

Roman Trade

The ultimate goal is to understand the economic processes that played part in shaping Roman trade.





Trade is a complex dynamical system

COMPLEX - consisting of multiple elements interacting with each other in a non-linear way.
The properties of the system are difficult to infer from the properties of its individual elements.

DYNAMICAL - it changes over time.

Modelling to

*we only need
distributions -
large trends*

Two main problems with

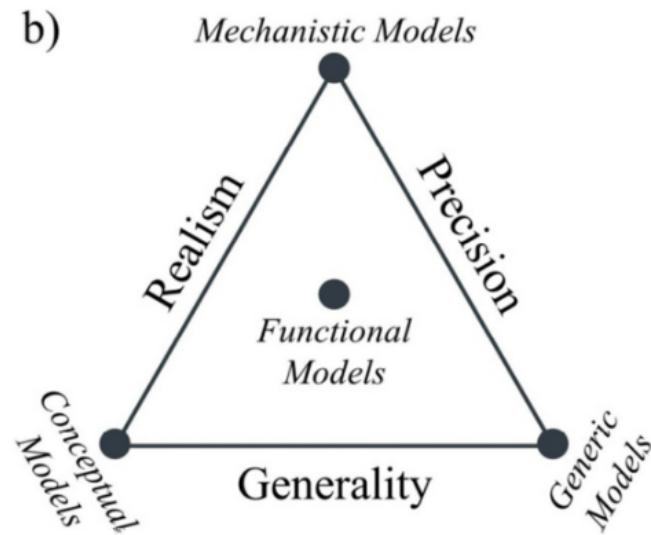
- incompatibility of datasets
- incompleteness of data

*Easier to identify
gaps when you
have a benchmark*

Simulation

A family of methods used by
virtually all disciplines of science.

A model + time dimension



Bullock 2014, fig.1b

Three heuristic uses of simulation

- Tool to think with (formalism)
- Theory building
- Hypotheses testing

Models from first principles

*54·43. $\vdash \alpha, \beta \in 1. \text{Def} : \alpha \cap \beta = \Lambda . \equiv . \alpha \cup \beta \in 2$

Dem.

$\vdash *54·26. \text{Def} \vdash \alpha = t^e x . \beta = t^e y . \text{Def} : \alpha \cup \beta \in 2 . \equiv . x \neq y .$

[*51·231] $\equiv . t^e x \cap t^e y = \Lambda .$

[*13·12] $\equiv . \alpha \cap \beta = \Lambda \quad (1)$

$\vdash . (1) . *11·11·35. \text{Def}$

$\vdash \alpha = (\exists x, y) . \beta = t^e x . \beta = t^e y . \text{Def} : \alpha \cup \beta \in 2 . \equiv . \alpha \cap \beta = \Lambda \quad (2)$

