Object Store Based Simulation Interworking

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CoSMoS Project

www.cosmos-research.org

Simulation for Scientific Research

Process

Technology

Simulations

occoids

Granuloma Formation

Household Power Comsumption

CoSMoS

Agile - small point solutions

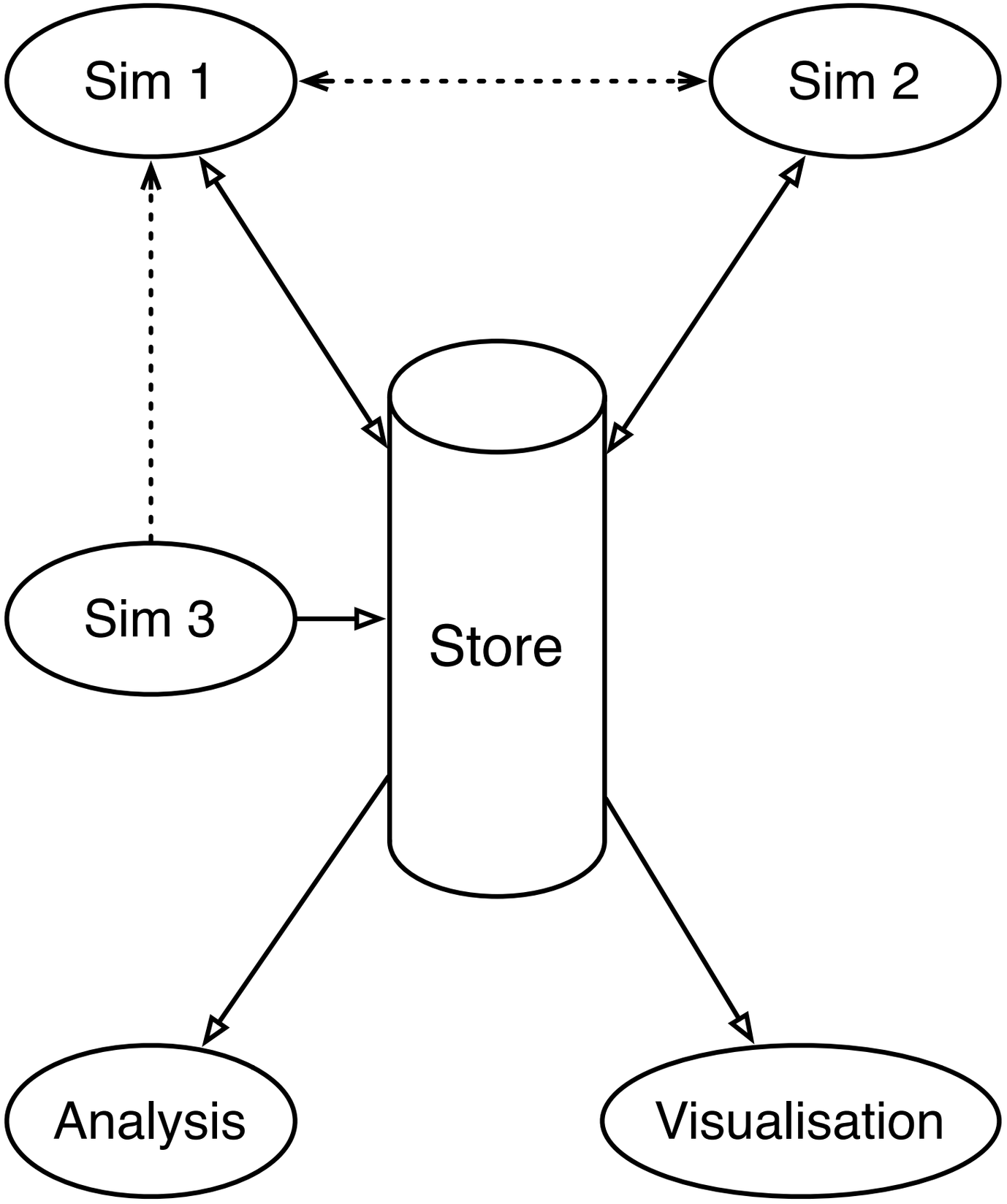
No framework

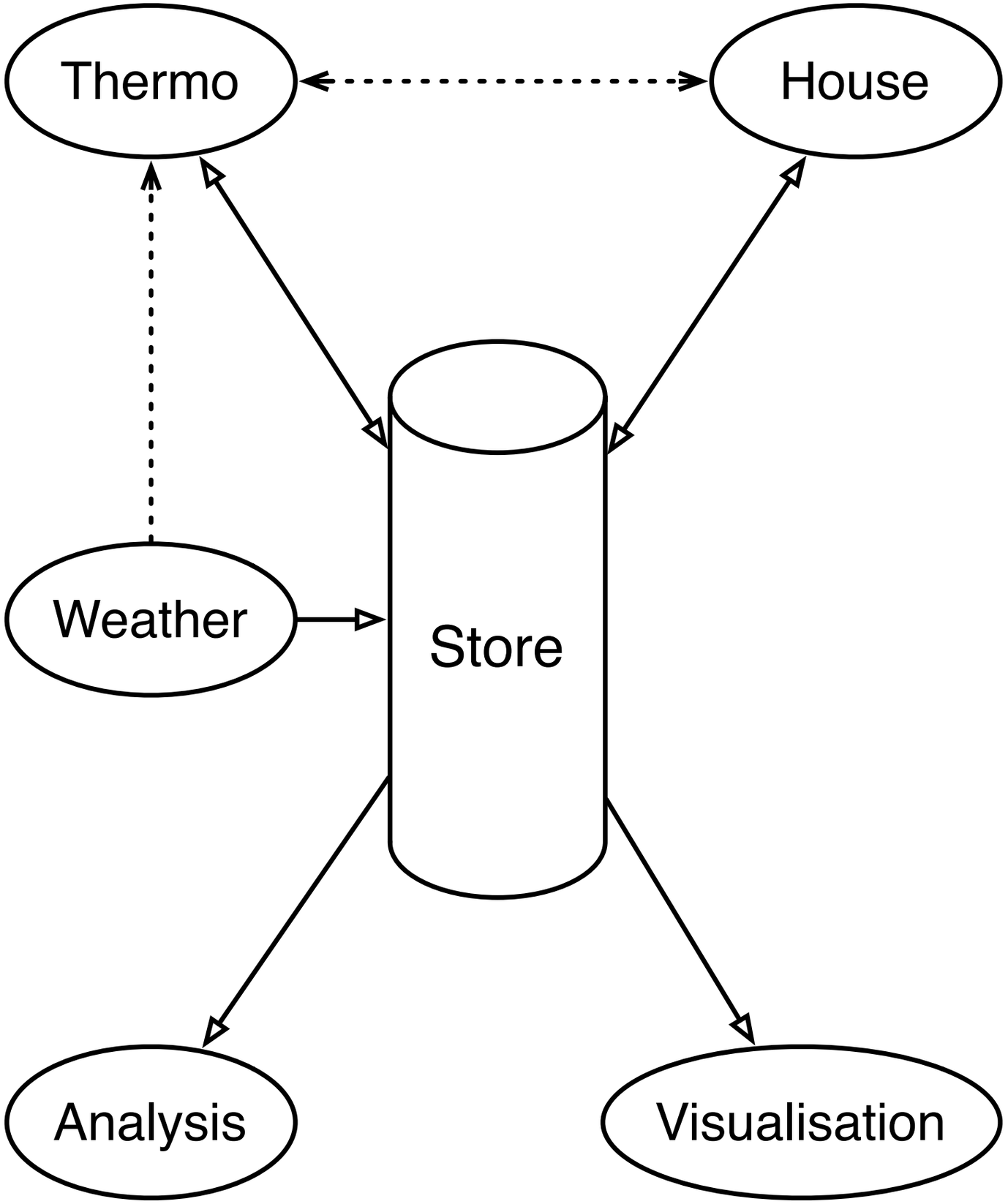
CoSMoS Driver

Integrate simulations (multi-lingual)

Connect analysis and visualisation (to simulations)

Store parameters and simulations results


Sim 1
Sim 2
Sim 3
Store
Analysis
Visualisation


Thermo
House
Weather
Store
Analysis
Visualisation

Basic Protocol

create (name, start time)

delete (name)

update (name, field, value)

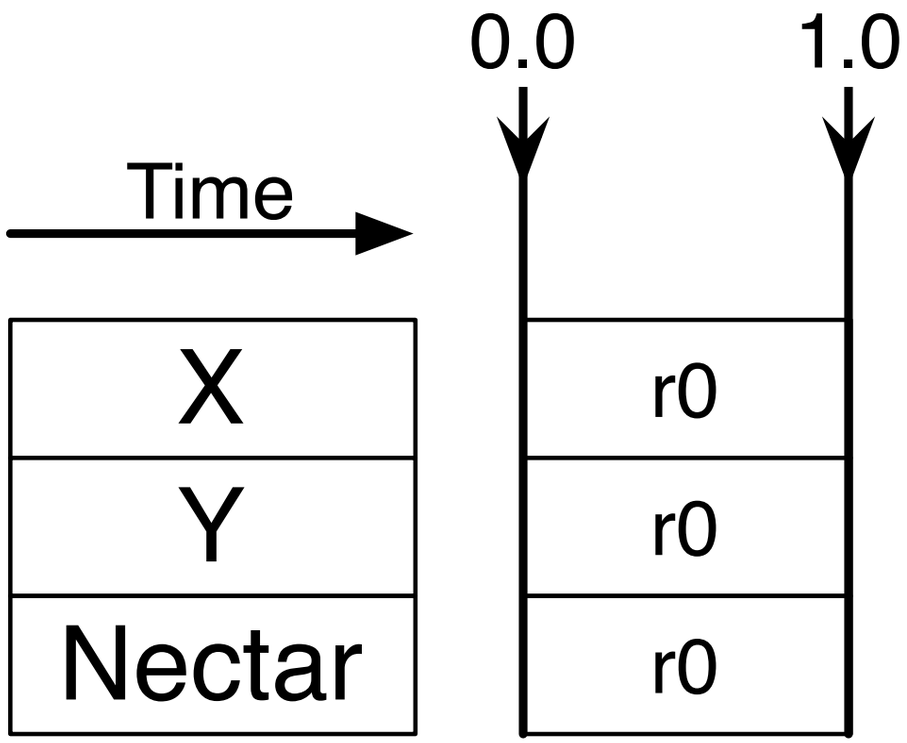
publish (name, time)

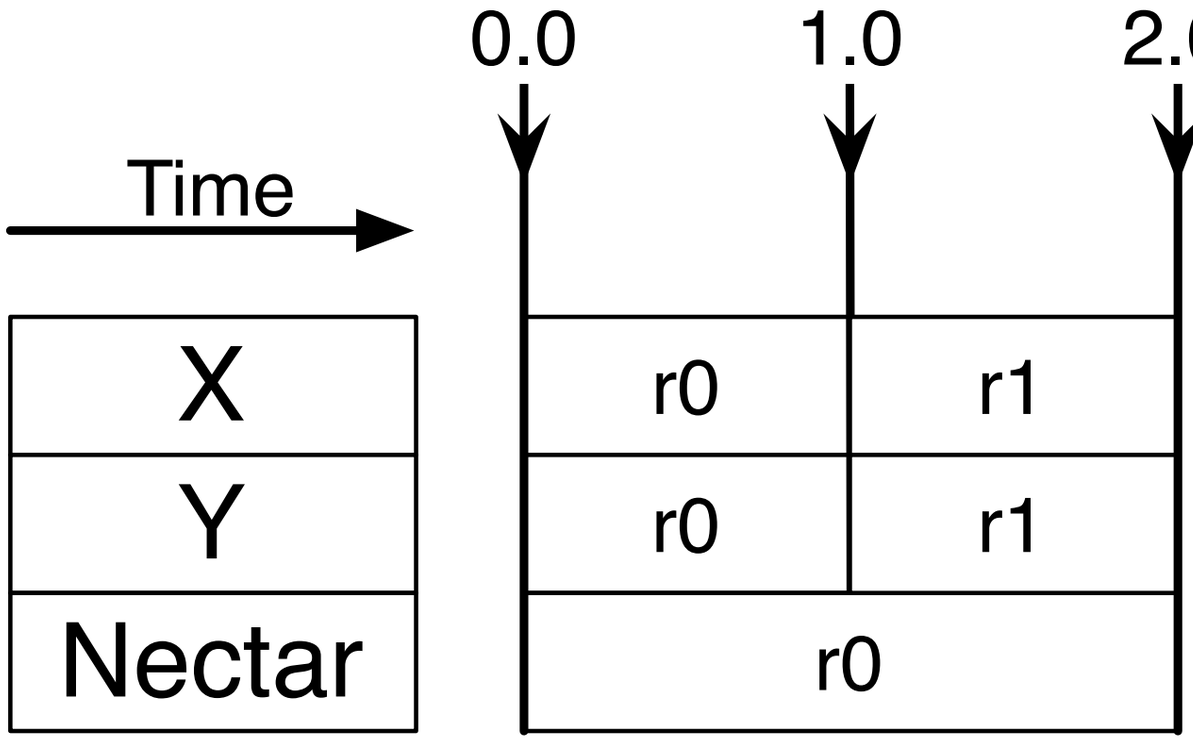
read (name, field, time)

