



BANCA D'ITALIA
EUROSISTEMA

AAAI Bridge FINST
February 8, 2023

BLACK-IT DEMO: CALIBRATING MULTI-AGENT SYSTEMS TO MIMIC FINST REALITIES *

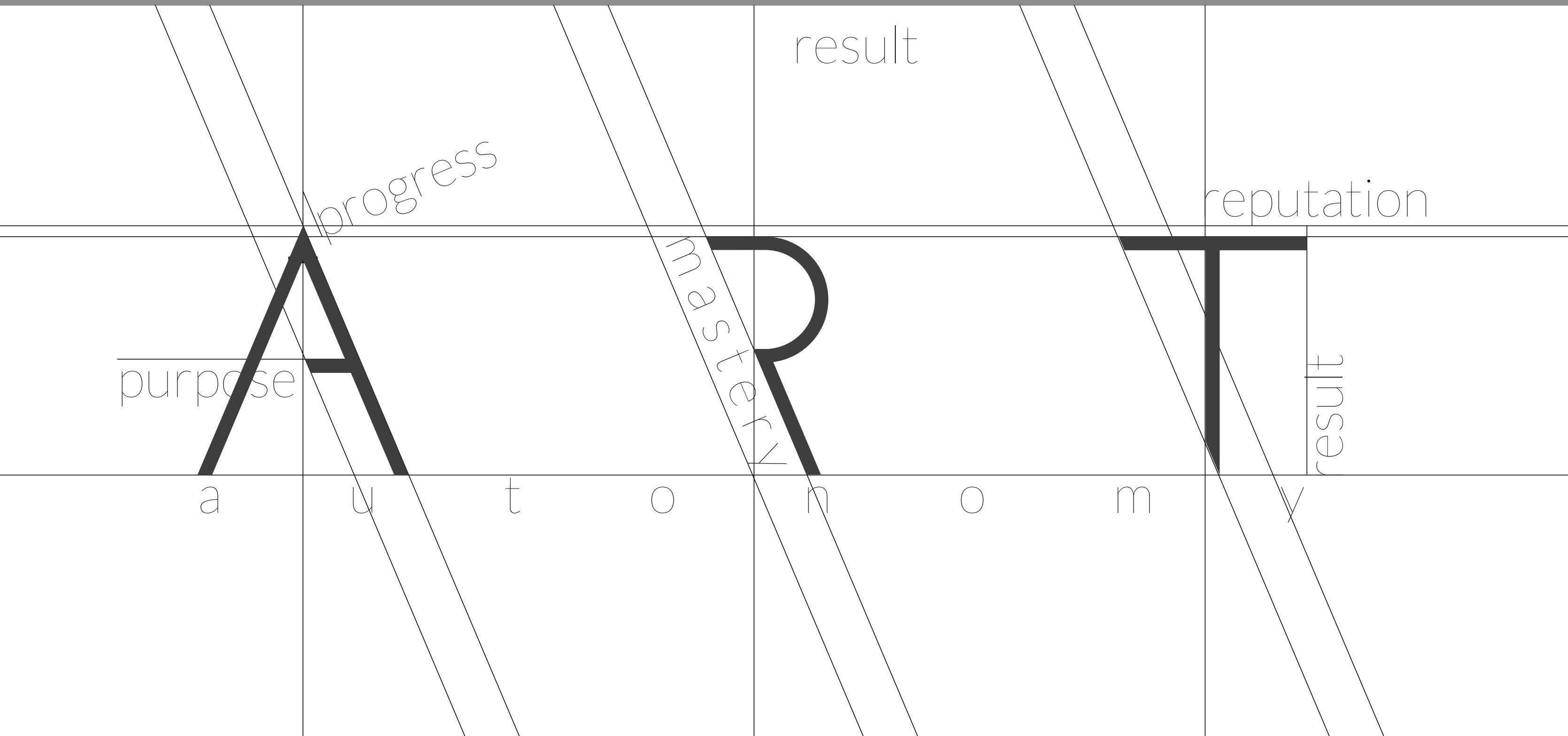
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Applied Research Team (ART)

aka "Divisione Ricerca sulle Tecnologie Avanzate - DRTA" (**Bank of Italy**)



*All views and opinions are those of the speaker(s)

and do not necessarily reflect the position of Bank of Italy

AMBS AND CENTRAL BANKS

ABMs and
central banks

ABM
calibration

Key
features

Extensive
documentation

High modelling **flexibility**
Intrinsically **non-equilibrium**

heterogeneity
bounded rationality

Complementary to DSGE modelling

Published on 12 August 2008

Working Paper No. 352
By Marco Galbiati and Kimmo Soramäki

This paper lays out and simulates a multi-agent, multi-period model of an RTGS payment system. At the beginning of the day, banks choose how much costly liquidity to allocate to the settlement process. Then, they use it to execute an exogenous, random stream of payment orders. If a bank's liquidity stock is depleted, payments are queued until new liquidity arrives from other banks, imposing costs on the delaying bank. The paper studies the equilibrium level of liquidity posted in the system, performing some comparative statics and obtaining: i) a liquidity demand curve which links liquidity to delay costs and ii) insights on the efficiency of alternative system configurations.