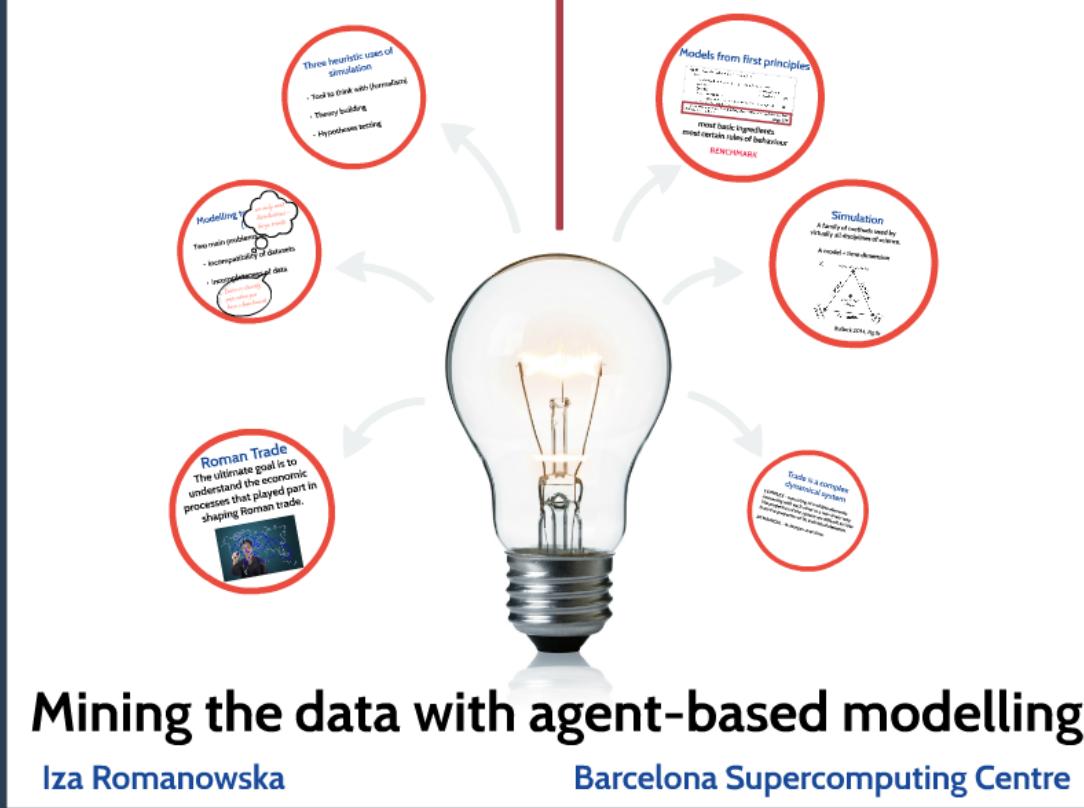
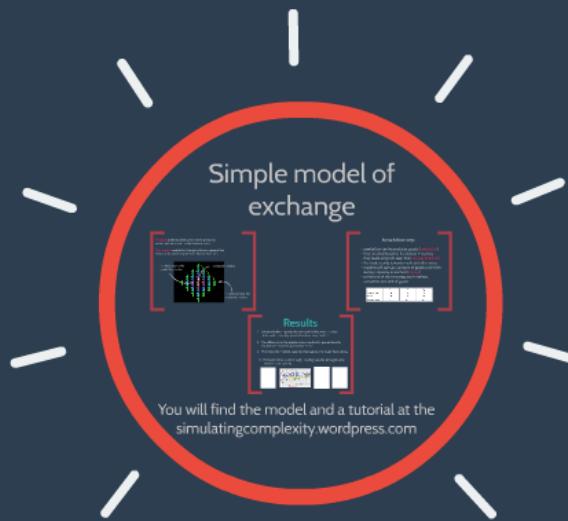
$\vdash . (2) . *11·54 . *52·1. \text{Def} \vdash . \text{Pron}$

From this proposition it will follow, when arithmetical addition has been defined, that $1 + 1 = 2$.

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**most basic ingredients
most certain rules of behaviour**

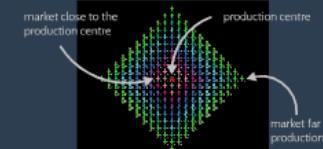
BENCHMARK



Simple model of exchange

The goal: understand what economic processes are behind the trends in distribution curves.

The model: model of exchange between a production centre and markets located at different distances.



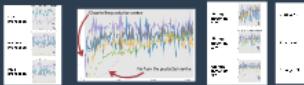
At each time step:

- production centre produces goods (**production**)
- they are distributed to the closest 4 markets
- they trade all goods over their **storage threshold**
- the trade is only towards markets further away
- markets will take any amount of goods until their **storage capacity** is reached (**storage**)
- at the end of the time step each markets consumes one unit of goods

	low	medium	high
Production level	10	50	100
Storage	10	50	100
Storage threshold	10%	50%	100%

