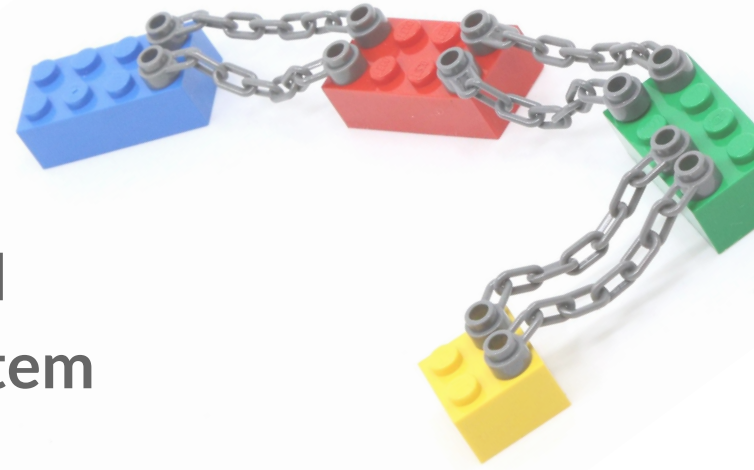# A Blockchain based Recommendation System

Andrea Lisi
Laura Ricci

Università degli studi
di Pisa

Andrea De Salve

Institute of Applied
Sciences, CNR Lecce

Paolo Mori

Istituto Informatica e
Telematica, CNR Pisa

Walkthrough

1. **Context**

2. **Model**

3. **Prototype and Experimental evaluations**

4. **Conclusions**

Recommender and Rating systems

Platforms processing user input with the goal of suggesting new products and services

Typical user input data: the **Rating**
   Star score system, Like/Dislike, Like...

⭐⭐⭐⭐⭐ Excellent
⭐⭐⭐⭐⭐ Above Average
⭐⭐⭐⭐⭐ Average
⭐⭐⭐⭐⭐ Below Average
⭐⭐⭐⭐⭐ Poor
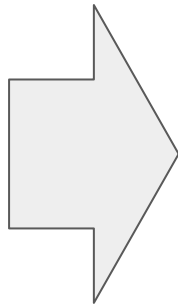
👍 2,7 MLN   👎 17 MLN

Ratings

Assessing the storage of a Rating in the Blockchain

Blockchain

- Transparency

- Immutability

Rating

- Auditable, not censurable

- Is it possible to ask the removal of a Rating?

Ratings

Una recensione è per sempre: il ristorante non ha diritto all'oblio

Due decisioni del tribunale di Roma sanciscono che sulle piattaforme conta di più l'interesse dell'utente