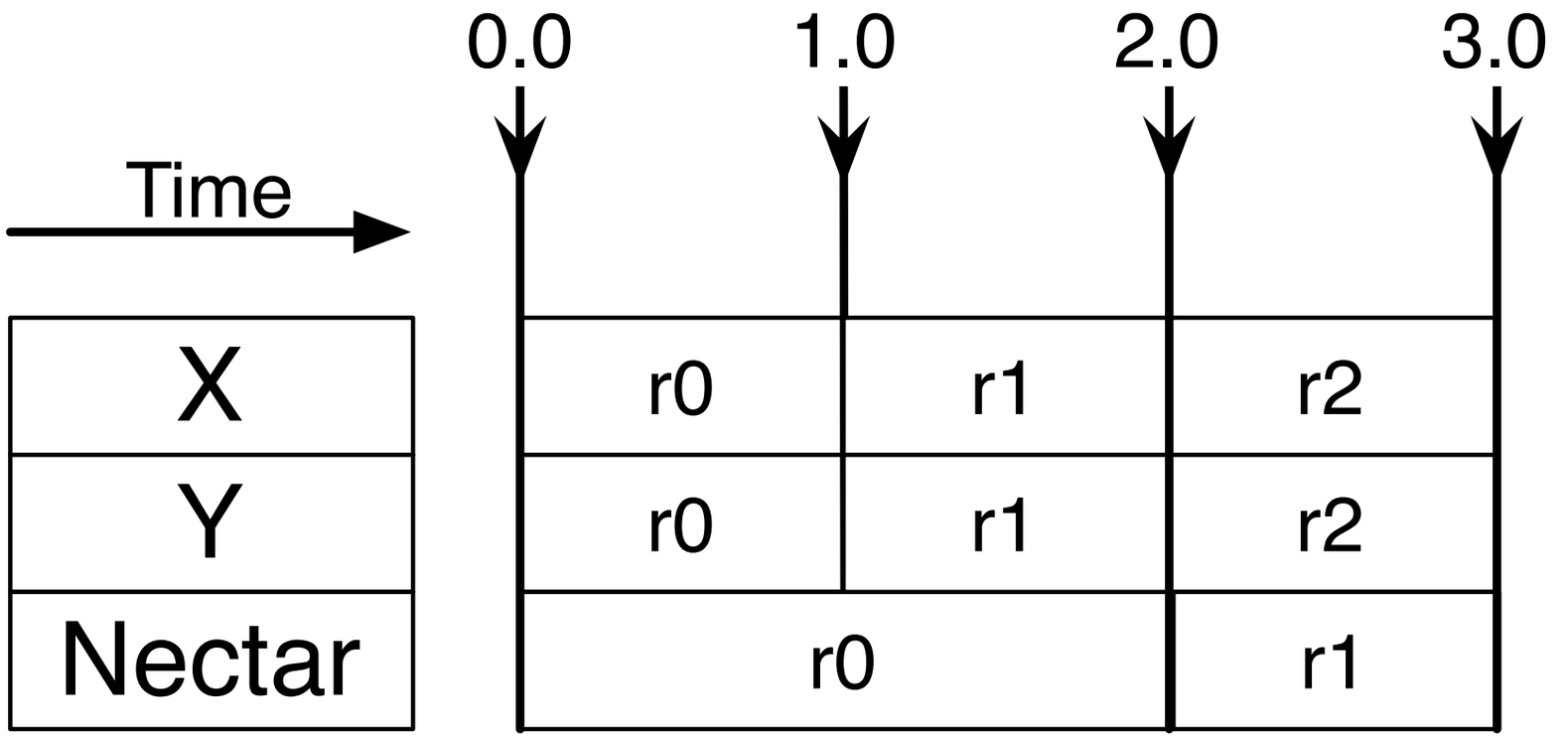
query (regular expression)