Results

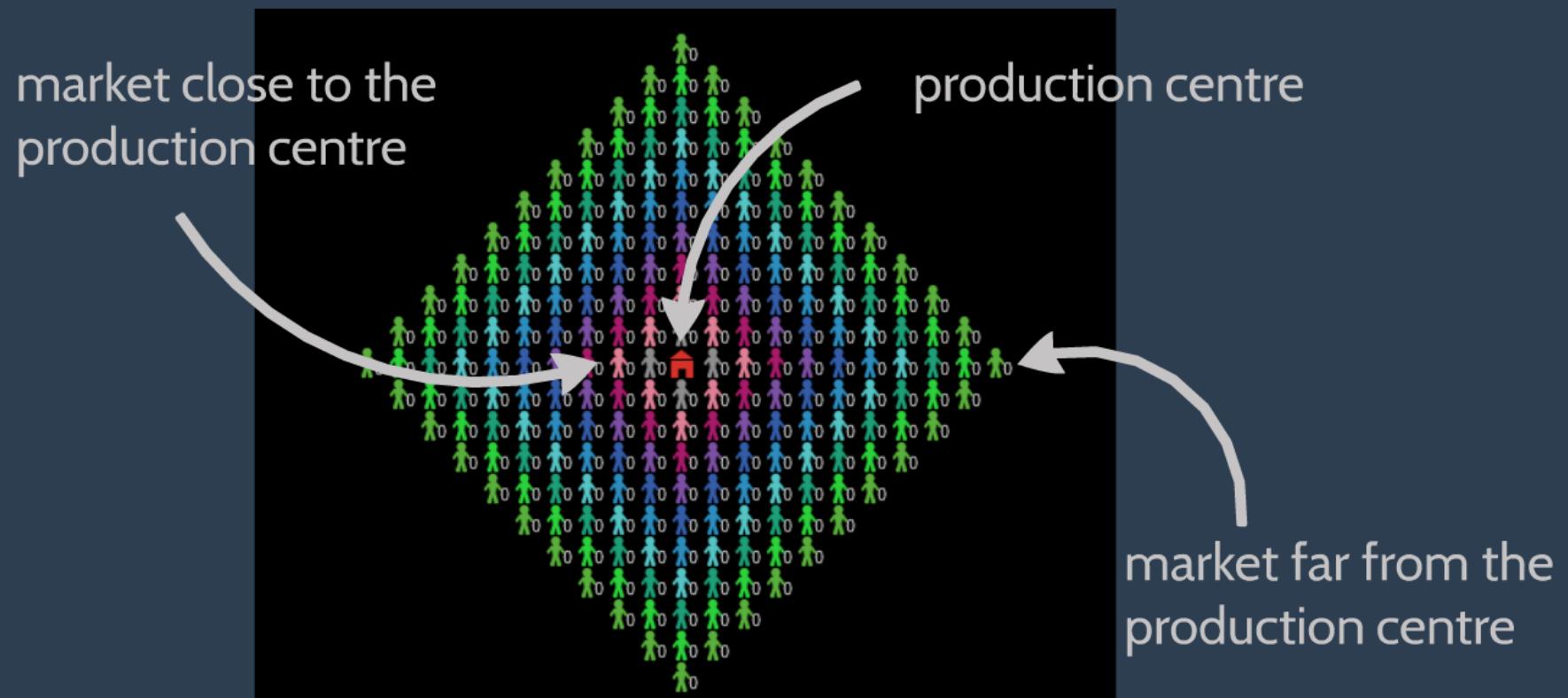
1. Low production → goods do not reach further away markets (but medium and high production level very similar).
2. The difference in the uptake curves are directly proportional to the distance from the production centre.
3. The more the markets keep for themselves the fewer fluctuations.
4. Production level is not enough - trading capacity (storage) is key (again only to a point).