Proposal

A framework for the **record-keeping** of user ratings on a blockchain platform

Provide **a model** for the definition of a transparent and traceable functionality for the storage control and the processing of user ratings
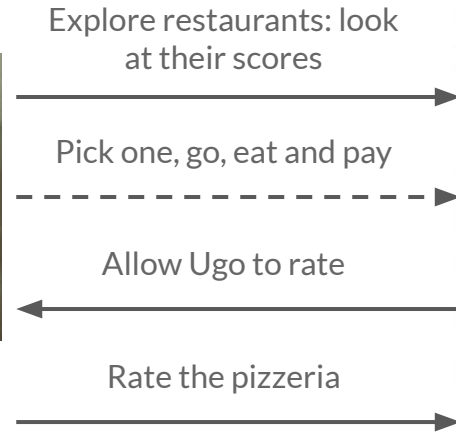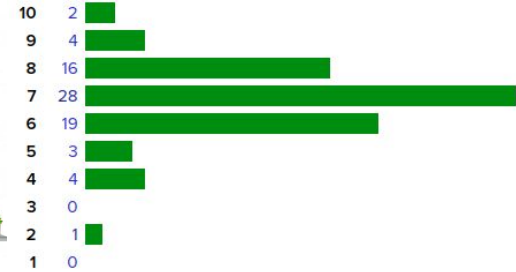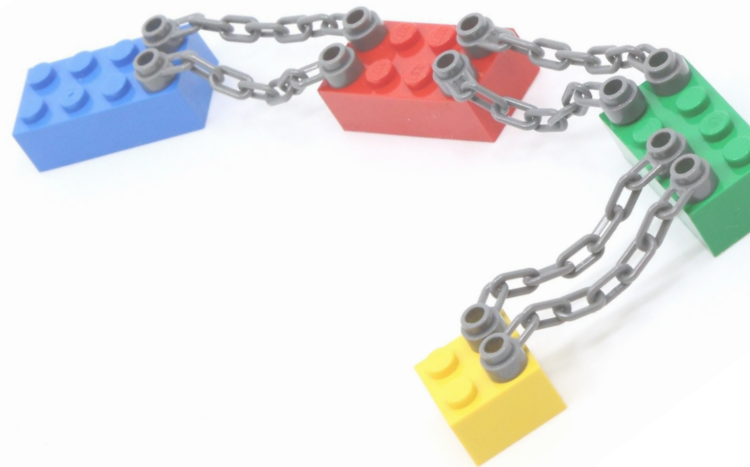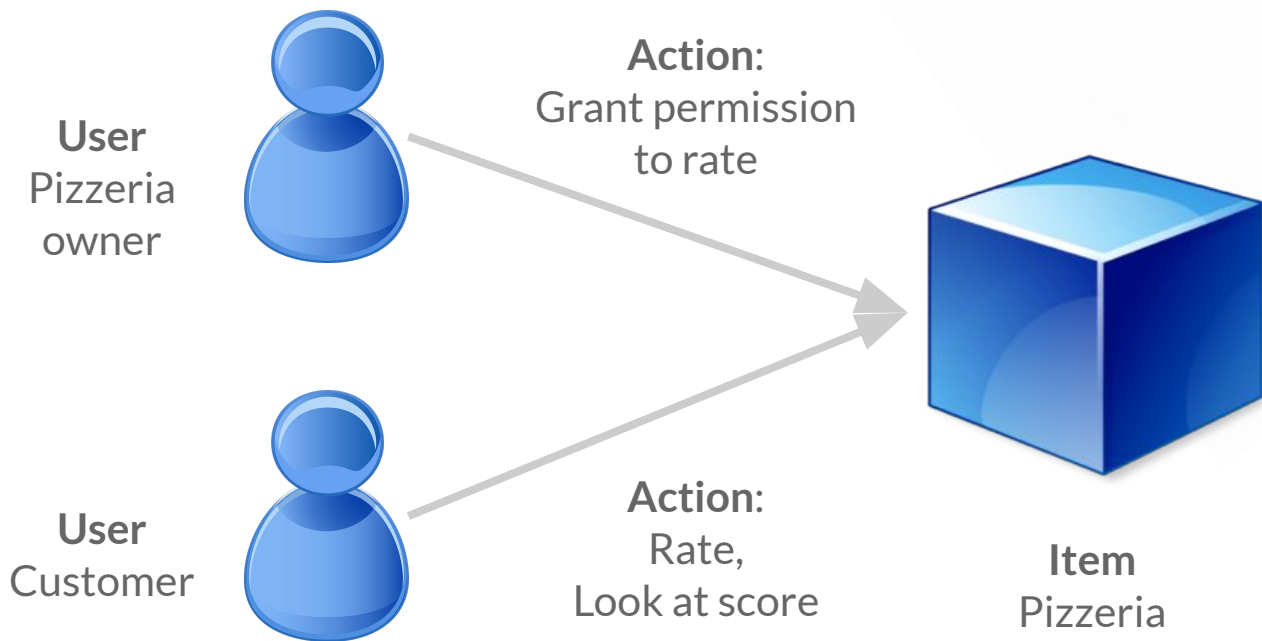
Workflow

