Creativity, Science and **Innovation**

Federated Learning
Data anomalies

December 4th, 2025

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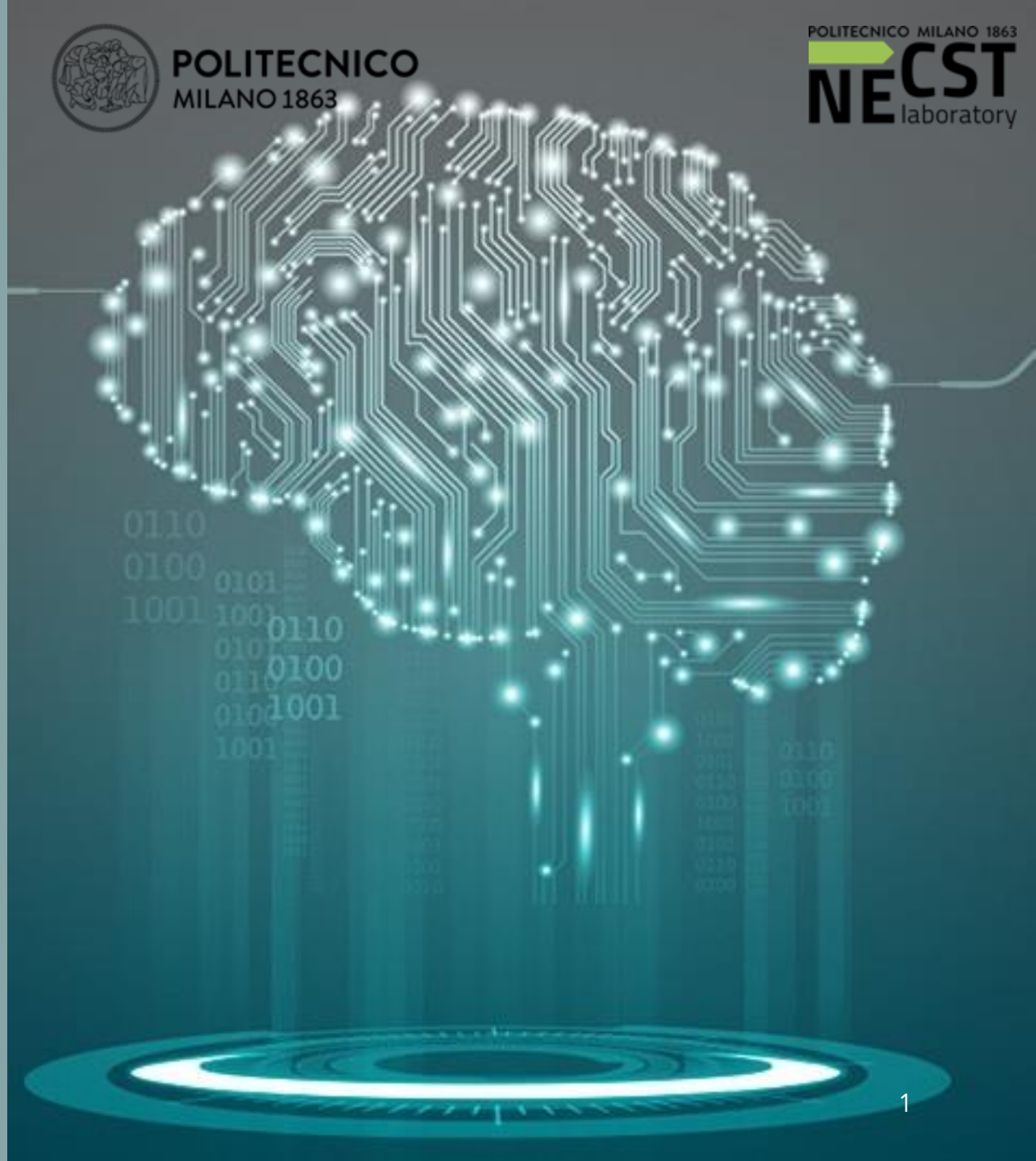
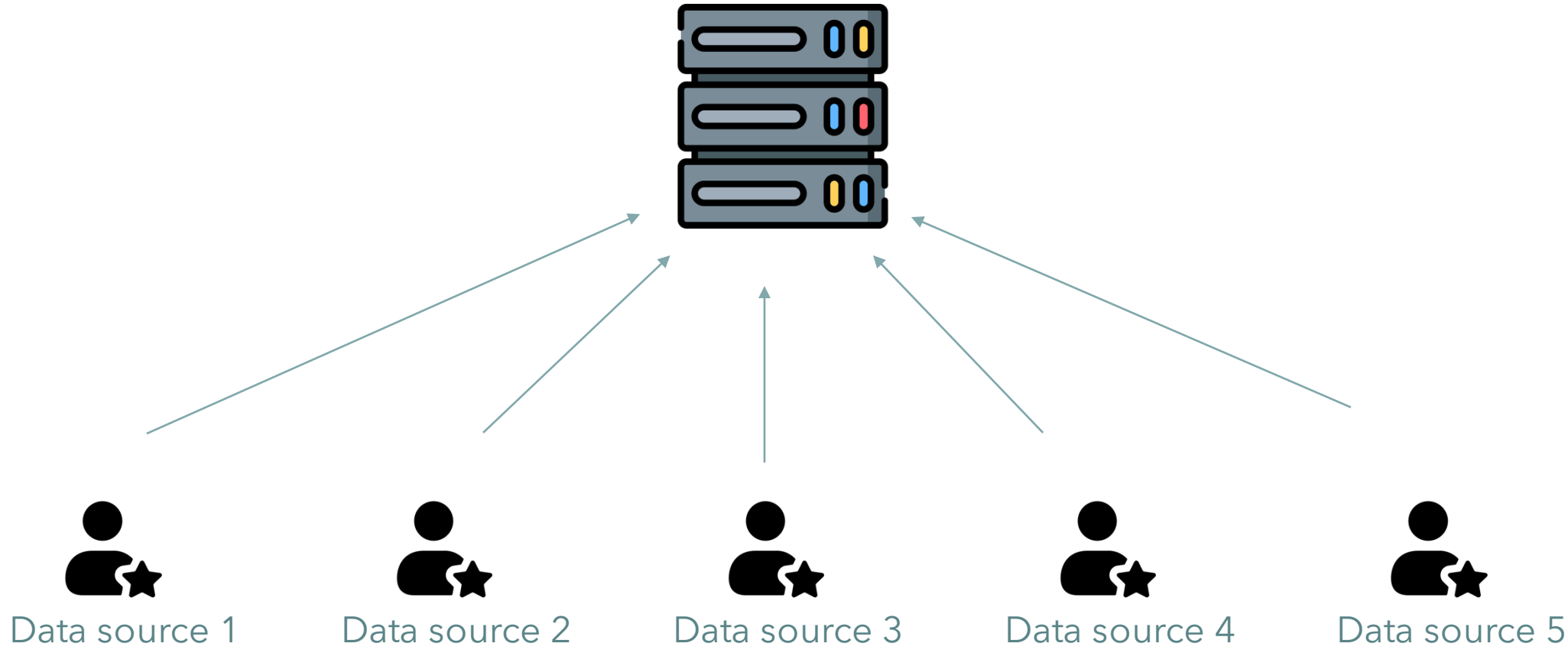
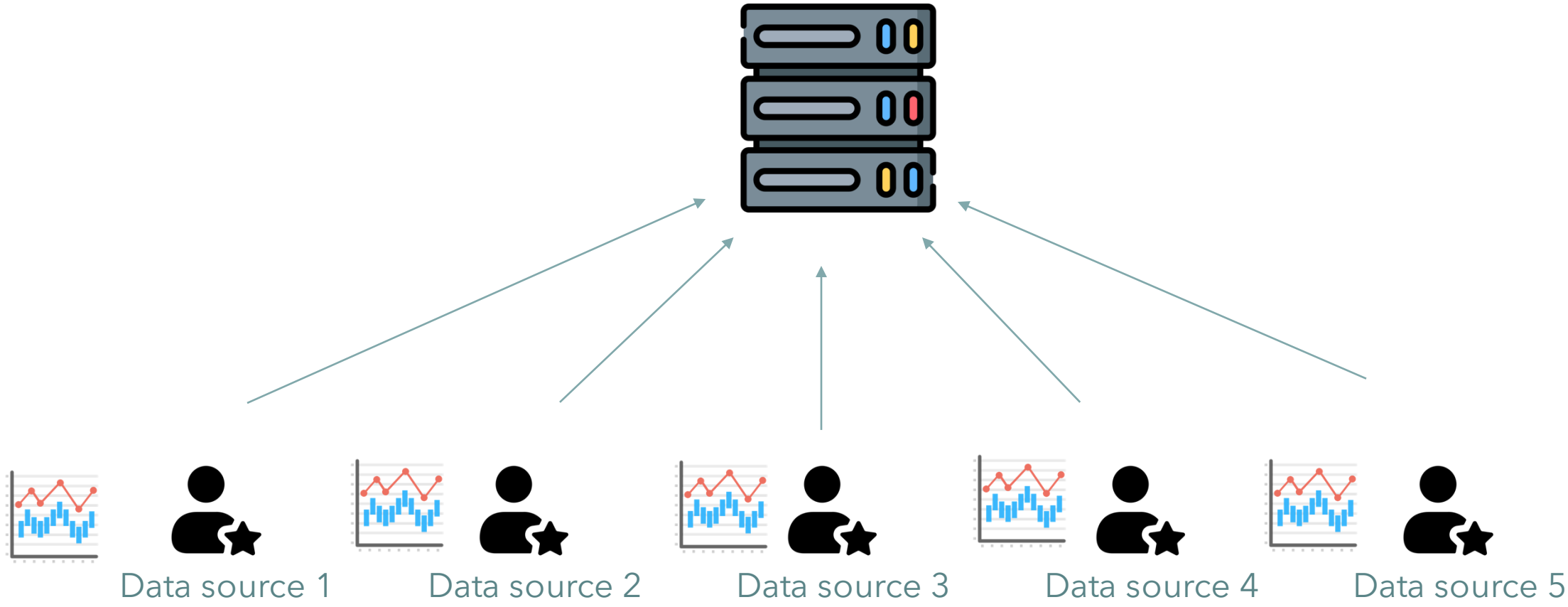