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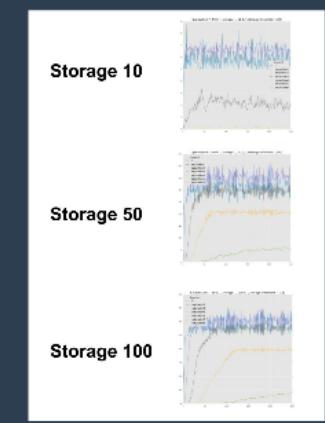
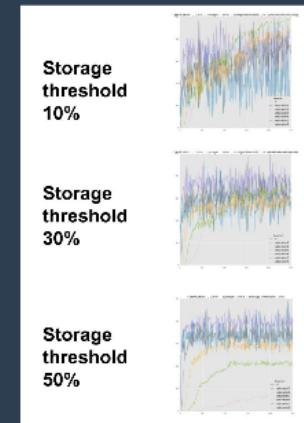
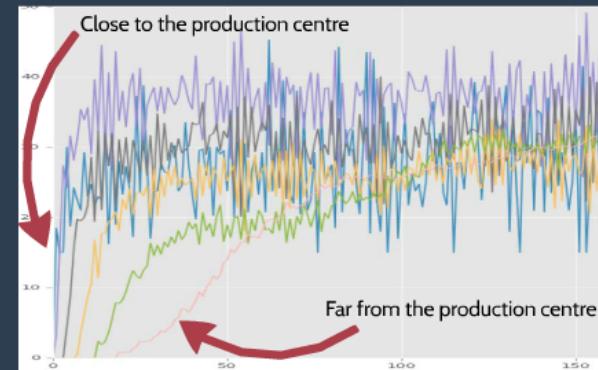
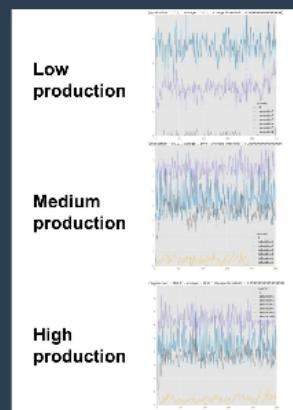
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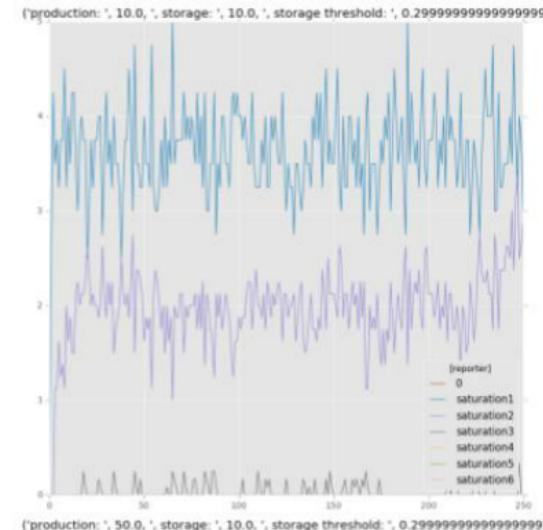
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Production level	10	50	100
Storage	10	50	100
Storage threshold	10%	30%	50%

Results

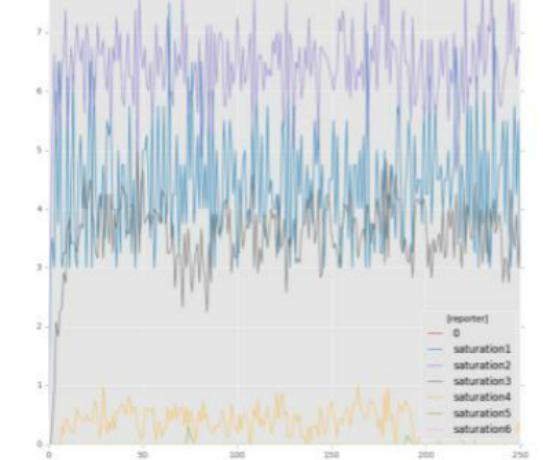
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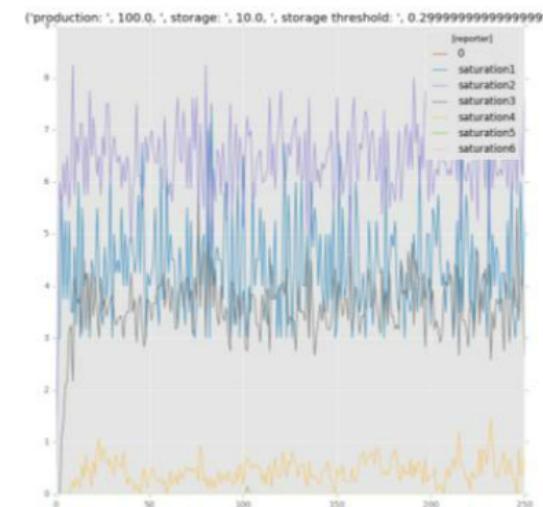
**Low
production**



