ESR 14: Multi-Paradigm Distribution for Model Management Operations

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“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 813884”.

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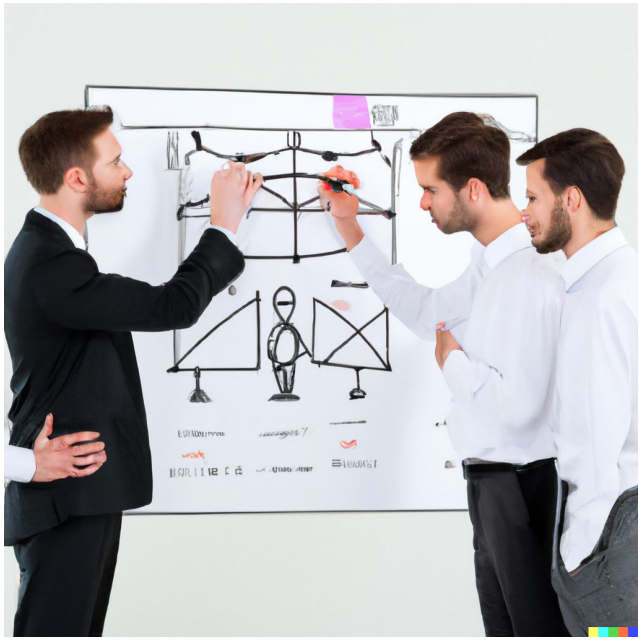
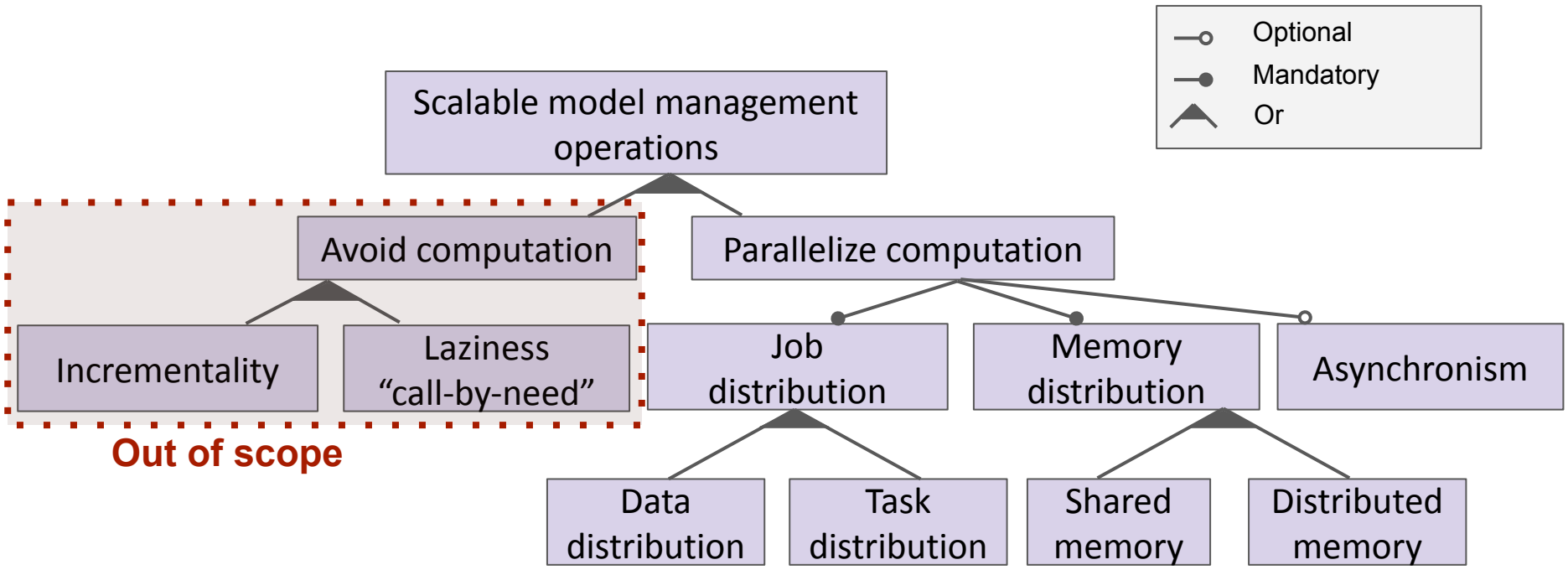
Model management for Very Large Models (VMLs)

- Computational complexity
  - Size of the model
  - Storage and memory constraints
- Scalability challenges
  - Horizontal scalability
  - Vertical scalability

