36TH AAAI CONFERENCE
ON ARTIFICIAL INTELLIGENCE

MLink: Linking Black-box Models for Collaborative Multi-model Inference

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Introduction

Cost-effective Inference

- Multi-task learning and zipping
- Model compression
- Inference reusing
- Source filtering
- Multi-model scheduling

How to obtain as accurate inference results as possible without the exact execution of ML models?

Introduction

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Linking Black-box Models

- Multi-task learning and zipping
- Model compression
- Inference reusing
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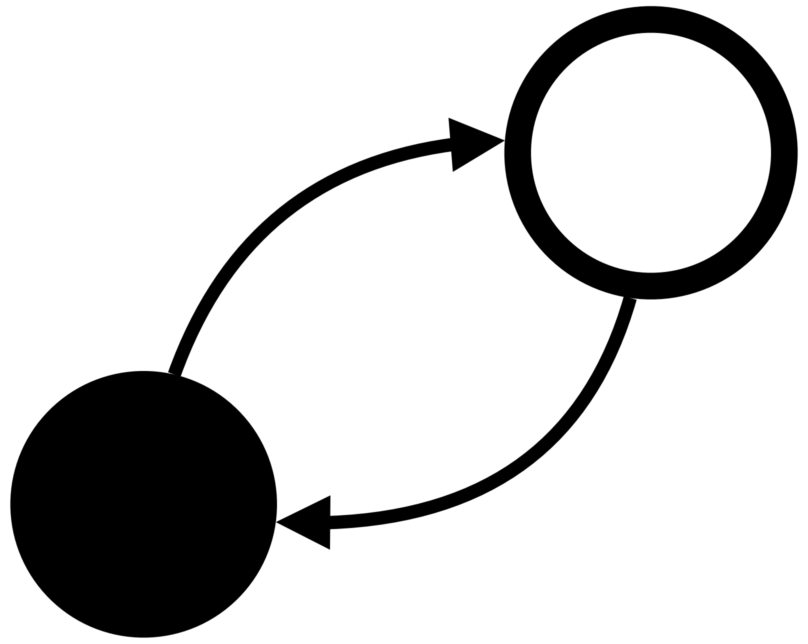
- **Model Linking**



How to obtain as accurate inference results as possible without the exact execution of ML models?