**Medium
production**

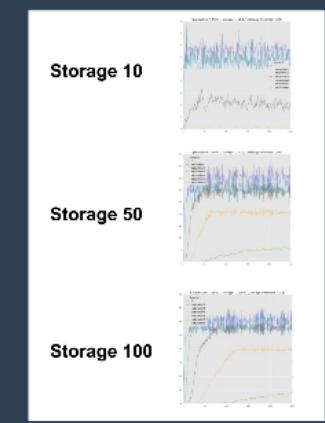
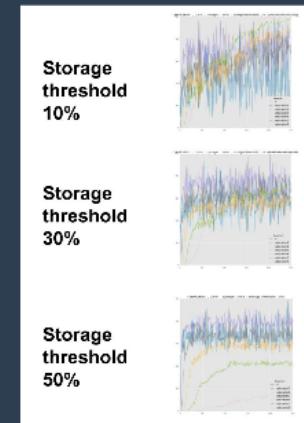
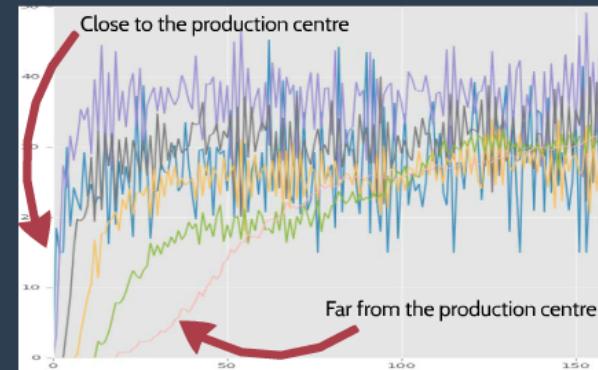
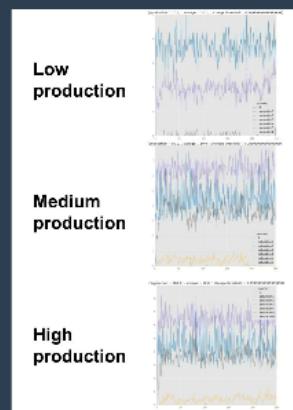