An agent-based model of payment systems



2008

No. 686 - Exploring agent-based methods for the analysis of payment systems: A crisis model for StarLogo TNG



Temi di Discussione
(Working Papers)

by Luca Arciero, Claudia Biancotti, Leandro D'Aurizio, Claudio Impenna
August 2008

Share

2008

Payment systems



Staff Working Paper No. 619
Macroprudential policy in an agent-based model of the UK housing market

Rafa Baptista, J Doyne Farmer, Marc Hinterschweiger, Katie Low, Daniel Tang and Arzu Uluc

October 2016

No. 1338 - Macroprudential policy analysis via an agent-based model of the real estate sector



Temi di Discussione
(Working Papers)

by Gennaro Catapano, Francesco Franceschi, Michele Loberto and Valentina Michelangeli
June 2021

2021

Housing market

CANVAS: A Canadian Behavioral Agent-Based Model

by Cars Hommes,¹ Mario He,² Sebastian Poledna,³ Melissa Siqueira⁴ and Yang Zhang²



INTERNATIONAL MONETARY FUND
To Demand or Not to Demand: On Quantifying the Future Appetite for CBDC

2022-2023

Macro and CBDC

ABM CALIBRATION

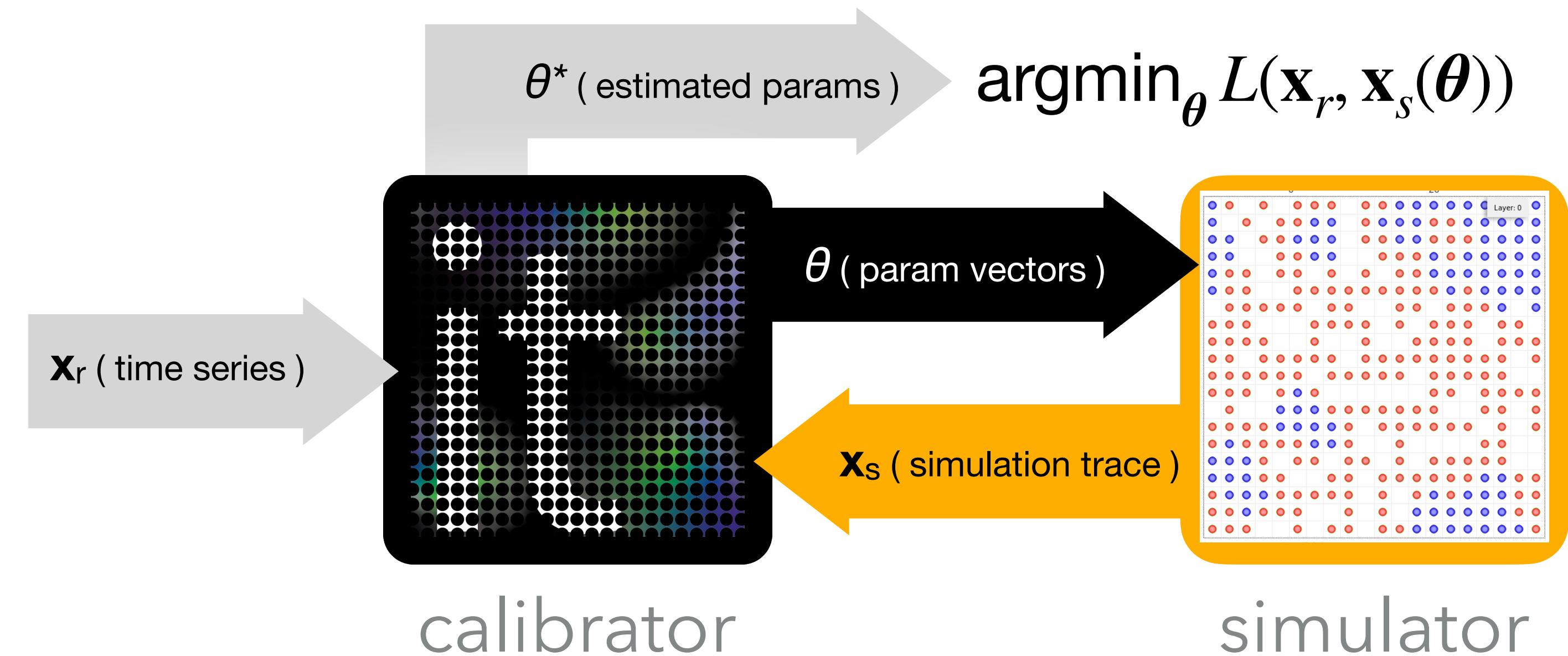
ABMs and
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ABM
calibration