Explore restaurants: look at their scores

Pick one, go, eat and pay

Allow Ugo to rate

Rate the pizzeria

Ugo

Pizzeria

Ratings

10	2
9	4
8	16
7	28
6	19
5	3
4	4
3	0
2	1
1	0

Model

User
Pizzeria
owner

Action:
Grant permission
to rate

User
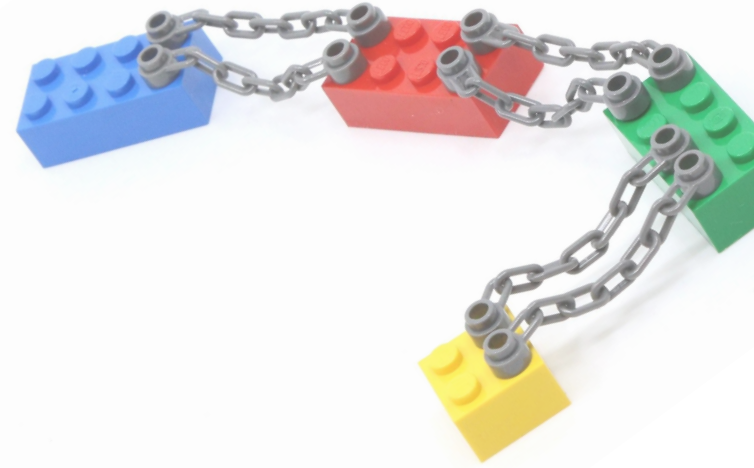Customer

Action:
Rate,
Look at score

Item
Pizzeria
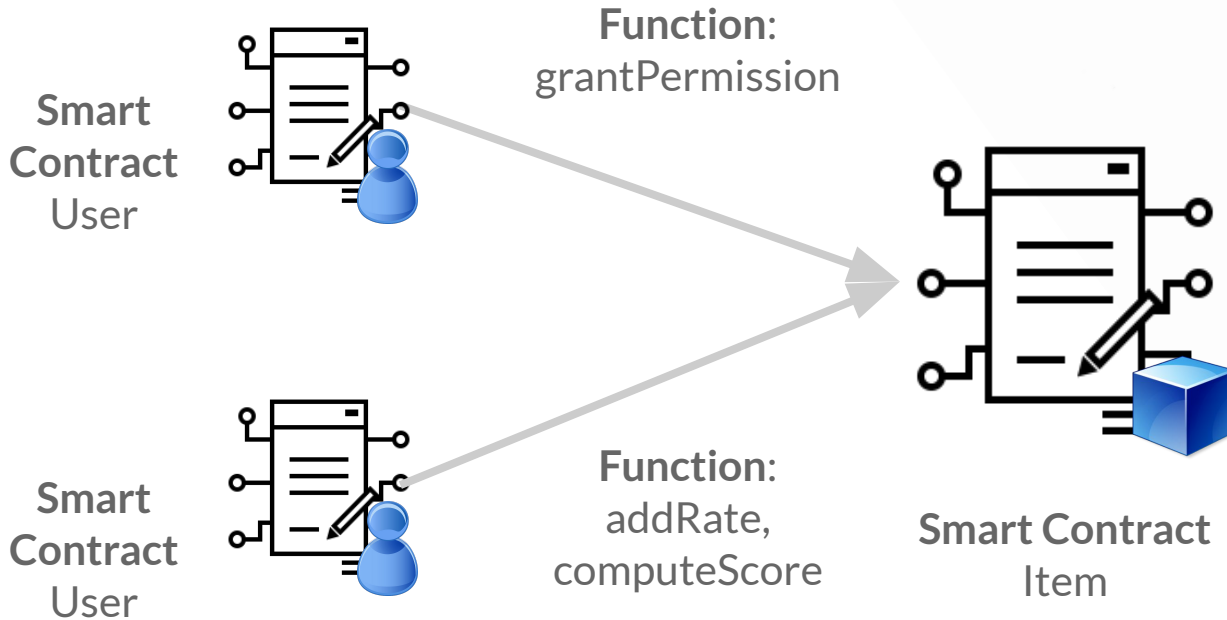
Terminology:
Recommender Systems:
Introduction and Challenges
F. Ricci, L. Rokach, B. Shapira

