Evaluation of Distributed Computing Frameworks

DIFUTURE Workshop

Daniel Schalk

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LMU Munich
Working Group Computational Statistics

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The Problem

About the data:

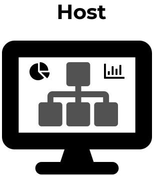
- 4 Hospitals (we call them clients/sites), each one holds data about patients and a disease
- For data protection reasons, these data may not be combined

About the analysis:

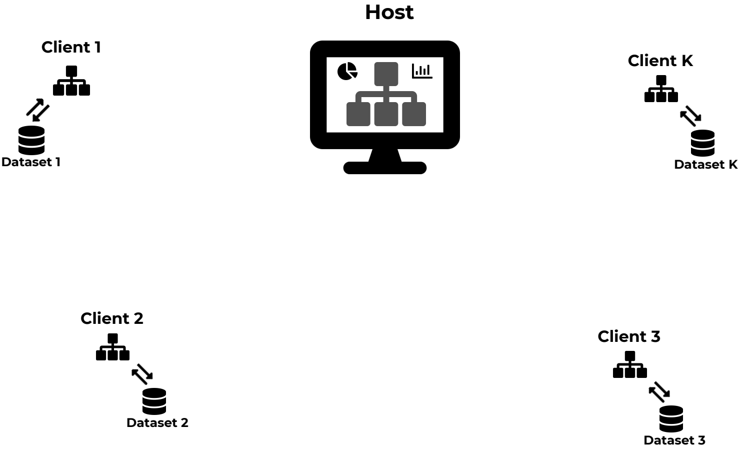
- A statistician wants to analyze the data and predict whether a patient is sick or not on a single machine (the host)
- **But:** Most statistical or machine learning approaches require **one** dataset for modeling

⇒ We want to learn one model on datasets distributed over multiple clients (decentralized learning).

General Concept



General Concept



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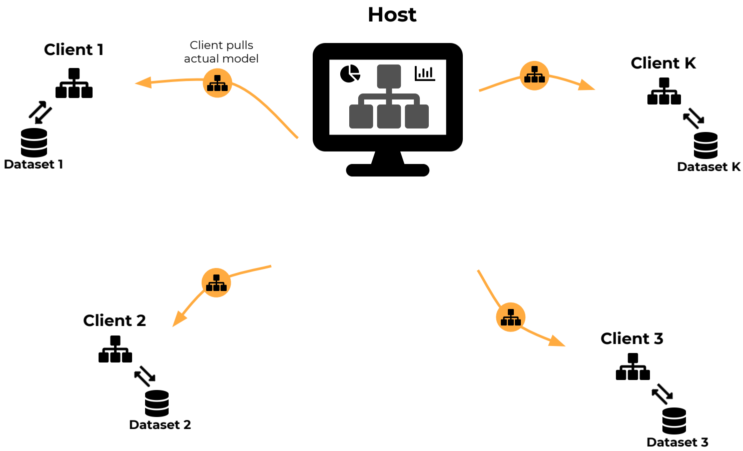

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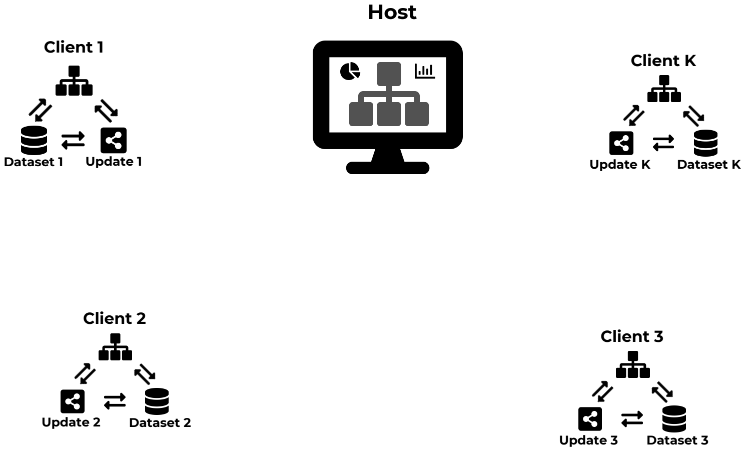

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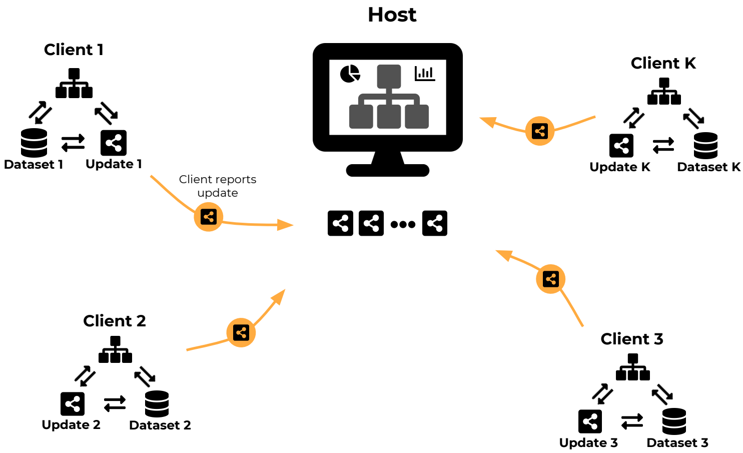