Key
features

Extensive
documentation

A software capable of finding the **ABM parameters** that **best fit real data**



ABM CALIBRATION

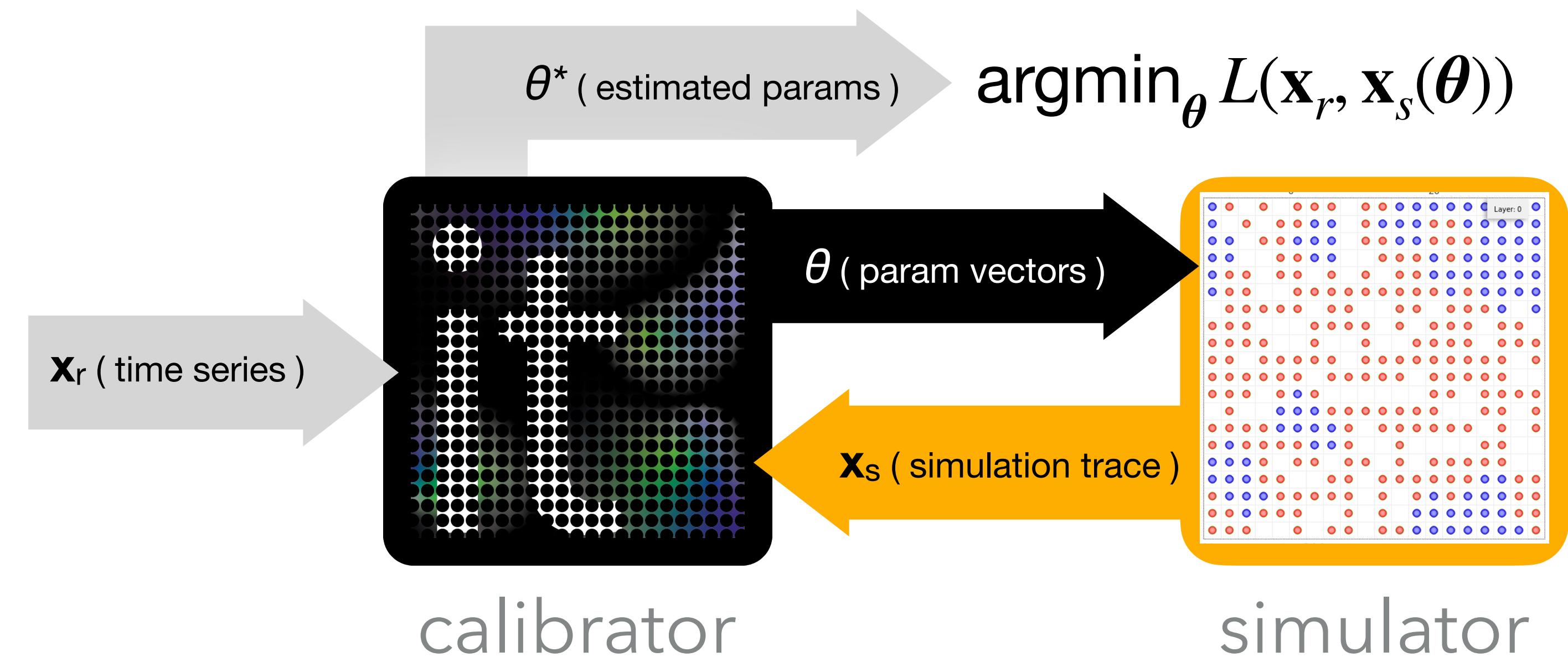
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A software capable of finding the **ABM parameters** that **best fit real data**



In a typical scenario, for **20 free parameters**,
you would need $20^{20} \sim 10^{26}$ combinations

