Towards Transparent Combination of Model Management Execution Strategies for Low-Code Development Platforms

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MODELS 20

Introduction

LCDP manipulates model:

- At design time
- At runtime

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Large models? Modification frequency? Connectivity?

NEED OF ADAPTED TECHNIQUES

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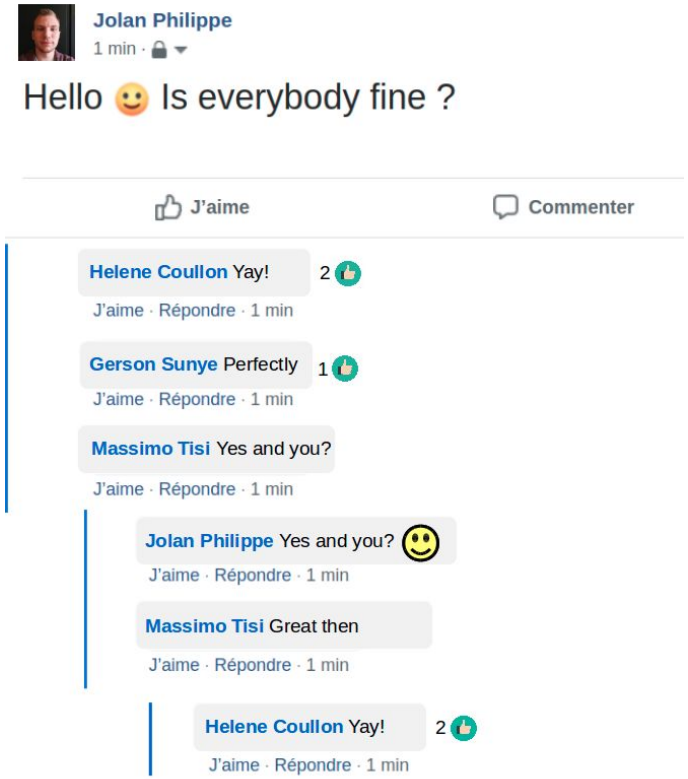
Running example: Build a LCDP to manipulate social networks
- Large datasets (huge social graph)
- Often modified
- Large number of users

Transformation Tool Contest 2018



- Query:

  What is the most debated post in a social network?

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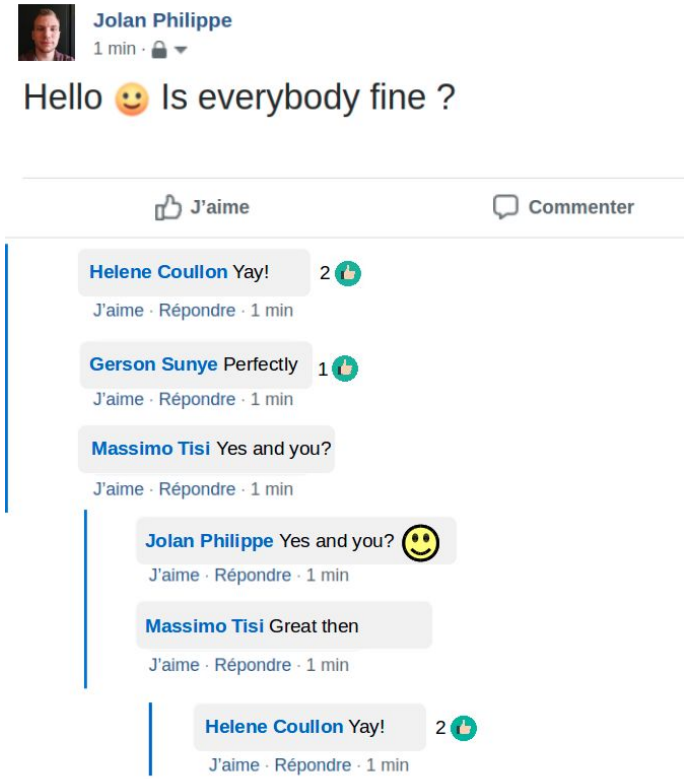

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  Score(post) = 10 * #(post.comments) + #(post.comments.likes)

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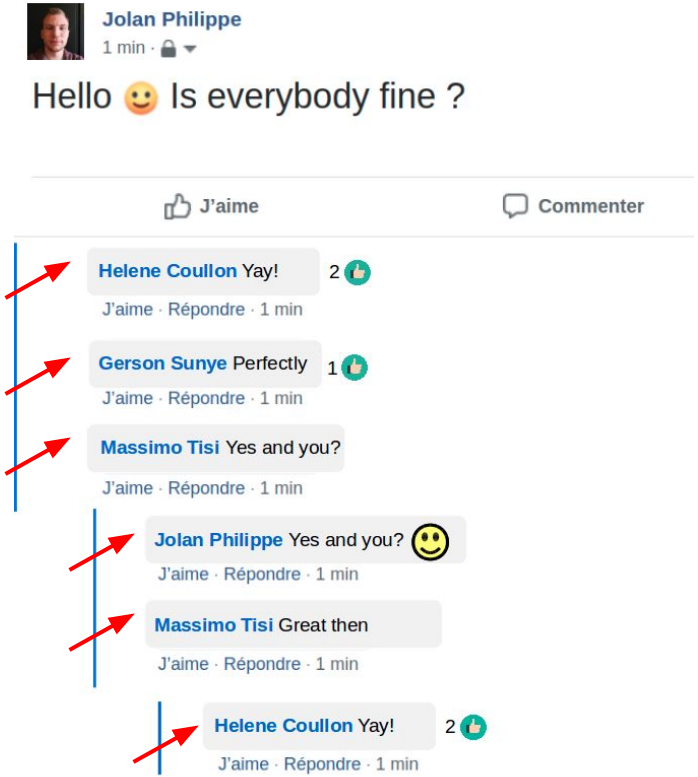

