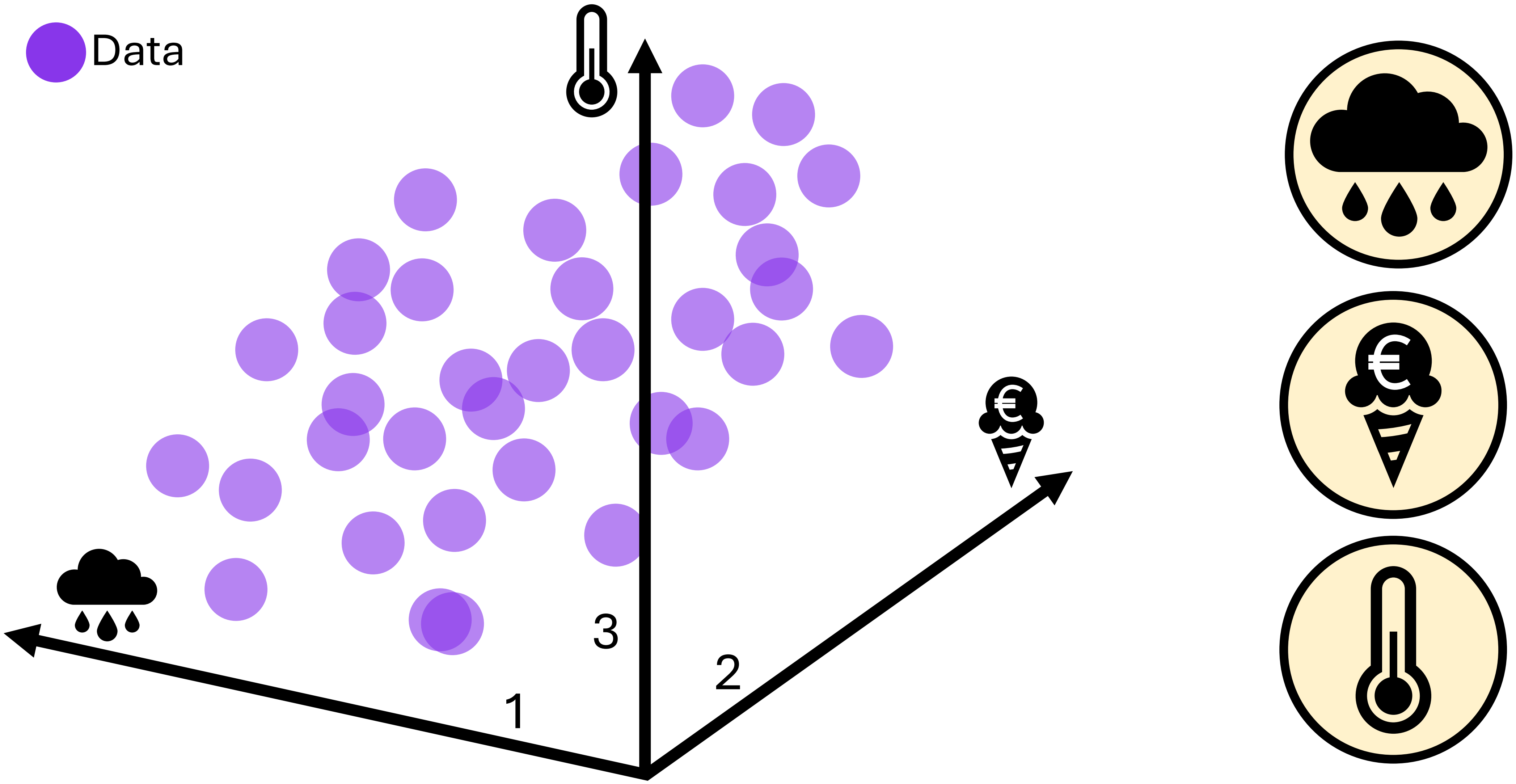
Data
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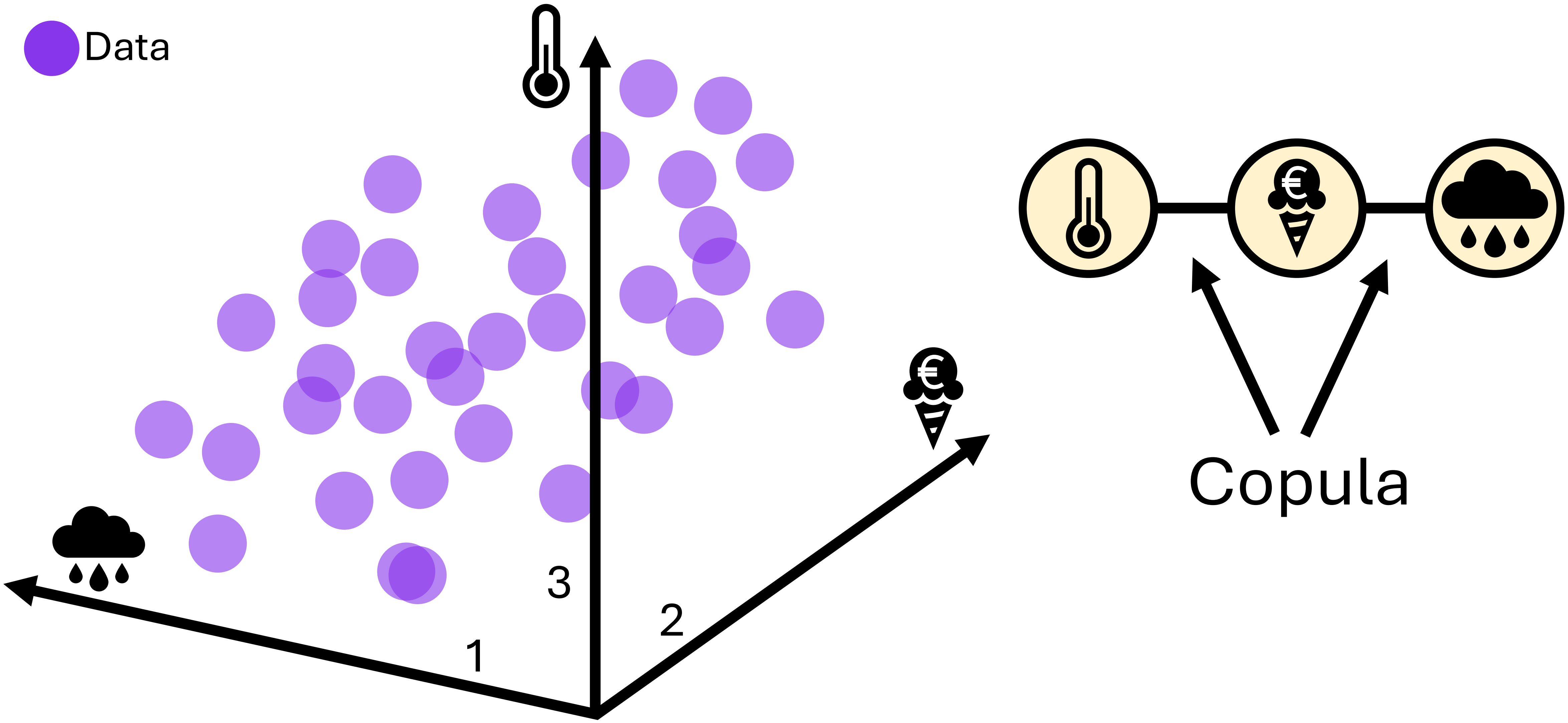

Data
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2
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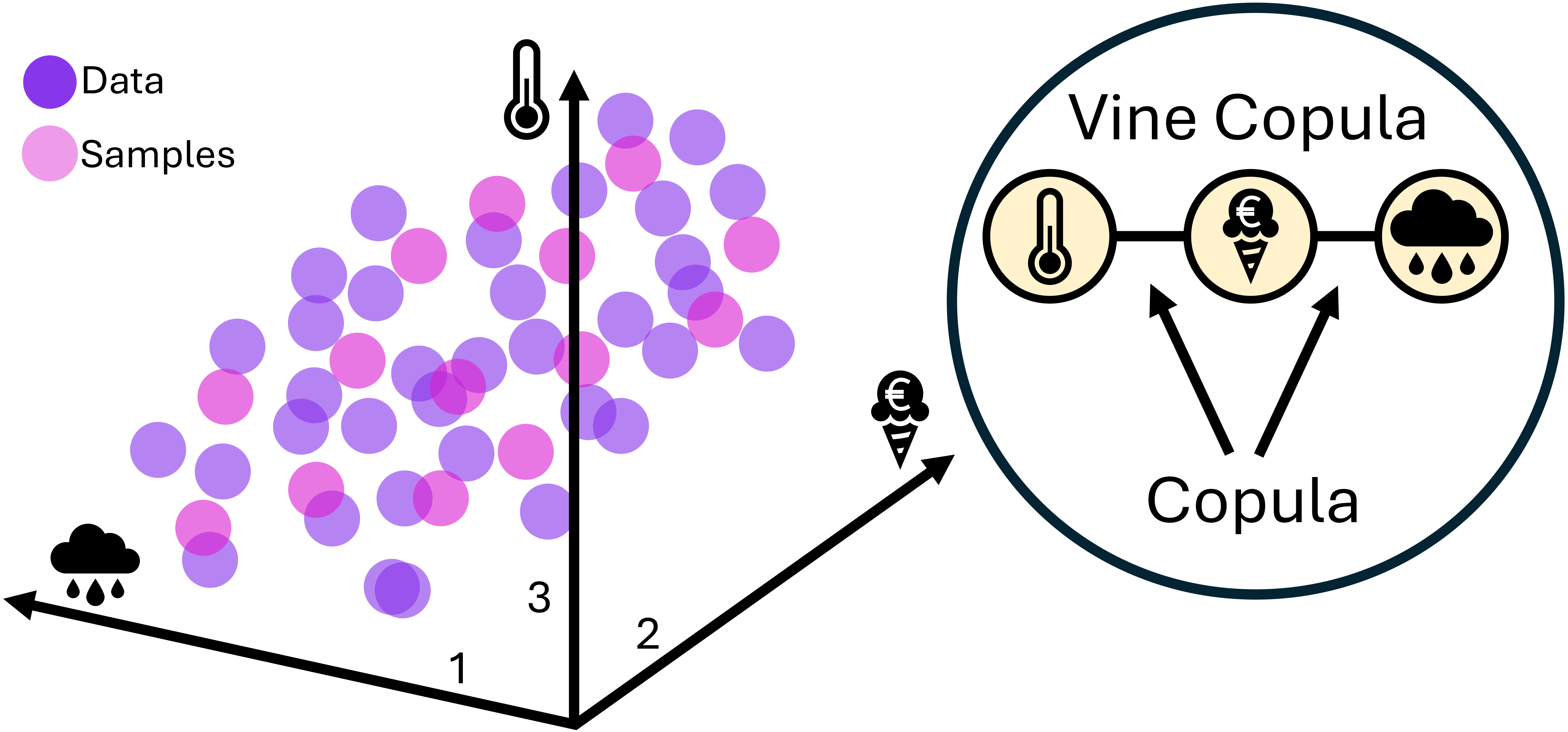
Copula


Data
Samples
3
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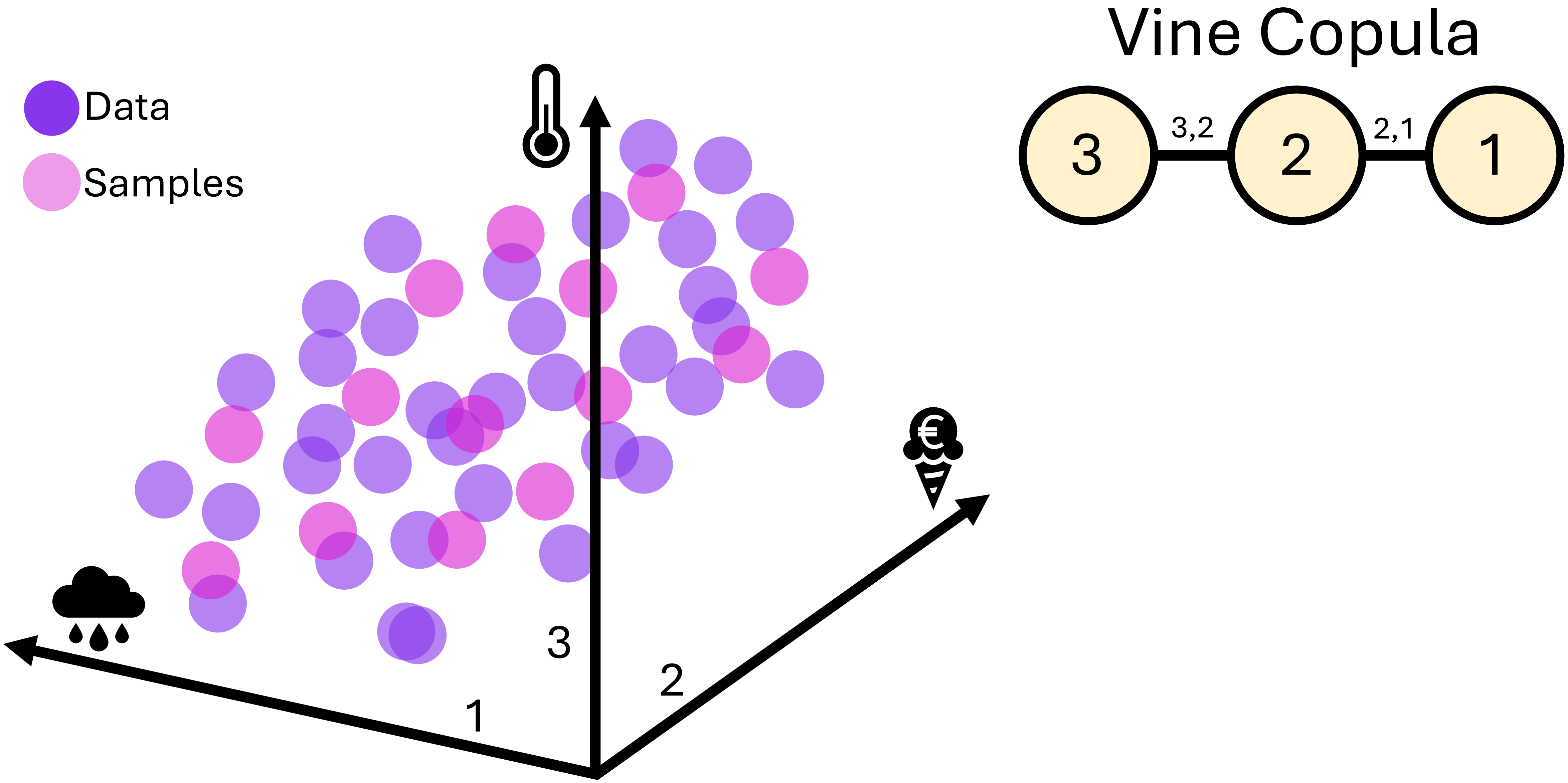
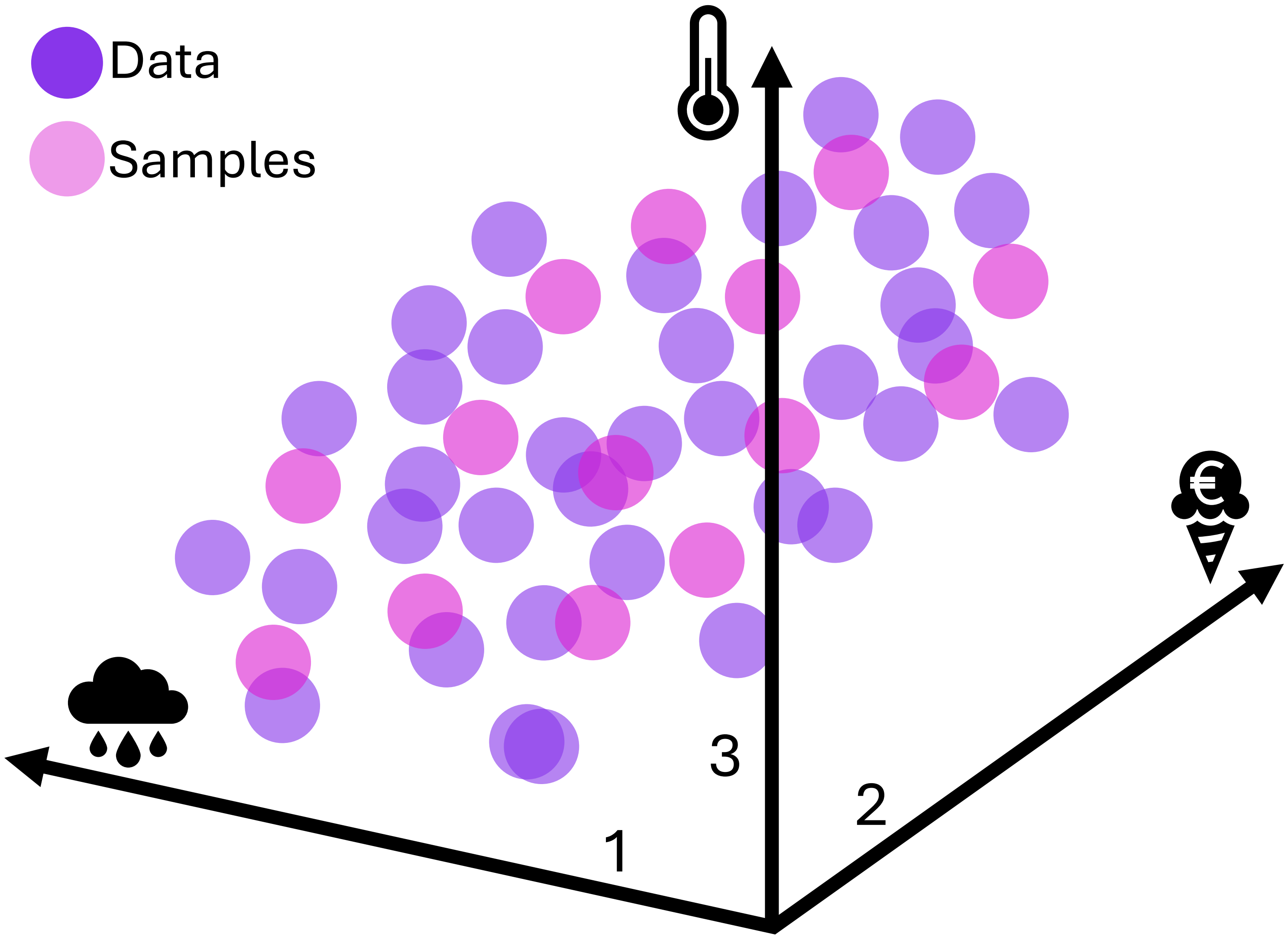
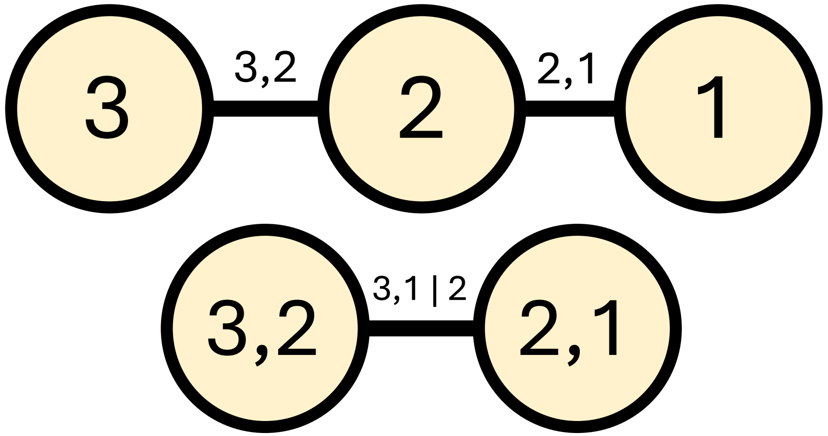
2
Vine Copula
Copula