ABM CALIBRATION

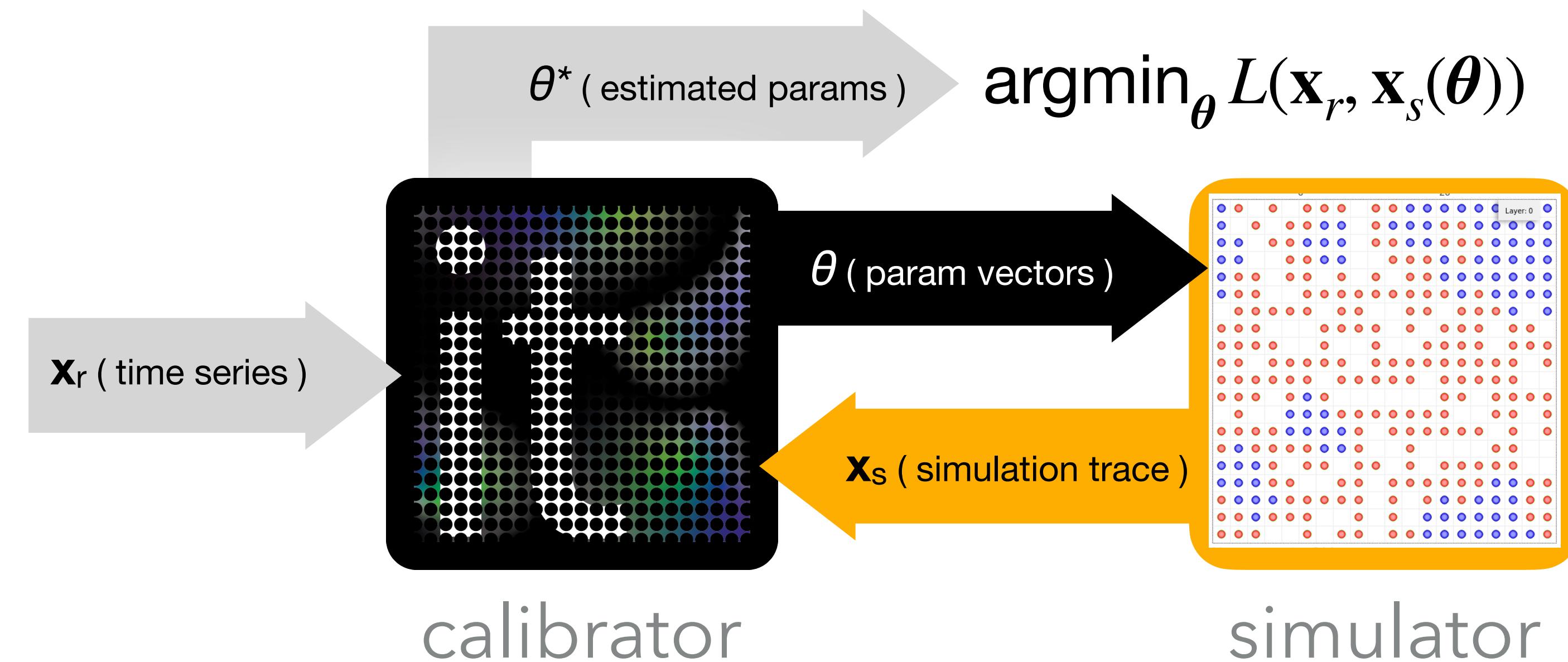
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👉 Need for efficient
calibration strategies

In a typical scenario, for **20 free parameters**,
you would need $20^{20} \sim 10^{26}$ combinations