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- **#(post.comments) = 6**

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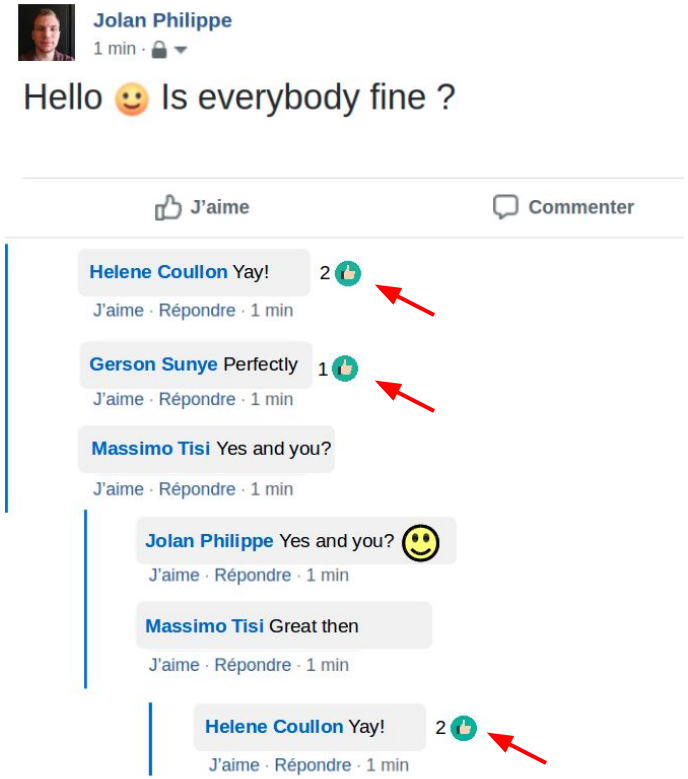

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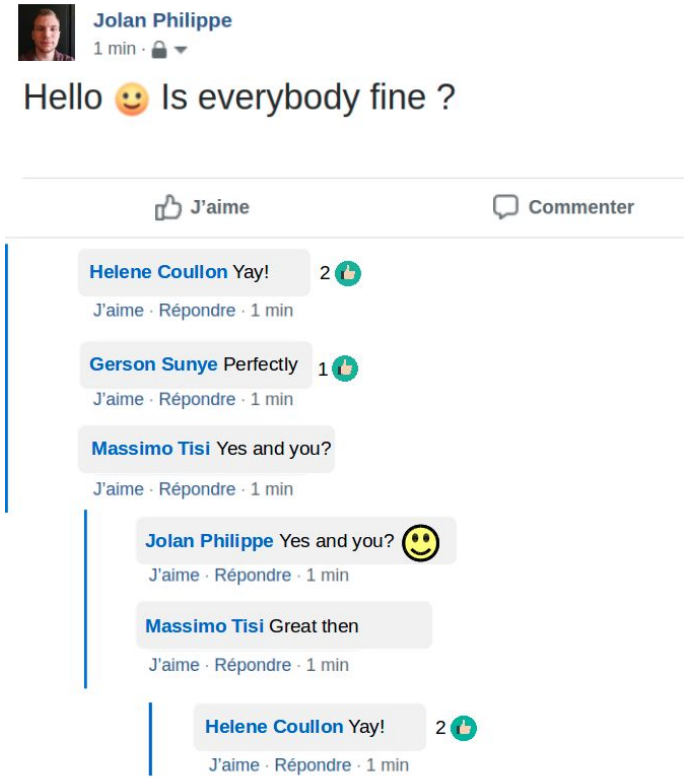

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  What is the most debated post in a social network?

  Score(post) = 10 * #(post.comments) + #(post.comments.likes)
- **#(post.comments) = 6**
- **#(post.comments.likes) = 5**
- **Score(post) = 65**

Many execution strategies

- **Reactivity**
  - Incrementality
  - Laziness
- **Parallelism**
  - Data-Parallelism
  - Task-Parallelism
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- **Need of knowledge (expertise)**
- **Need of configuration**
- **<u>Not lowcode friendly</u>**

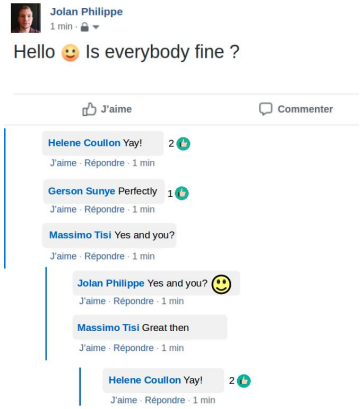
Multi-strategy for parallelism

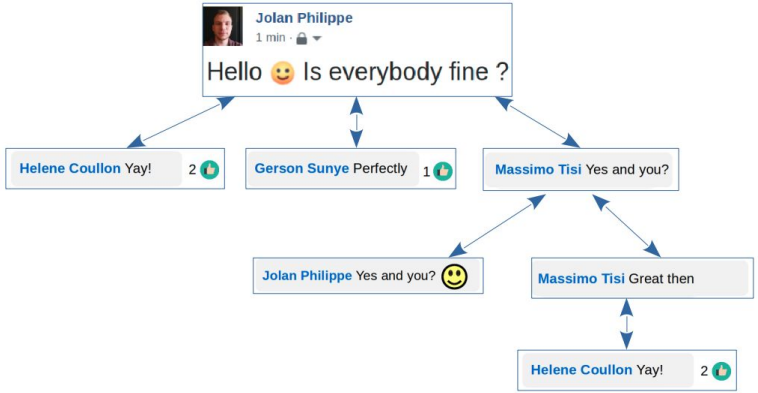
Implementation of strategies using Apache Spark

Support for distributed data structures:

- High-order functions
- MapReduce
- GraphX (+ Pregel)

Model as graphs: A node per class, an edge per relationship.