Vine Copula
3
3,2
2
2,1
1
Data
Samples
3
2
1

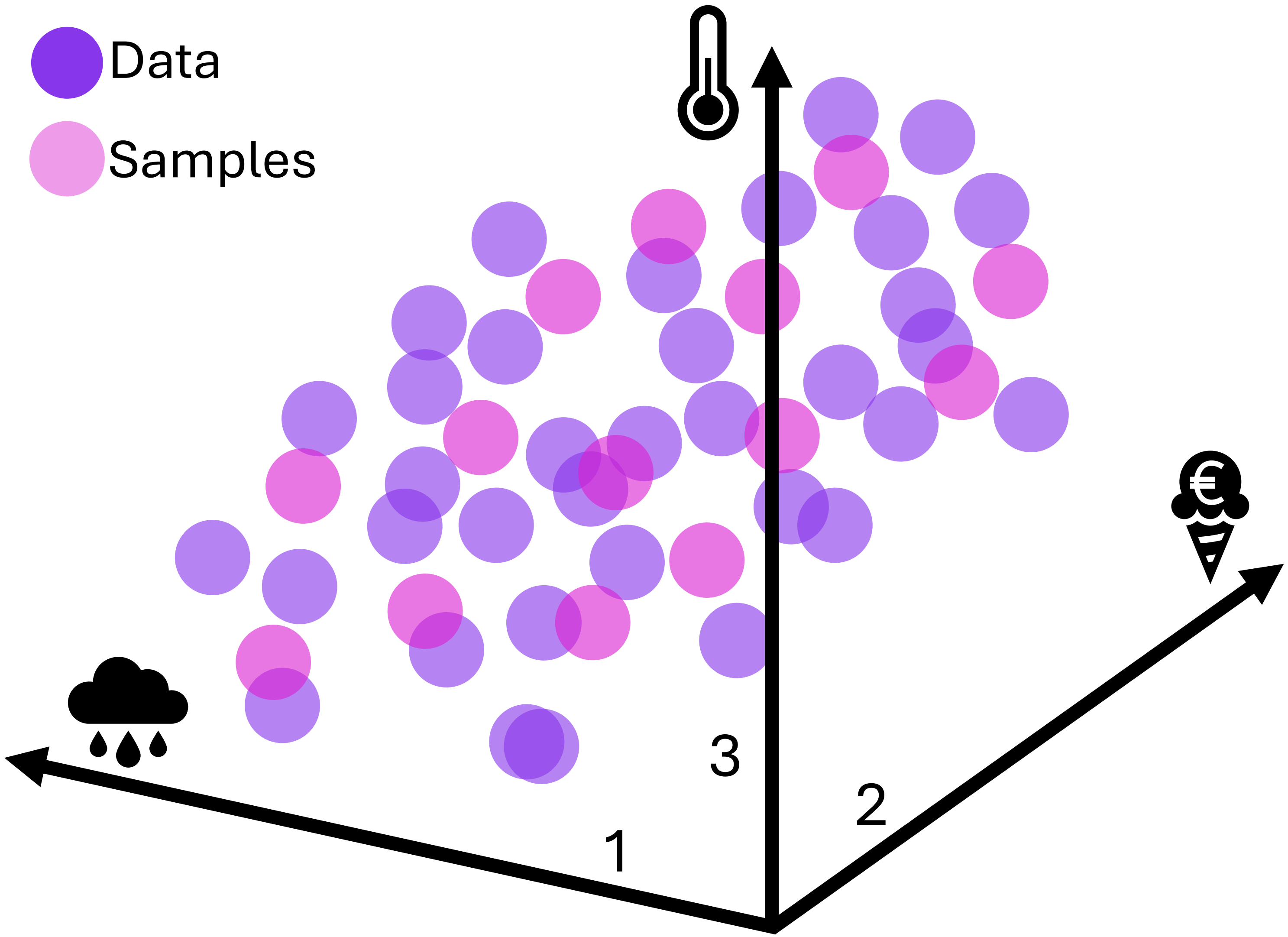


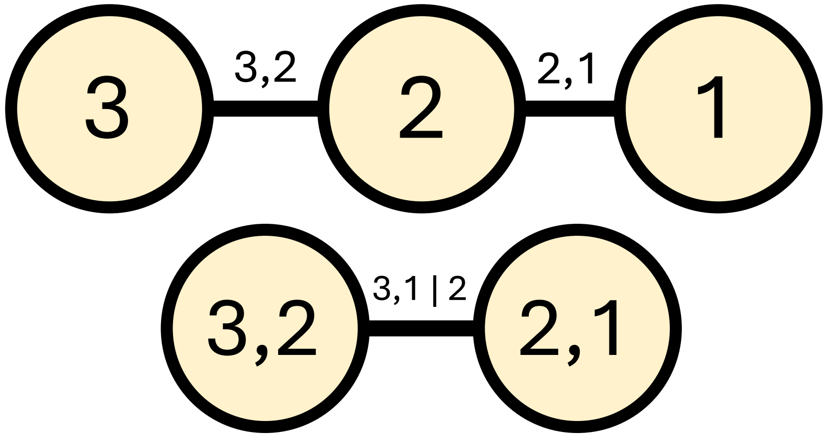
Vine Copula



- For each vine copula with d variables, there are 2^{d-1} implied sampling orders (Cooke et al., 2015).
- Possible sampling orders: [1,2,3], [3,2,1], [2,1,3], [2,3,1]

Vine Copula





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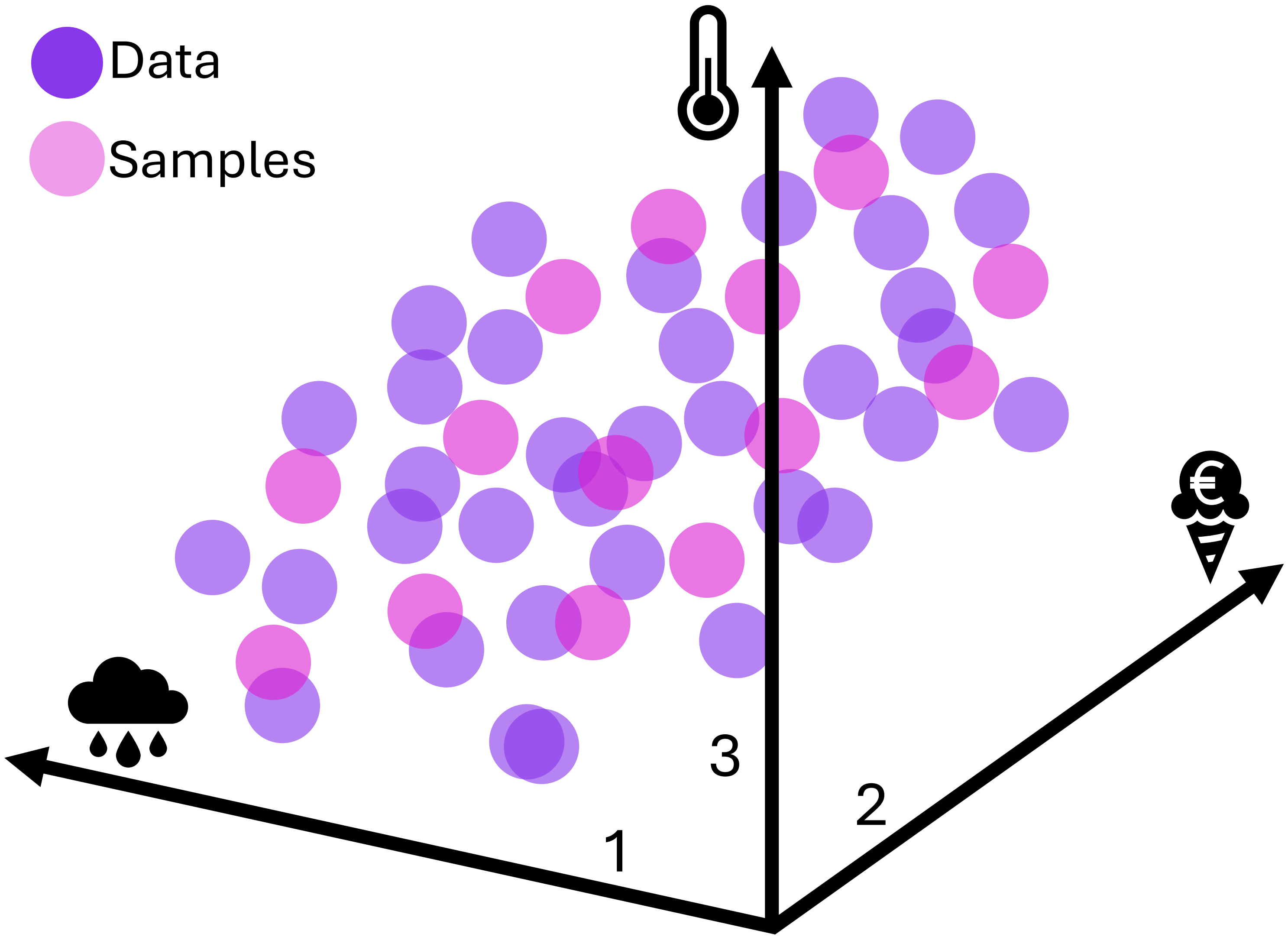
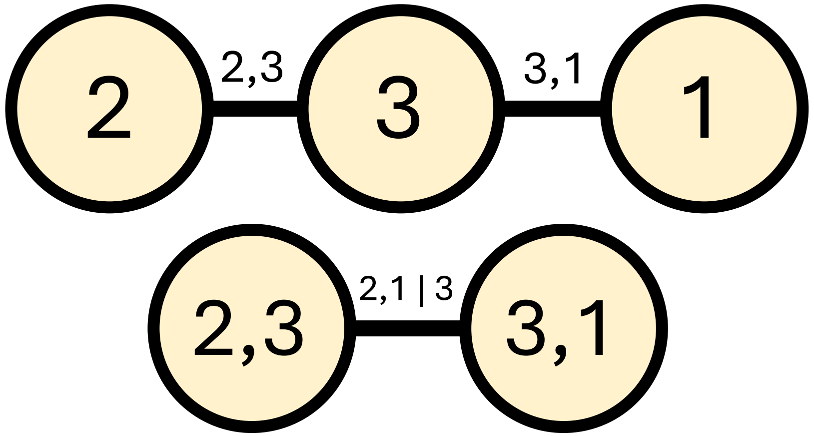
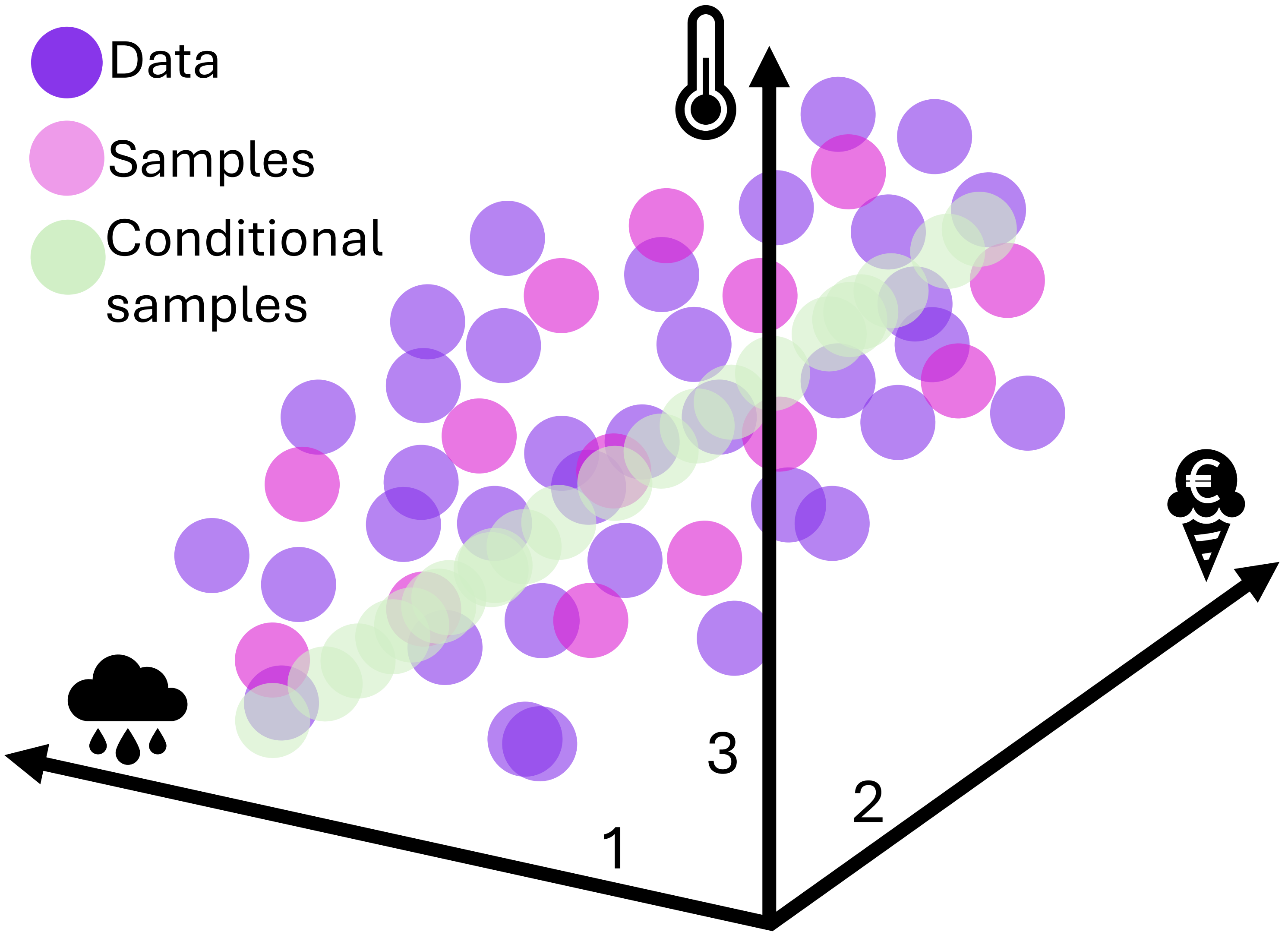