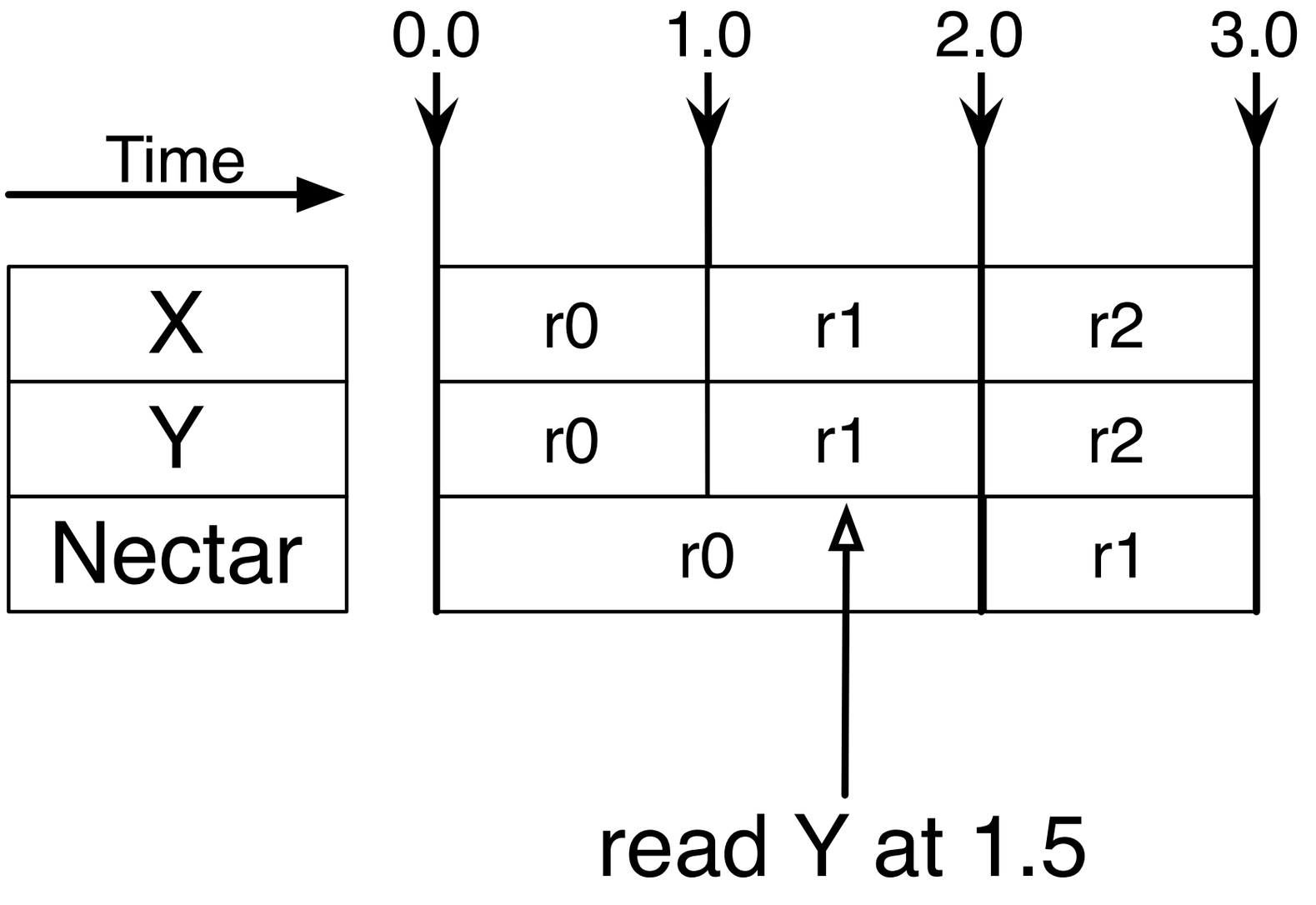
Object Timelines

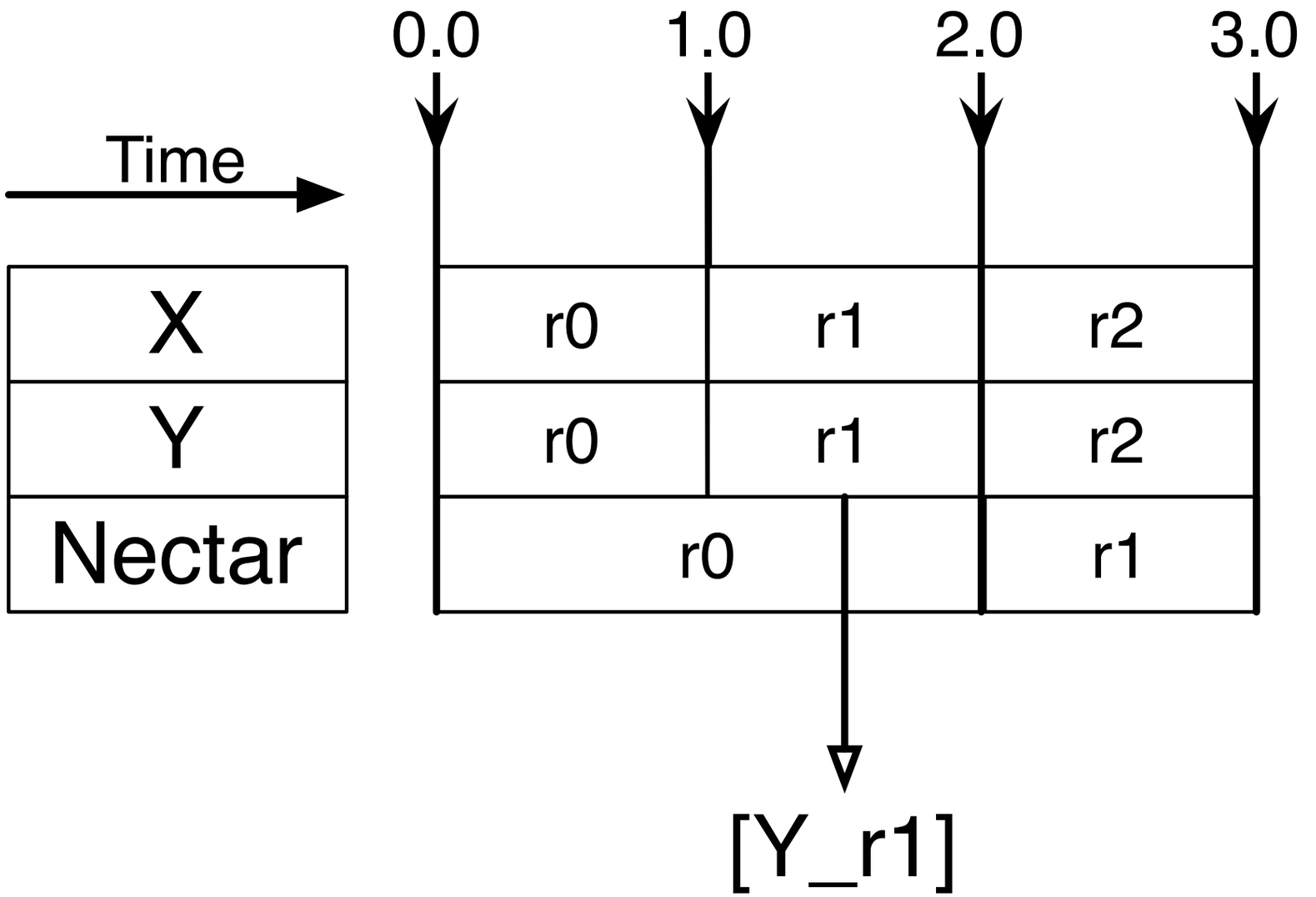
Separate simulation time steps

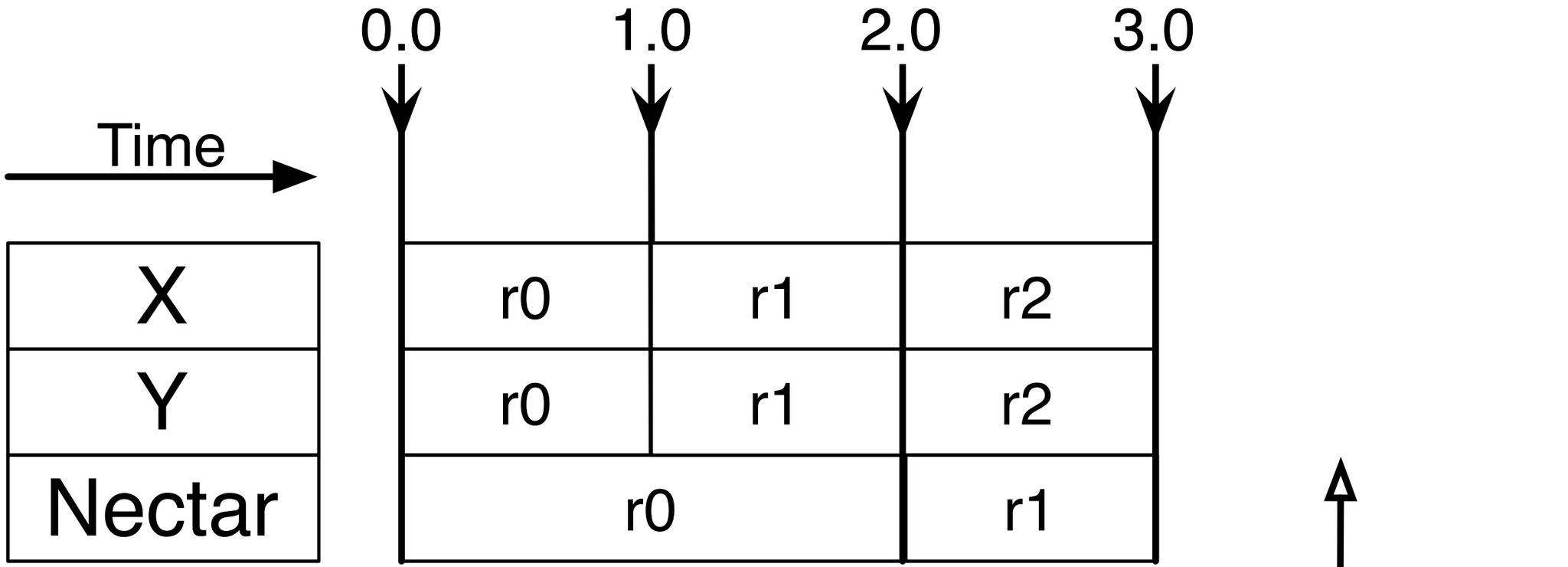

0.0
1.0
Time
X
Y
Nectar
r0
r0
r0

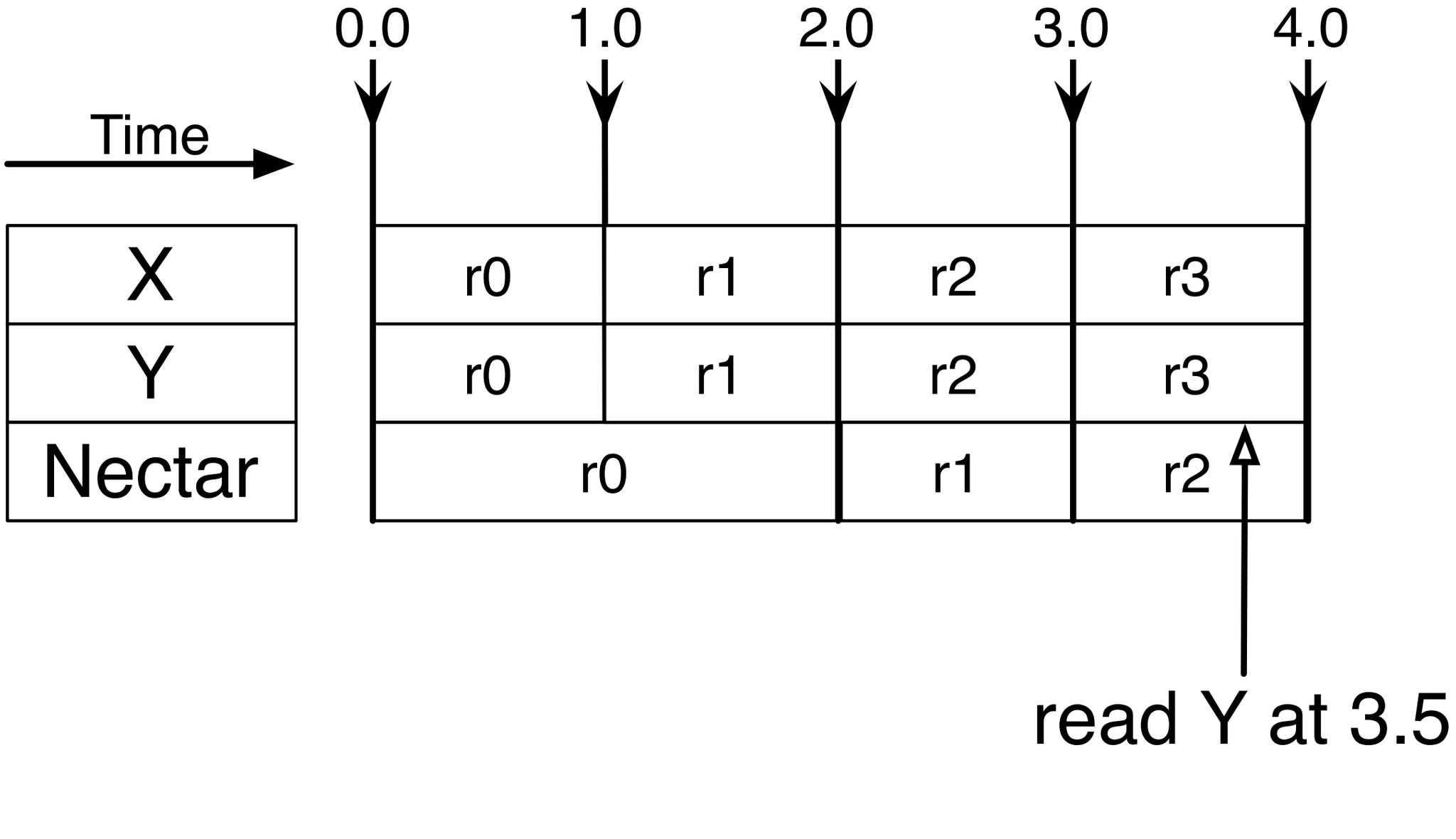

0.0
1.0
2.0
Time
X
Y
Nectar
r0
r1
r0
r1
r0

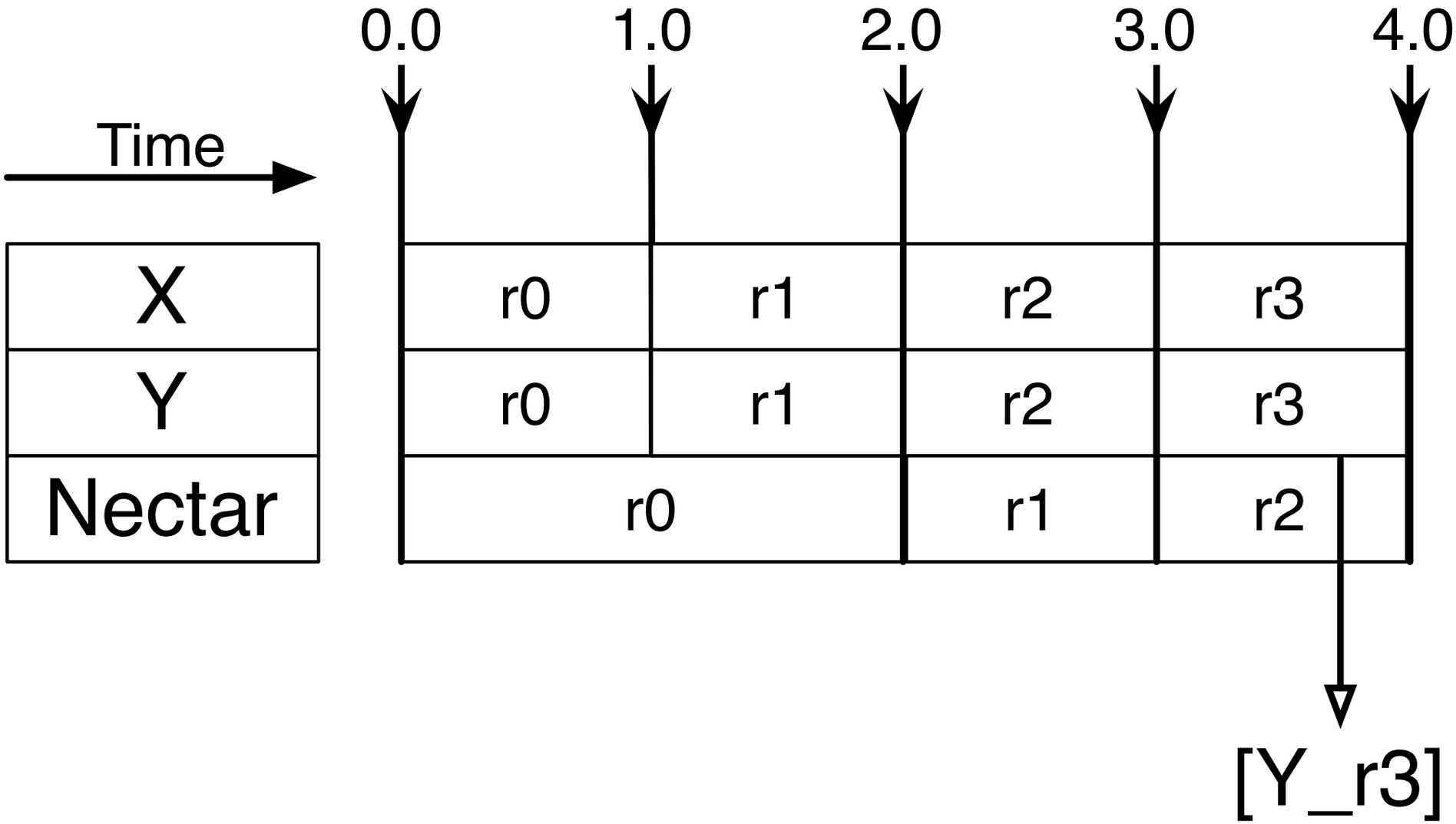

0.0
1.0
2.0
3.0
Time
X
Y
Nectar
r0
r1
r2
r0
r1
r2
r0
r1

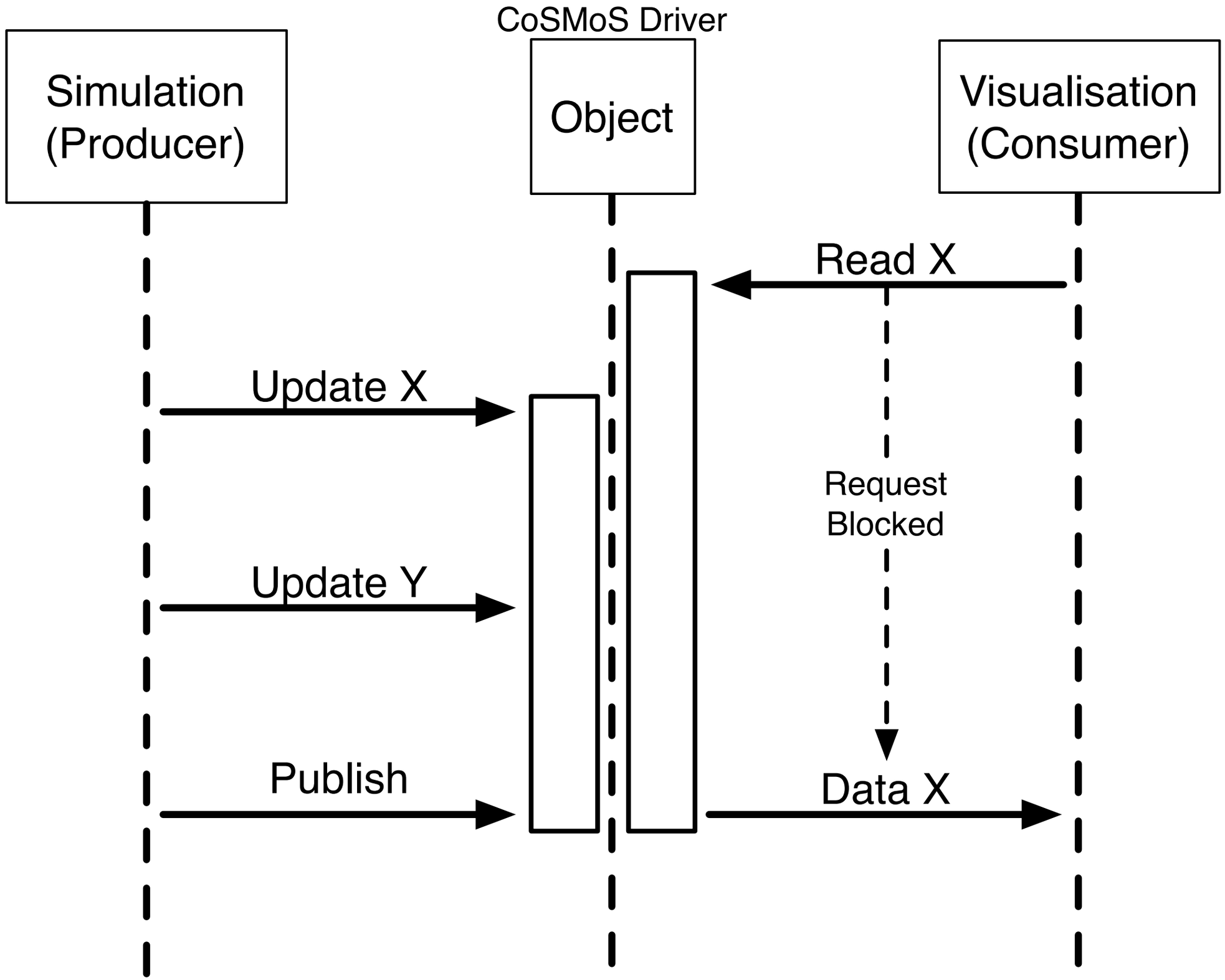

0.0
1.0
2.0
3.0
Time
X
Y
Nectar
r0
r1
r2
r0
r1
r2
r0
r1
read Y at 1.5


0.0
1.0
2.0
3.0
Time
X
Y
Nectar
r0
r1
r2
r0
r1
r2
r0
r1
[Y_r1]


0.0
1.0
2.0
3.0
Time
X
Y
Nectar
r0
r1
r2
r0
r1
r2
r0
r1
read Y at 3.5


0.0
1.0
2.0
3.0
4.0
Time
X
Y
Nectar
r0
r1
r2
r3
r0
r1
r2
r3
r0
r1
r2
read Y at 3.5


0.0
1.0
2.0
3.0
4.0
Time
X
Y
Nectar
r0
r1
r2
r3
r0
r1
r2
r3
r0
r1
r2
[Y_r3]


CoSMoS Driver
Simulation
(Producer)
Object
Visualisation
(Consumer)
Read X
Update X
Request
Blocked
Update Y
Publish
Data X