Introduction

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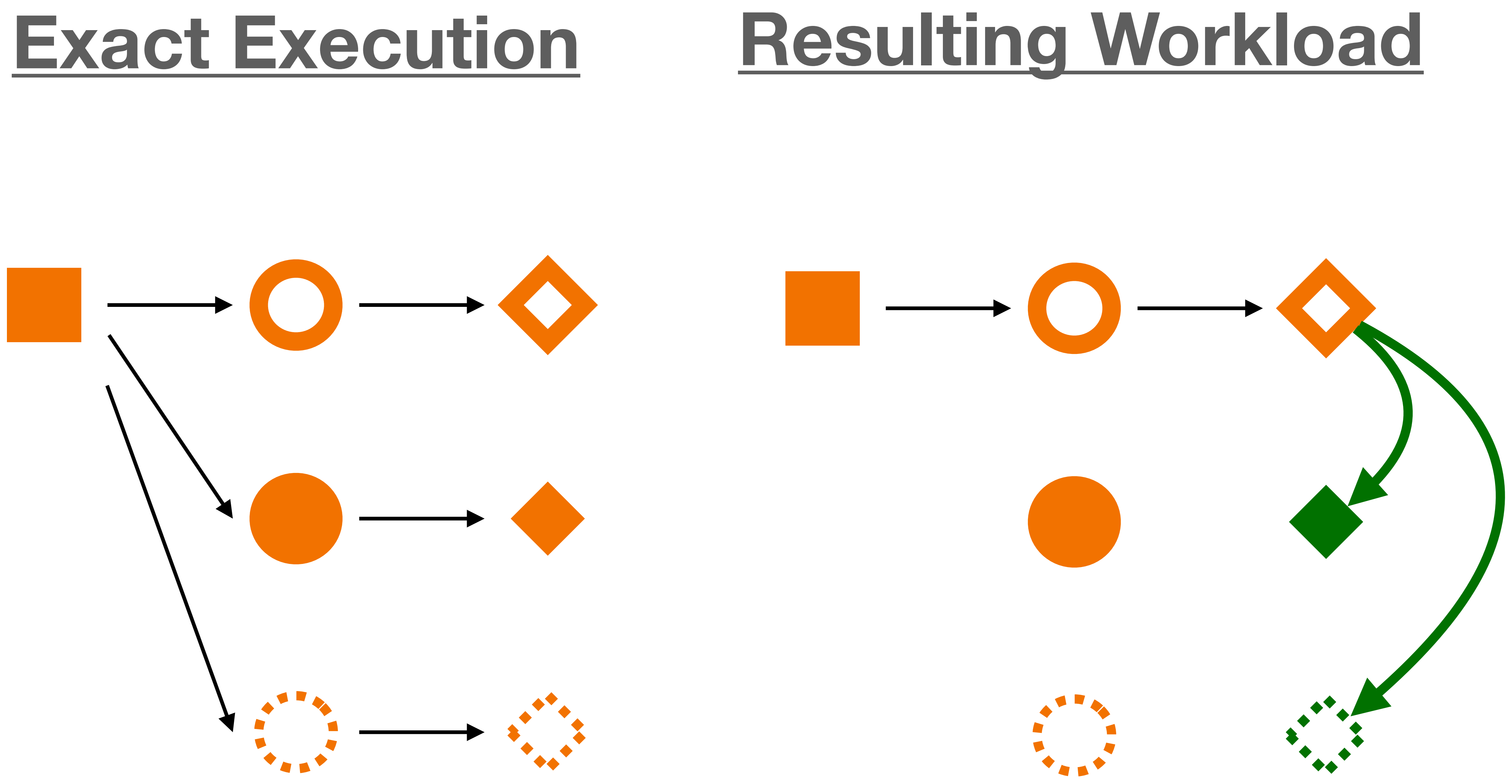
Linking Black-box Models

- **Model Linking**
  - machine over-learning
  - cross-task semantic correlation

Predict un-executed models' inference results based on executed models'?



Introduction

Linking Black-box Models

- Model Linking
  - machine over-learning
  - cross-task semantic correlation
- **Target application**
  - inference results of multiple models are required
  - cost budget is too limited to run them all