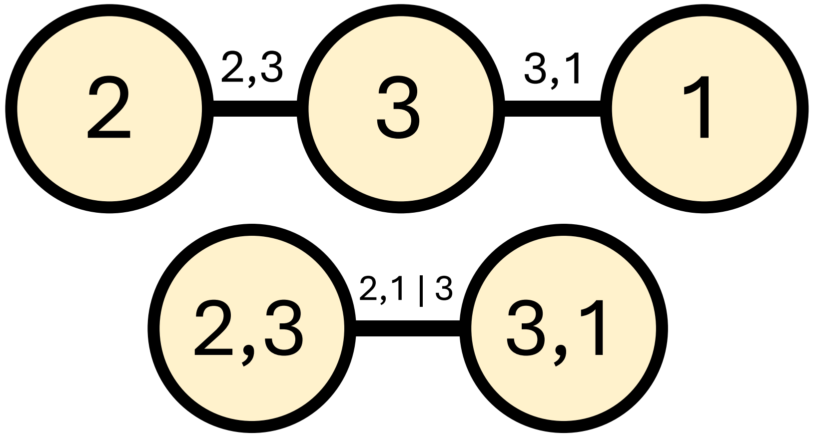
Vine Copula



- Possible sampling orders: [2,3,1], [1,3,2], [3,1,2], [3,2,1]



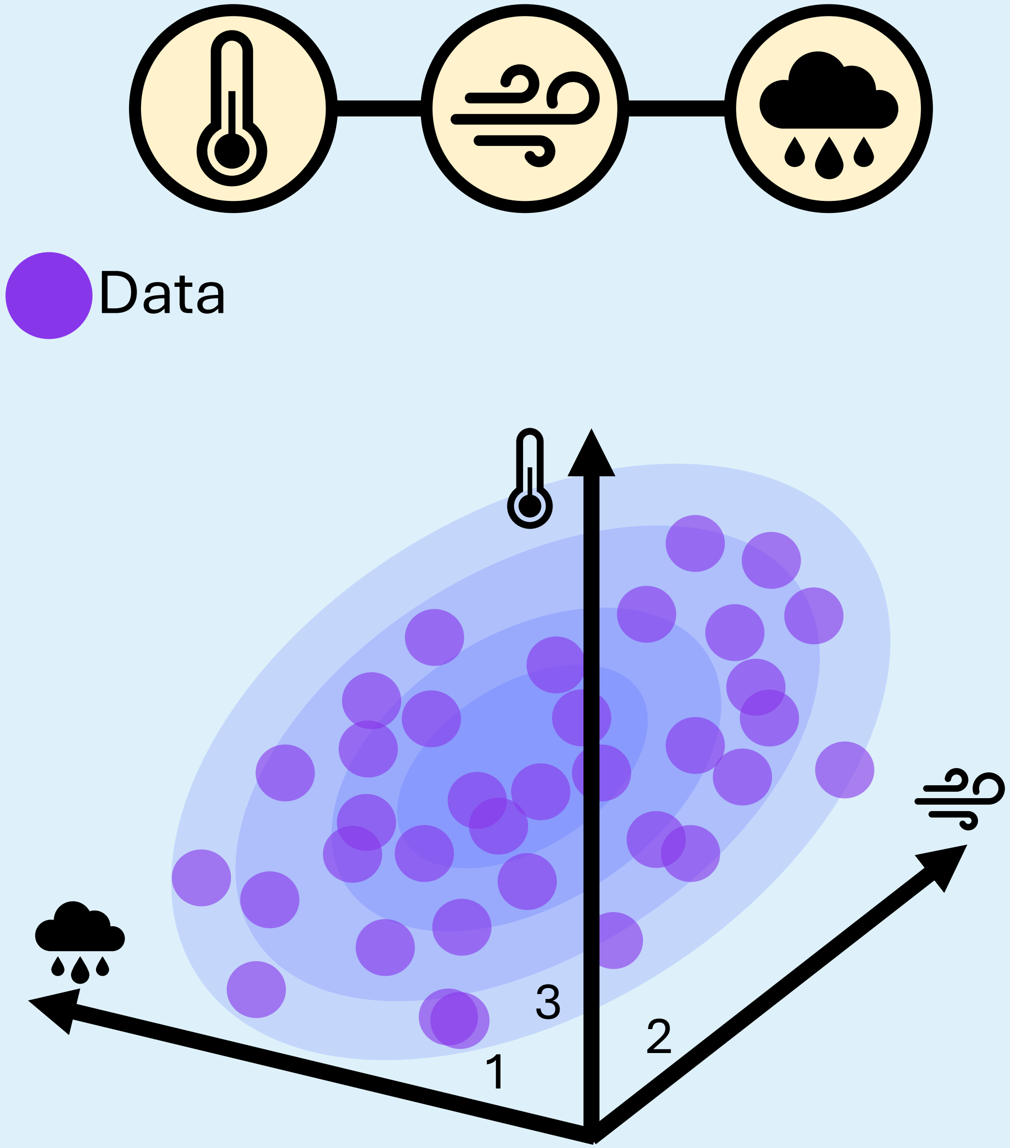
Vine Copula



- Possible sampling orders: [2,3,1], [1,3,2], [3,1,2], [3,2,1]

Python Code

```
#%% VineCopulas
Import(vincecopulas)
#%% load data
t2m = load(temperature)
pr = load(precipitation)
ws = load(windspeed)
#%% fit vine-copula
fit.vinecopula(t2m,pr,ws)
```



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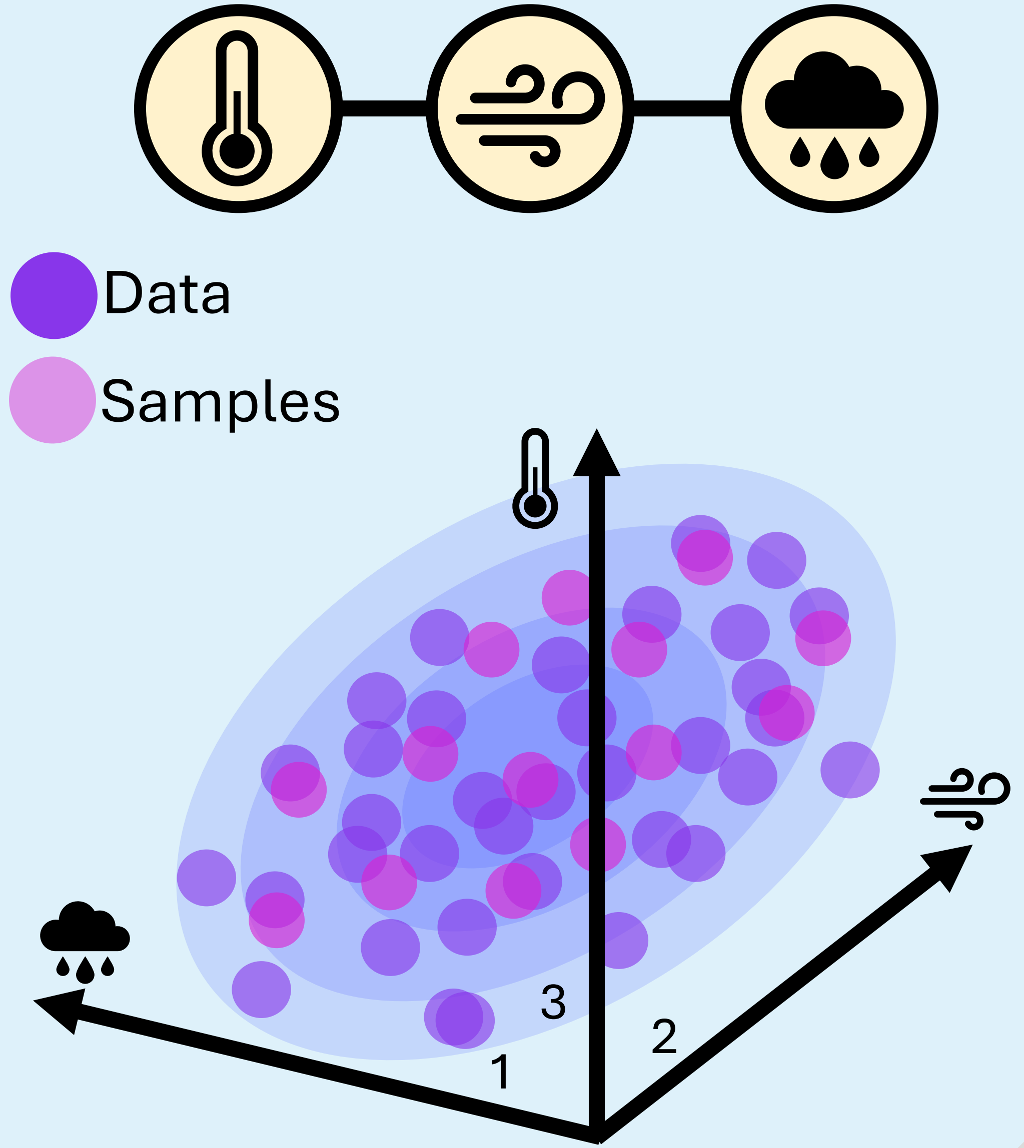
#%% generate random samples
sample.vinecopula(t2m,pr,ws)
```



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#%% fit vine-copula
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#%% generate random samples
sample.vinecopula(t2m,pr,ws)
#%% generate conditional samples
sampleconditional.vinecopula(ws)
#%% fit conditional vine
fitconditional.vinecopula(ws)
```