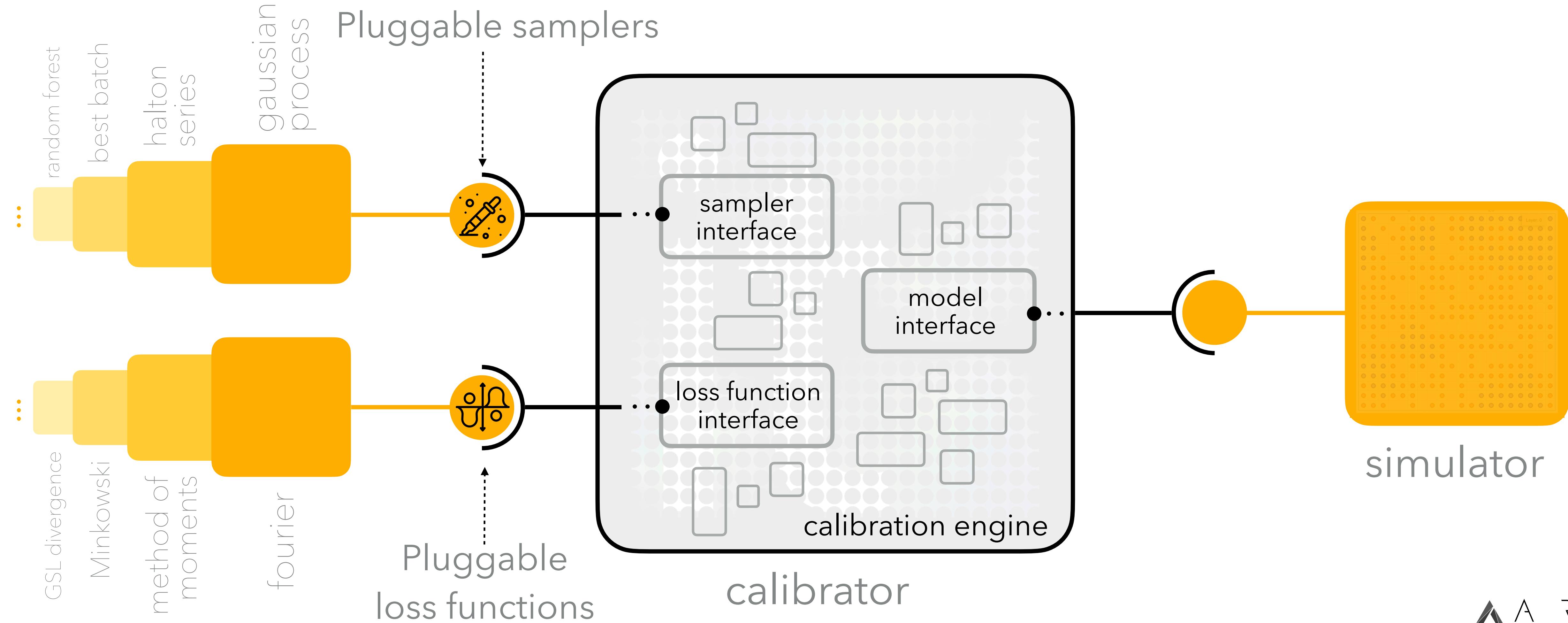
KEY FEATURES

ABMs and
central banks

ABM
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Key
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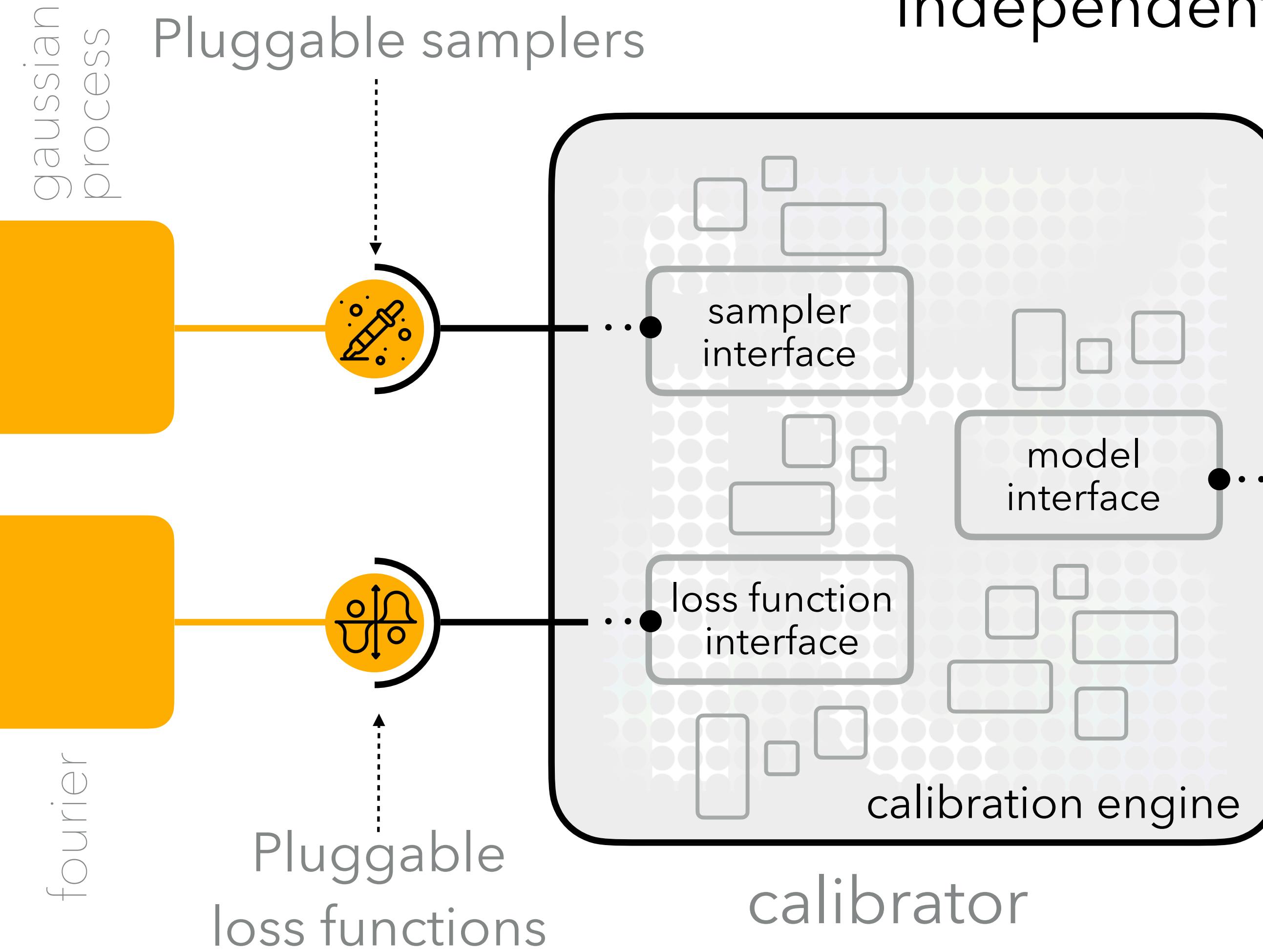