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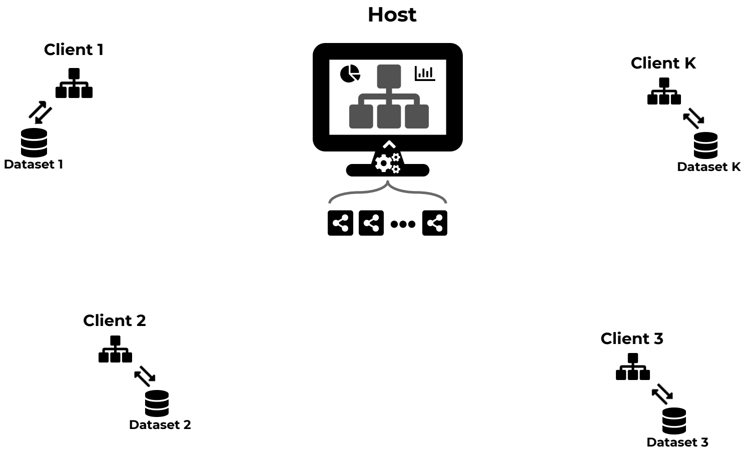

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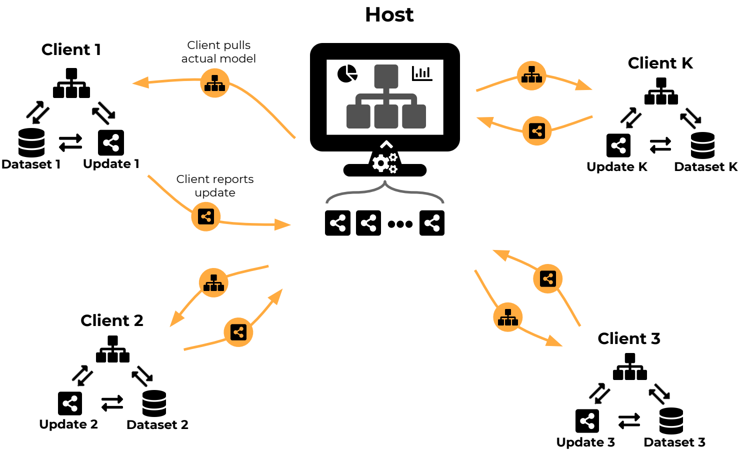


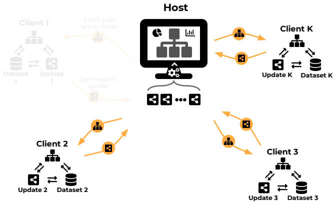
Performance Evaluation of Distributed Learning Systems

- To evaluate the performance we usually resample the model
  → Not clear how to resample due to the decentralized dataset
- Possible approaches:
  - Leave k sites out evaluation
  - Partitioning of individual datasets:
    - Split individual datasets and train federated learning model on the individual ones
    - Subsampling across all sites

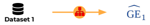
What is the data generating process? Is the hospital an important factor (can we account for that)? Do new hospitals want to use the model?

Leave k Datasets Out

Train **model** on 3 Datasets

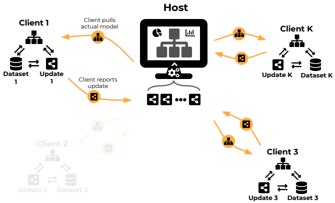


Evaluate model on the **left out dataset**



Leave k Datasets Out

Train model on 3 Datasets



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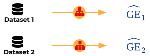

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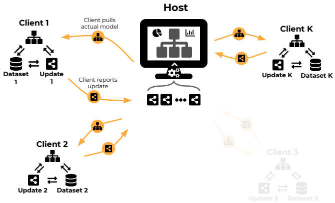
Train model on 3 Datasets



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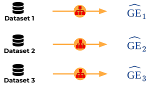

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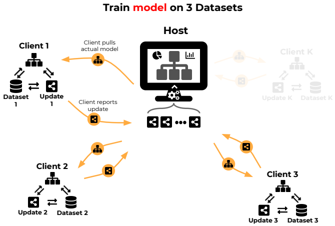
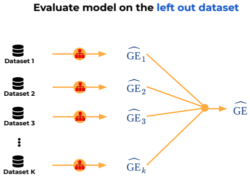


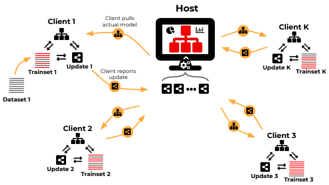


Problem: It may happen, that sites have a different data distribution, hence the model doesn't get the chance to learn from this distribution and is not able to predict well.

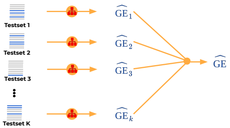
Partitioning of Individual Datasets

- **Subsampling**: Randomly sample observation used for training and testing

Train model on randomly drawn observations



Evaluate model on the left out observations

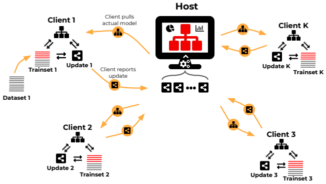


→ Not all observations are used for training or testing.

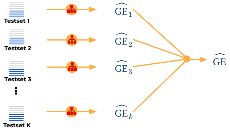
Partitioning of Individual Datasets

- **Cross Validation**: Split individual datasets into k pieces

Train model on randomly drawn observations



Evaluate model on the left out observations



Practical Difficulties

- What information is allowed to get shared?
- No expertise in how to set up and control communication between host and clients:
  - What are the requirements (Docker?)
  - How expensive is the communication? Is it better to reduce communication?
  - What about parallelization?
- What does the PHT need to fit a model?

Correcting for Features Shifts

Detecting feature shifts of individual datasets to correct them.

- Assumption: Distribution of observations of individual datasets is equal
- Train a surrogate model instead of averaging the updates:
  - Is it possible to correct the model for these features?
  - The surrogate model can be used to give insights about problems of individual datasets.

→ Train model-based boosting model using the proposed federated learning framework.