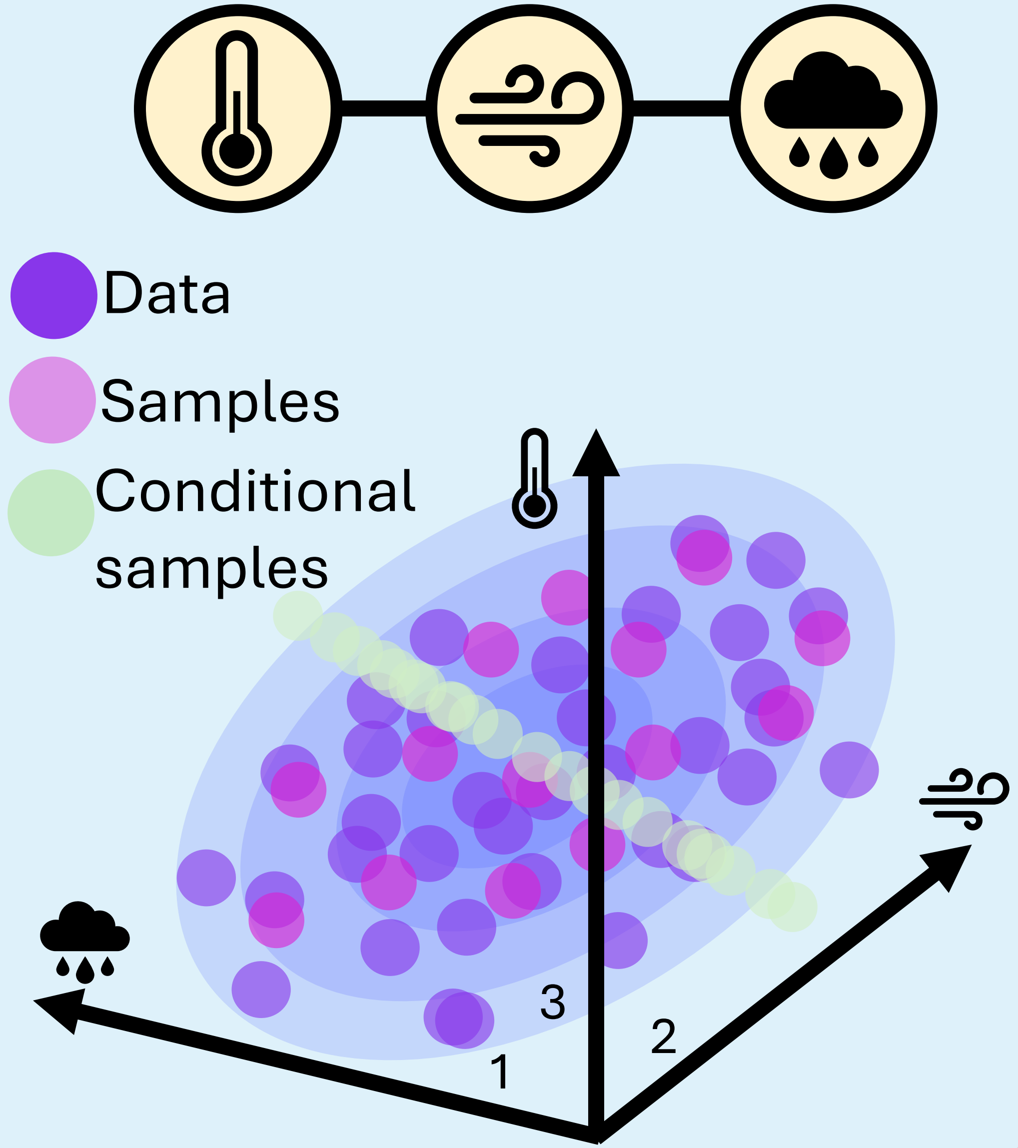

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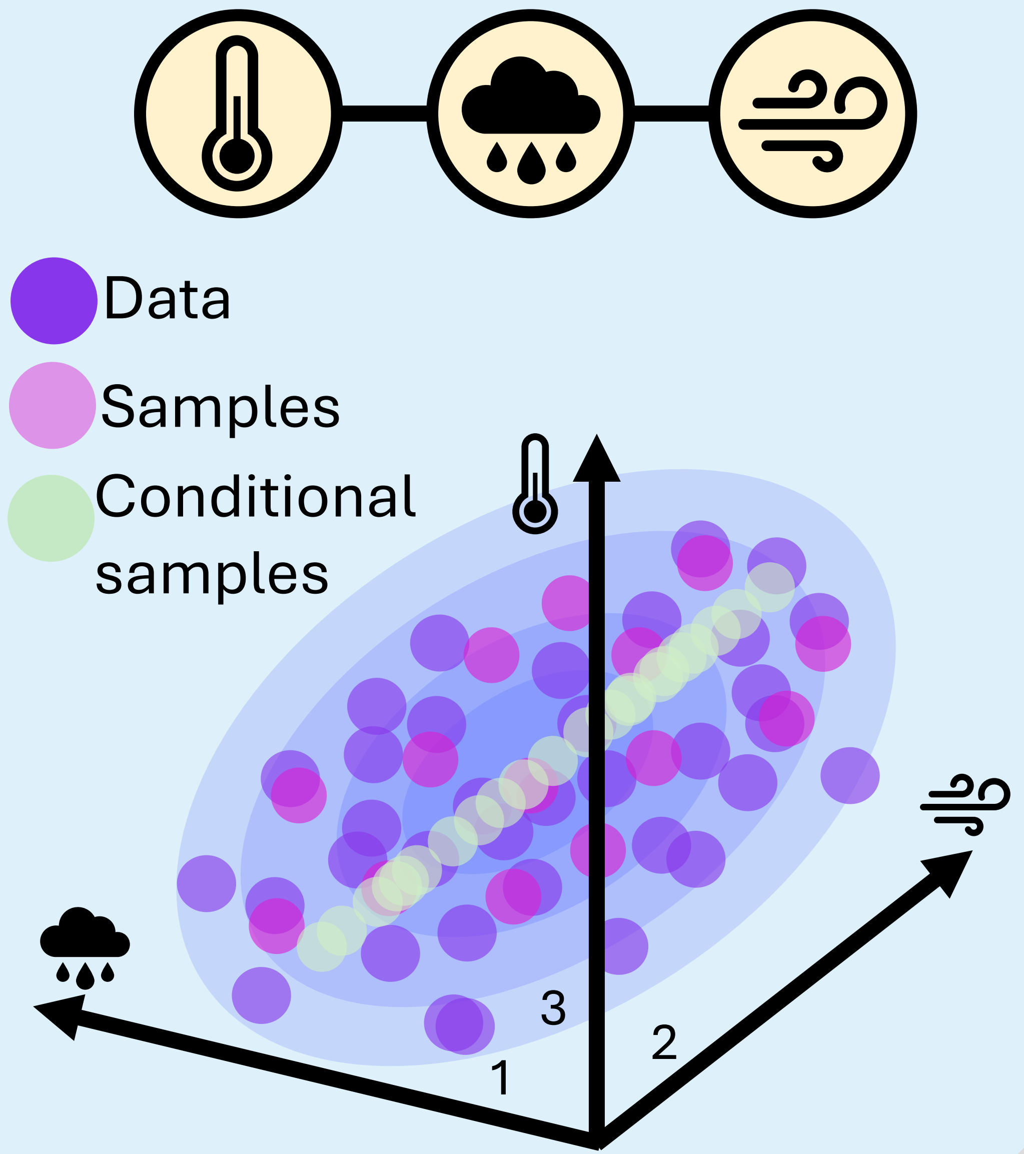

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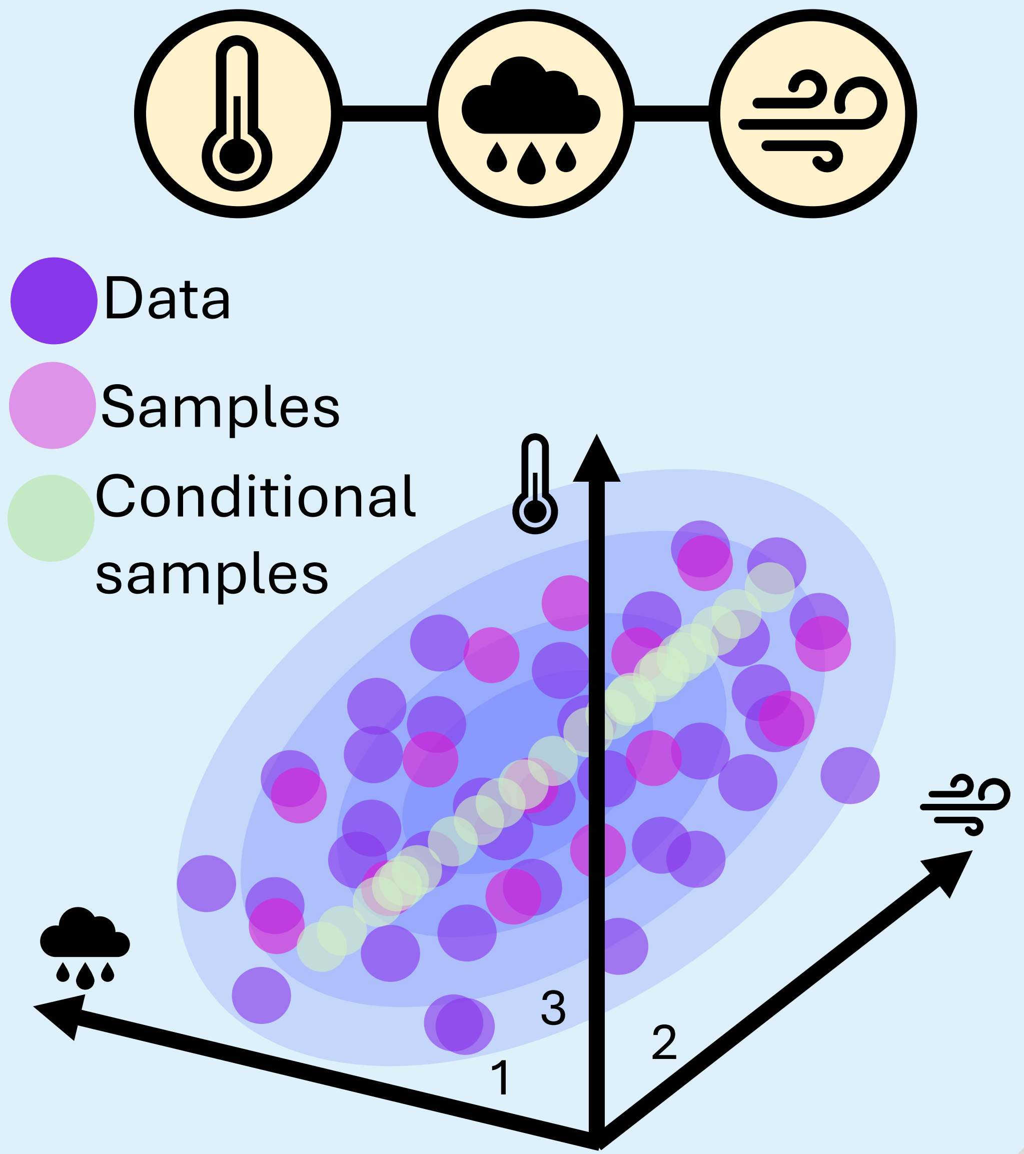
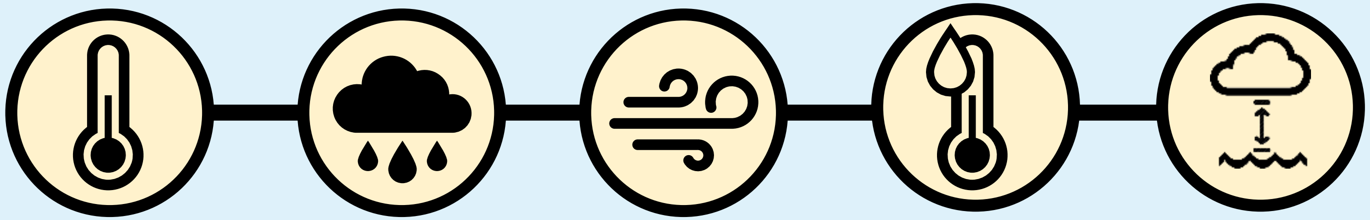


More Variables



- While a vine copula with 3 variables only has 3 structures, the number of possible structures increases exponentially as

$d! \times 2^{\frac{(d-2)(d-3)}{2}-1}$(Morales Napoles, 2011)

- Meaning 5 variables already has 480 possible structures, and with 6 values this already increases to 23000

VineCopulas

VineCopulas

Open-source Python Package

VineCopulas

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Welcome to VineCopulas's documentation!

View page source

Welcome to VineCopulas's documentation!

VineCopulas is a Python package that is able to:

- Fit both bivariate and vine copulas
- Simulate from both bivariate and vine copulas
- Allow for both discrete as well as continuous input data
- Draw conditional samples for any variables of interest with the use of bivariate copulas and different vine structures

Installation

```
pip install vinecopulas
```

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Getting Started

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QR code to tutorial

Using VineCopulas to generate stochastic weather data and understand co-occurring extremes