**High
production**

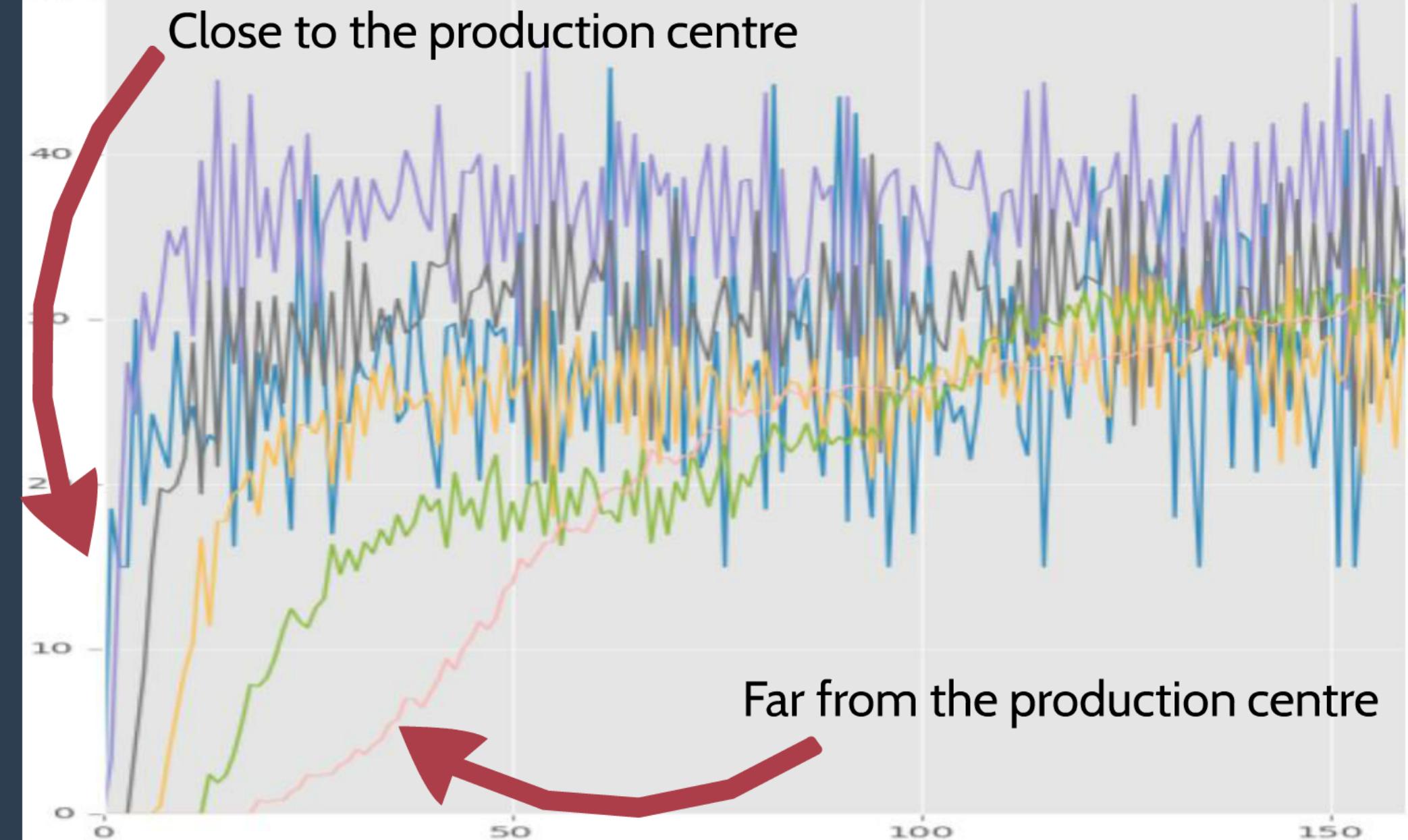


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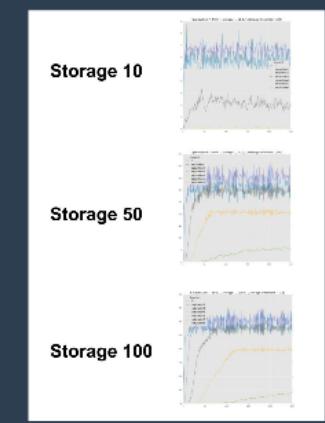
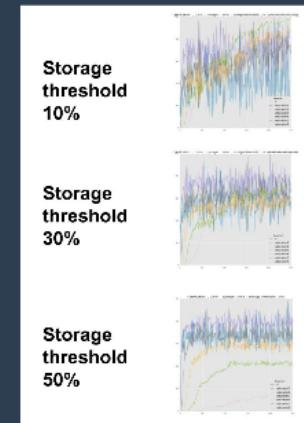
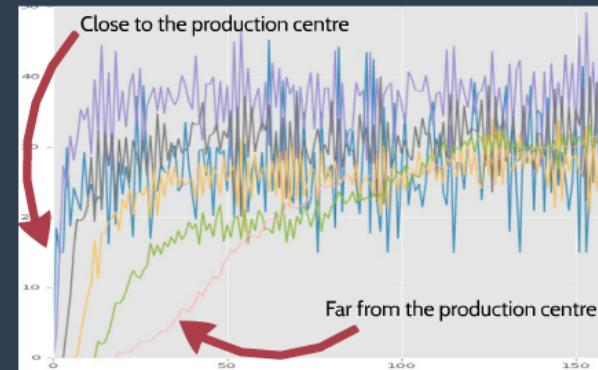
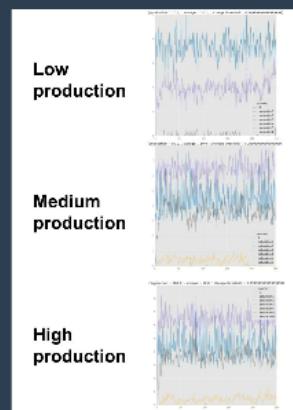
Close to the production centre