Storage and Architecture

Inspiration from web services

Client => Frontend => Database

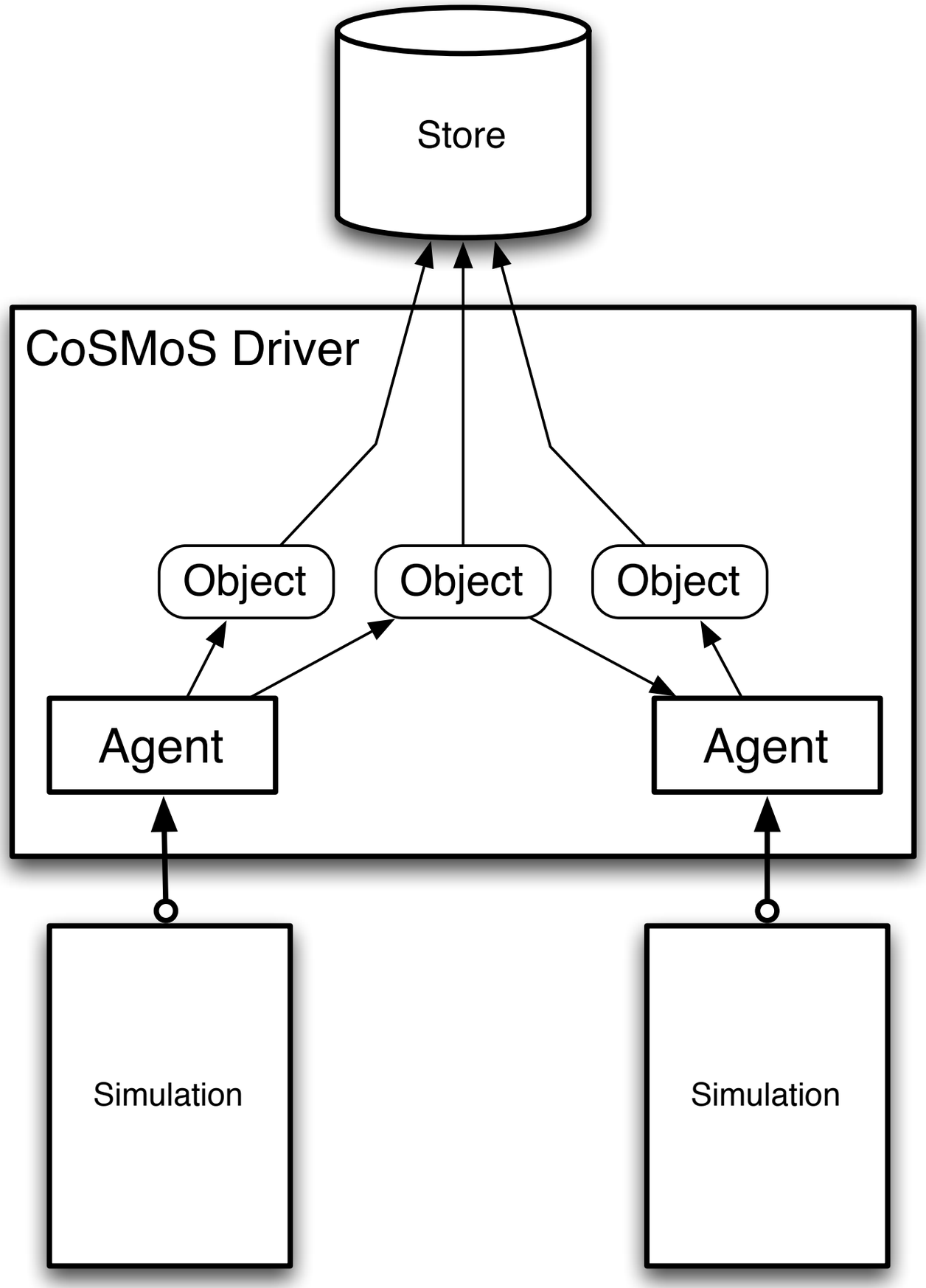
Key-Value Store

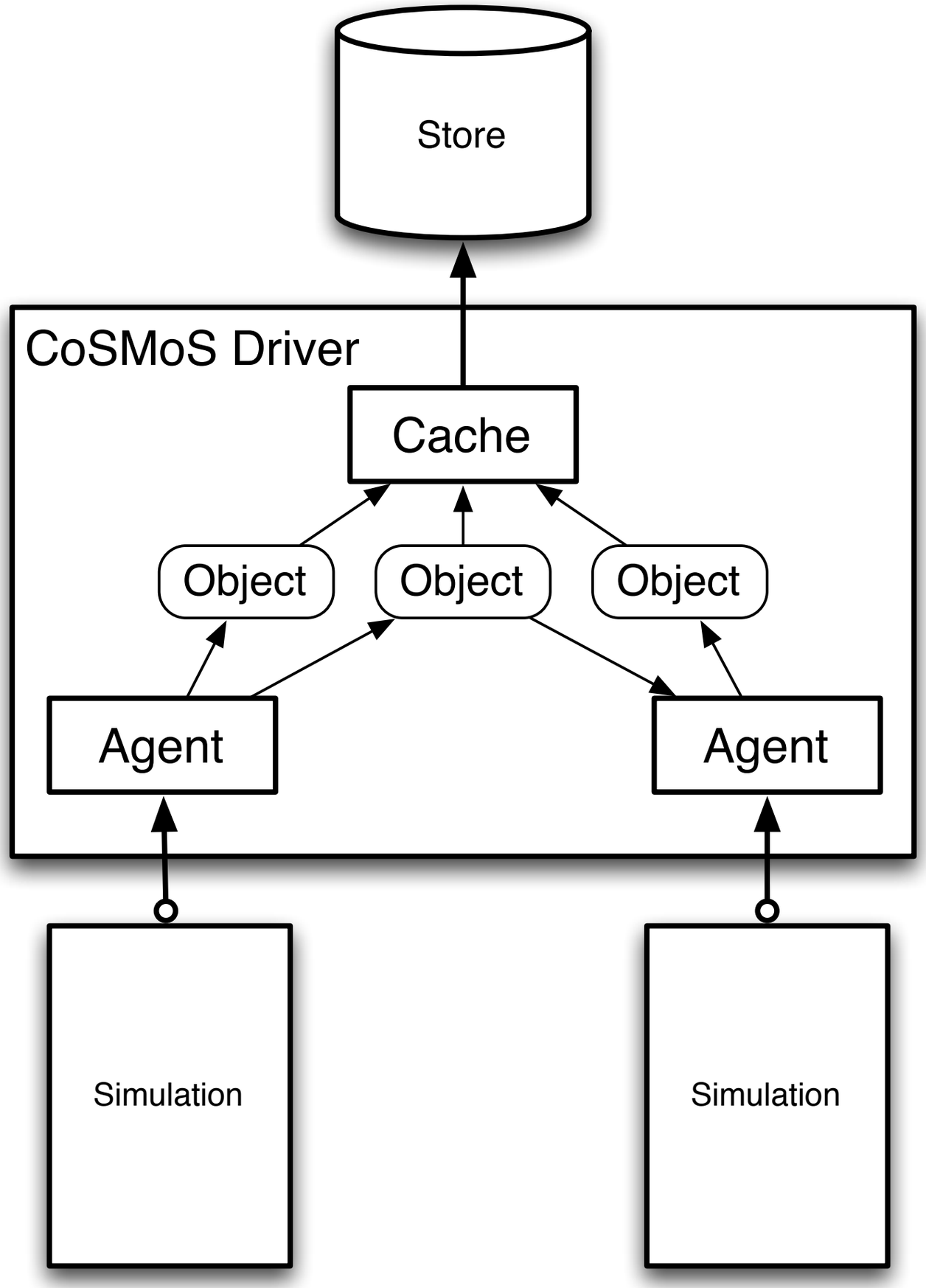
Key-Value Store

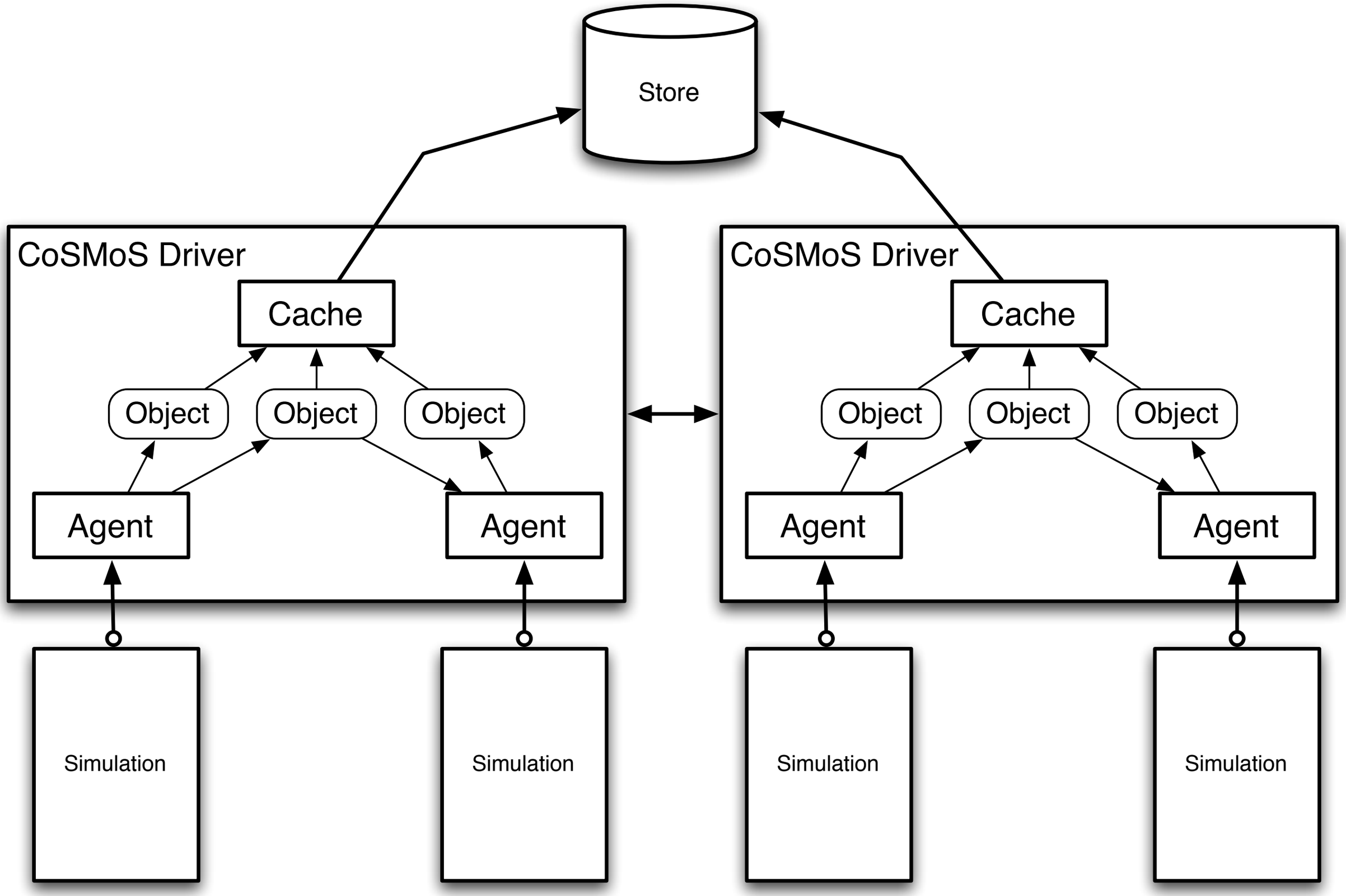
Big hash table / dictionary

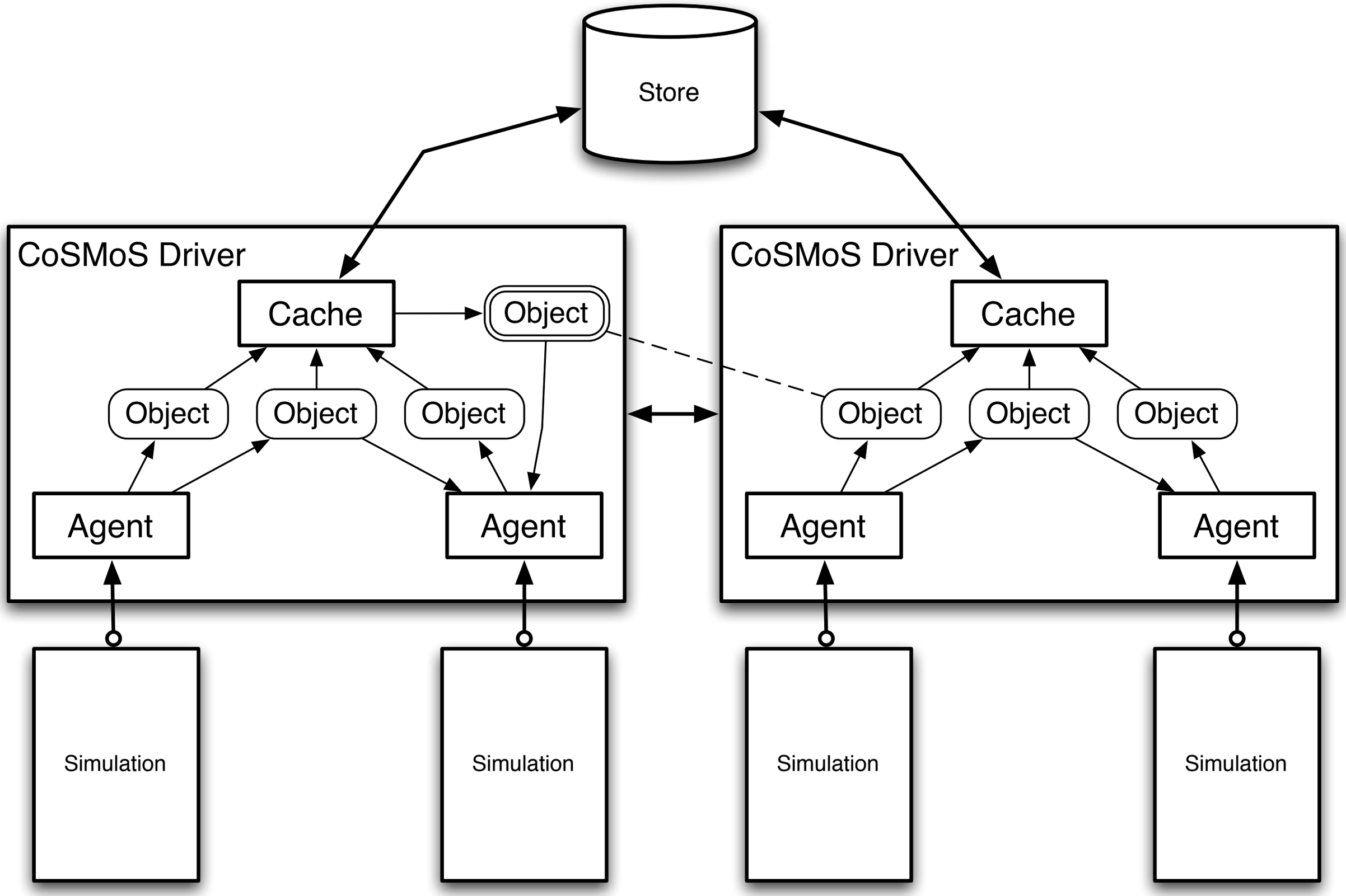
O(1) access, replication, etc

Keys, e.g. obj_1:field_1:r0


Store
CoSMoS Driver
Object
Object
Object
Agent
Agent
Simulation
Simulation


Store
CoSMoS Driver
Cache
Object
Object
Object
Agent
Agent
Simulation
Simulation


Store
CoSMoS Driver
Cache
Object
Object
Object
Agent
Agent
Simulation
Simulation
CoSMoS Driver
Cache
Object
Object
Object
Agent
Agent
Simulation
Simulation

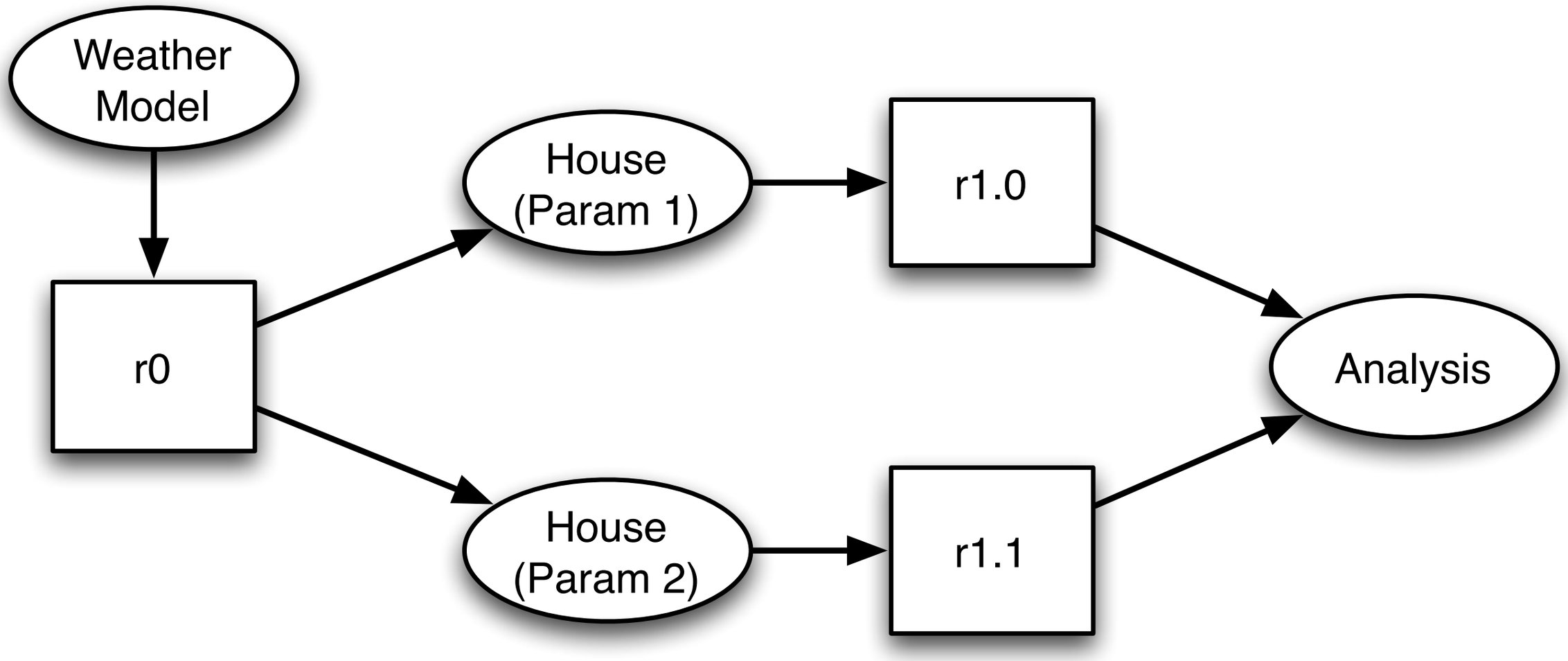

Store
CoSMoS Driver
Cache
Object
Object
Object
Object
Agent
Agent
Simulation
Simulation
CoSMoS Driver
Cache
Object
Object
Object
Agent
Agent
Simulation
Simulation