Direct implementation

1. Get all the comments from a post (recursive DFS)
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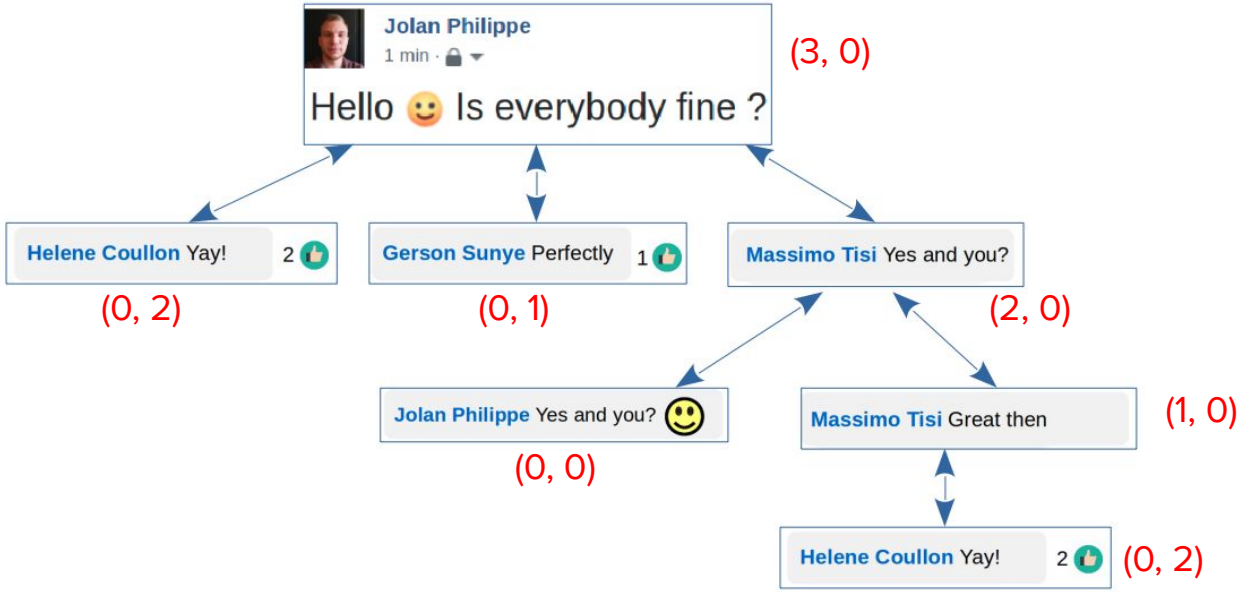
Pros	Cons
Easy to write Easy to read	We do not expect good performances

MapReduce implementation

1. Parallel Map + Reduce: a score by submission
2. Accumulation of sub-scores (recursive DFS) for a given post



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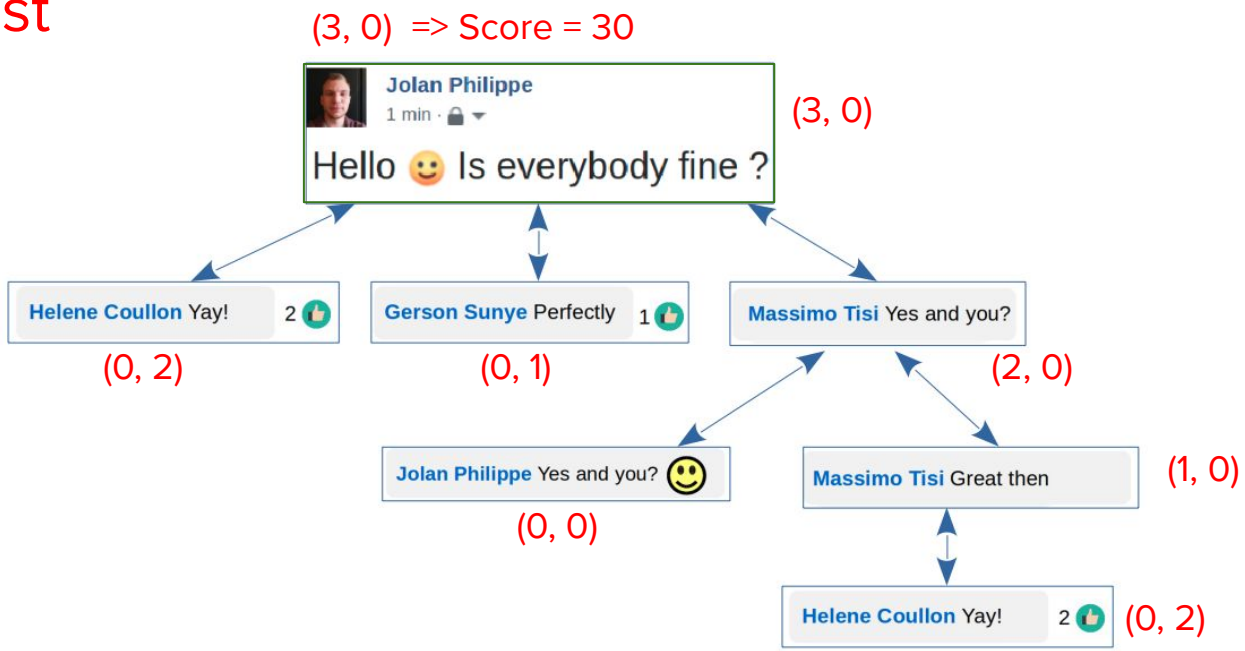

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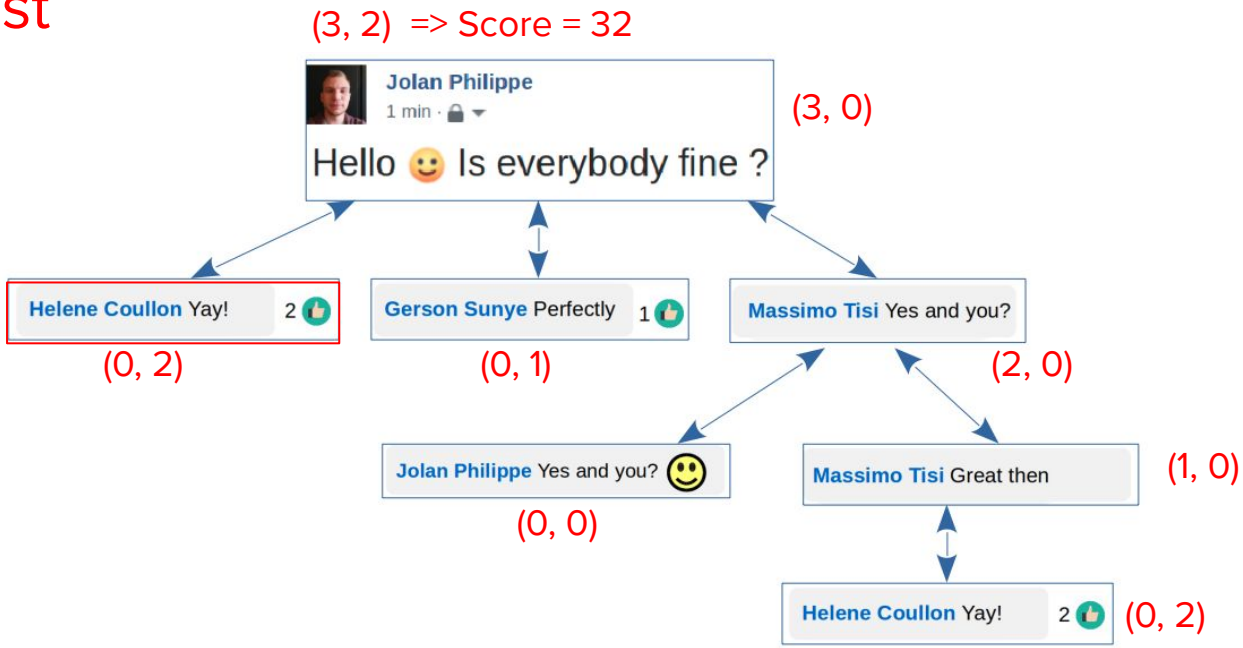