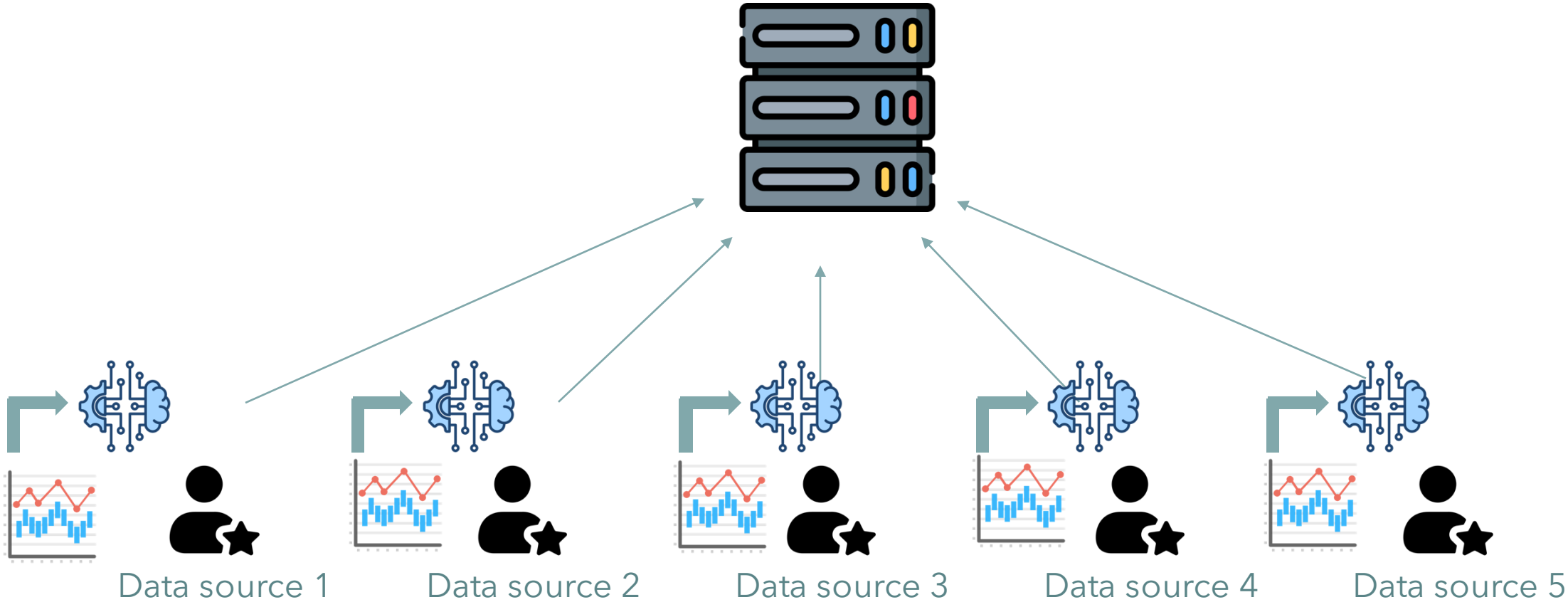
Horizontal Federated Learning



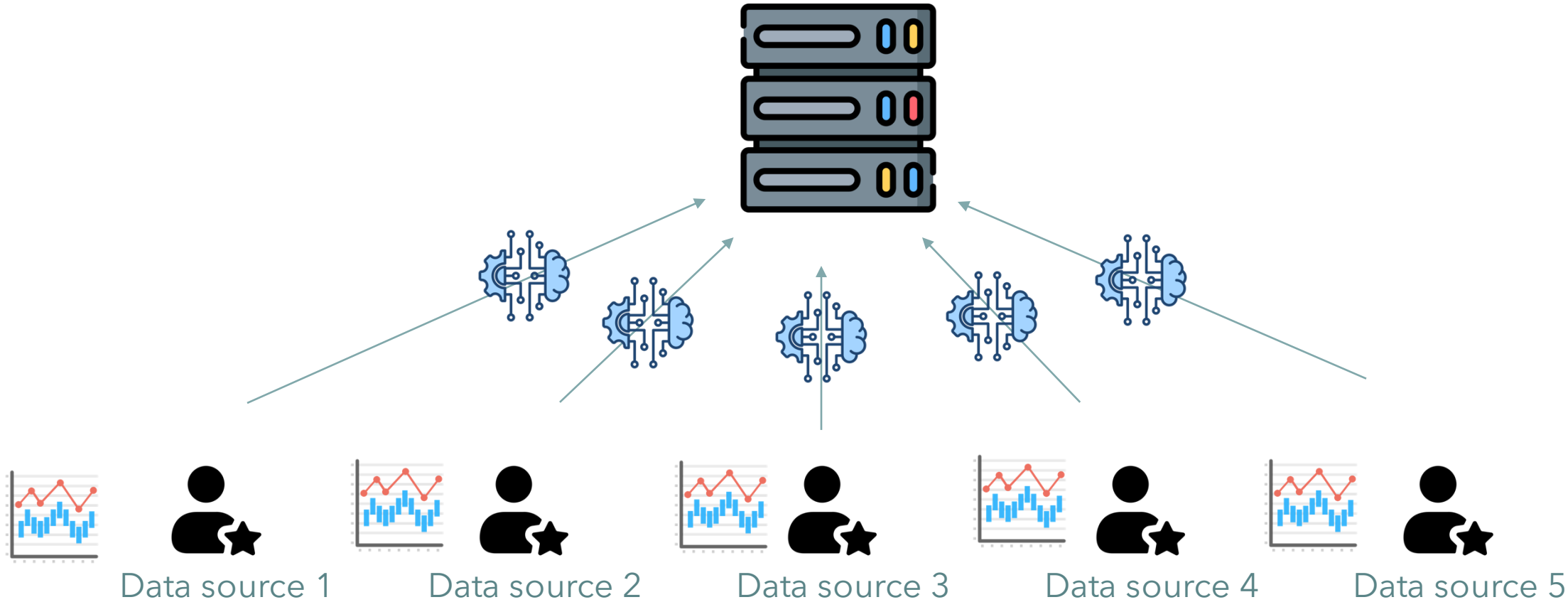