Versioning

Repeat runs based on stored data

Analysis of multiple data sets

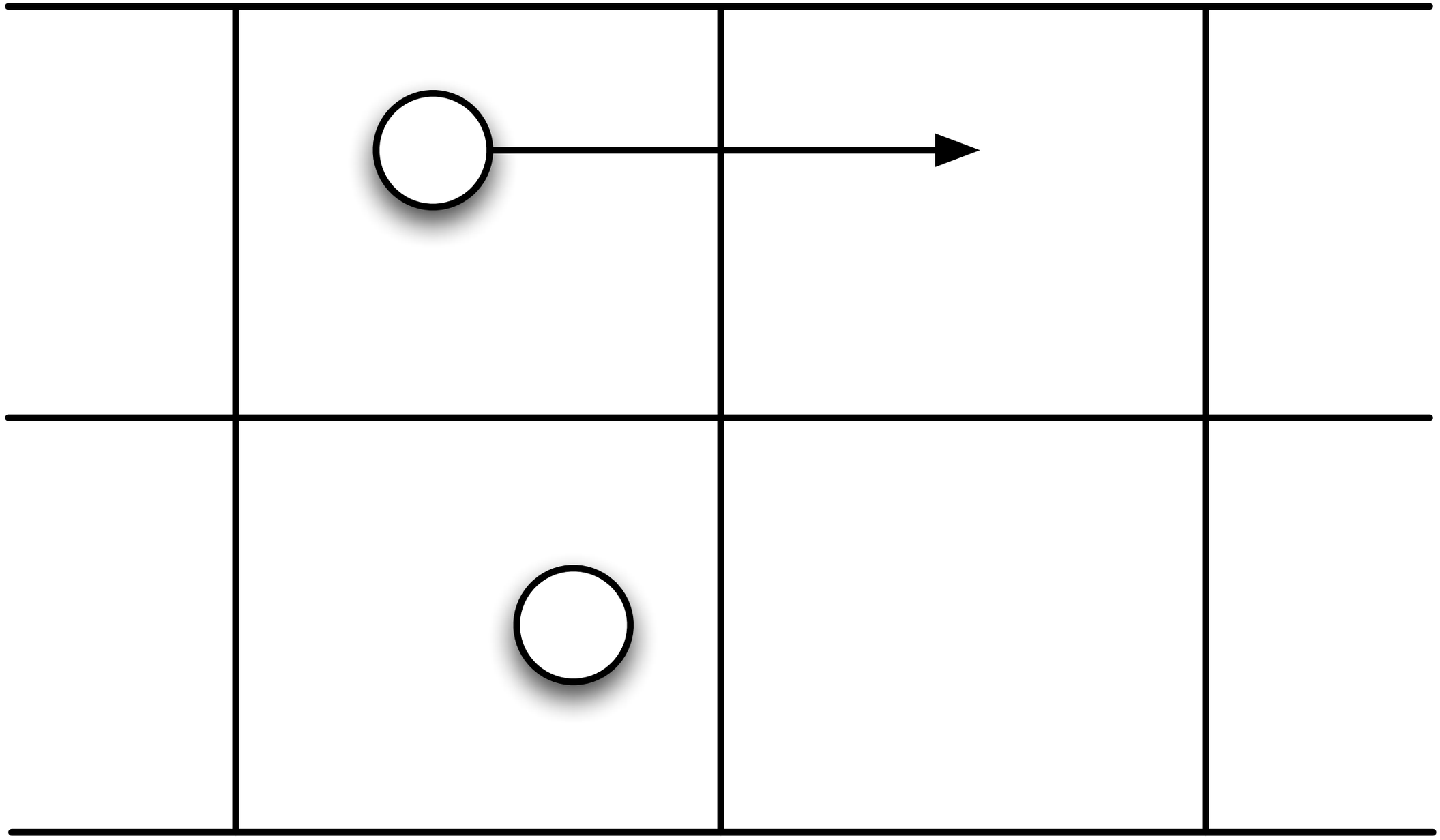
Prefix/postfix keys

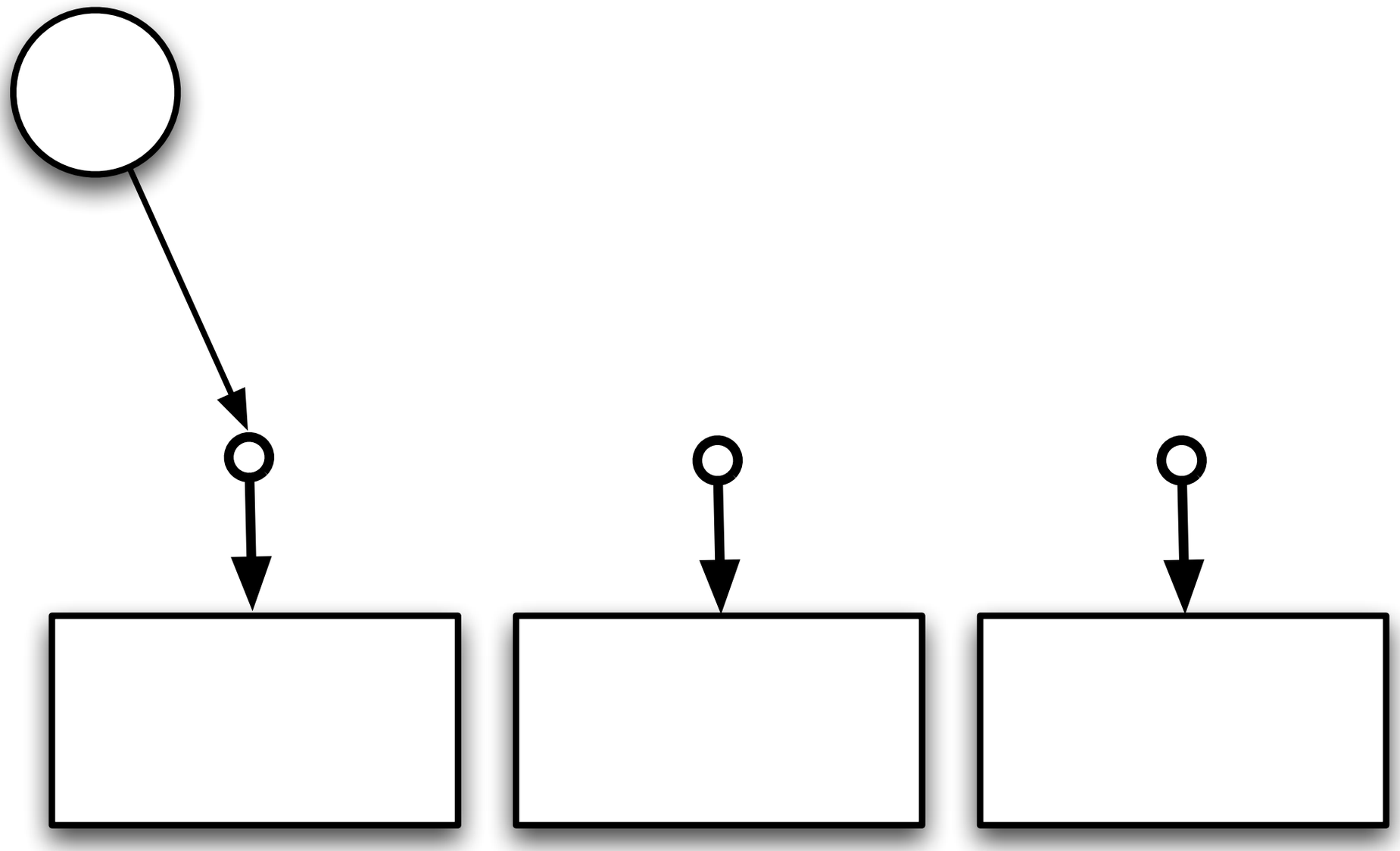

Weather
Model
r0
House
(Param 1)
r1.0
House
(Param 2)
r1.1
Analysis

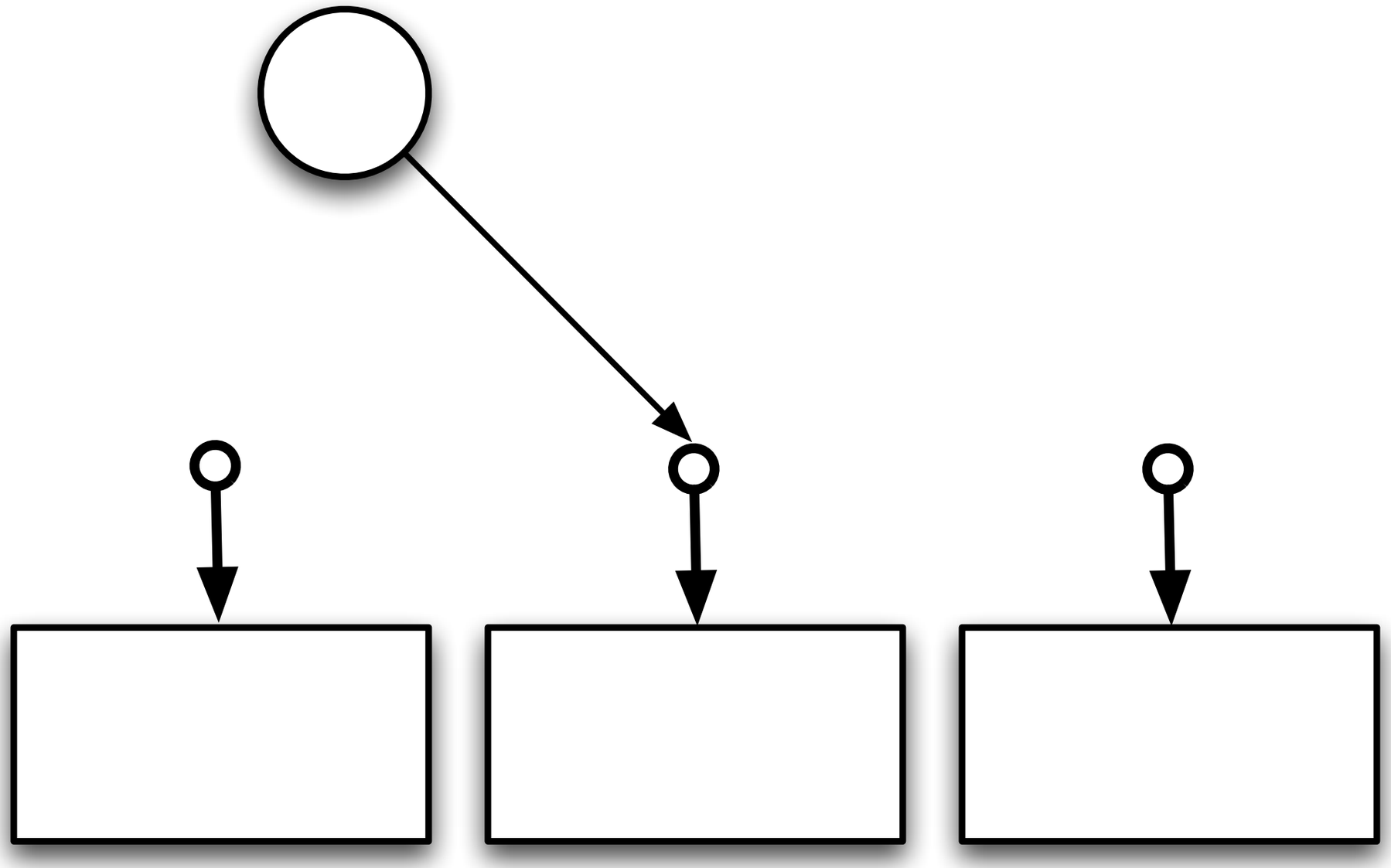
Case Study

Boids (occoids)

Flocking emergence (depending on parameters)







Retasking

Visual demo

Different dynamics: Bees

Not scientific

Modifications

Record simulations

Analyse agent movement

System Entropy

Singular Value Decomposition

$$Z = \begin{bmatrix} \overbrace{P.x_1^1\ P.y_1^1\ V.x_1^1\ V.y_1^1}^{Boid_1} & \dots & \overbrace{P.x_1^n\ P.y_1^n\ V.x_1^n\ V.y_1^n}^{Boid_n} \\ \vdots & \vdots & \vdots \\ \overbrace{P.x_m^1\ P.y_m^1\ V.x_m^1\ V.y_m^1}^{Boid_1} & \dots & \overbrace{P.x_m^n\ P.y_m^n\ V.x_m^n\ V.y_m^n}^{Boid_n} \end{bmatrix}$$

$$\bar{P}_{group_n} = \frac{\sum_{i \in group_n} P_t^i}{n} \wedge \bar{V}_{group_n} = \frac{\sum_{i \in group_n} V_t^i}{n}$$

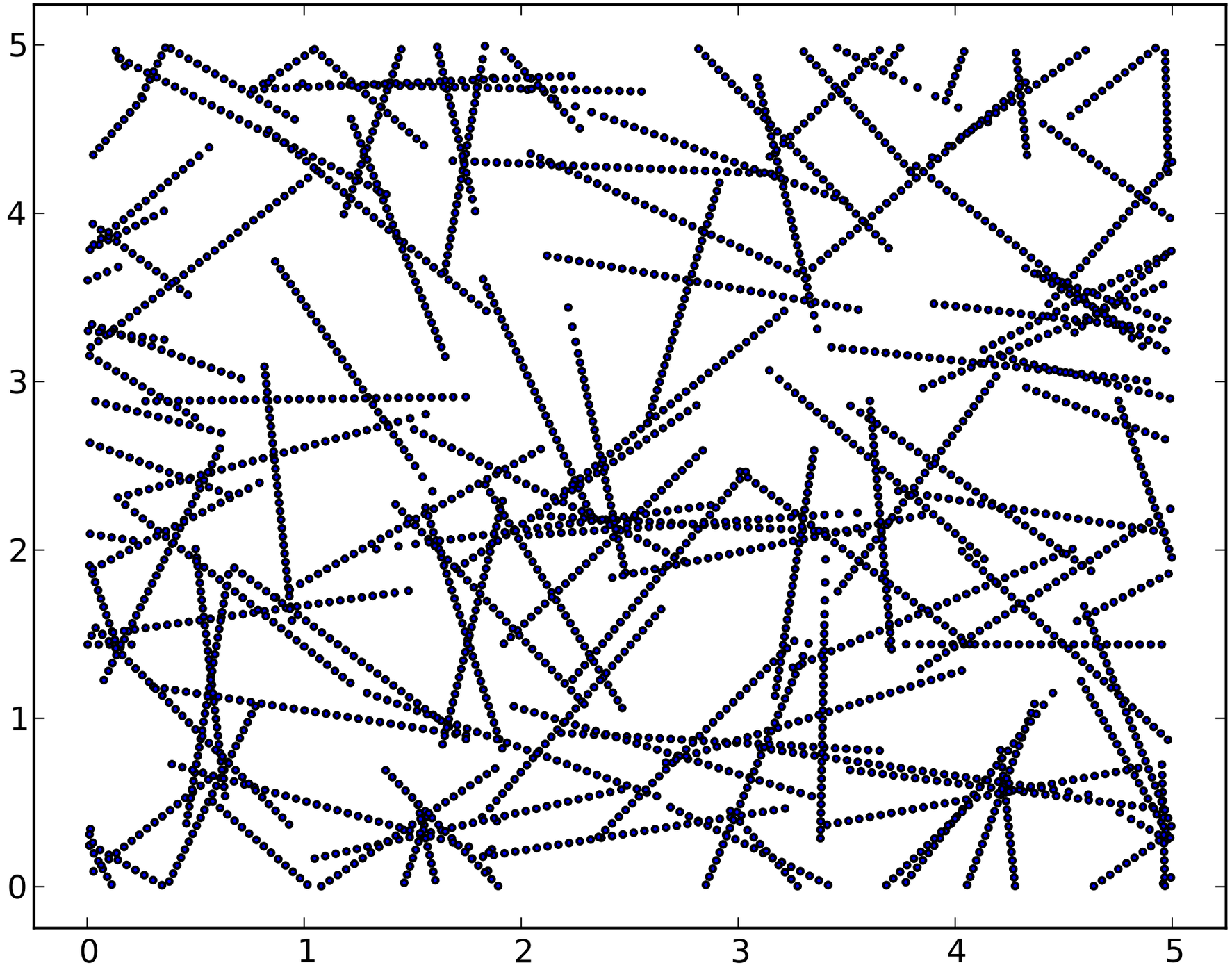
$$\forall_i Z.P_t^i \leftarrow \bar{P}_t - Z.P_t^i \wedge \forall_i Z.V_t^i \leftarrow \bar{V}_t - V.P_t^i$$