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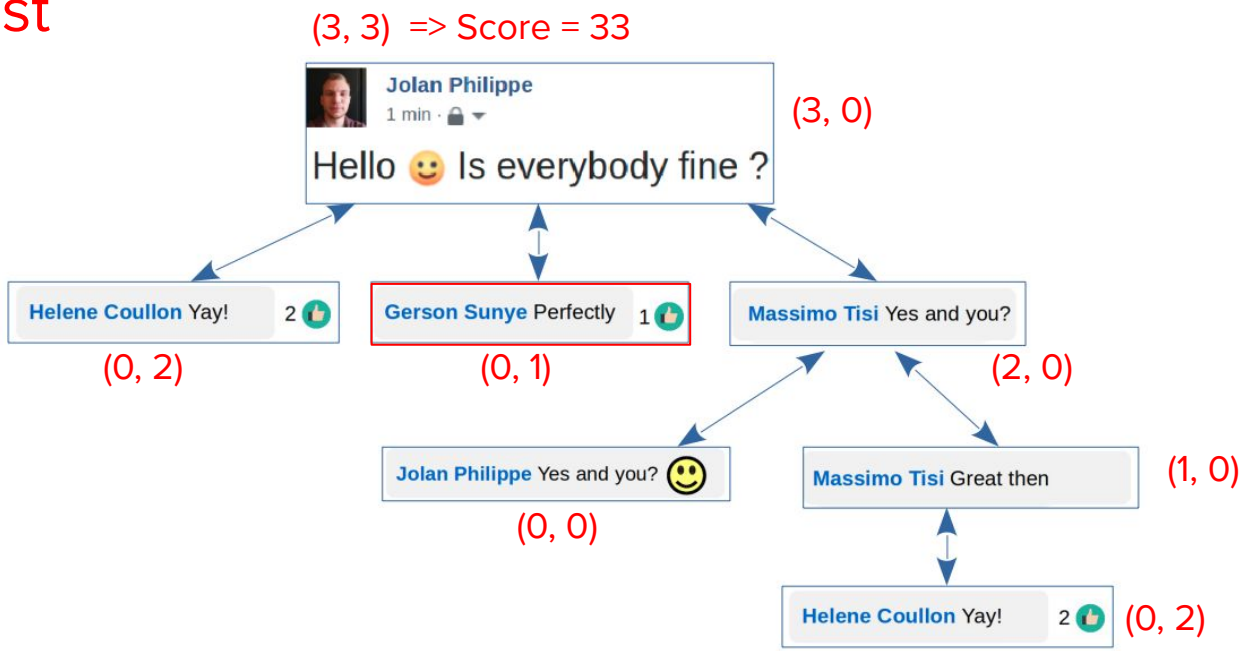

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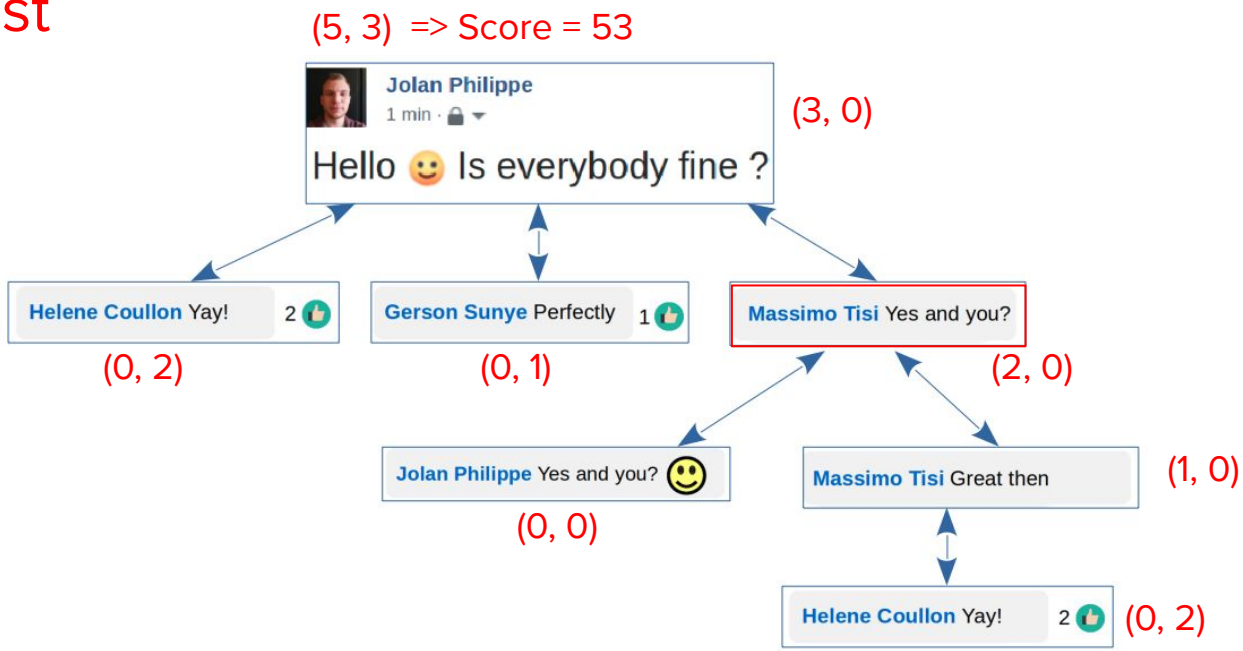