Horizontal Federated Learning



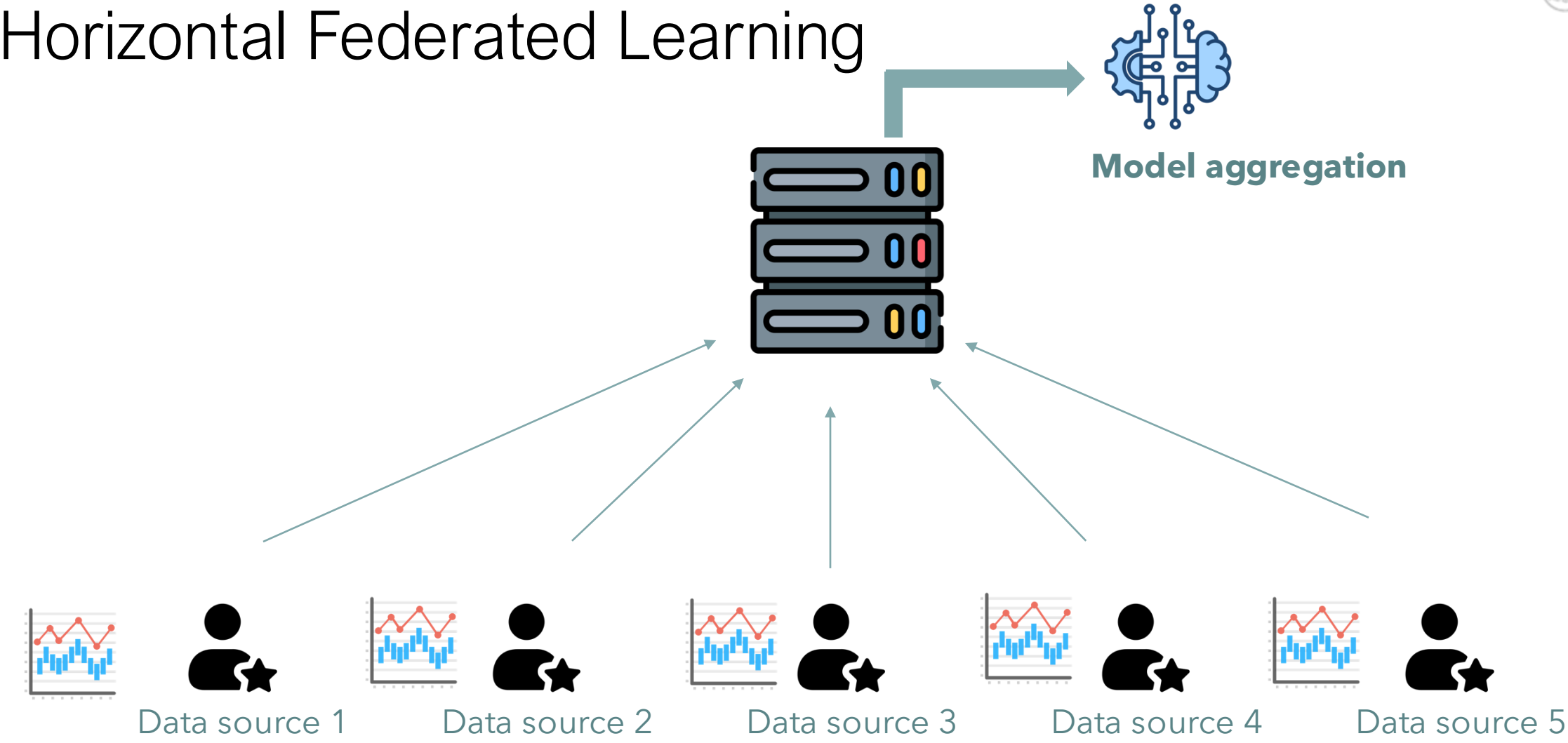
Horizontal Federated Learning