Model

Smart Contract User

Function: grantPermission

Smart Contract User

Function: addRate, computeScore

Smart Contract Item

Model

Smart Contract User

Function: grantPermission

Smart Contract User

Function: addRate, **computeScore**

Smart Contract Item

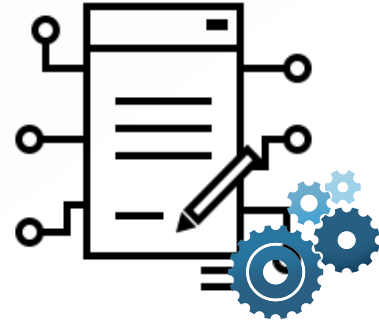**Function**: compute Score

Smart Contract RatingFunction
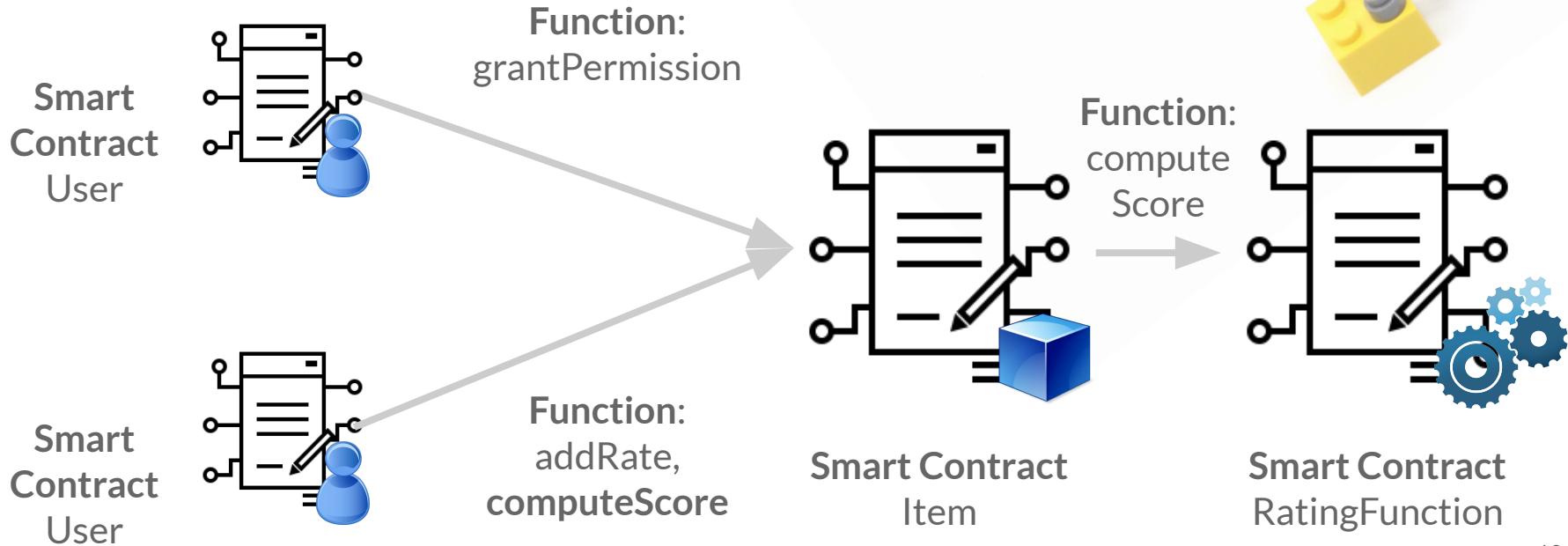
Rating Functions

A **Rating Function** is a smart contract with the sole purpose of computing the score of an Item

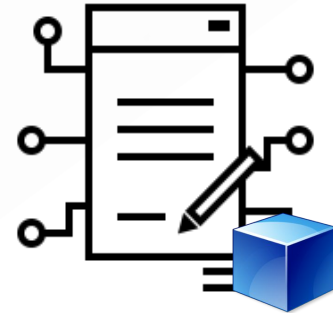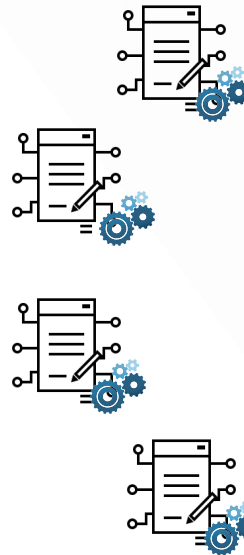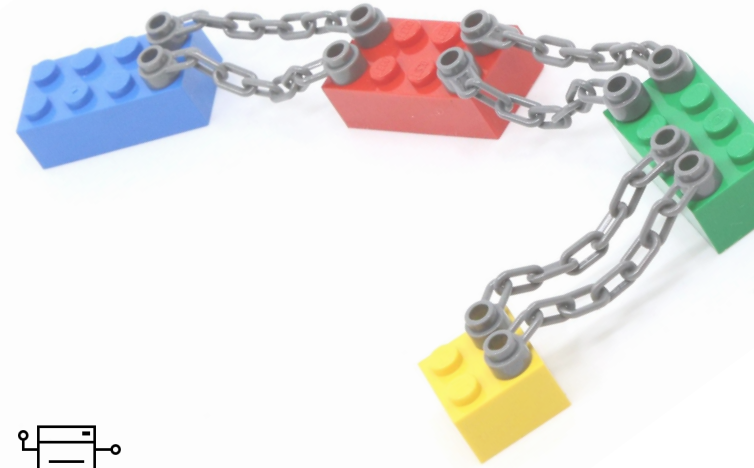As a smart contract, a Rating Function is public and immutable