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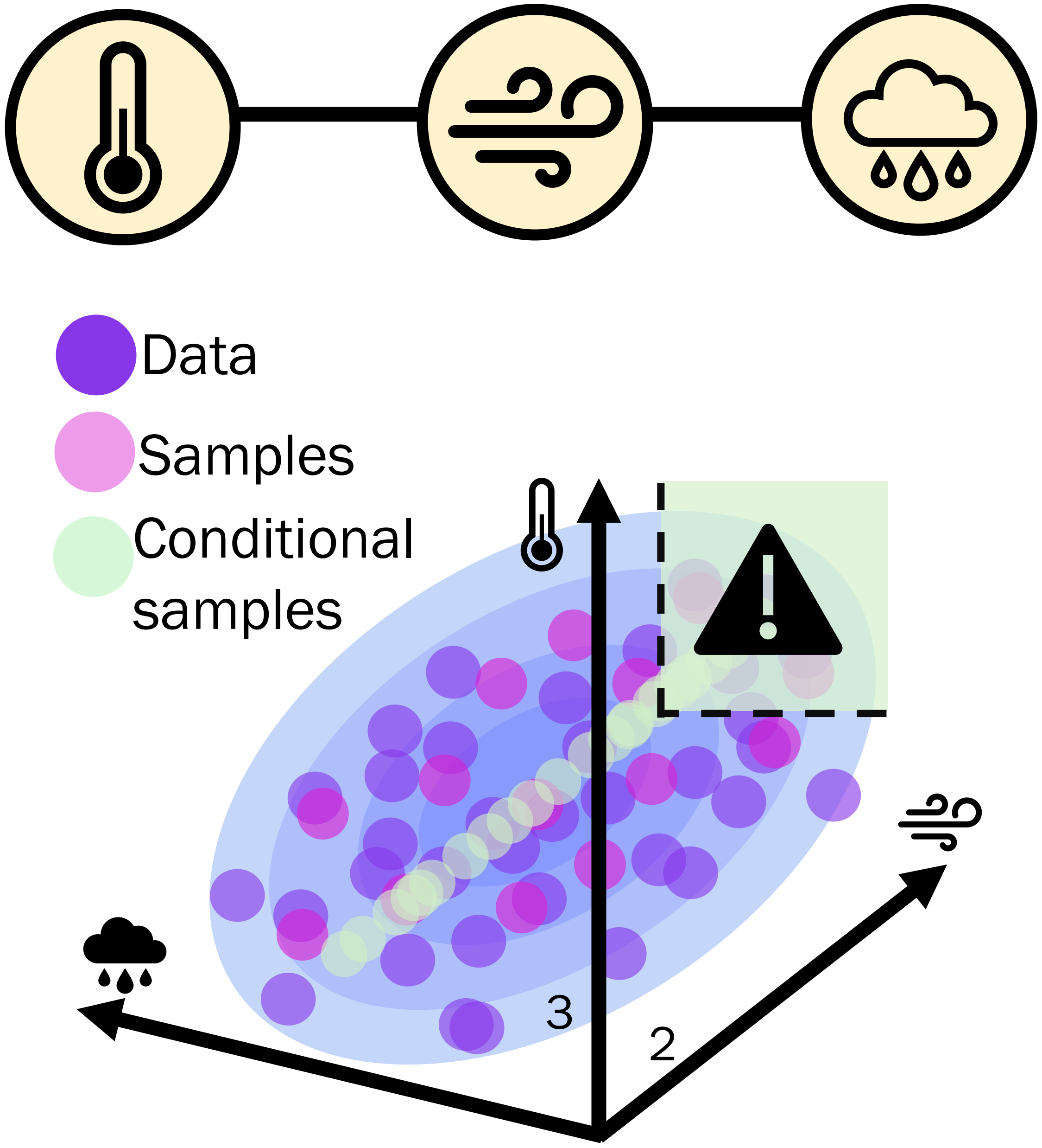
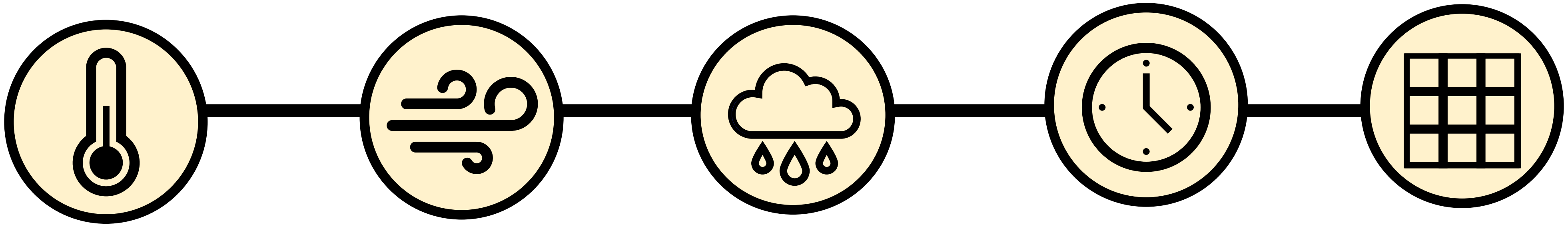
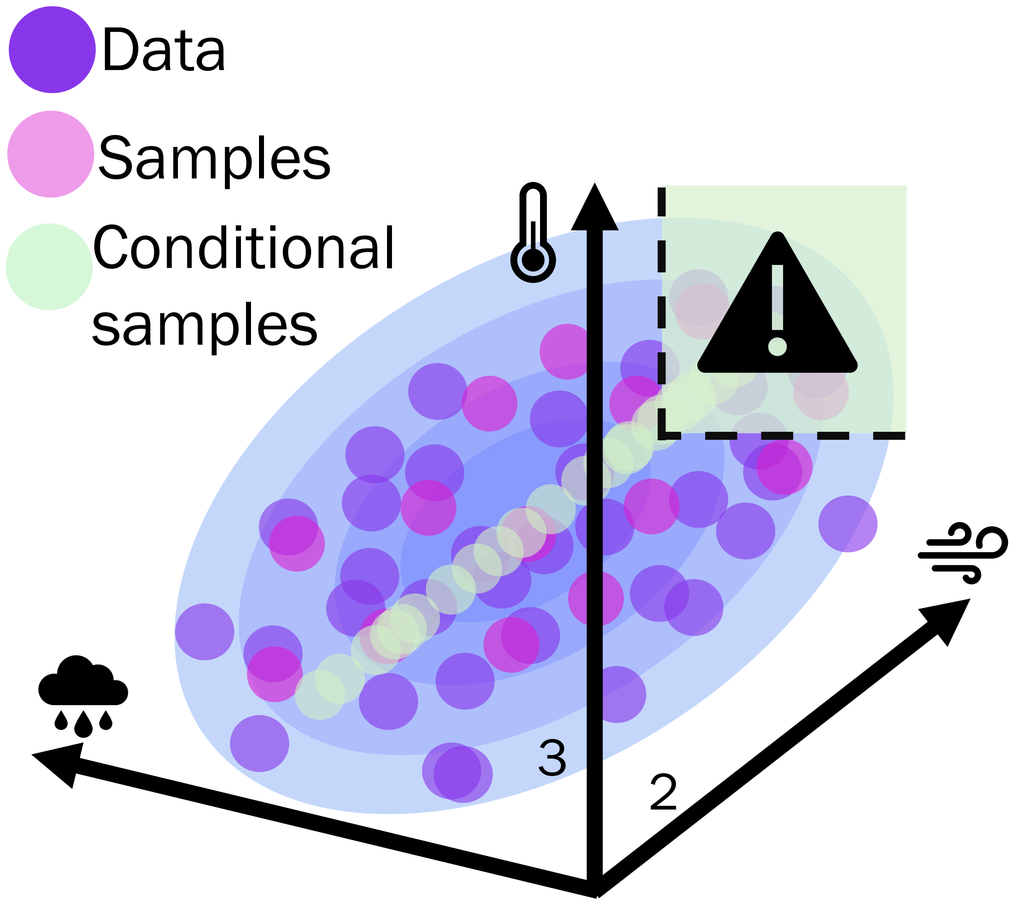
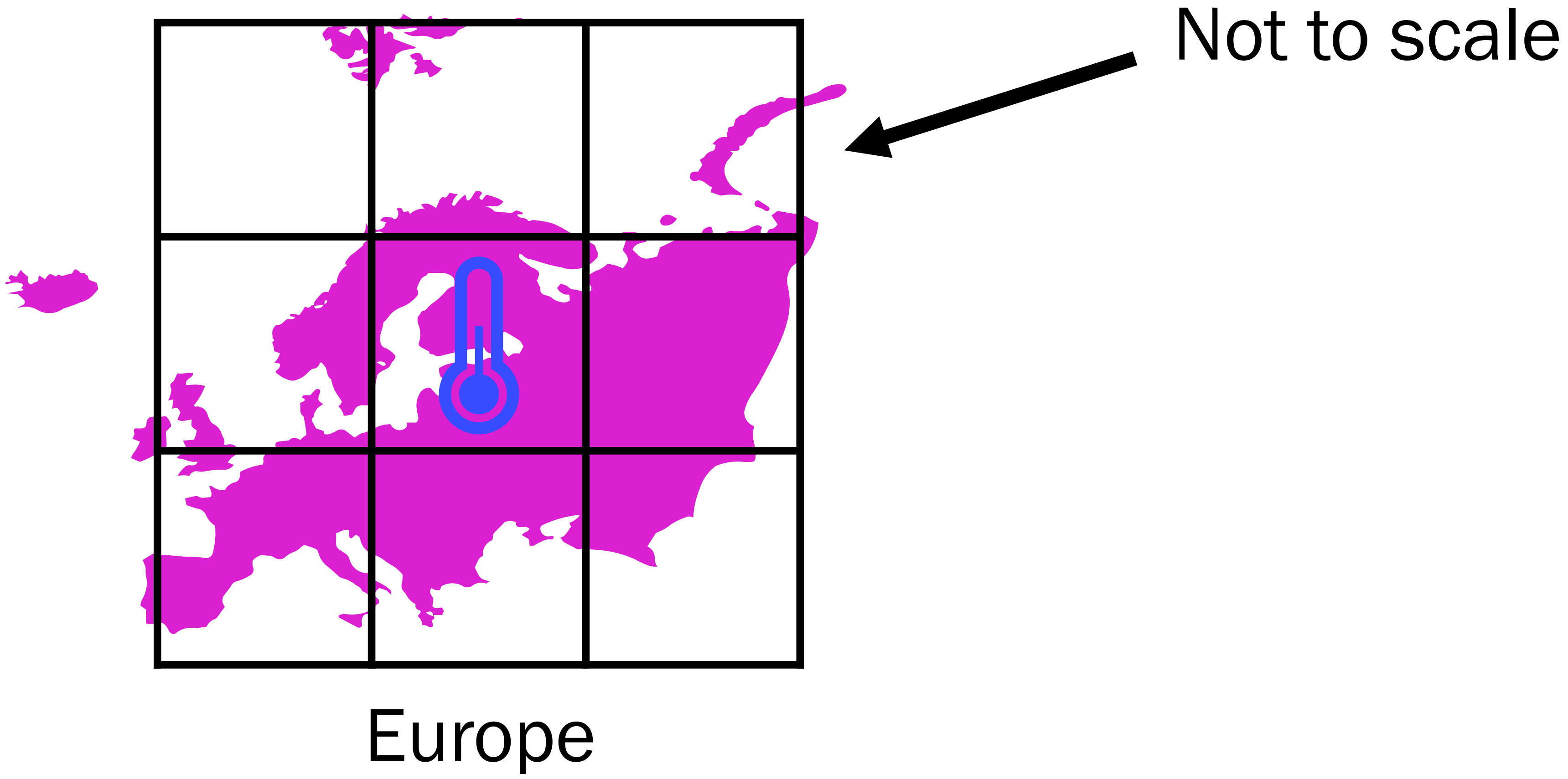

Data
Samples
Conditional samples
3
2




Data
Samples
Conditional samples
3
2

Model Setup: spatiotemporal dependencies



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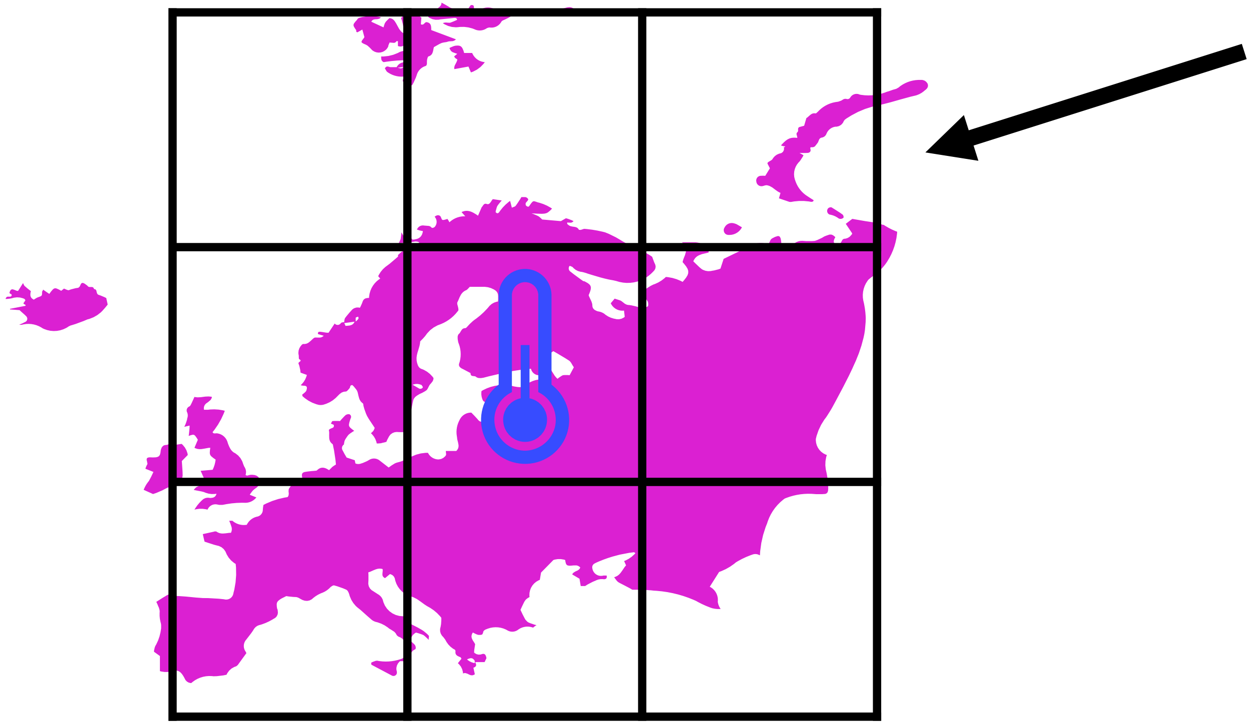
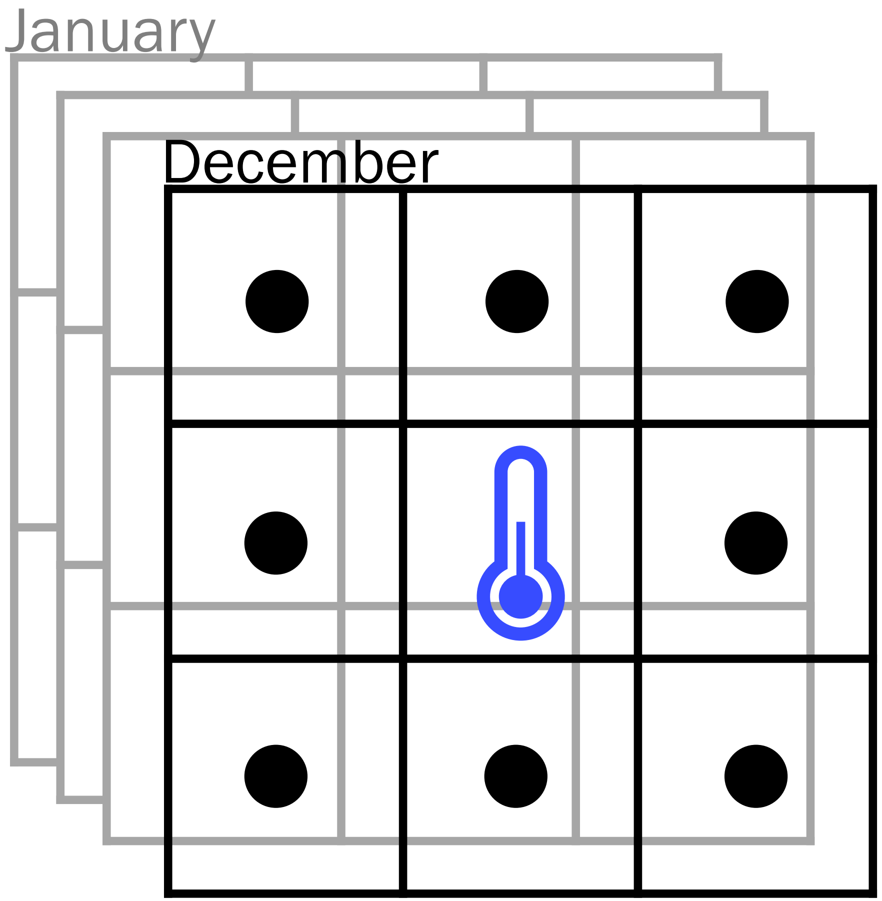


Europe

Model Setup: spatiotemporal dependencies



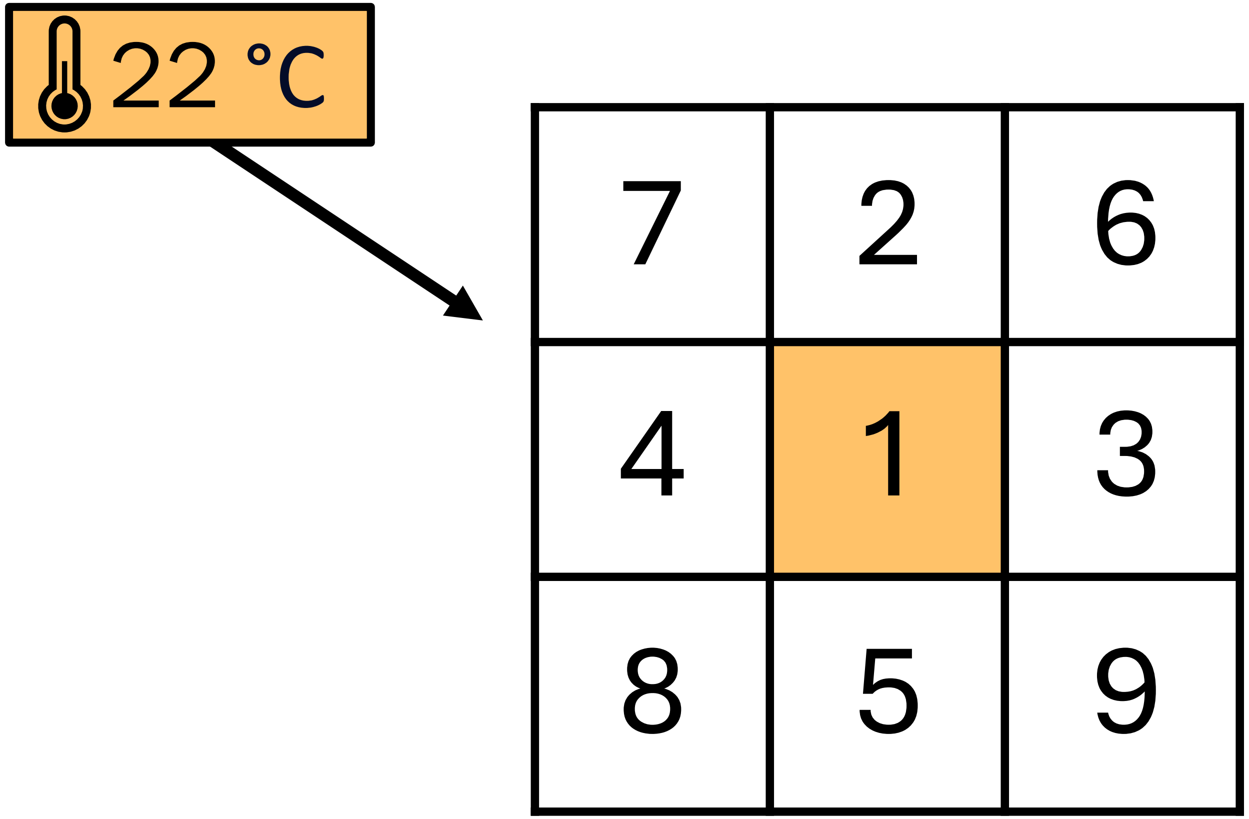
Marginal distribution per season per grid cell