KEY FEATURES

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ABM
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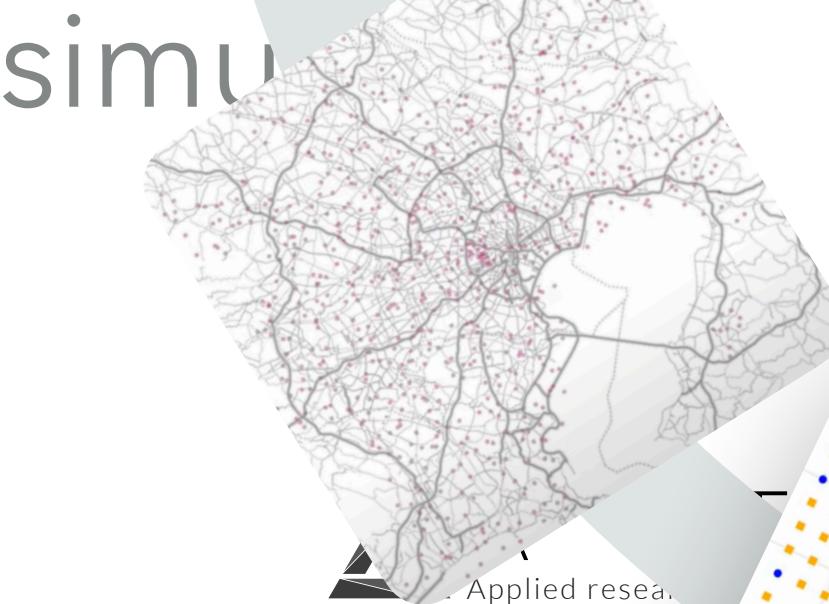
Key
features