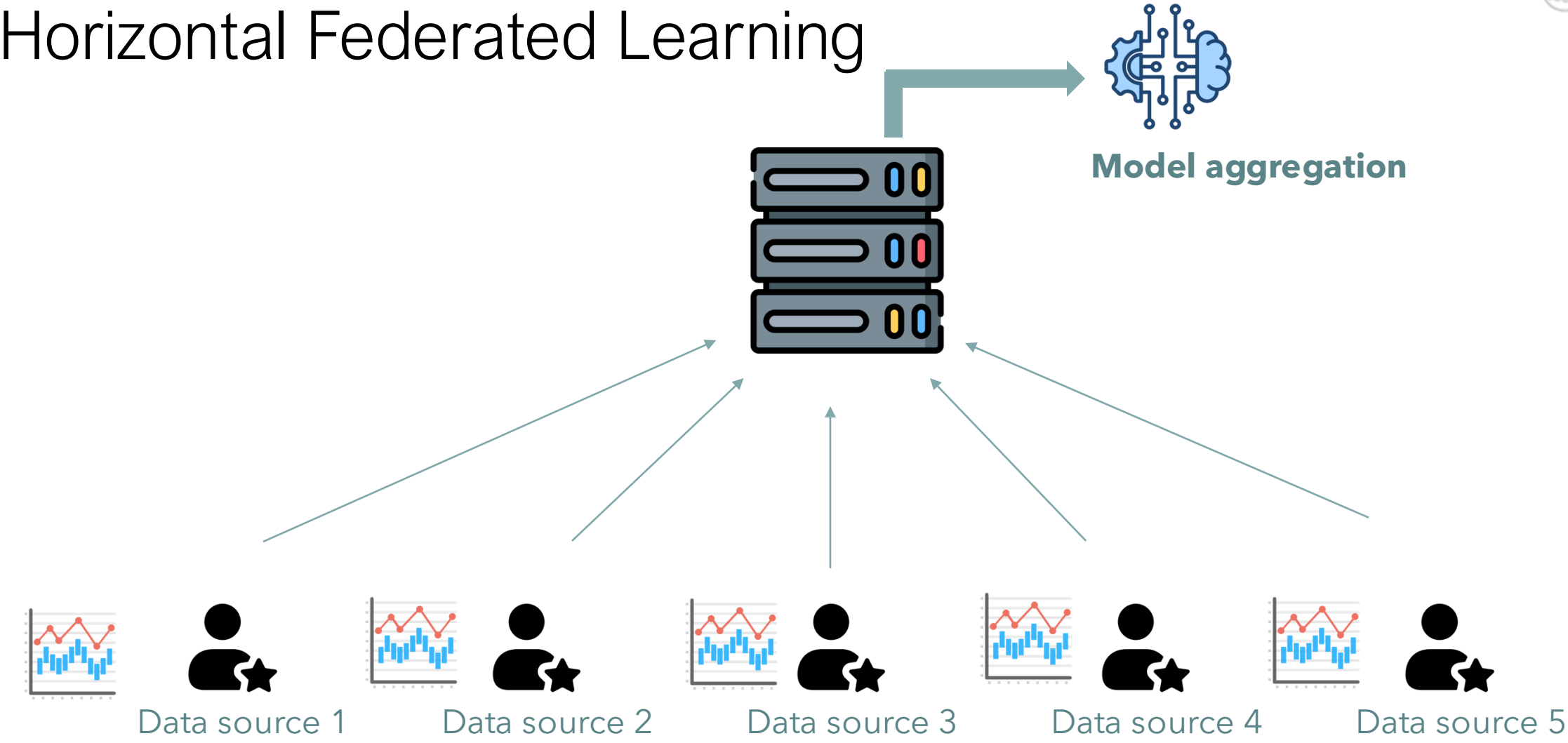
Horizontal Federated Learning



Horizontal Federated Learning