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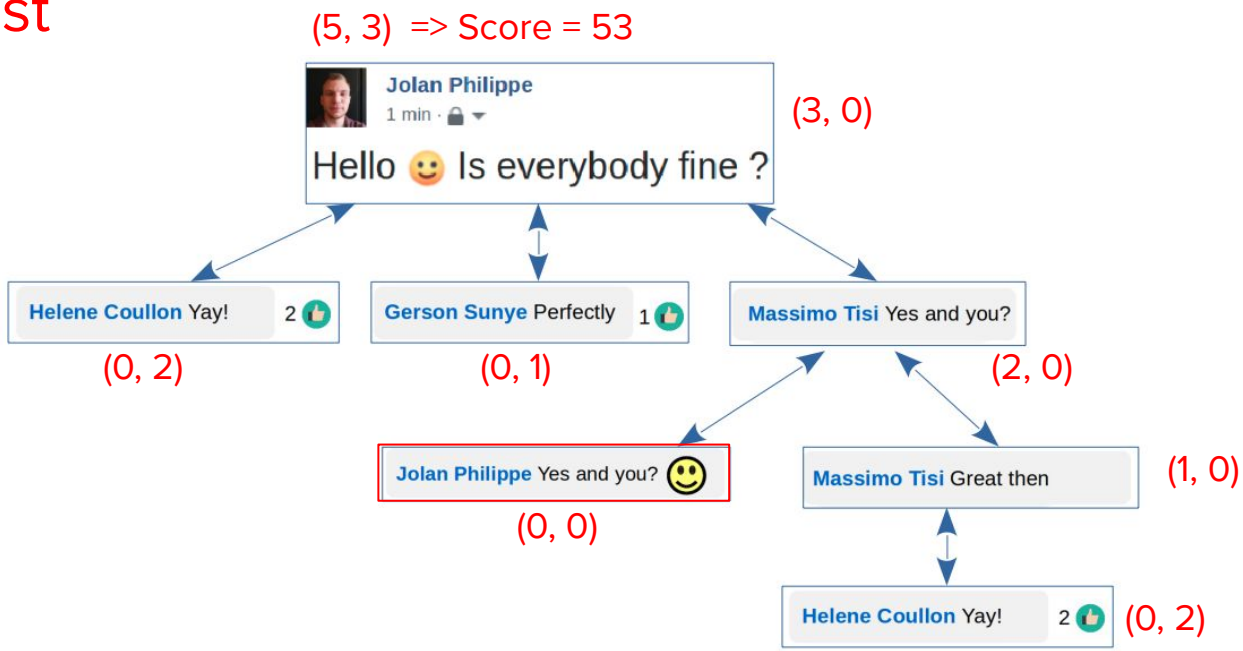

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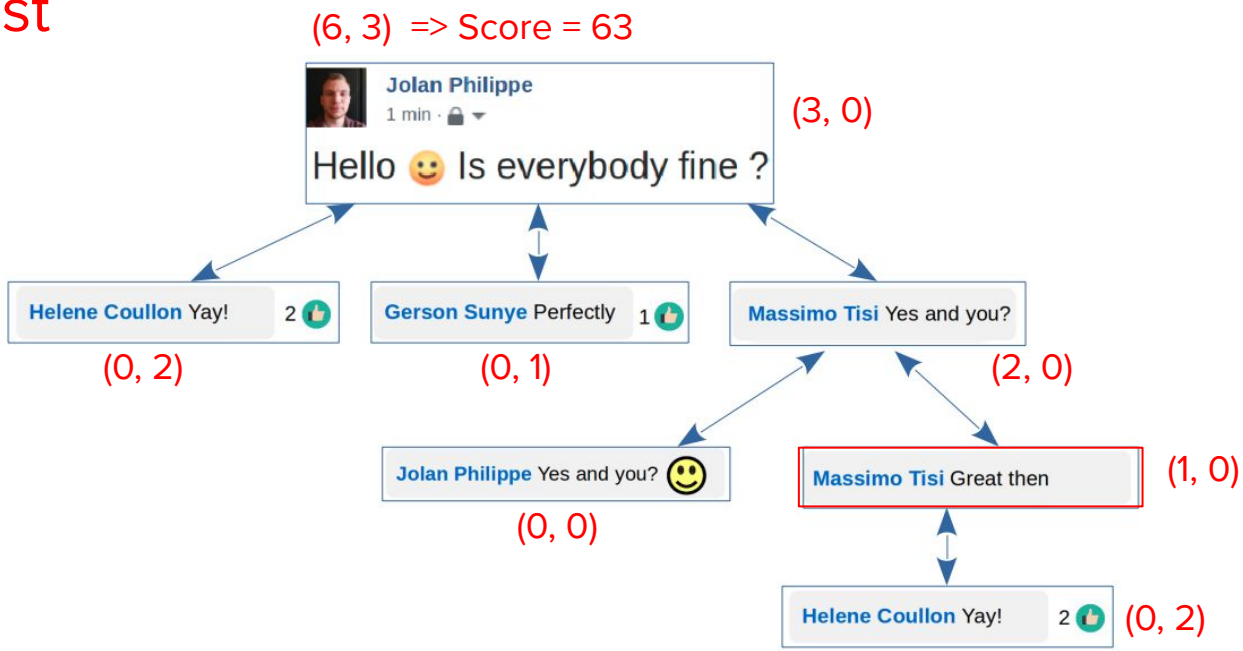