$$\Sigma_t = \mathrm{SVD}(Z_t)$$

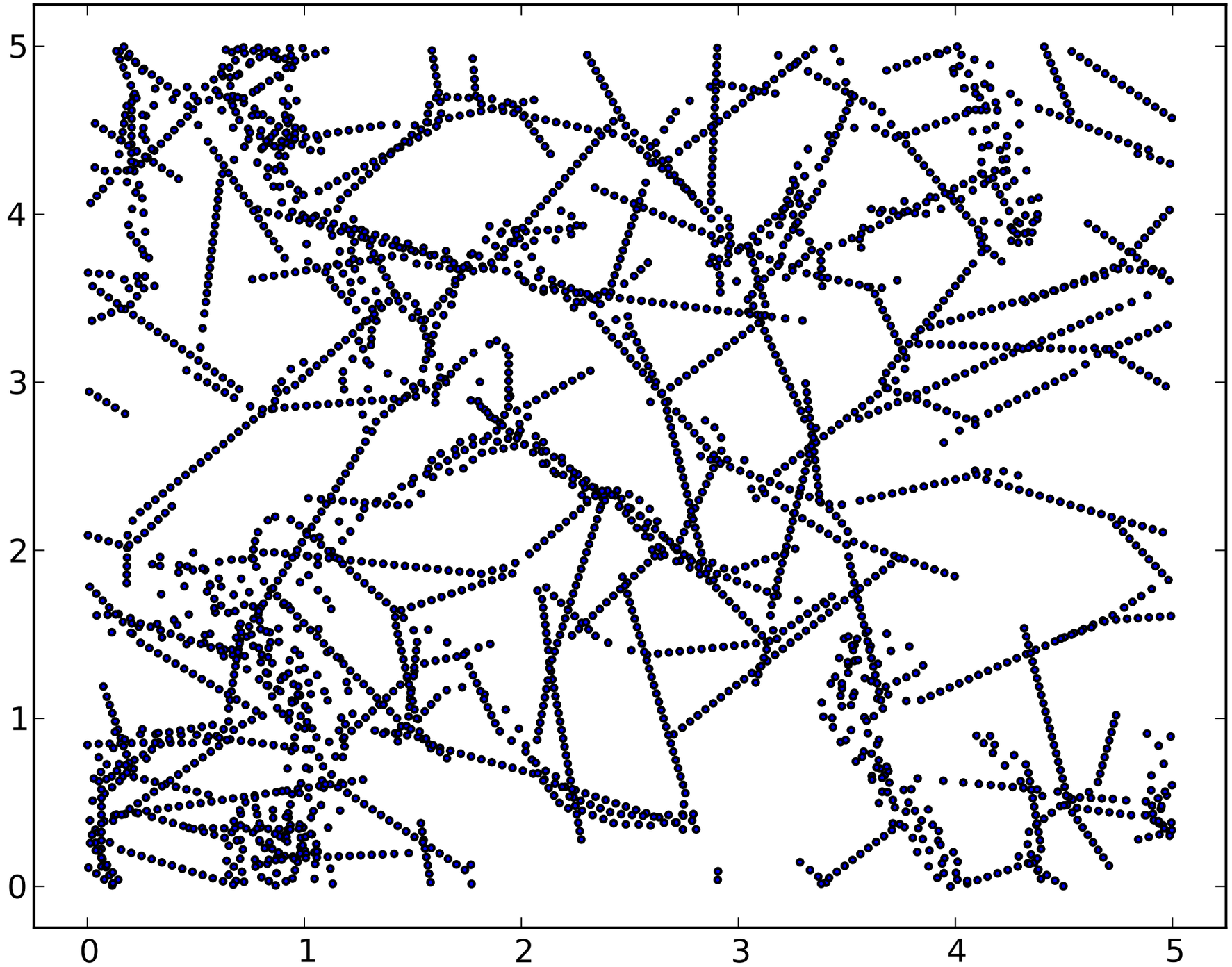
$$\Sigma'_t = \frac{\Sigma_t}{(\sum_i \sigma_{i,t})} \text{ where } \sigma_{i,t} \in \Sigma_t$$