➢ Two main approaches
  - Avoid computation
  - Parallelize computation



Background: Scalability of model management for VLMs



State of the art: Parallelization in MDE

	Model query	Model transfo.	Pattern match.	Optimization	Shared mem.	Distrib. mem.	Task-parallel	Data-parallel	Asynchronism
Amine Benelallam et al. «**Efficient model partitioning for distributed model** …» SLE 2016		X		X		X		X	
Amine Benelallam et al. «**ATL-MR: model transformation on MapReduce**» SPLASH 2015		X				X		X	
Loli Burgueño et al. «**A Linda-Based platform for the parallel execution** …» IST 2016		X			X			X	X
Loli Burgueño et al. «**Towards distributed model transformations with LinTra**» JISBD 2016		X		X		X		X	X
Loli Burgueño et al. «**Parallel in-place model transformations with LinTra**» CEUR-WS 2015		X			X		X		X
Jesús S. Cuadrado et al. «**Efficient execution of ATL model transformations** …» TSE 2020		X			X			X	
Gábor Imre et al. «**Parallel graph transformations on multicore systems**» MSEPT 2012		X			X		X		
Christian Krause et al. «**Implementing graph transformations in the BSP model**» FASE 2014			X			X		X	
Sina Madani et al. «**Distributed model validation with Epsilon**» SSM 2021	X				X	X		X	
Sina Madani et al. «**Towards optimisation of model queries: a parallel** …» ECMFA 2019	X			X	X		X		
Gergely Mezei et al. «**Towards truly parallel model transformations: a** …» EURCON 2019			X			X	X		
Massimo Tisi et al. «**Parallel execution of ATL transformation rules**» MODELS 2013		X			X		X		
Le-Duc Tung et al. «**Towards systematic parallelization of graph transfo.** …» IJPP 2017		X				X		X	
Tamás Vajk et al. «**Runtime model validation with parallel object** …» MoDeVVa 2011	X				X		X		

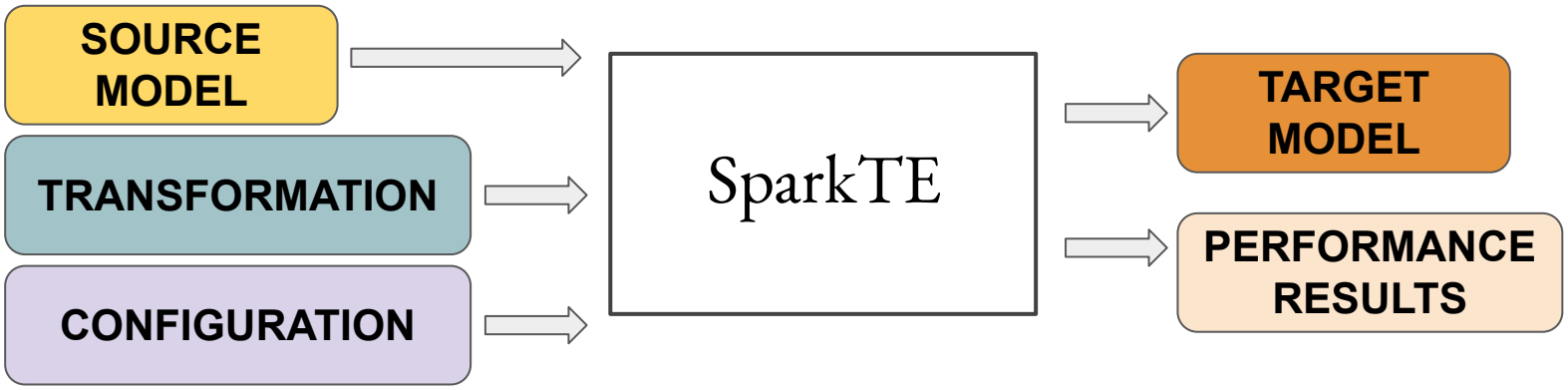
Problematic

- Large number of distributed engines
  - Designed with **different purposes**
  - Following **different design choices**
  - Implemented on **different languages** / infrastructures

What are the adapted design choices for a given case?