Model Setup: spatiotemporal dependencies

7	2	6
4	1	3
8	5	9

Number the grid cells for a sampling order

Model Setup: spatiotemporal dependencies



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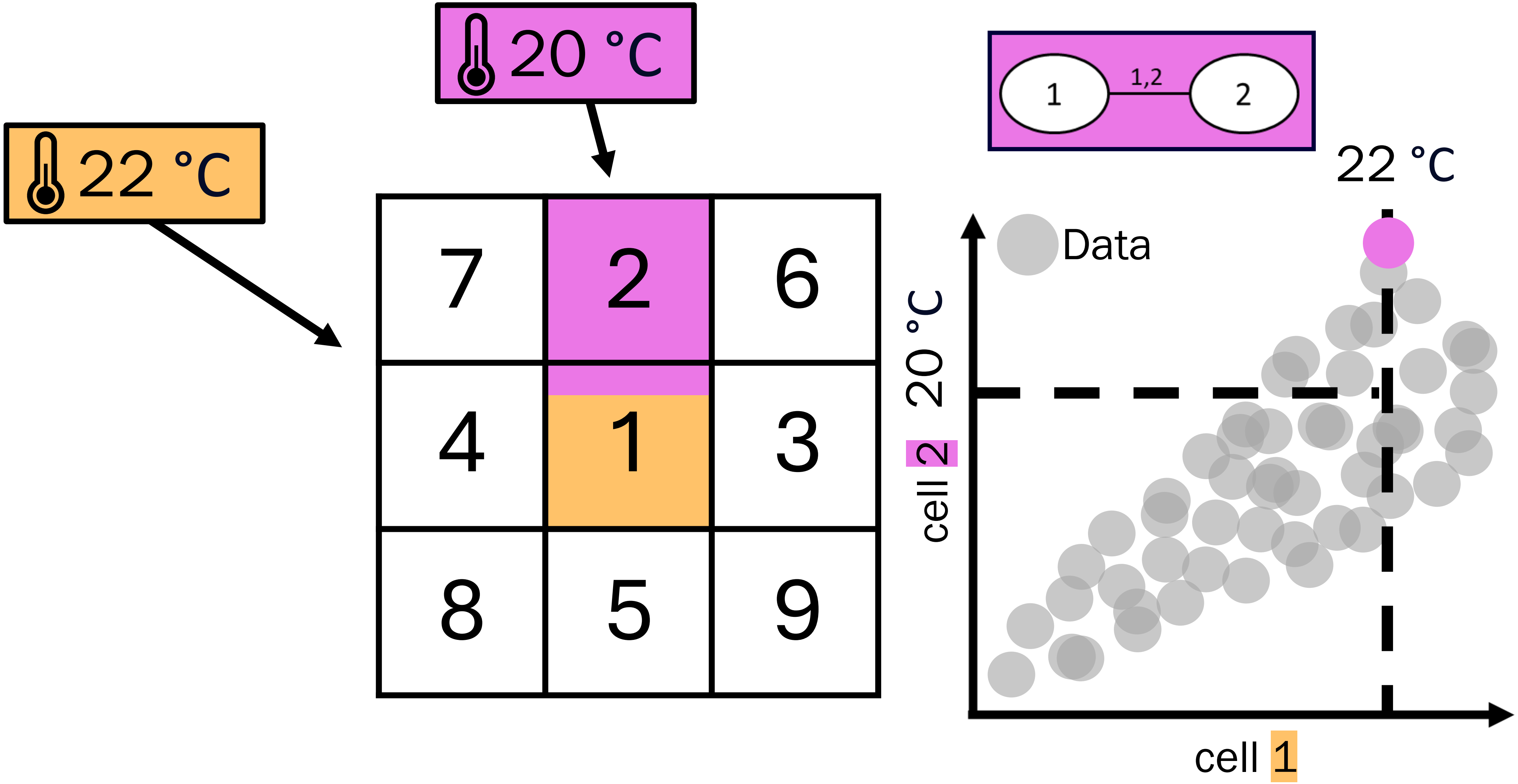

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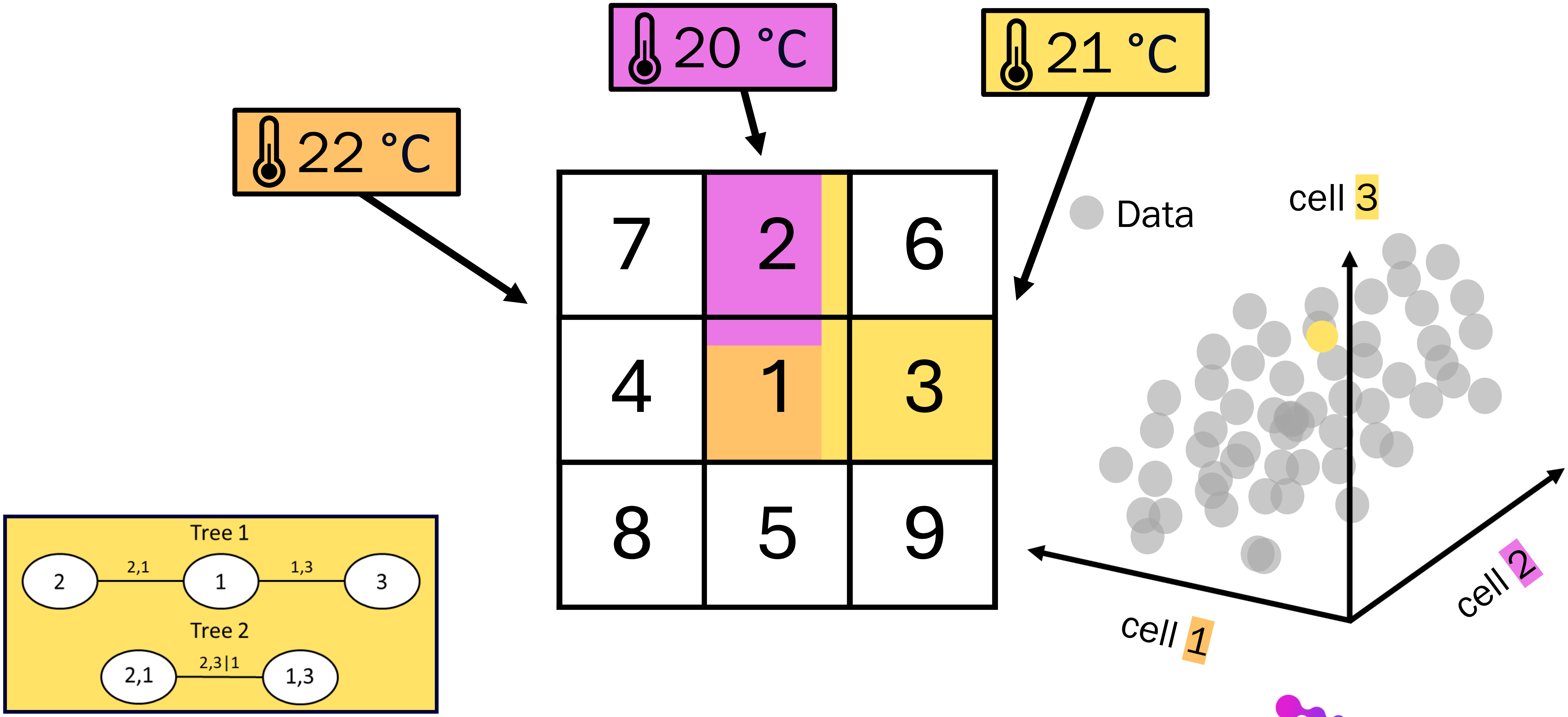

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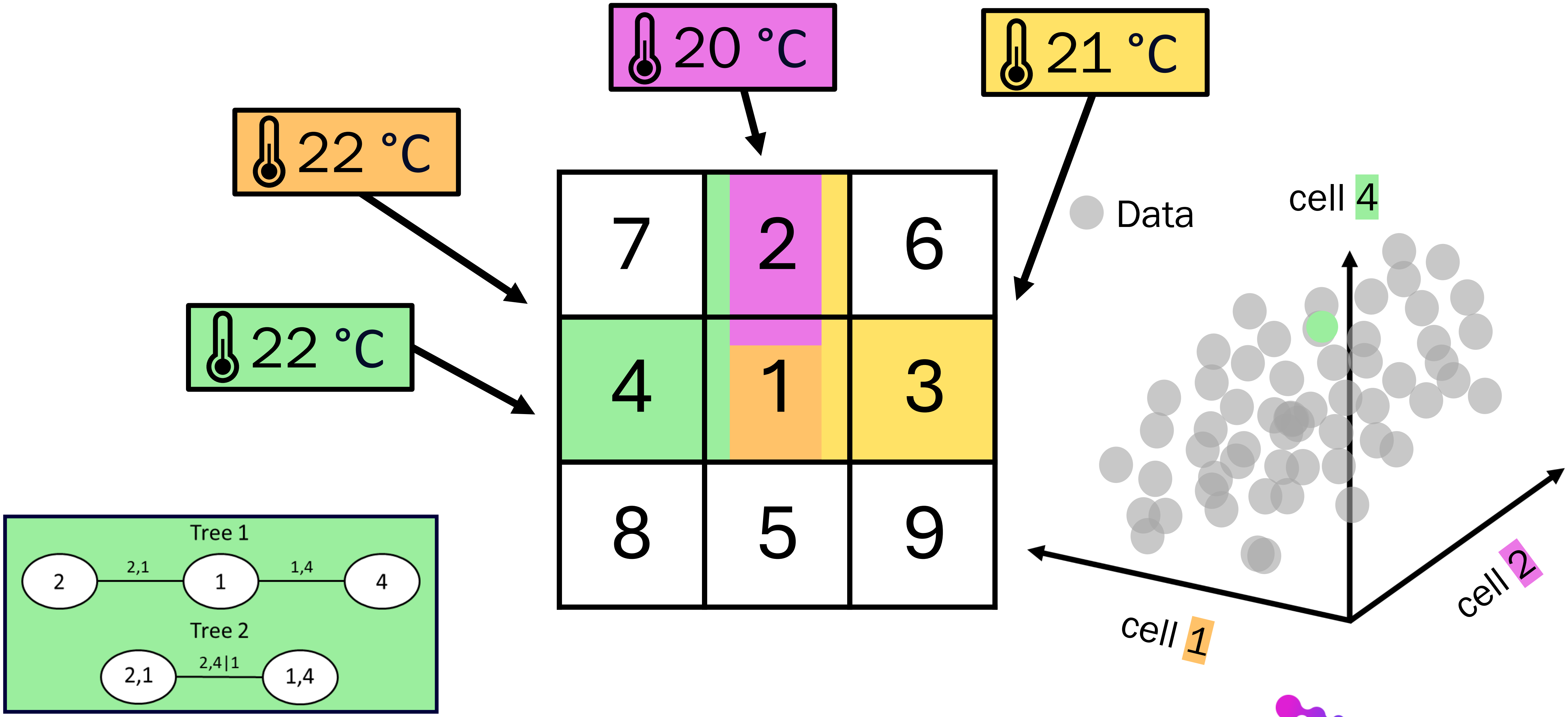

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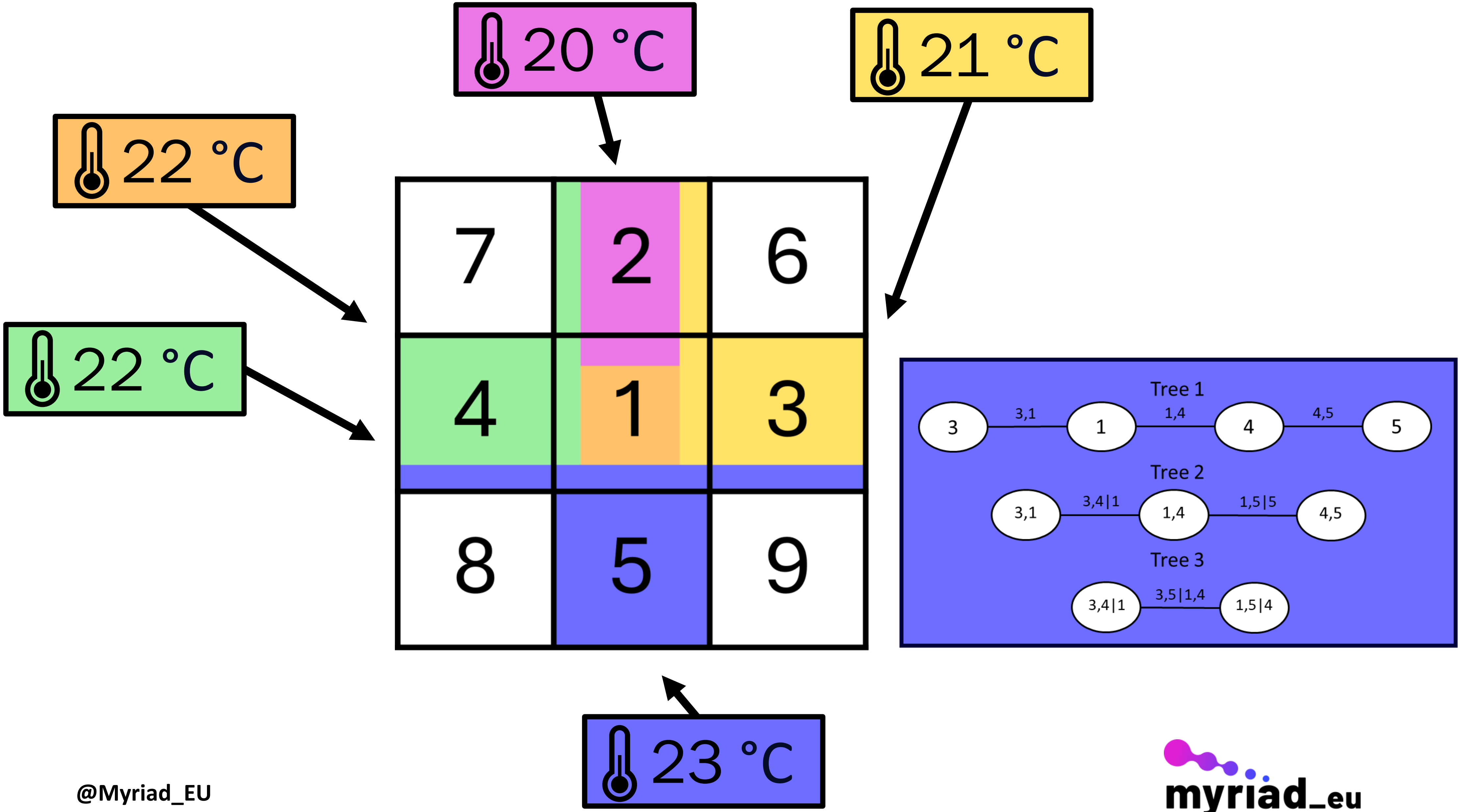
Model Setup: spatiotemporal dependencies