Extensive
documentation



Independent of **language**
and **domain**





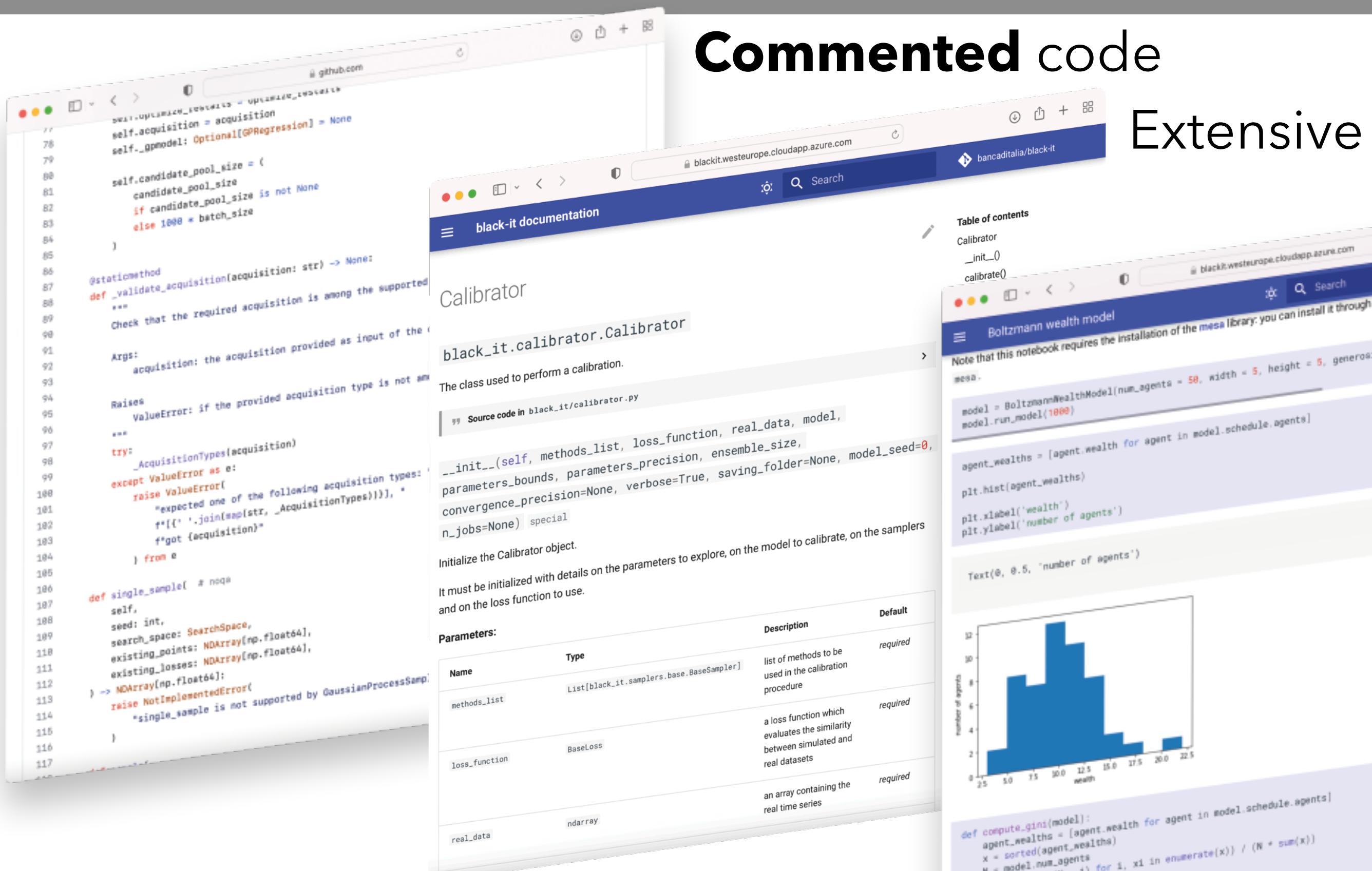
EXTENSIVE DOCUMENTATION

ABMs and
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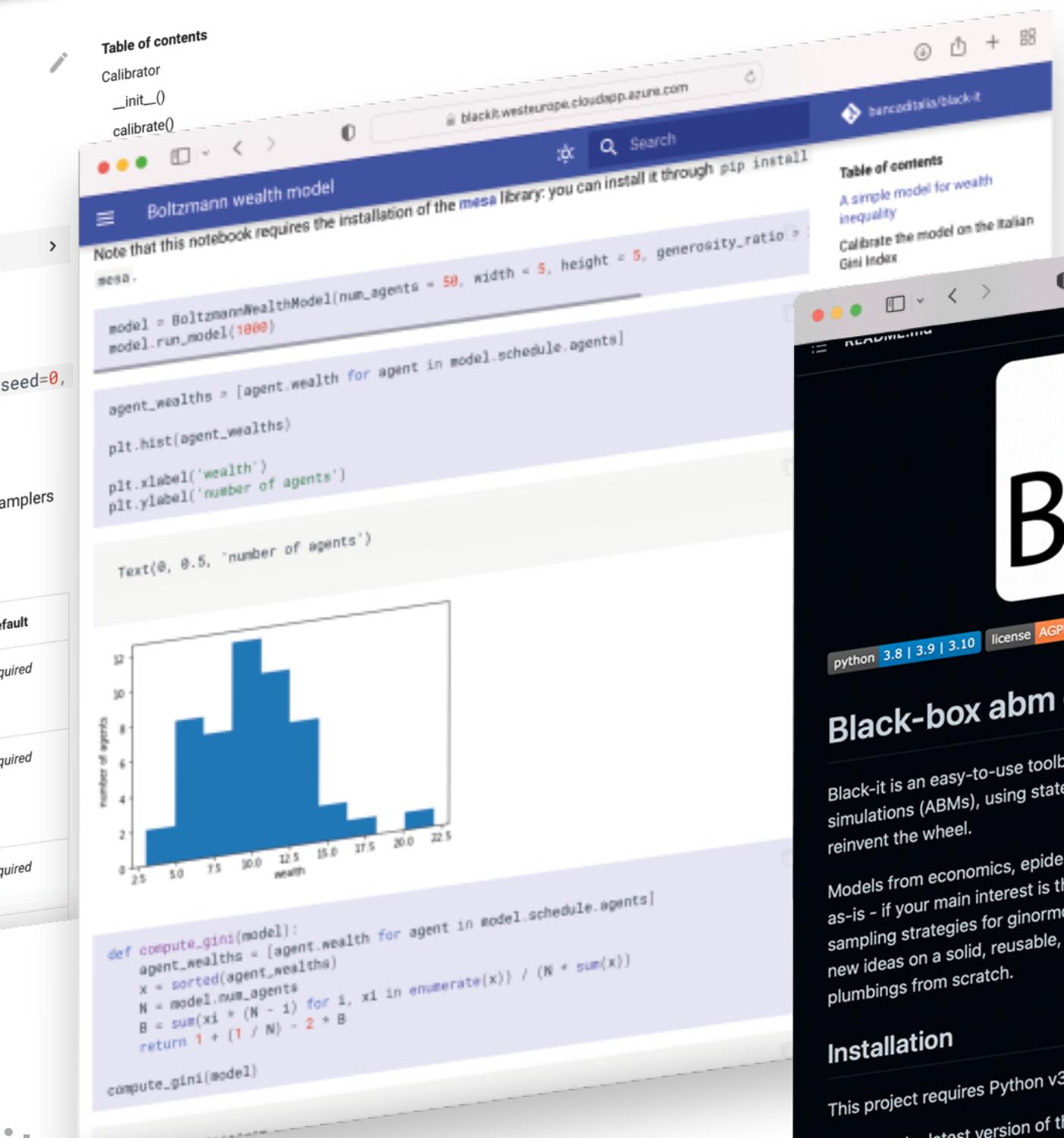


The screenshot shows a GitHub repository page for `black-it/calibrator.py`. The code is well-commented, explaining the purpose of each method and parameter. It includes a table of parameters with their types, descriptions, and default values.

Name	Type	Description	Default
<code>methods_list</code>	<code>List[black_it.samplers.base.BaseSampler]</code>	list of methods to be used in the calibration procedure	<code>required</code>
<code>loss_function</code>	<code>BaseLoss</code>	a loss function which evaluates the similarity between simulated and real datasets	<code>required</code>
<code>real_data</code>	<code>ndarray</code>	an array containing the real time series	<code>required</code>

Commented code

Extensive online **reference manual**



The screenshot shows a Jupyter notebook cell with Python code for a Boltzmann wealth model. The code initializes a `BoltzmannWealthModel` with 50 agents, runs it for 1000 steps, and plots a histogram of agent wealth. A note at the top of the cell explains that the `mesa` library must be installed via pip.