Horizontal Federated Learning



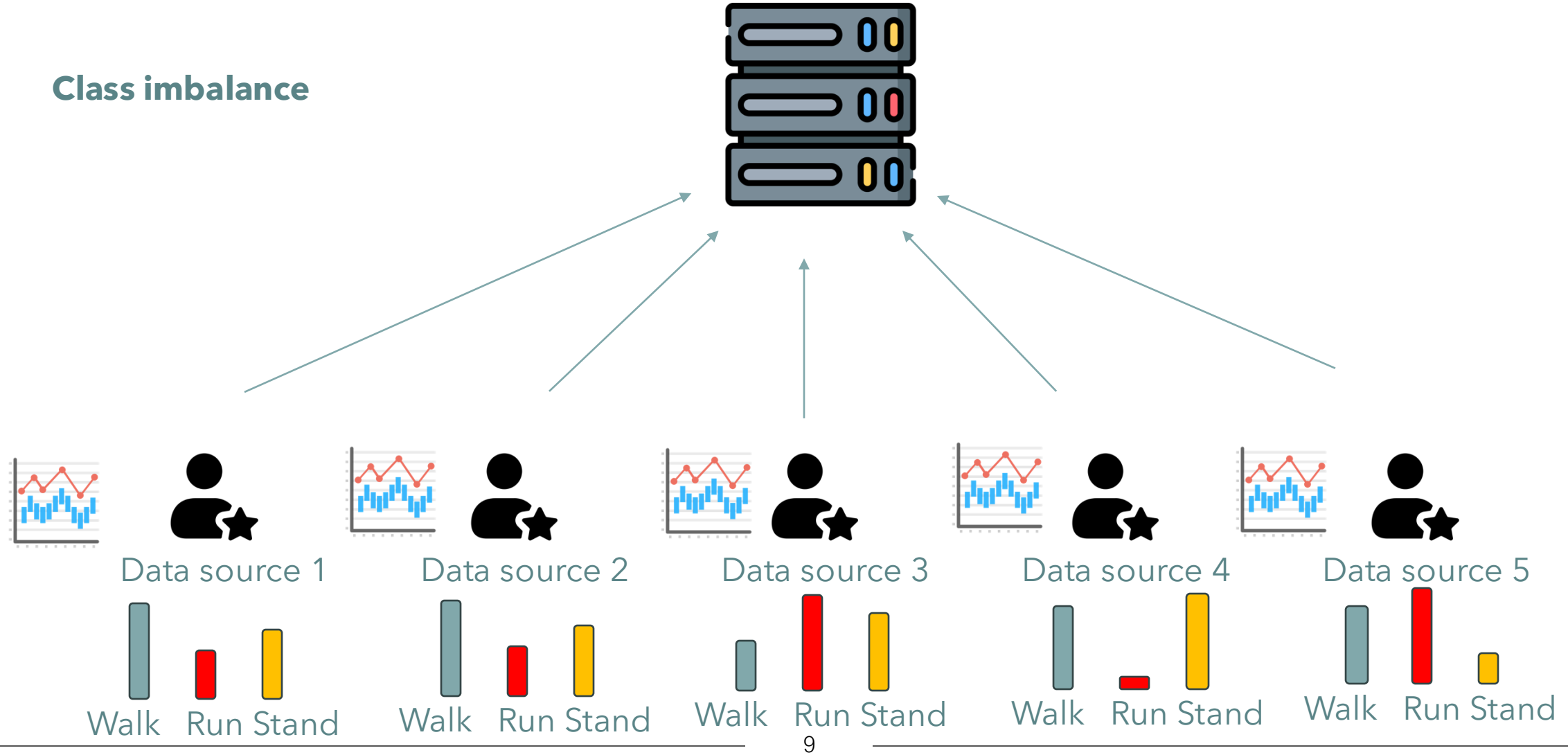
How are these data distributed?