Far from the production centre

Results

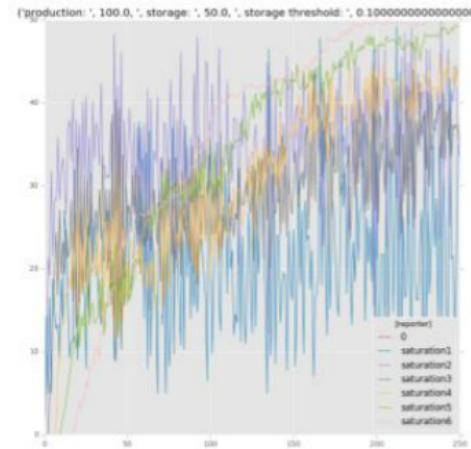
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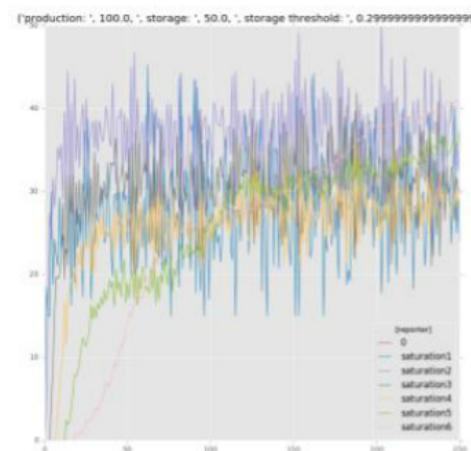
centre

150

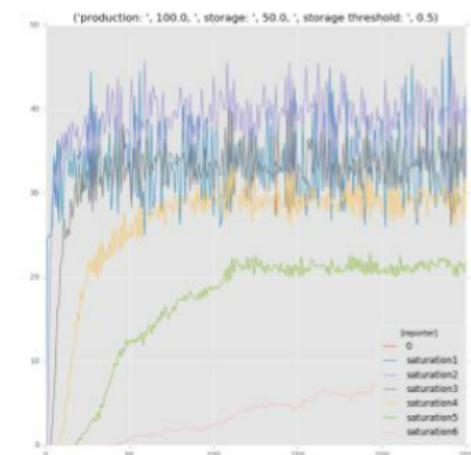
Storage
threshold
10%



Storage
threshold
30%



Storage
threshold
50%



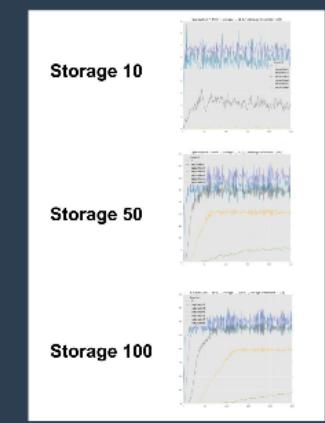
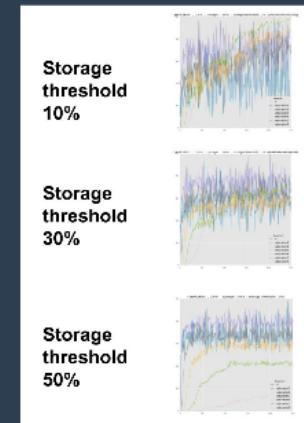
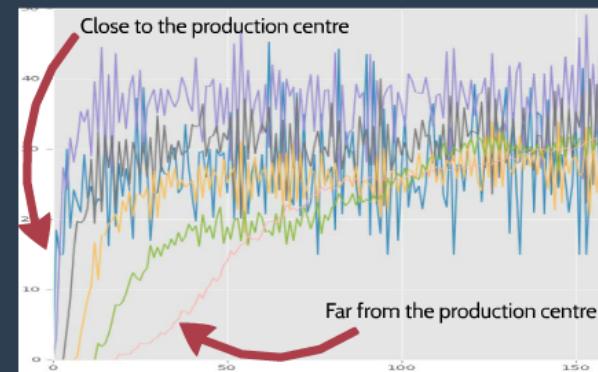
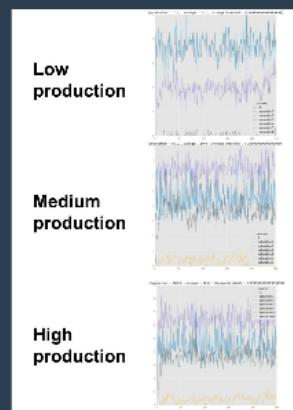
Storage