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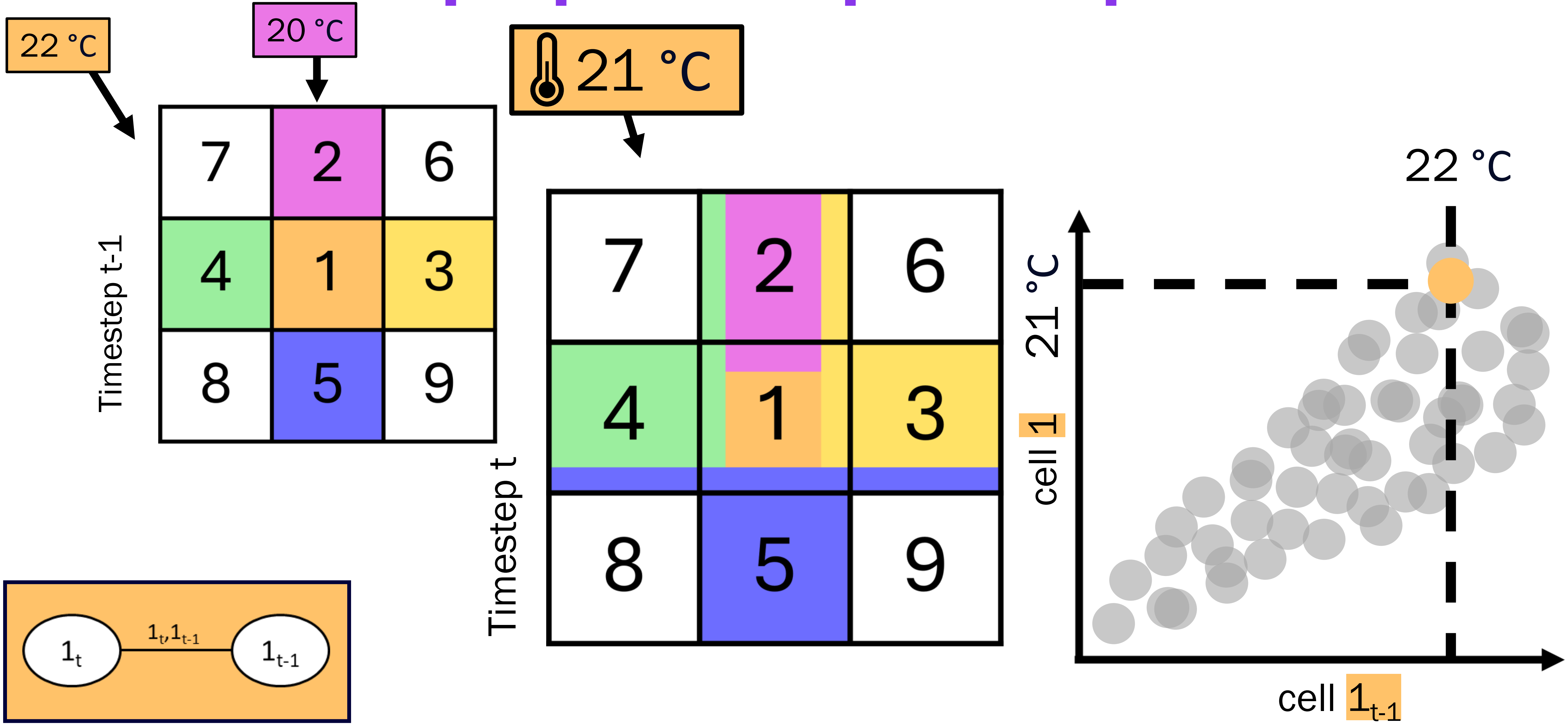

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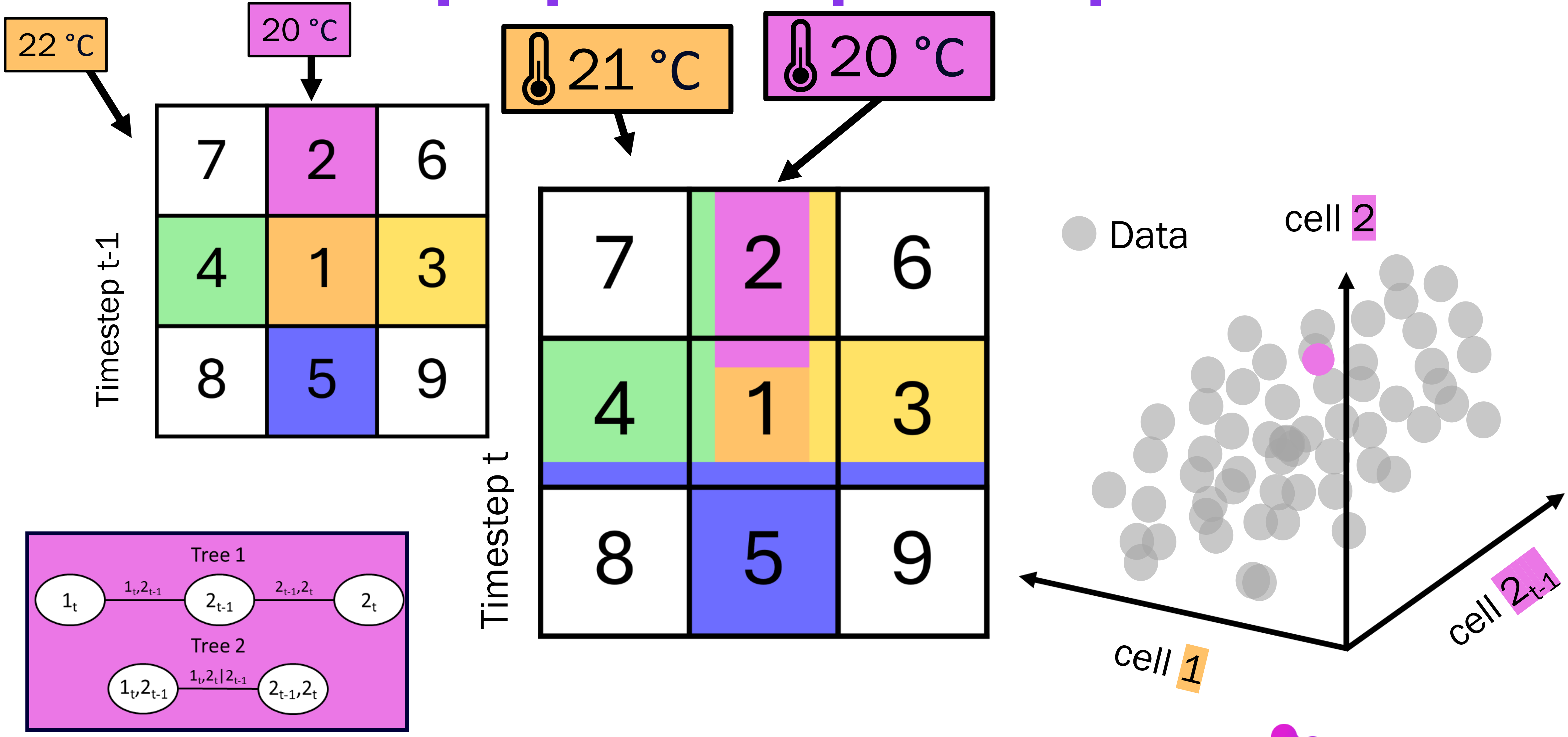

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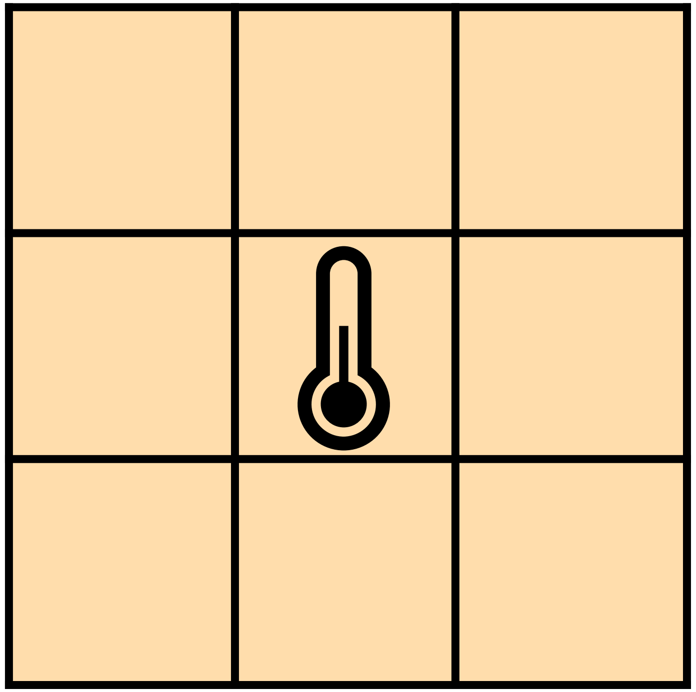
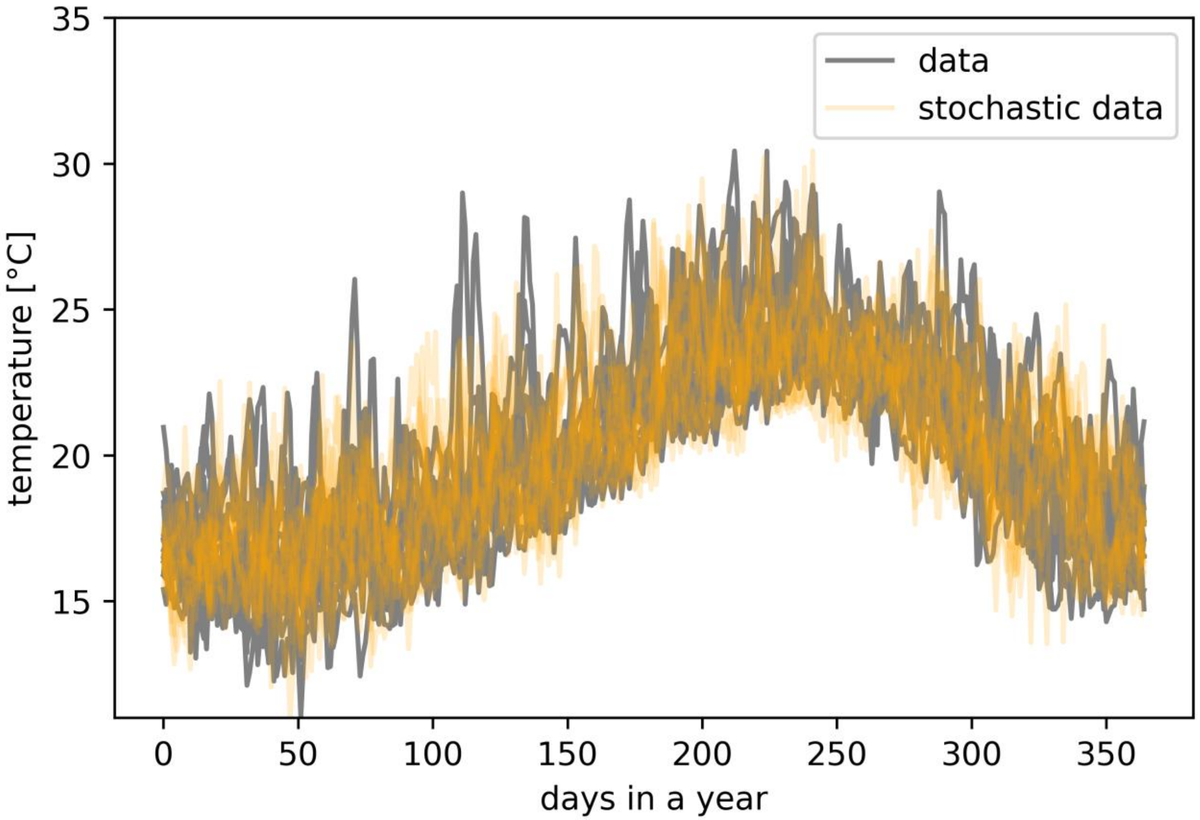
Model Setup: spatiotemporal dependencies