Horizontal Federated Learning: Statistical challenges

Class imbalance

Horizontal Federated Learning: Statistical challenges

Class imbalance



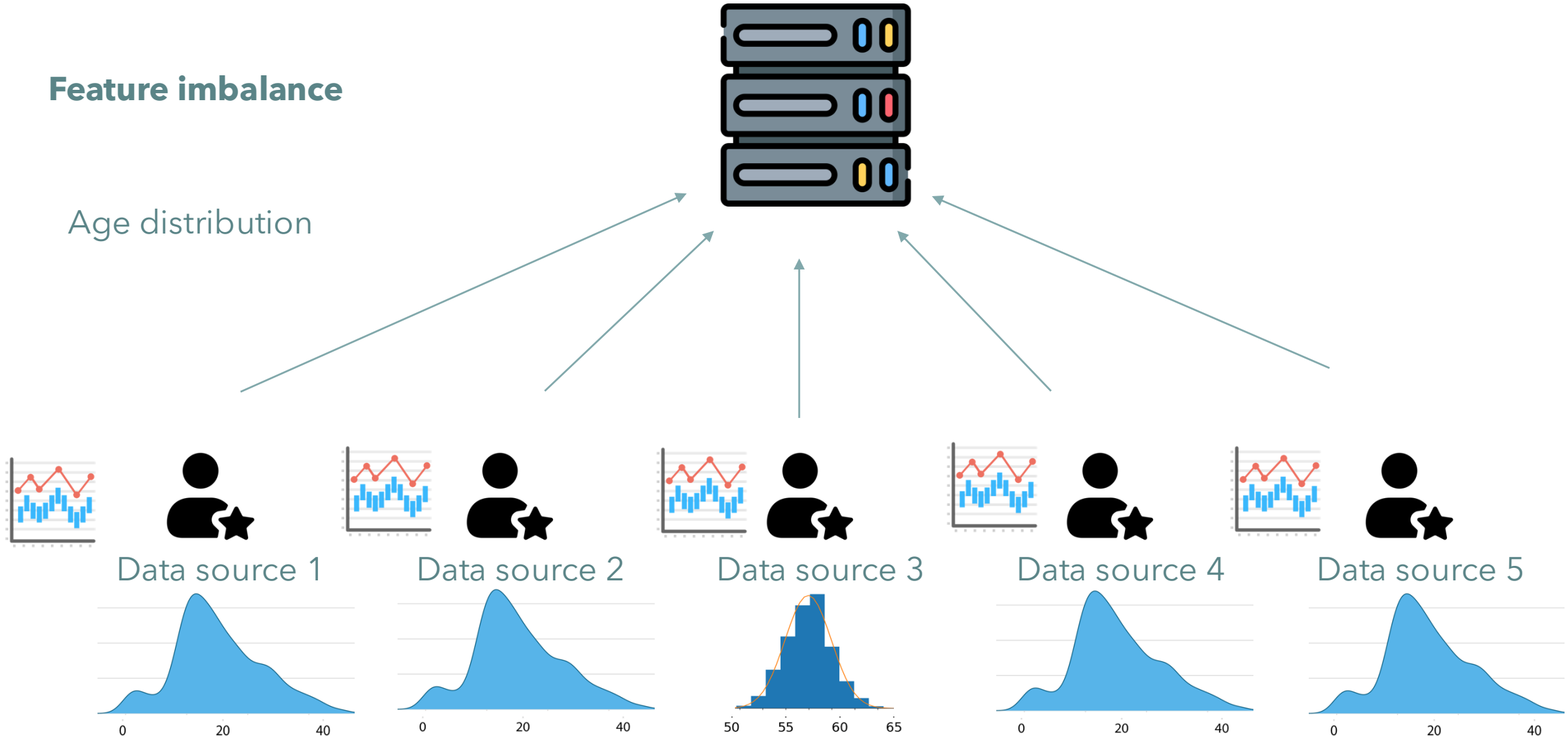
Horizontal Federated Learning: Statistical challenges