Rating Functions

Each Rating Function implements a single evaluation formula
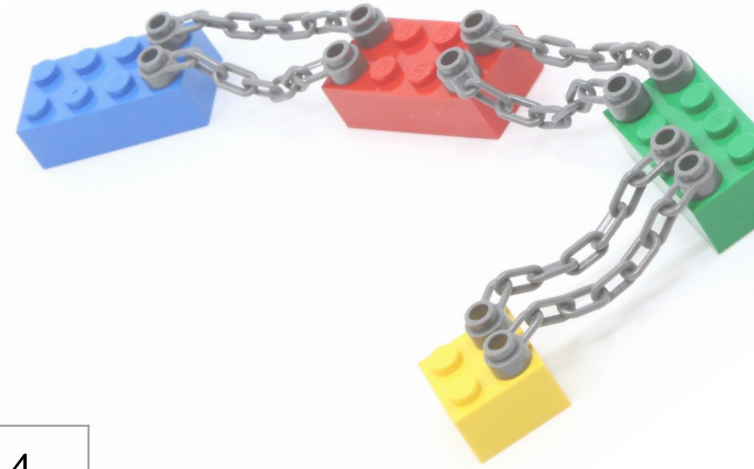- But all share the same input model

In this way users evaluate the score of Items according to different evaluation criteria
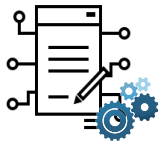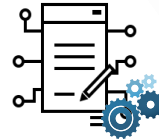
Rating Functions - Example

Input

Score	9	8	9	6	7	5	4
Timetamp	5	8	10	20	22	25	30

F1

F2

F3

Output   ★ ★ ★   ★ ★   ★ ⯪

Ethereum prototype

A simplified prototype running on top of **Ethereum**

Smart Contracts implemented in **Solidity**

Limitation inherited from Ethereum: **the Gas**

Evaluation: Rating Functions

Due to the **gas and Solidity constraints,** a Rating Function cannot implement complex formulas

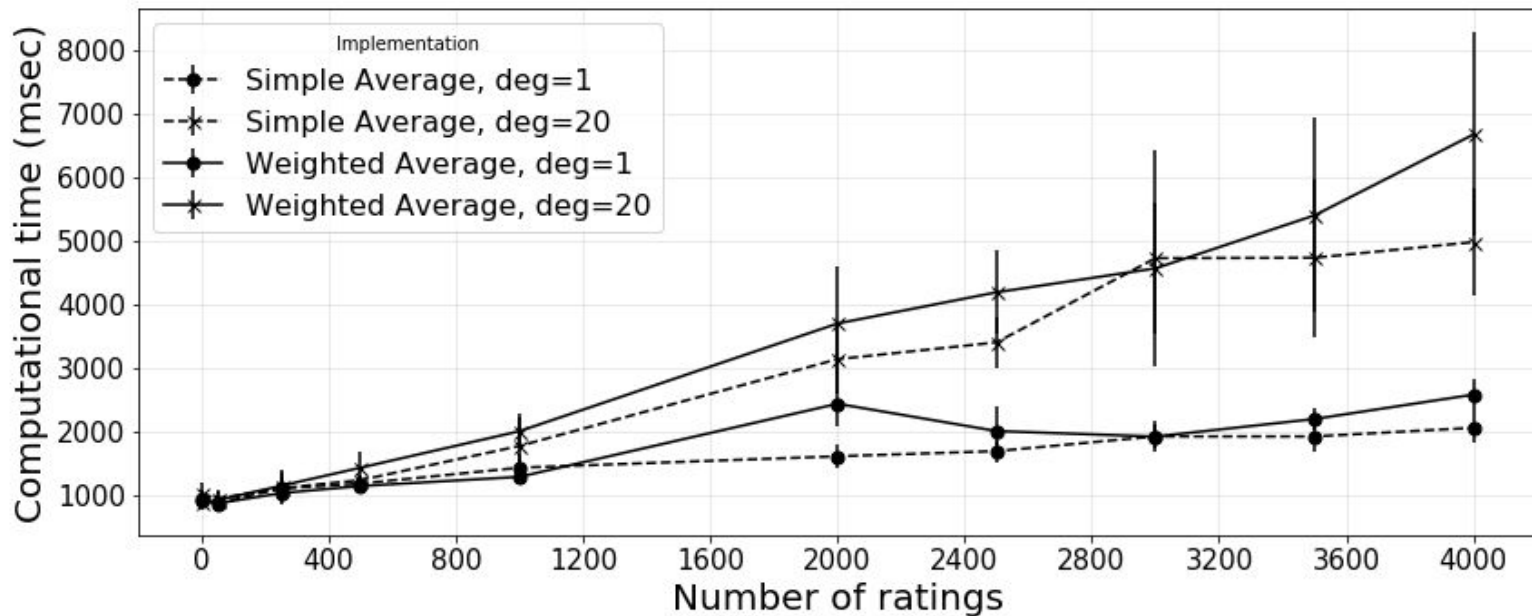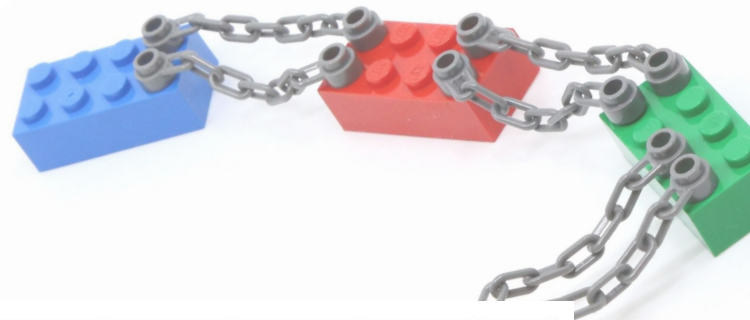We evaluate two functions: **Simple Average** and **Weighted Average**, with input composed by:
- A score list
- The block index list