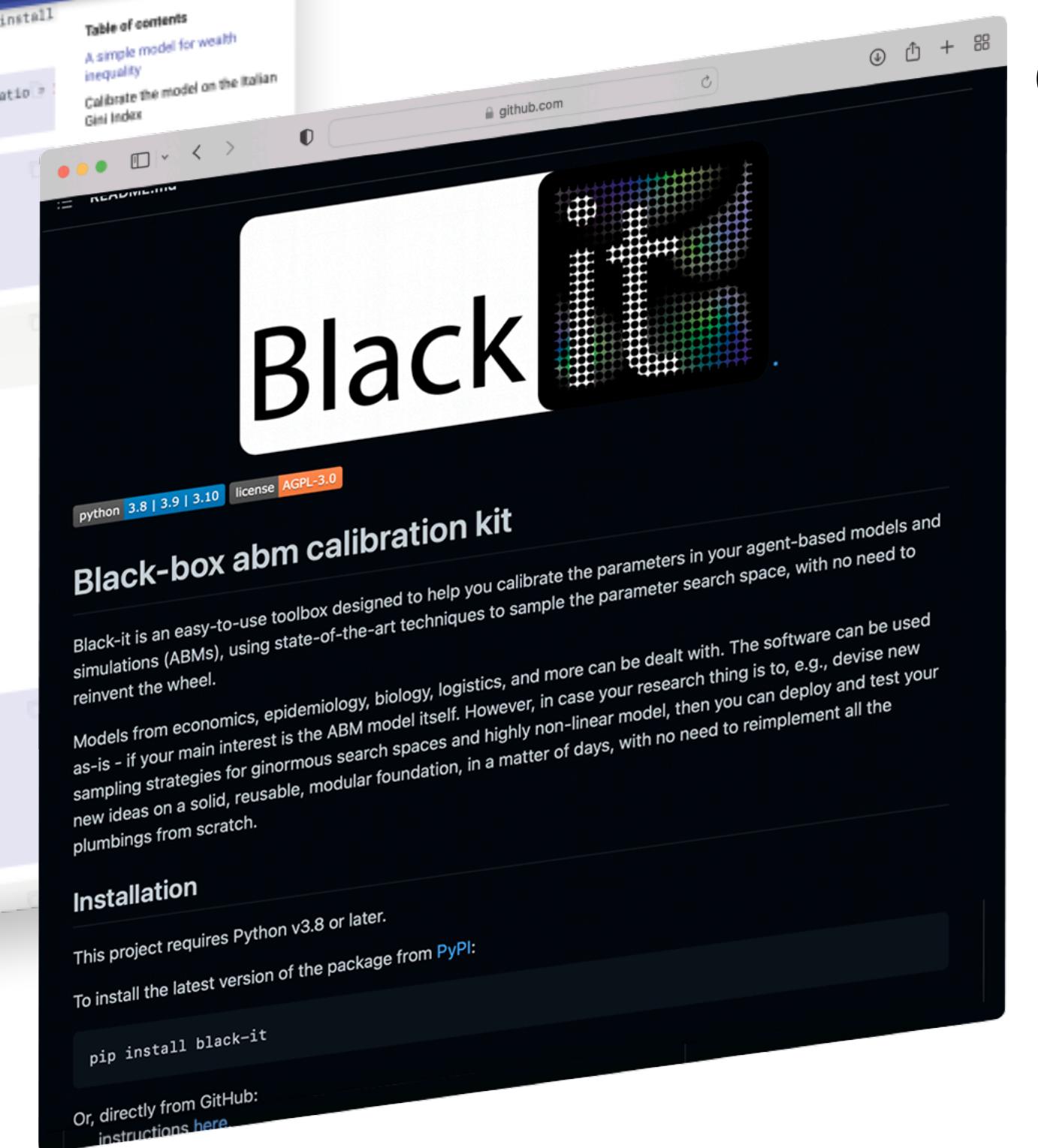
```

model = BoltzmannWealthModel(num_agents = 50, width = 5, height = 5, generosity_ratio = 0.5)
model.run_model(1000)

agent_wealths = [agent.wealth for agent in model.schedule.agents]
plt.hist(agent_wealths)
plt.xlabel('wealth')
plt.ylabel('number of agents')

```

Examples and Jupyter **tutorials**



The screenshot shows the GitHub page for `black-it`. It features a large logo, a brief description of the project as a black-box ABM calibration kit, and instructions for installation using Python 3.8 or later and pip. It also mentions that the latest version can be installed from PyPI.

Black-box abm calibration kit

Black-it is an easy-to-use toolbox designed to help you calibrate the parameters in your agent-based models and simulations (ABMs), using state-of-the-art techniques to sample the parameter search space, with no need to reinvent the wheel.

Models from economics, epidemiology, biology, logistics, and more can be dealt with. The software can be used as-is – if your main interest is the ABM model itself. However, in case your research thing is to, e.g., devise new sampling strategies for ginormous search spaces and highly non-linear model, then you can deploy and test your new ideas on a solid, reusable, modular foundation, in a matter of days, with no need to reimplement all the plumbing from scratch.

Installation

This project requires Python v3.8 or later.
To install the latest version of the package from PyPI:

```

pip install black-it

```

Or, directly from GitHub: [instructions here](#)

GitHub page

► **GitHub** page: github.com/bancaditalia/black-it

► **Documentation** page: bancaditalia.github.io/black-it/



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Thank you for your attention!

Time for a **Q&A** session: Any **Question**?