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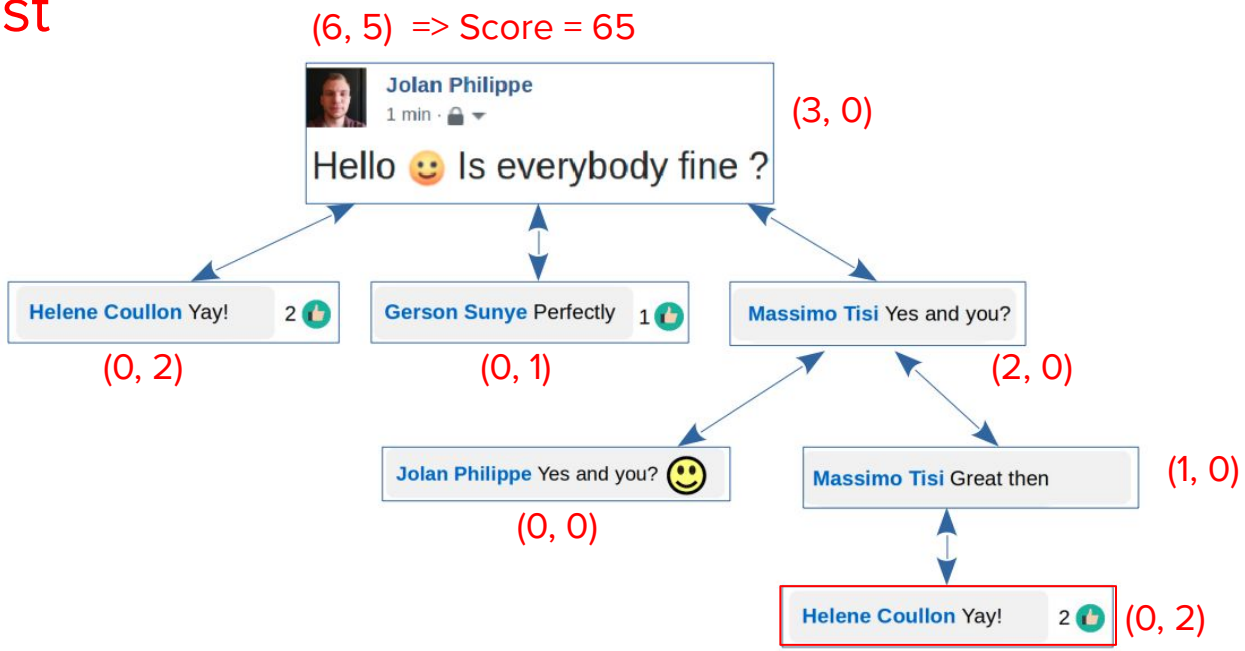

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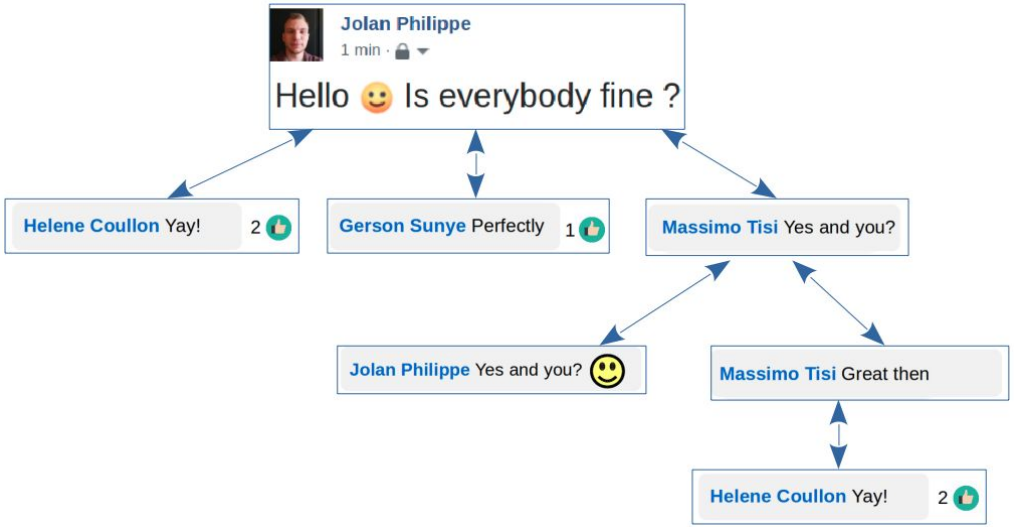
Pros	Cons
Highly parallel solution	Not fit for frequently modified model

Pregel implementation

1. Initial step: parallel Map
2. Reachability by propagation (Pregel) from a post
   a. message passing
   b. with accumulators
3. Calculate the score from accumulators



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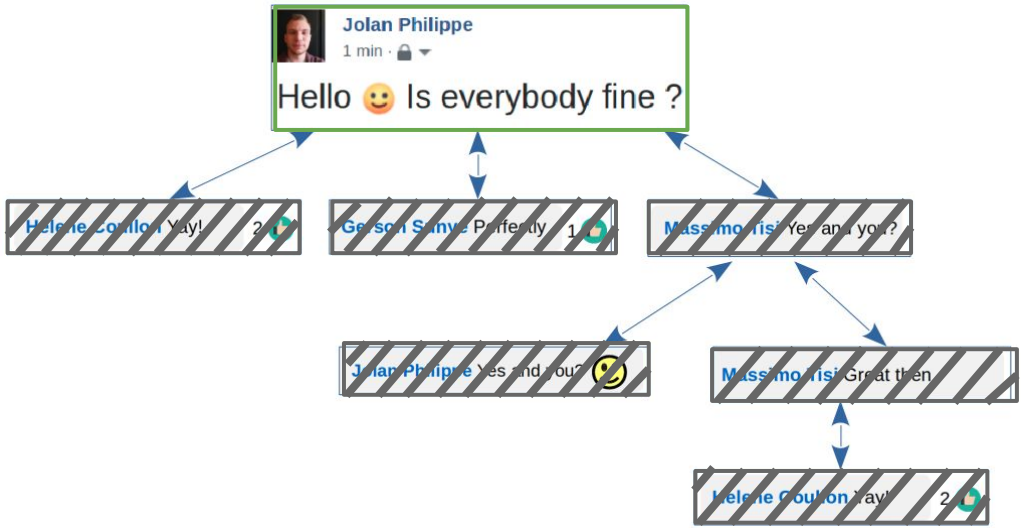