Network: Ropsten Testnet
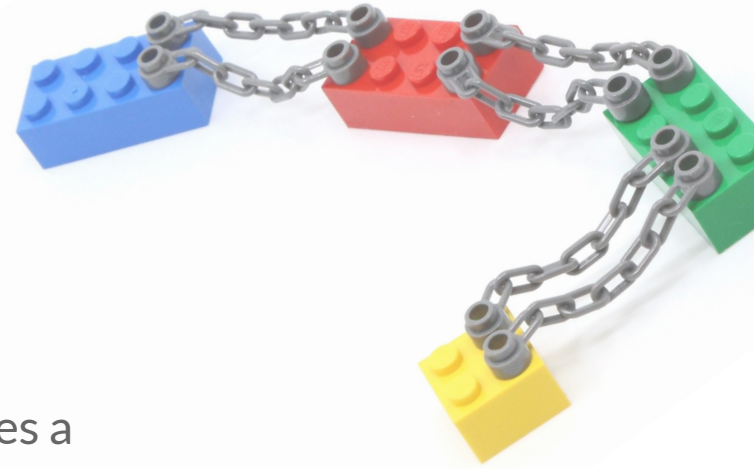
Evaluation: Rating Functions

Gas Limit: 4,7M

Evaluation: Transactions

It is a common knowledge Ethereum 1.0 processes a limited number of transactions per second
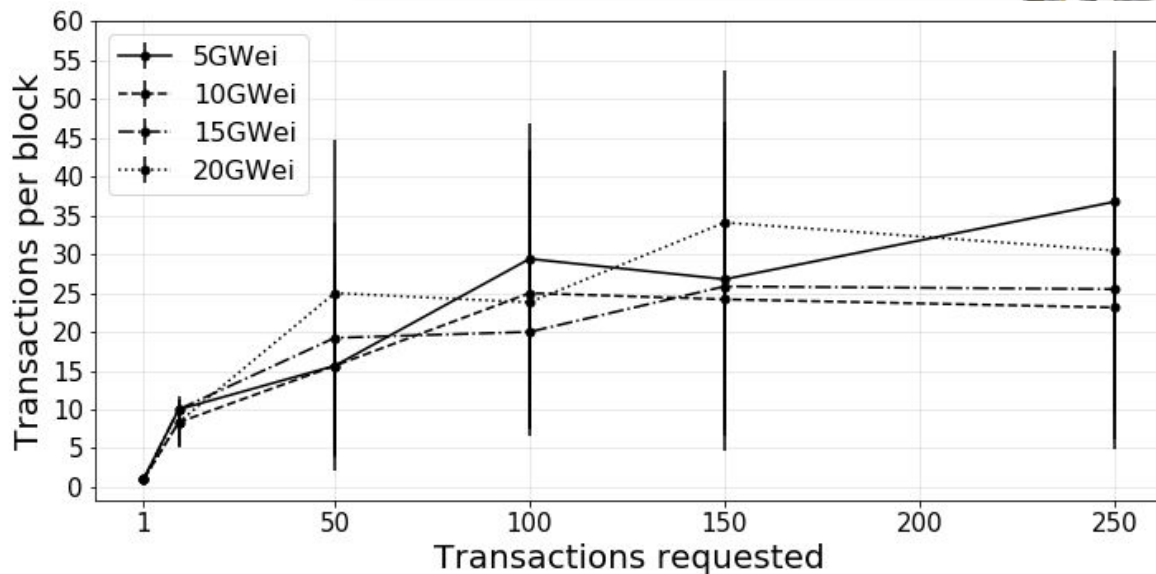
A write-function is embedded in a transaction, thus it is subjected to mining limitations