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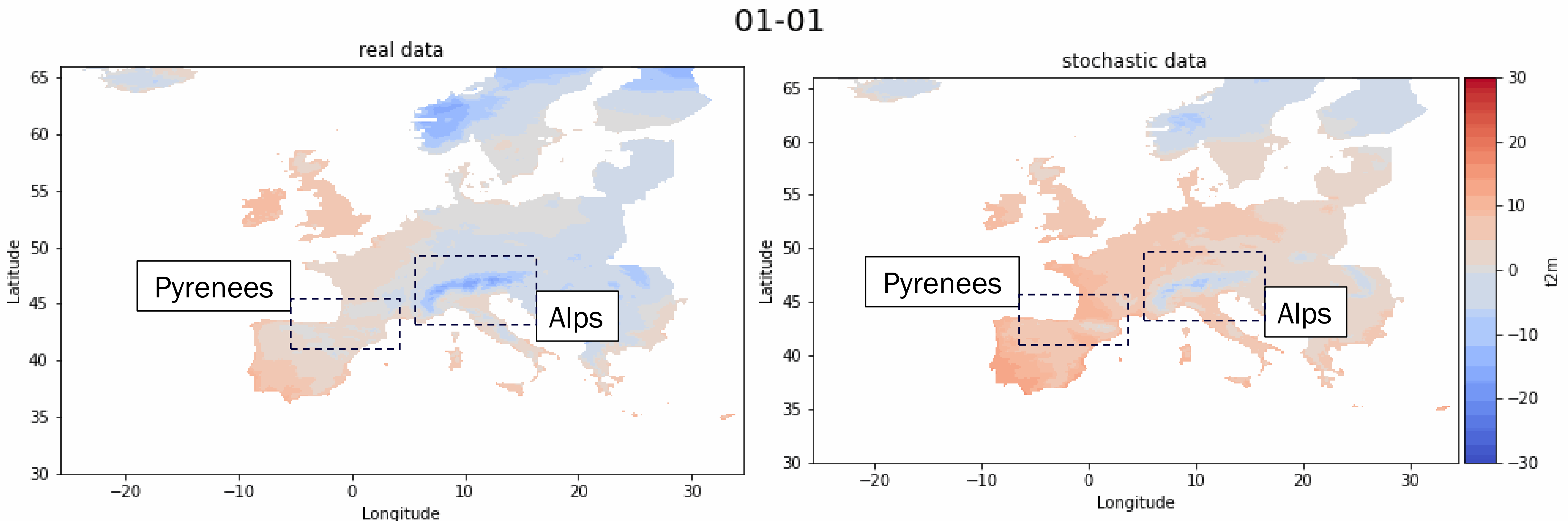
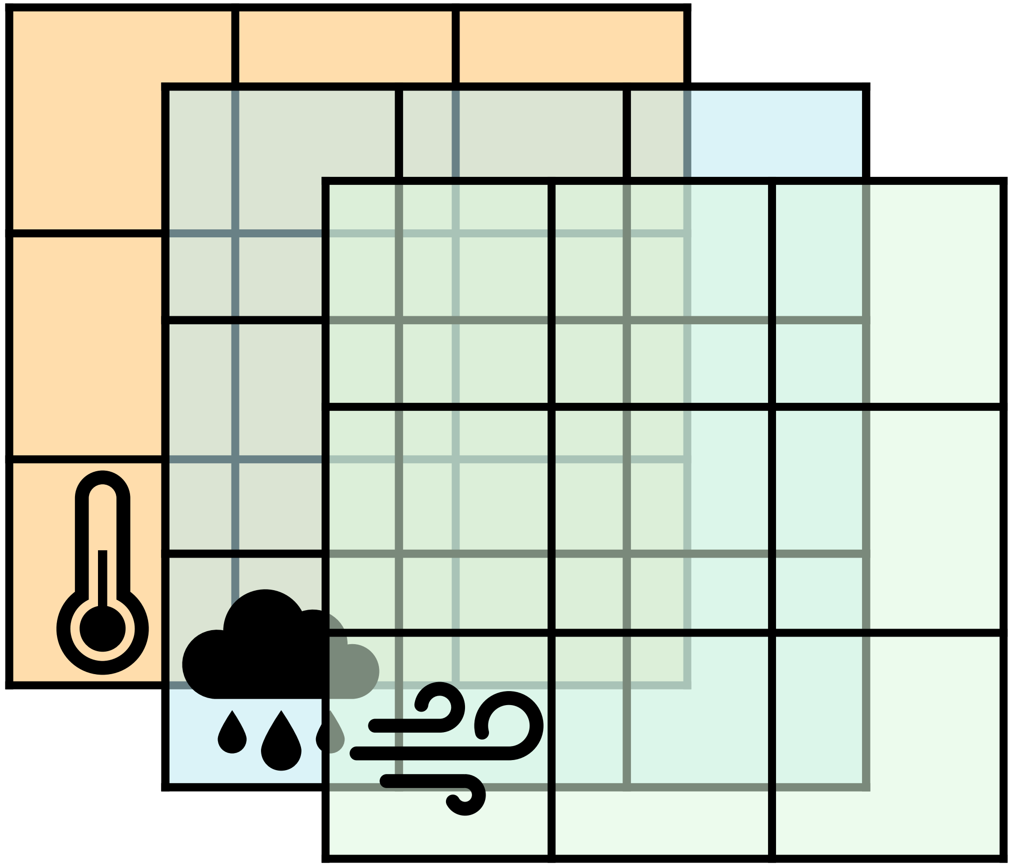
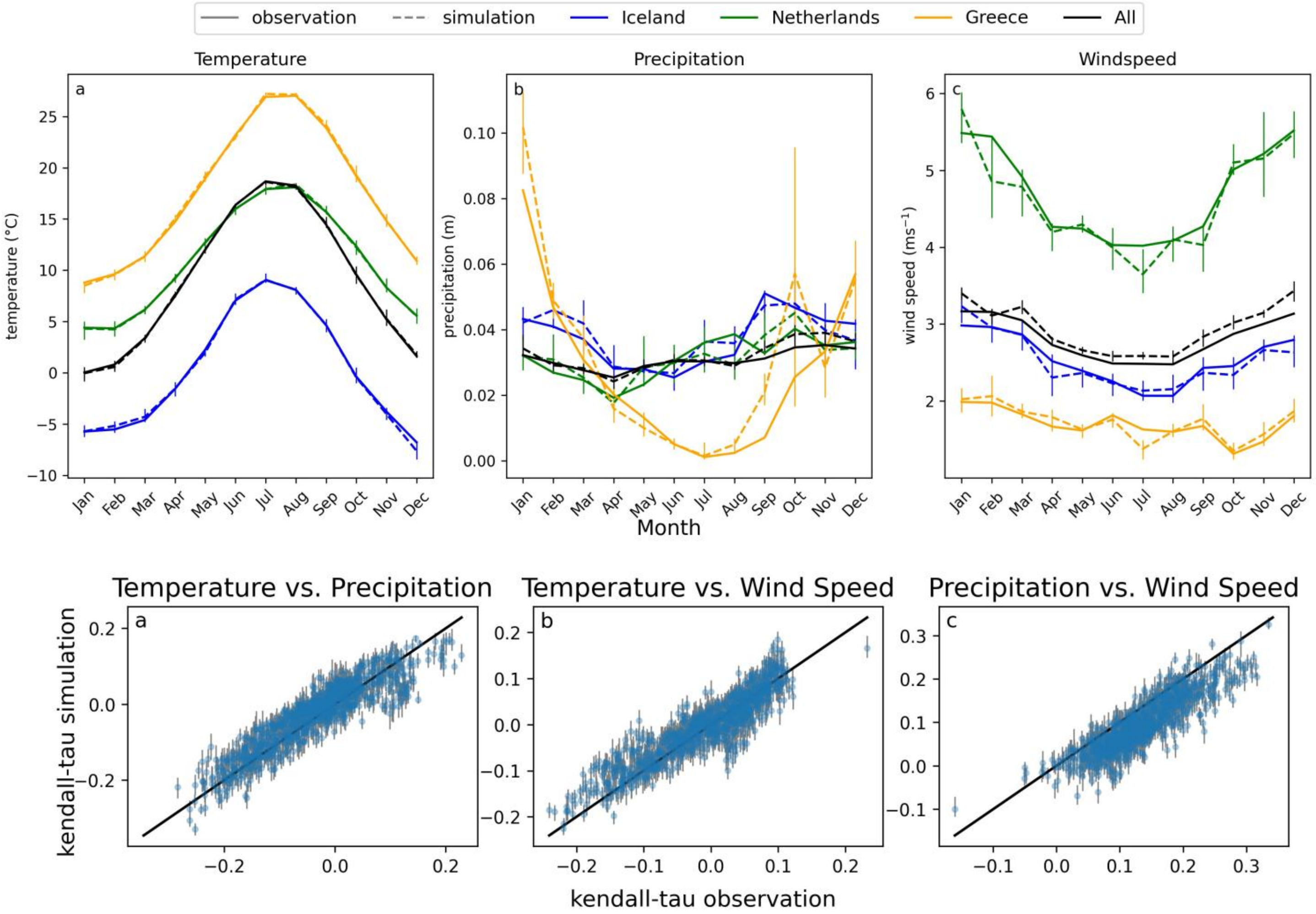
Model Setup: spatiotemporal dependencies

One year of daily mean temperature







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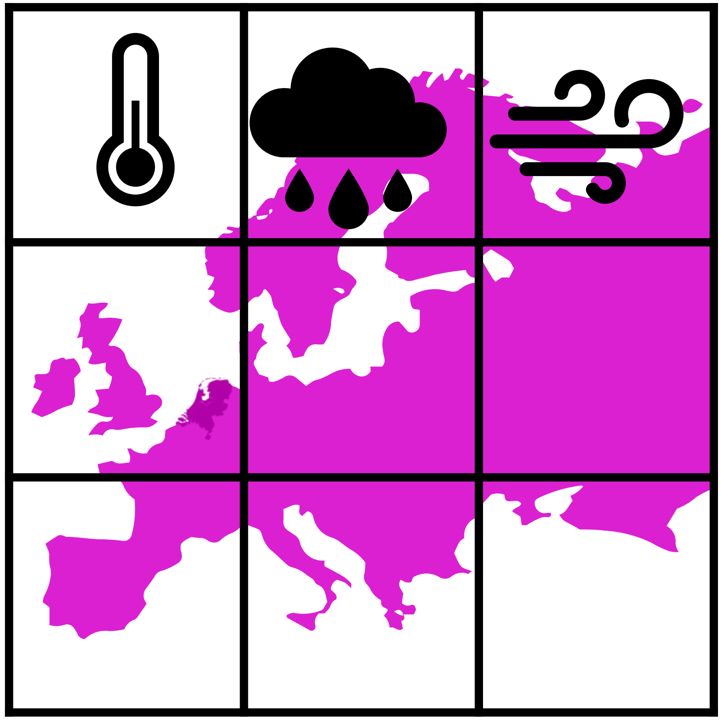
MYRIAD-Stochastic vIne-copula Model (MYRIAD-SIM)



Paper in Nature: Scientific data

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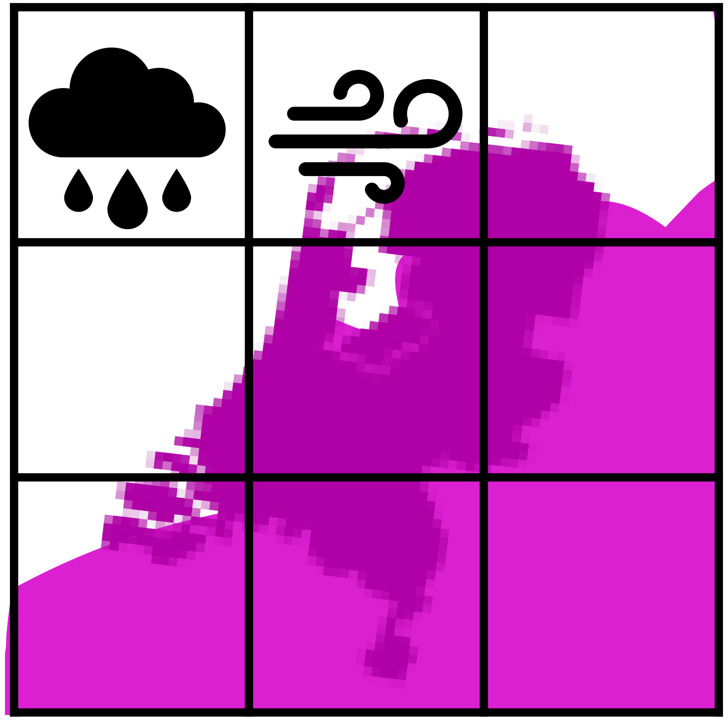

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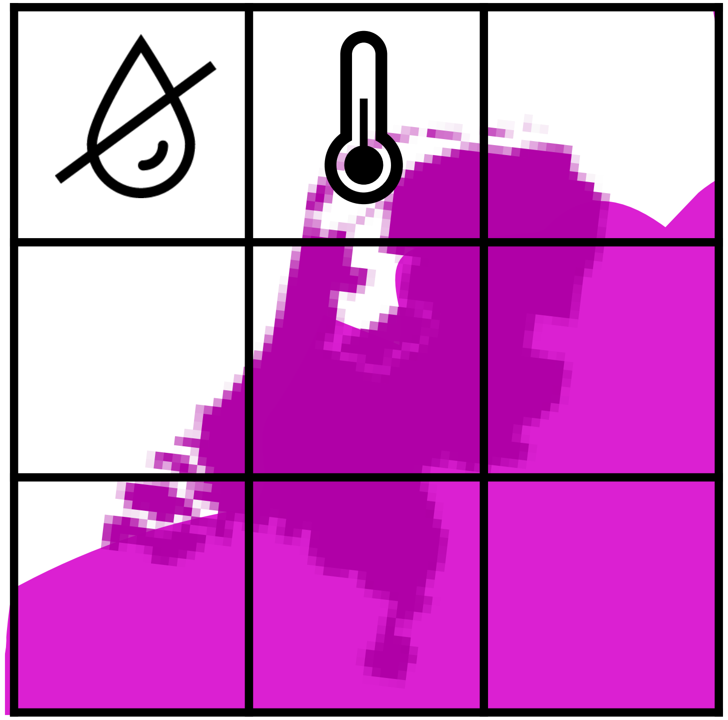

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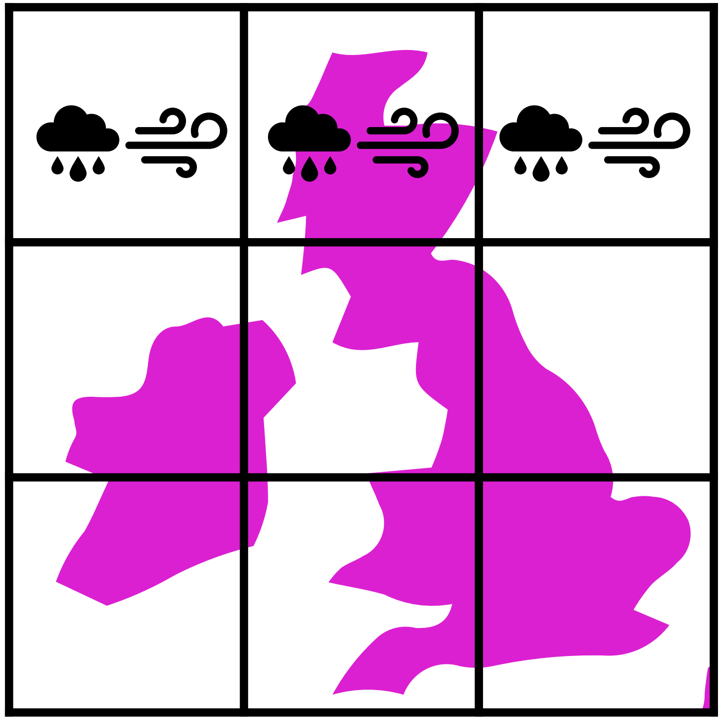

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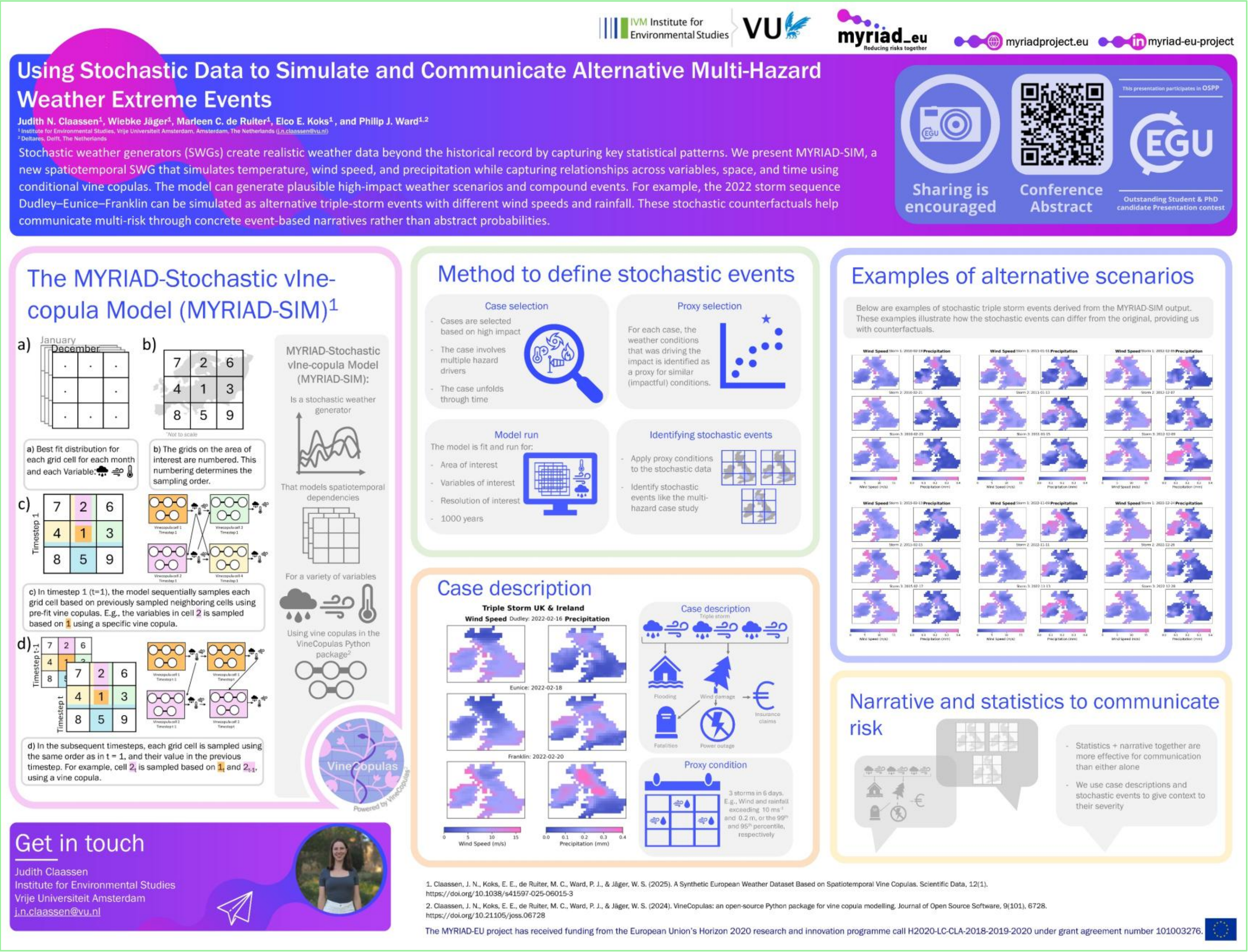

Conference Abstract

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The MYRIAD-EU project has received funding from the European Union's Horizon 2020 research and innovation programme call H2020-LC-CLA-2018-2019-2020 under grant agreement number 101003276