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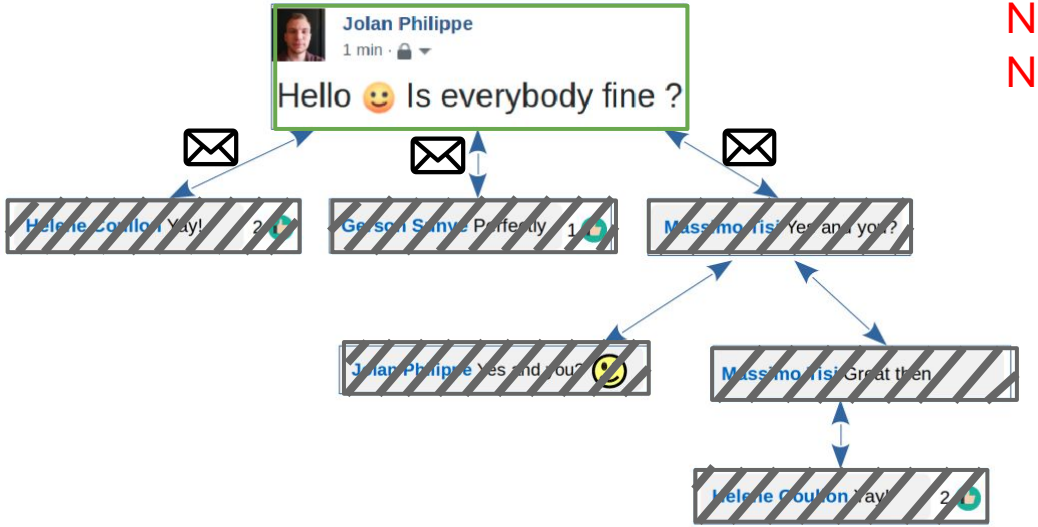

Nb_comments = 0
Nb_likes = 0

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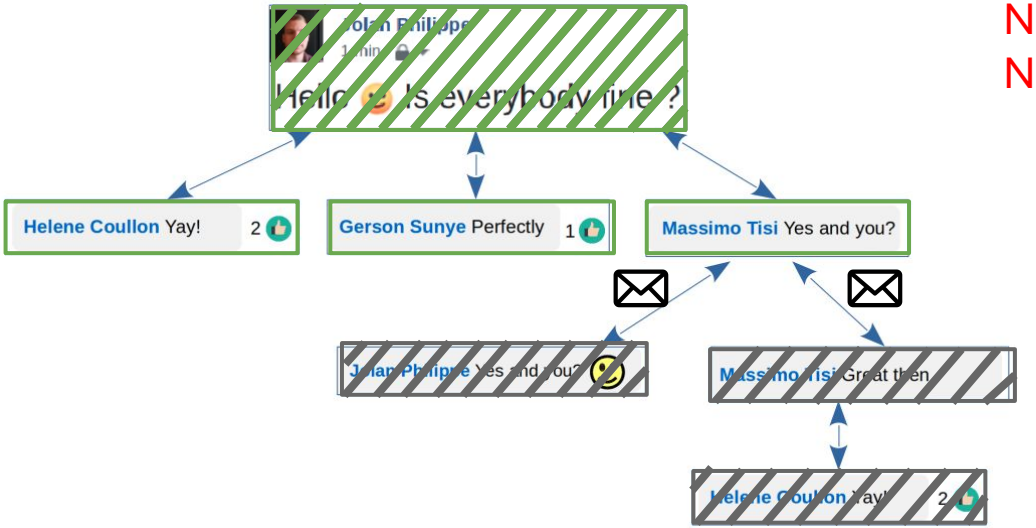

Nb_comments = 3
Nb_likes = 3

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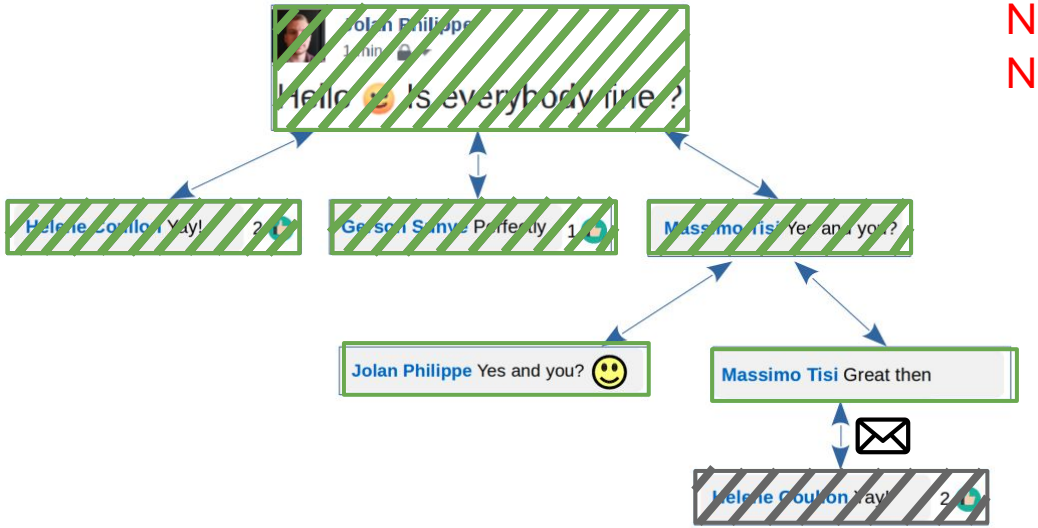

Nb_comments = 5
Nb_likes = 3

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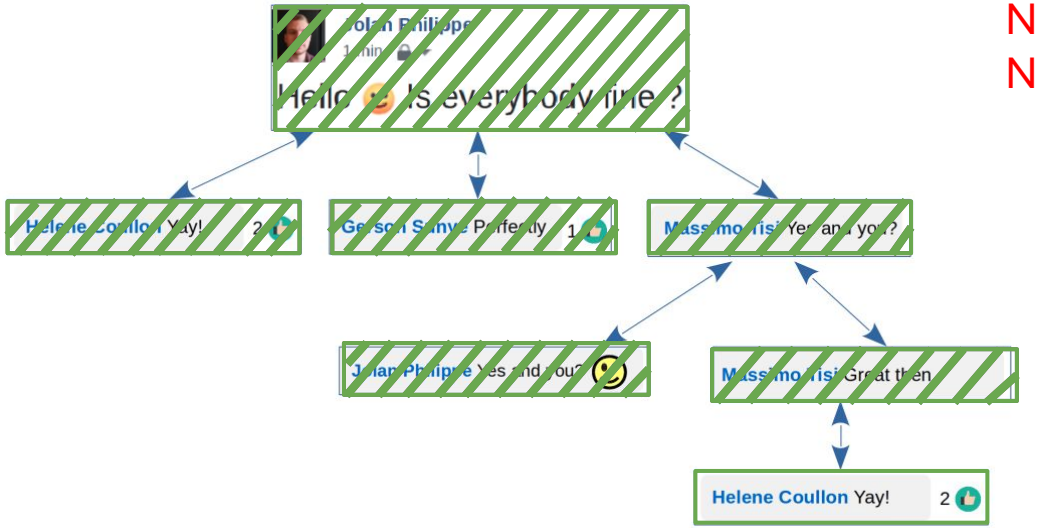