Black-box Model Linking

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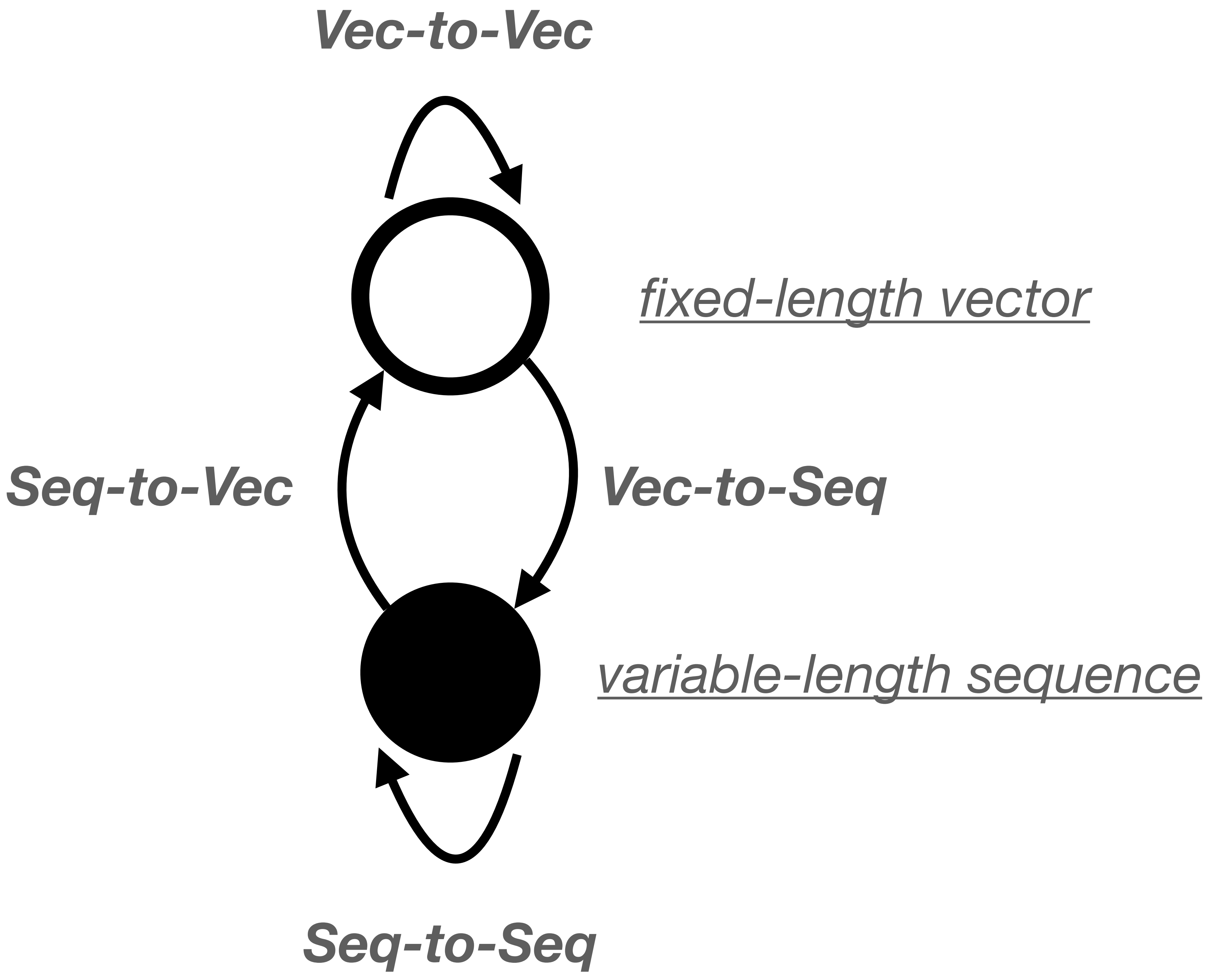
Model link architecture

- output formats determine the model link's architecture
  - fixed-length vector & variable-length sequence
  - 4 types of model link architectures
    - Vec-to-Vec
    - Seq-to-Vec
    - Vec-to-Seq
    - Seq-to-Seq