Goal: Compare design choices in distributed model transformation engine

Contribution



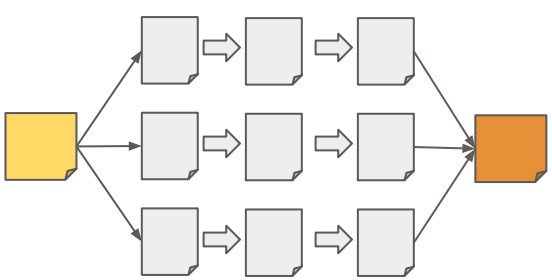
- Built a **modular** distributed transformation engine (SparkTE)
  - From a **formal specification**
  - Optimized for **data-distributed** computation
- Analysed **several strategies** for **query** execution
- Analysed design choices for distributed transformation

SparkTE: a modular distributed transformation engine

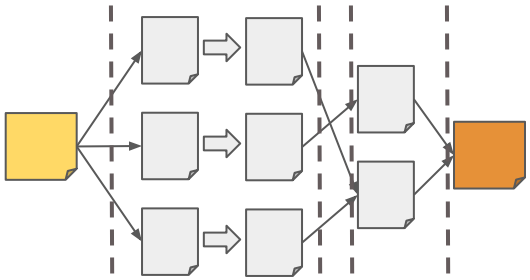
1. Took an existing formalization: CoqTL
2. Specified additional features for parallelization
   - Proof of equivalence
3. Implemented the specification on top of Spark

Analyzed several strategies for query execution

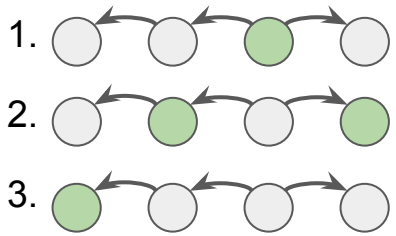
- Implemented a single query on social networks
  - Following different distribution strategies



Spark



MapReduce

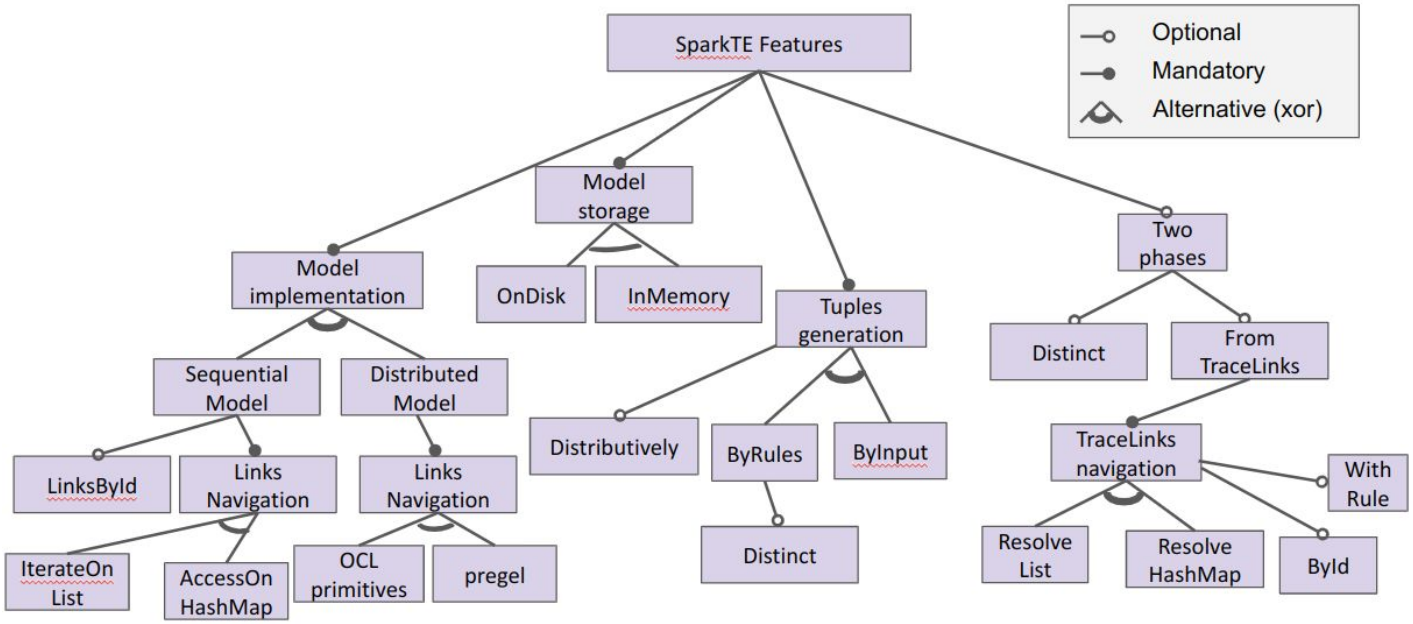


Pregel

  - Made hybrid strategies
- Analysed performances results
- Analysed correlation between input model and perf.

Analysed design choices for distributed transformation

- Formalized the design space of our solution



- Added the configuration aspect to SparkTE
- Experiments features

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