Nb_comments = 6
Nb_likes = 5

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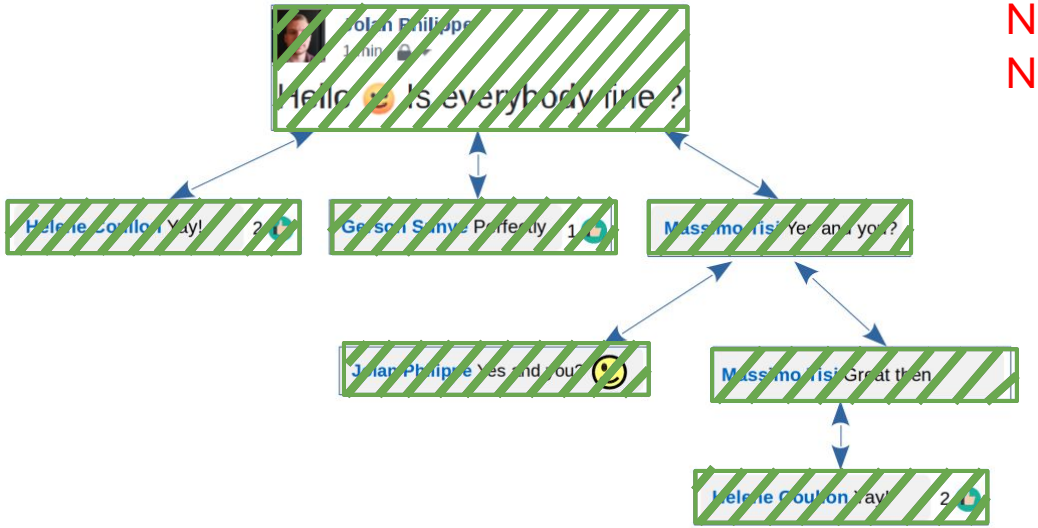

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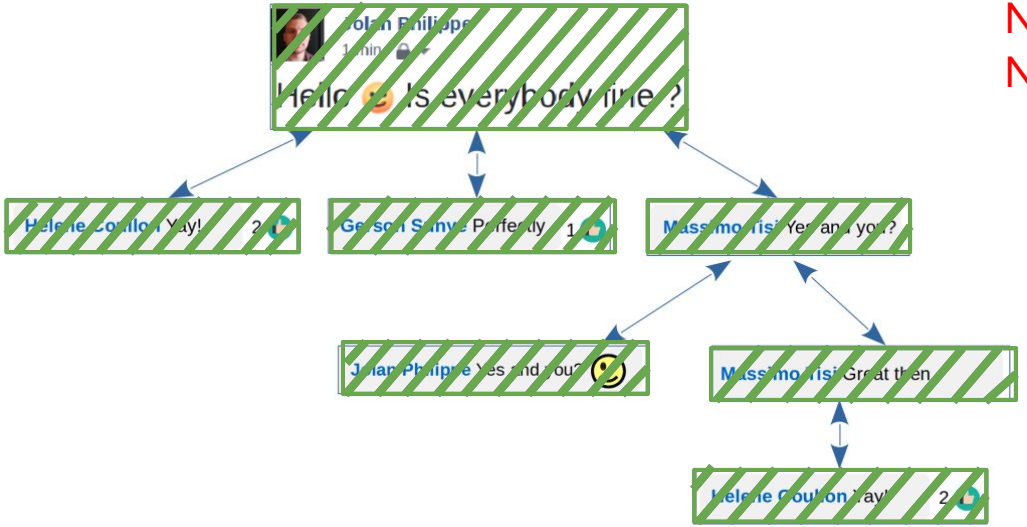

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Pros	Cons
Easy to write	Hard to read
Strong engine (perf)	Limited parallelism

Multi-Strategy implementation

- **Direct implementation + Pregel**
  1. Parallel Map + Reduce: a score by comment
  2. Accumulation of sub-scores (DFS to Pregel) for a given post

- **MapReduce implementation + Pregel**
  1. Get all the comments from a post (DFS to Pregel)
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Experiments

Execution of the score functions on all posts:

- 5 Strategies
- 30 executions each
- 8 datasets ((1274 nodes, 2533 edges) to (115121 nodes, 286502 edges))

Single machine configuration:

- Java 1.8 with Scala 2.13.2 (Spark 3.0.1)
- Intel(R) Core(TM) i7-8650U CPU
  - 8 cores
  - 1.90GHz
- Memory of 32 GB

Results

	Dataset				Speed-up (compared to Naive Sequential)					
#	# users	# posts	# comments	# likes	Naive Sequential	Naive Parallel	Pregel	MapReduce	OCL + Pregel	MapReduce + Pregel
1	80	554	640	6	**1x**	0.40x	10.30x	5.82x	9.40x	4.63x
2	889	1064	118	24	**1x**	0.39x	0.36x	0.46x	0.44x	0.46x
3	1845	2315	190	66	**1x**	0.51x	0.68x	0.85x	0.66x	0.71x
4	2270	5056	204	129	**1x**	0.27x	0.35x	2.34x	0.15x	2.96x
5	5518	9220	394	572	**1x**	4.25x	5.21x	4.17x	4.68x	4.03x
6	10929	18872	595	1598	**1x**	4.68x	2.83x	2.39x	1.97x	3.91x
7	18083	39212	781	4770	**1x**	4.07x	4.12x	4.58x	5.17x	3.27x
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Solution

- Several strategies for model management: Example with <u>parallelism</u>

  Not all adapted for every situation
- Need of additional metadata
  - Size and topology of model
  - Kind of operation and their frequency
  - (Available architecture)
- Adaptive engine based on a multi-strategy approach

Conclusion

- Many execution strategies
- As a concrete example: several parallel strategies (TTC18)
- There is no solution adapted in every situation
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- Conduct additional experiments:
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Questions ?