Currently, a block contains up to 8M units of gas
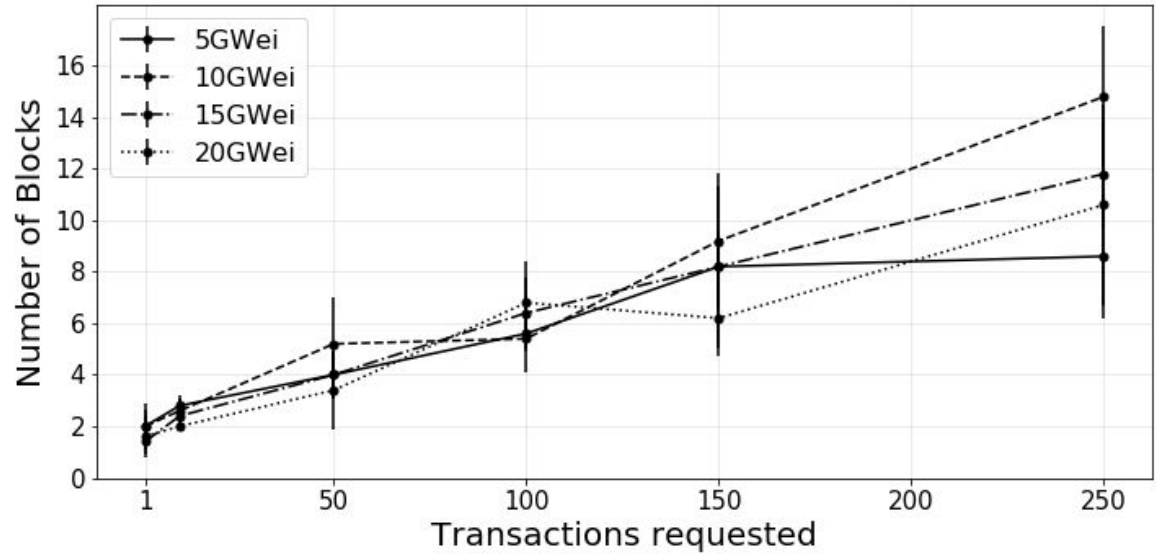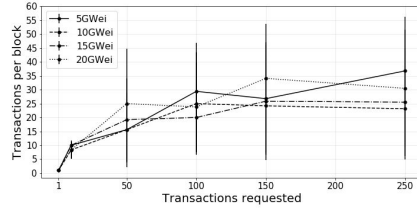
Transactions: grantPermission