Feature imbalance

Horizontal Federated Learning: Statistical challenges

Feature imbalance

Age distribution

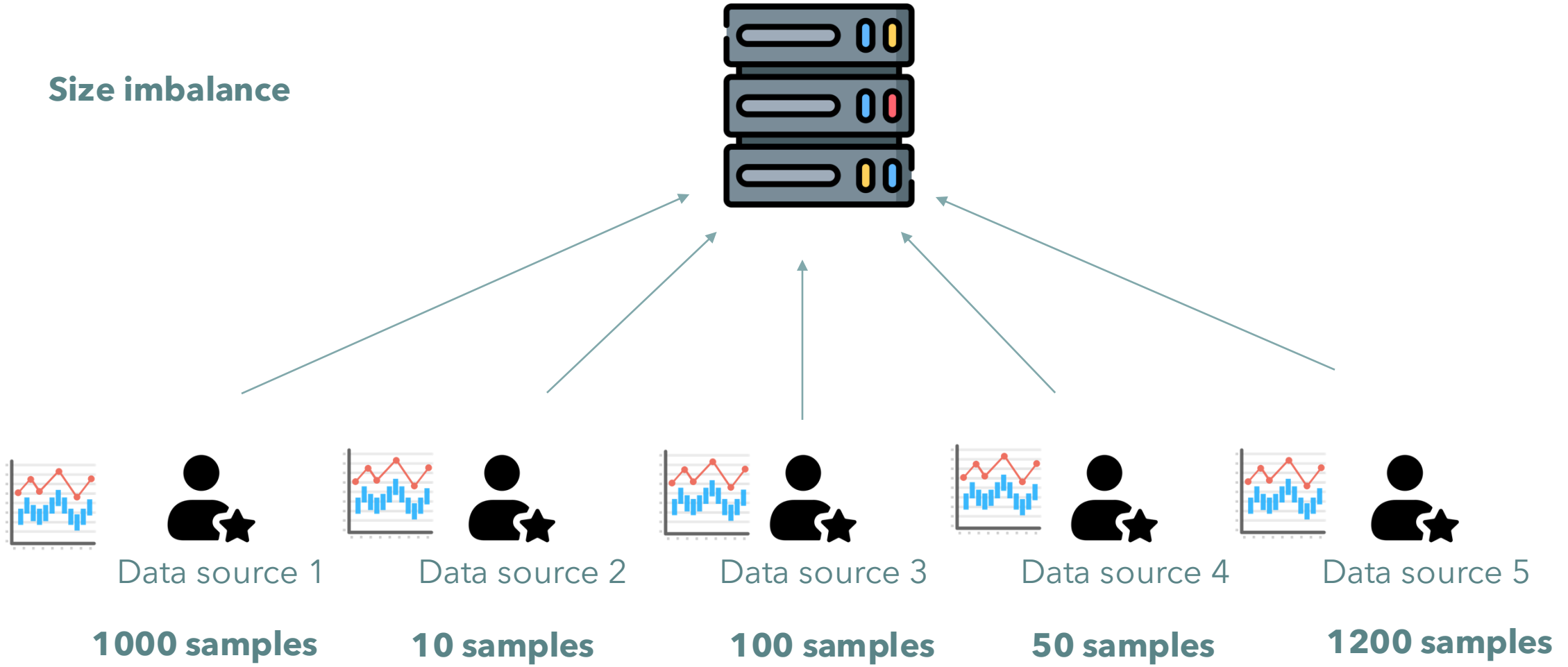


Horizontal Federated Learning: Statistical challenges

Size imbalance

Horizontal Federated Learning: Statistical challenges

Size imbalance



Horizontal Federated Learning: Statistical challenges

1. **Class imbalance**
2. **Feature imbalance**
3. **Size imbalance**

Solutions

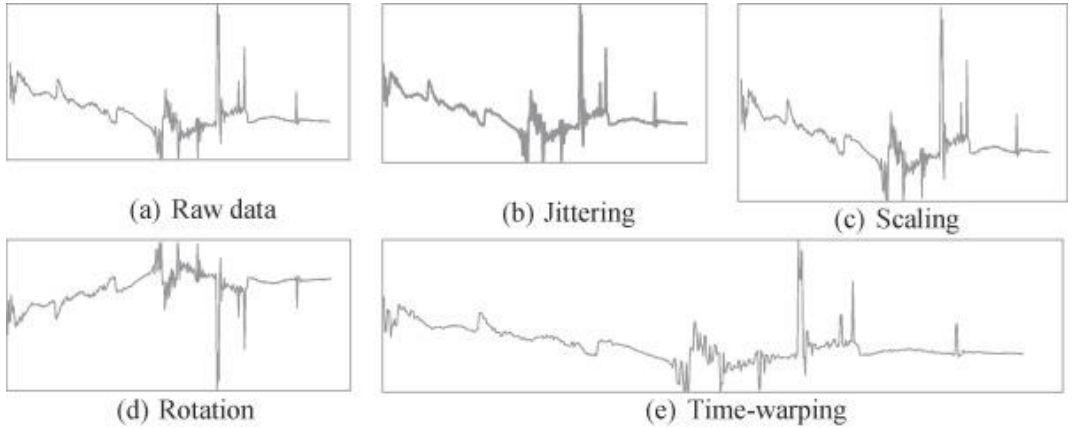
Data augmentation: generate new «fake» samples.

This is the most applied solution for problems 1 and 3.
It allows to balance the class distributions and the dataset sizes among all the clients.

Possible augmentations:

- Add noise to existing samples
- Apply geometric transformations to existing samples
- Interpolate couples of samples

Geometric transformations



Horizontal Federated Learning: Statistical challenges

1. **Class imbalance**
2. **Feature imbalance**
3. **Size imbalance**

Horizontal Federated Learning: Statistical challenges

1. **Class imbalance**
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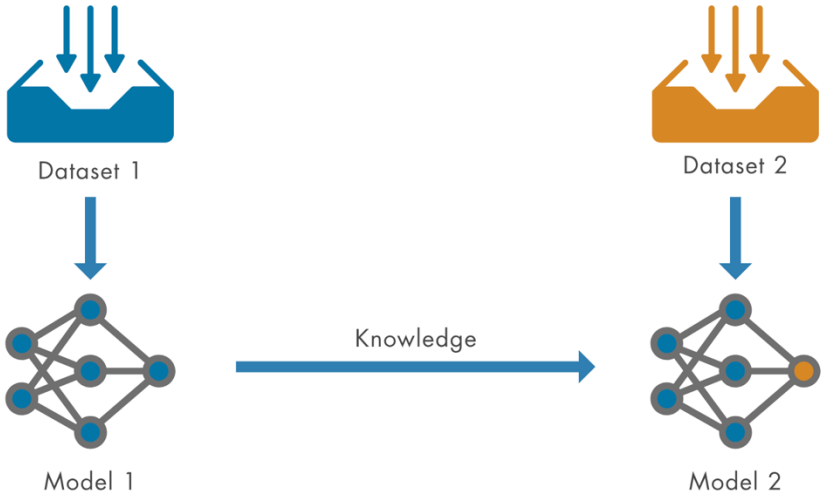
Solutions

Transfer Learning: start from a pre-defined model that has been trained over sufficiently big and generic data

Multitask Learning: train the model to solve multiple tasks to learn more general representations



[1] https://it.mathworks.com/discovery/transfer-learning.html

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Thank you for
your attention

December 1st, 2025

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