$$S_t = -\sum_i \sigma'_{i,t}.\log_2(\sigma'_{i,t})$$

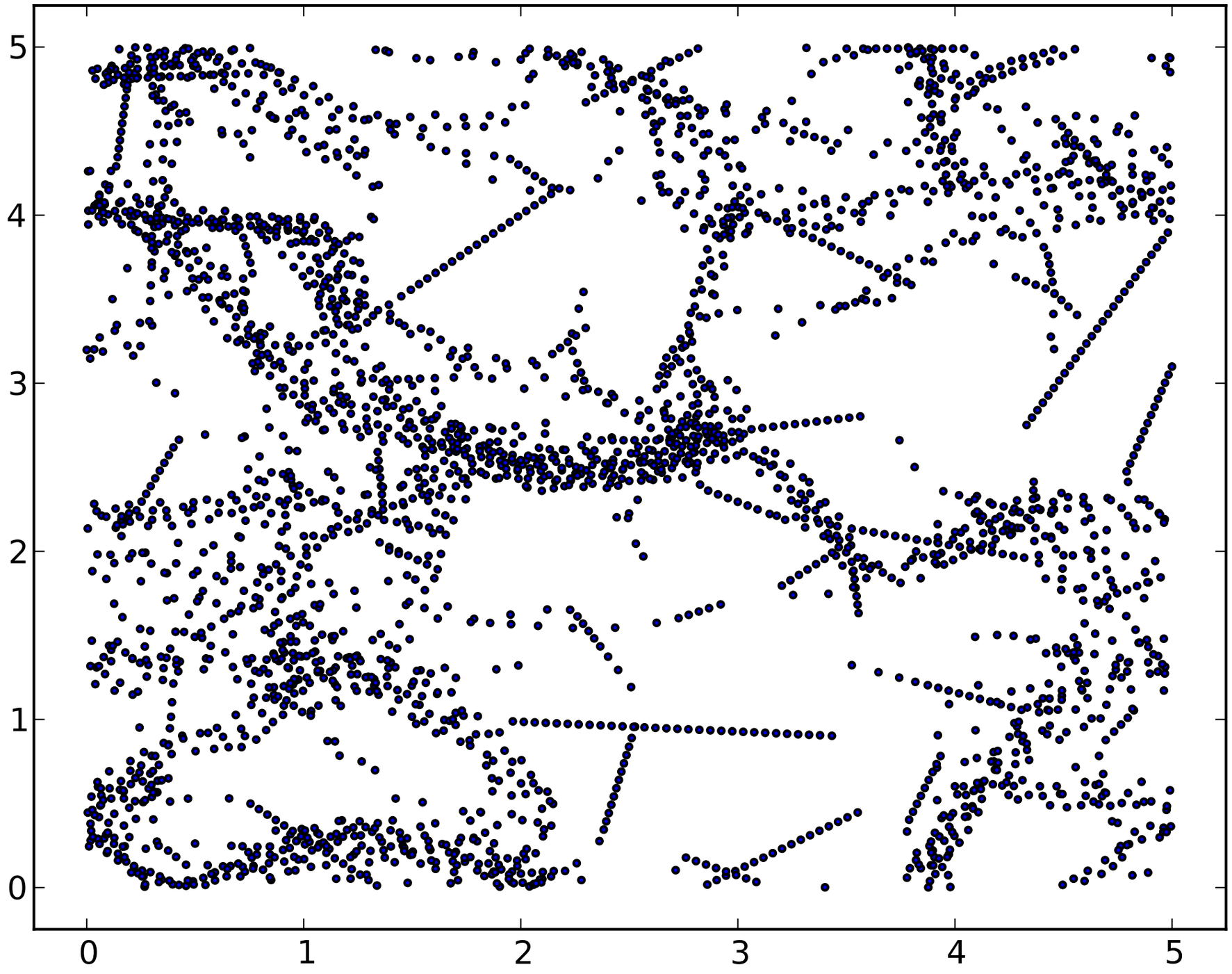
vision.radius=0.00



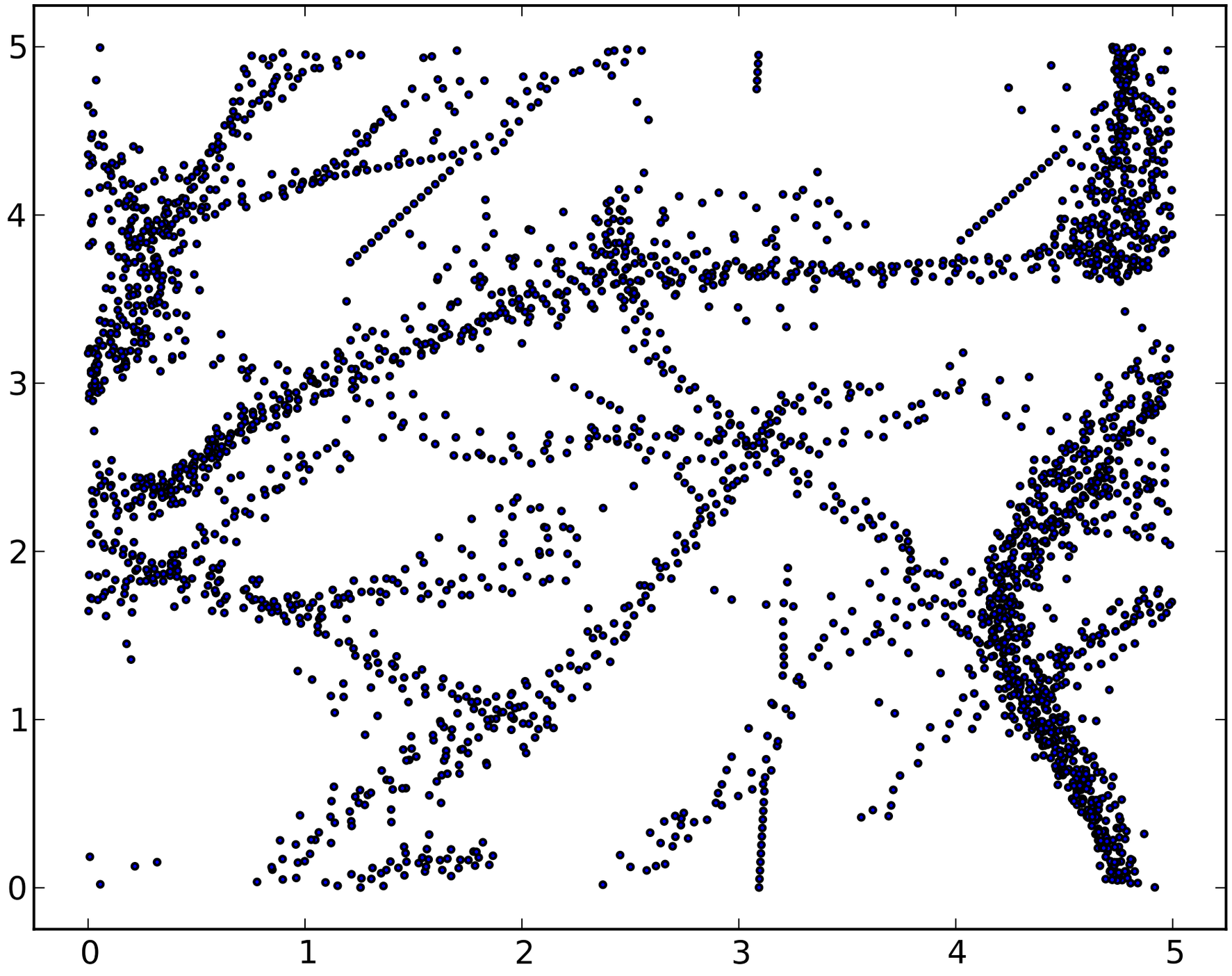
vision.radius=0.20



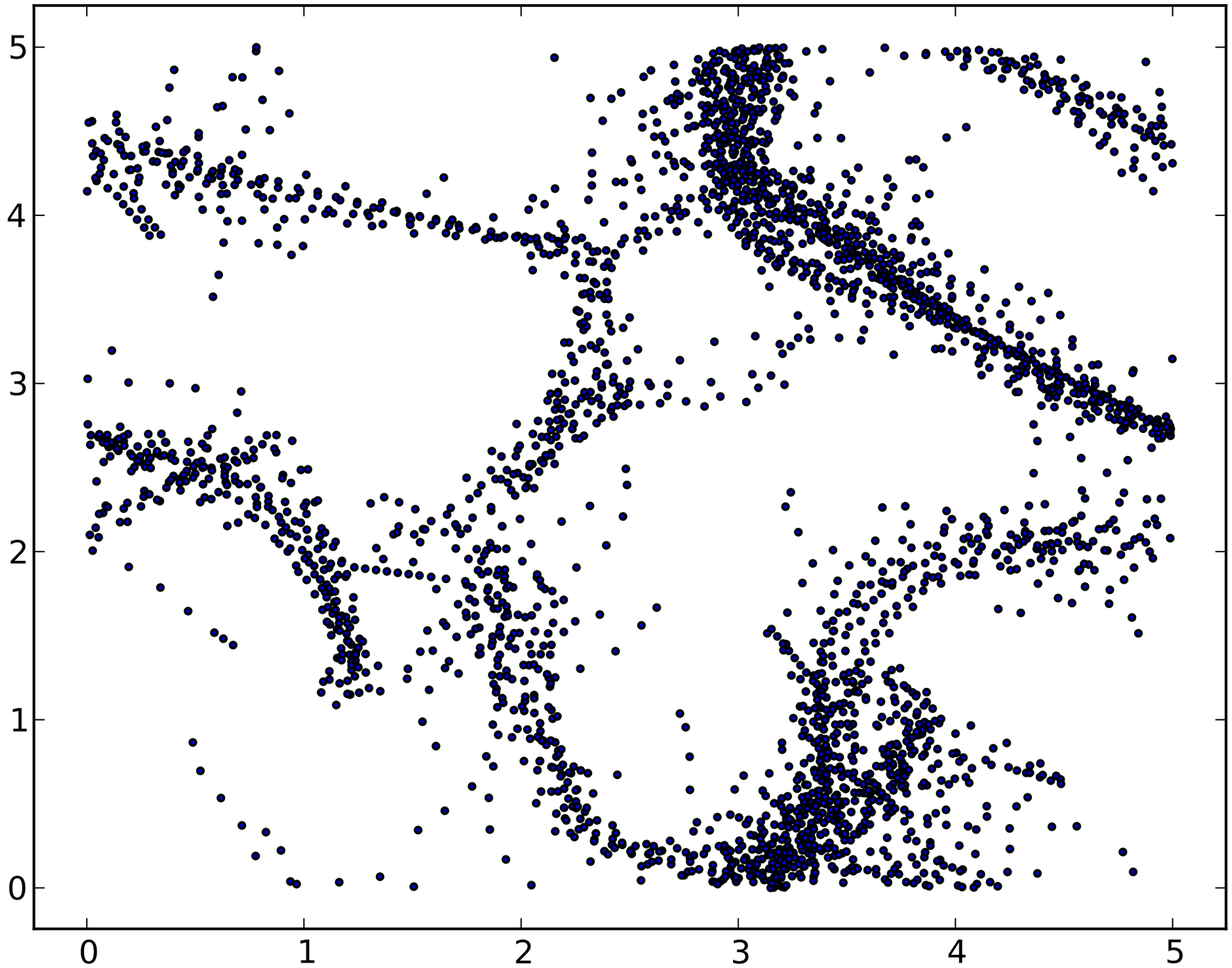
vision.radius=0.40

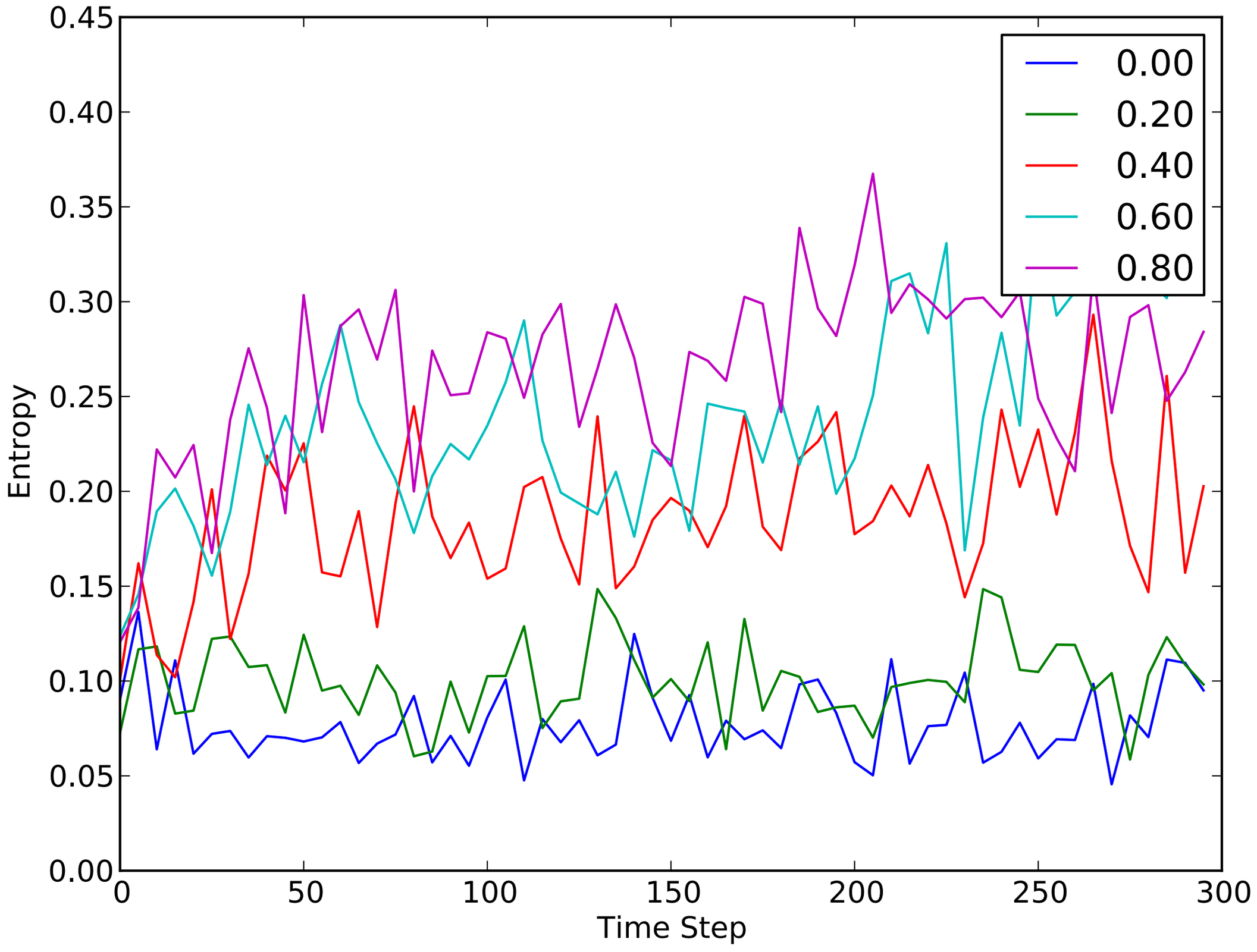


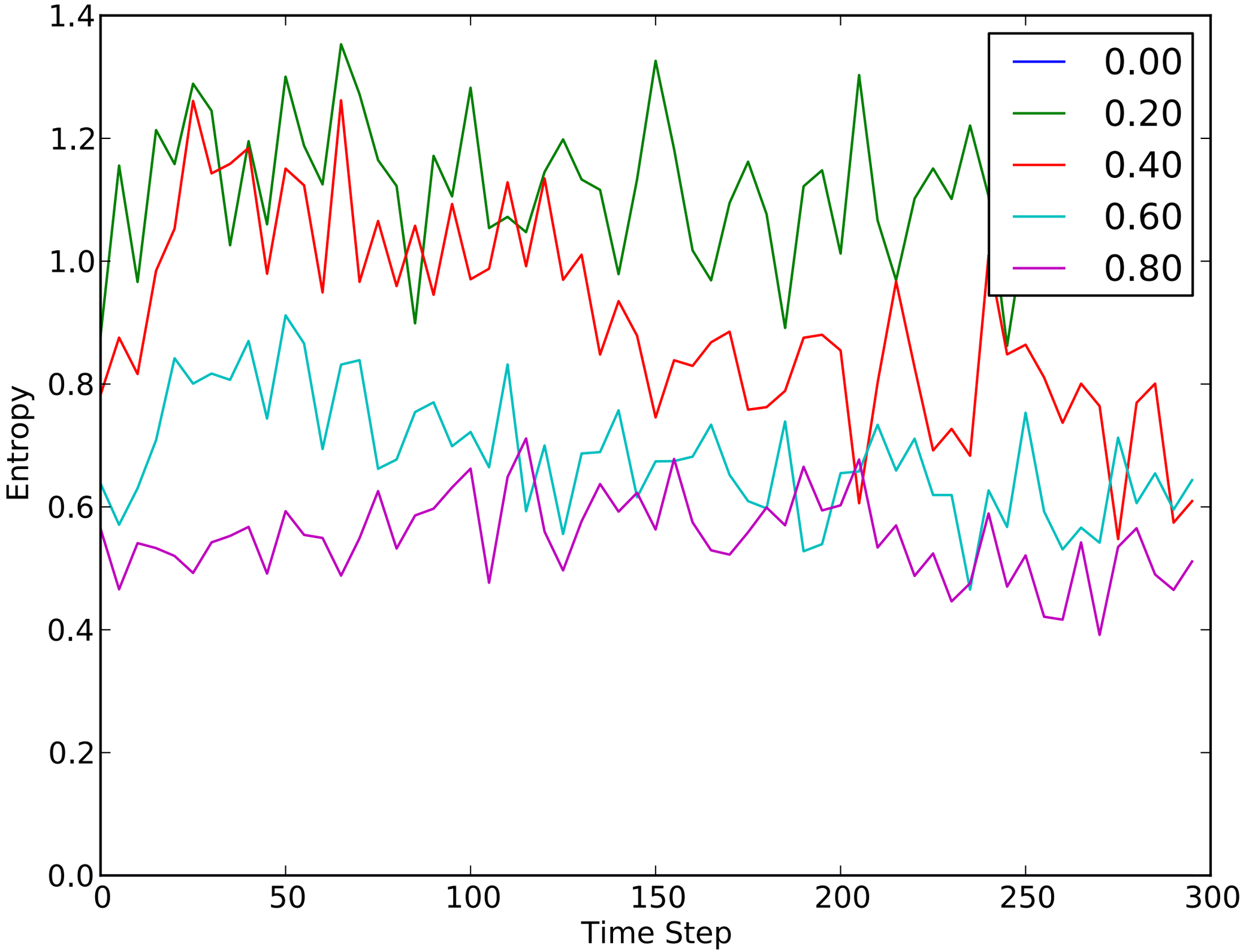
vision.radius=0.60



vision.radius=0.80




0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Entropy
0
50
100
150
200
250
300
Time Step
0.00
0.20
0.40
0.60
0.80


1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Entropy
0
50
100
150
200
250
300
Time Step
0.00
0.20
0.40
0.60
0.80

Summary

Loose coupling - synchronisation when required

On data, not explicit lock step

Coarse-grain to fine-grain support

Future Work

Performance

Time fuzziness

Questions?

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