Transactions per block   **Gas cost:** 78,735
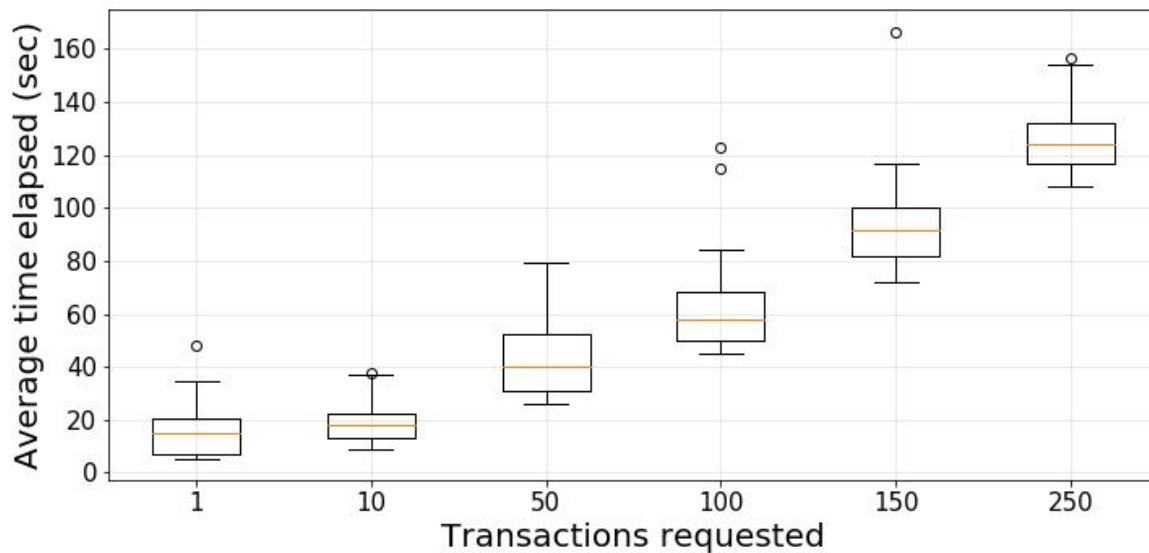
Transactions: grantPermission
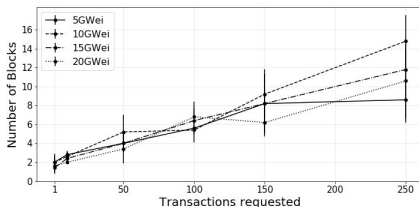

Elapsed time: number of Blocks   **Gas cost:** 78,735
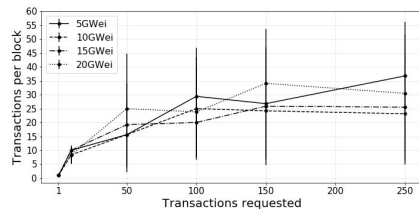
Transactions: grantPermission

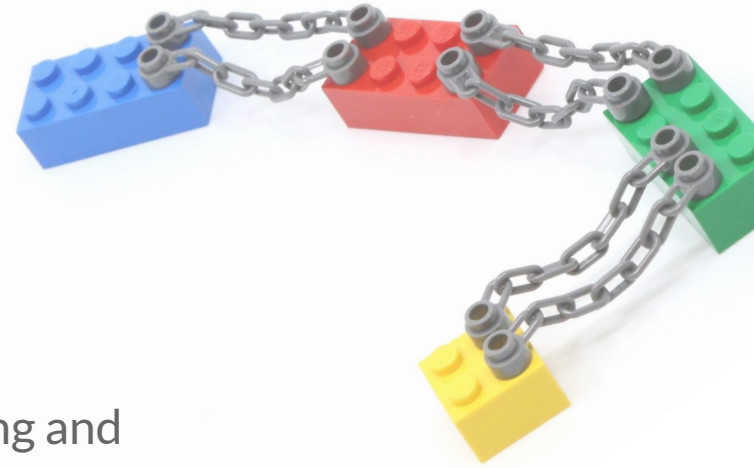

Elapsed time: seconds   **Gas cost:** 78,735

Conclusions

We presented a framework for the record keeping and evaluation of rating data for recommender system platforms

Rating data stored on a blockchain benefits of immutability and transparency

Smart contracts implement a basic logic for the management of the rating data

Discussion

The framework inherits flaws as well, e.g. the gas concept in Ethereum limits the complexity and performance of the framework

Moreover, gas is paid by user in ETH, i.e. money

Twin problem: difficult to guarantee perfect duality of off-chain activities and on-chain storage

Future steps

Improve the permission access control to limit un-authorized ratings

Integrate a token economy to incentivize user engagement (**Work in progress**)

Evaluate on different smart contract platforms, and the upcoming Ethereum 2.0

Thank you!

Lisi A., De Salve A., Mori P., Ricci L. (2019) A Smart Contract Based Recommender System. In: Economics of Grids, Clouds, Systems, and Services. GECON 2019. Lecture Notes in Computer Science, vol 11819. Springer, Cham

Any doubts?

Lisi A., De Salve A., Mori P., Ricci L. (2019) A Smart Contract Based Recommender System. In: Economics of Grids, Clouds, Systems, and Services. GECON 2019. Lecture Notes in Computer Science, vol 11819. Springer, Cham