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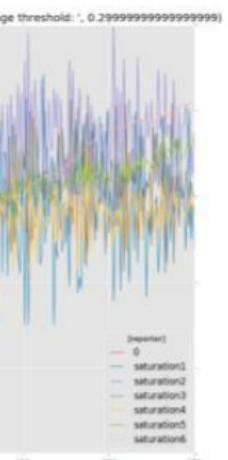
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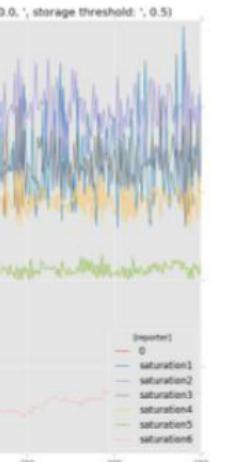




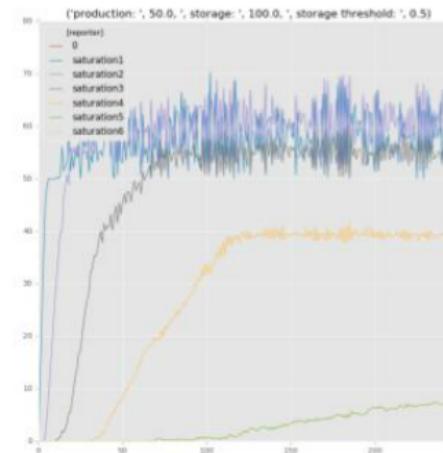
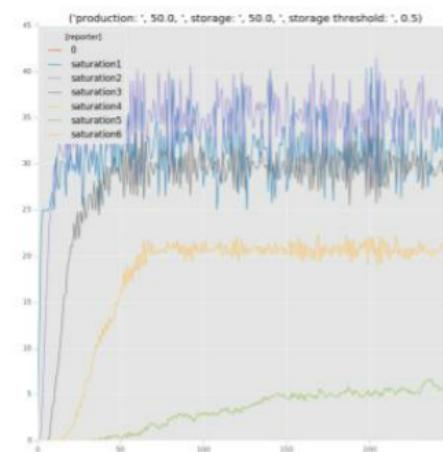
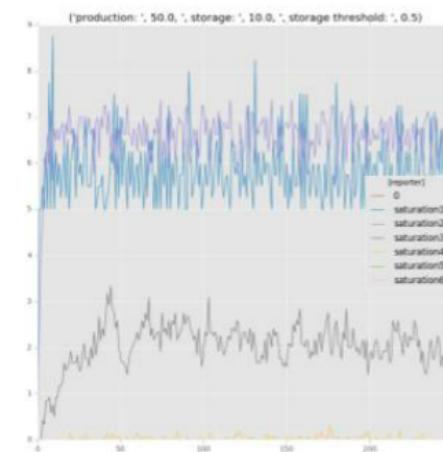
Storage 10



Storage 50



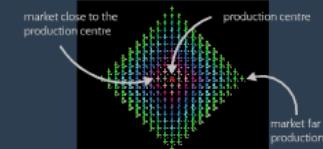
Storage 100



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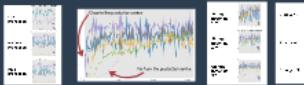
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