Collaborative Multi-model Inference

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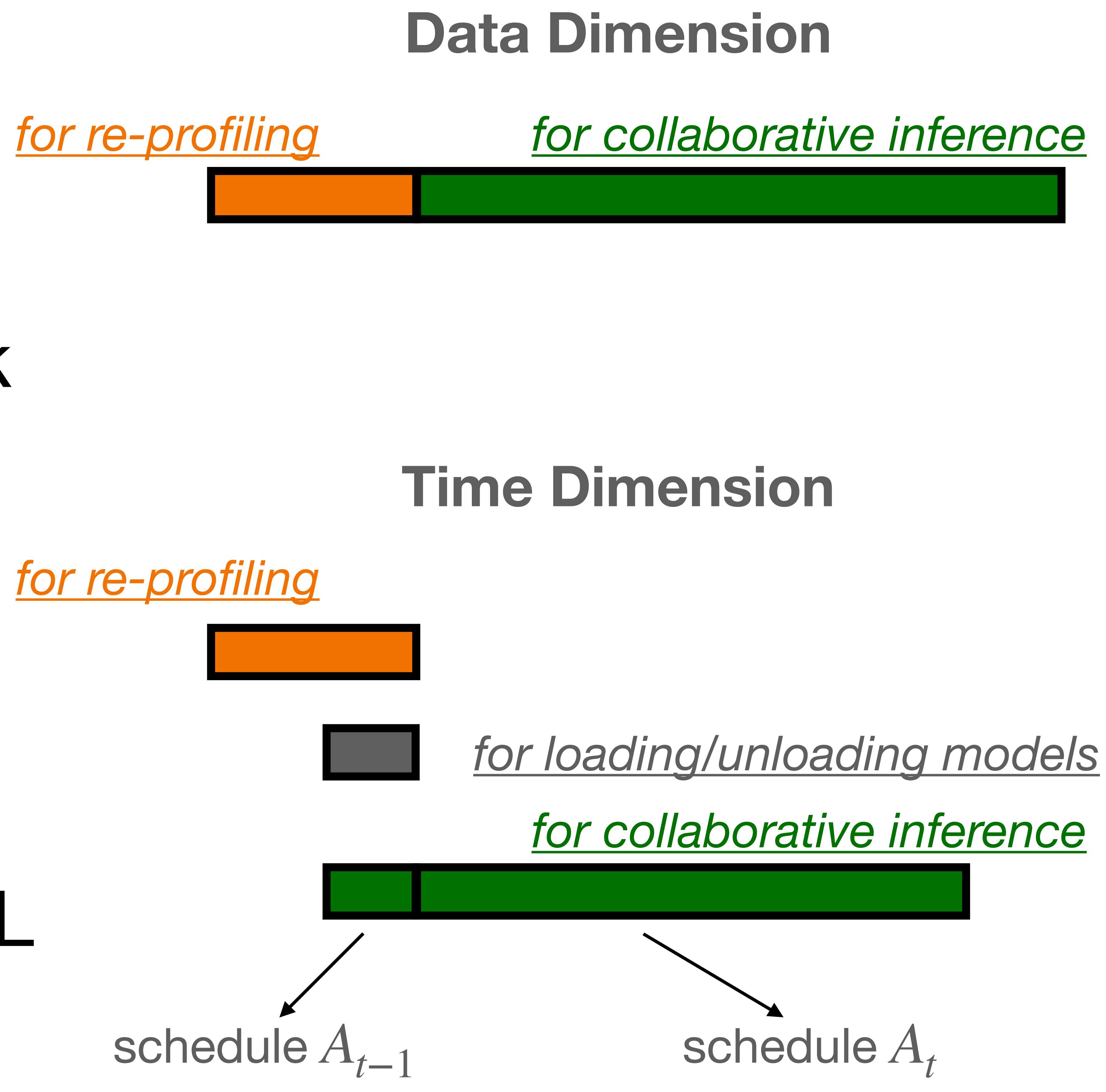
Algorithm

- select greedily w.r.t. activation probability under the cost budget
- activated models do exact inference while the others' outputs will be predicted by the model link ensemble of activated sources.
- periodic re-profiling and re-selection
  - By reasonably setting the period length and the proportion of data used for profiling, we can amortize the overheads of loading/unloading ML models to negligible.



Evaluation

Real Systems

- Smart Building
  - two days (one weekday & one weekend) of videos (1 frame per minute) from 58 cameras
  - 3 models deployed
    - person counting, action classification, object counting

Evaluation

Real Systems

- City Traffic
  - two days (one weekday & one weekend) of videos (1 FPS) from 10 cameras at road intersections
  - 3 models deployed
    - person counting, traffic condition classification, vehicle counting

Evaluation

Baselines

- Standalone: selects models in ascending order of delay and runs models independently
- MTL: a multi-task learning approach
- DRLS: a deep reinforcement learning-based scheduling approach
- Reducto: a low-level feature difference-based frame filtering approach

Target Application

- inference results of multiple models are required
- cost budget is too limited to run them all

Evaluation

Video Analytics with Model Links

- GPU Memory as the cost budget

Table 4: Comparisons of MLink, MTL, Reducto, DRLS, and Standalone

Method	Building (5/9 GB Mem.)		City (5/9 GB Mem.)	
	Acc. (%)	Time (ms)	Acc. (%)	Time (ms)
Standalone	33.3/66.7	30/74	33.3/66.7	55/121
MTL	53.3	32.8	61.3	32.5
DRLS	45.7/81.3	58.7/107	39.5/77.6	102/188
Reducto	91.8/96.9	45.7/89	84.1/95.3	64/127
MLink	**94.1/97.9**	39.3/84	**94/97.4**	62/125

accurate, lightweight, and widely applicable

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Thanks for your listening.

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