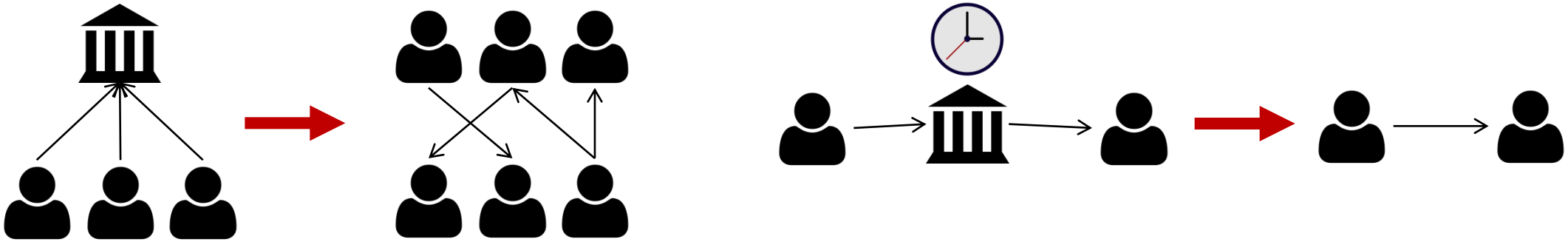
Digital Transformation of Finance

Decentralization, Accessibility and Efficiency



October 2021

Outline

- Introduction
- Stages of Transformation
  - Digitization
  - Digitalization
  - Digital Transformation
- Case Studies
  - (Global) Real Time Transaction Networks
  - (P2P Lending) **(Bonus slides – Intended to be used if there is enough time)**

Introduction

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- Specific Institutions

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- Long transfer and approval times

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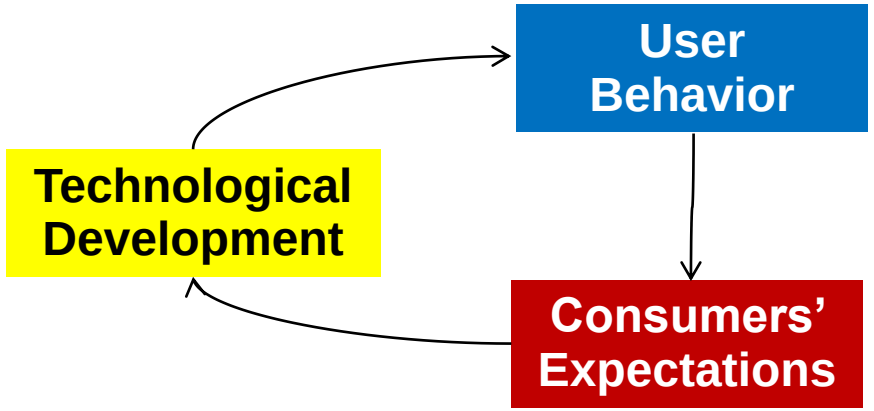

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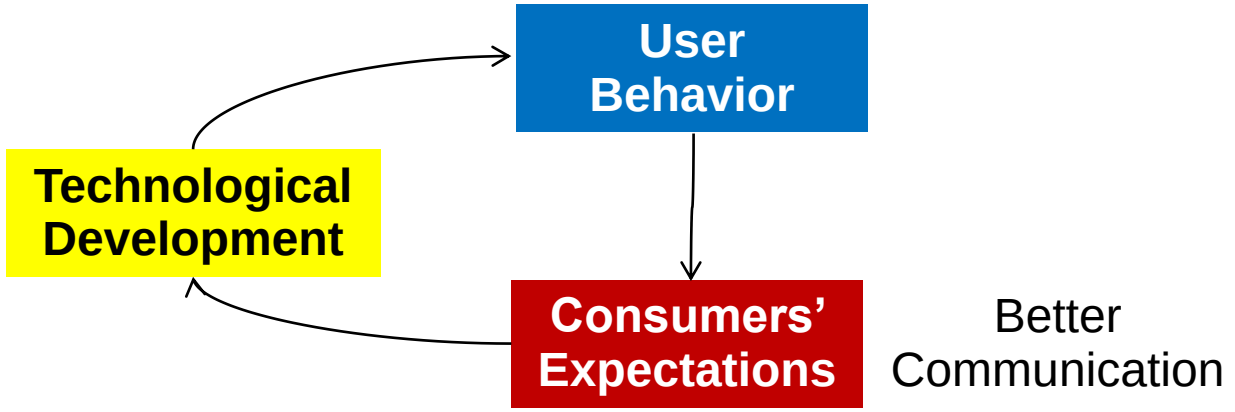

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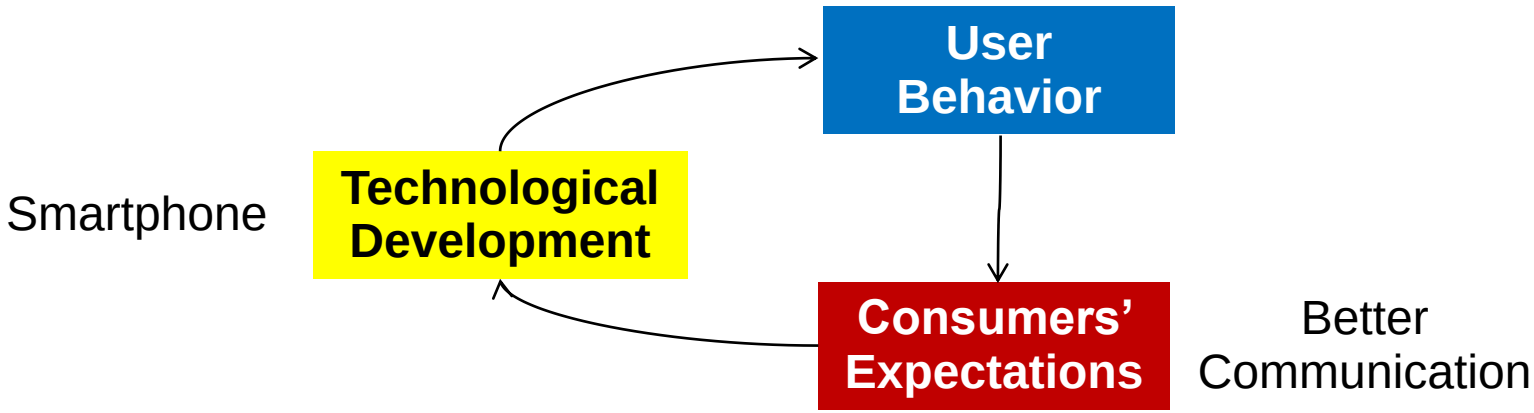

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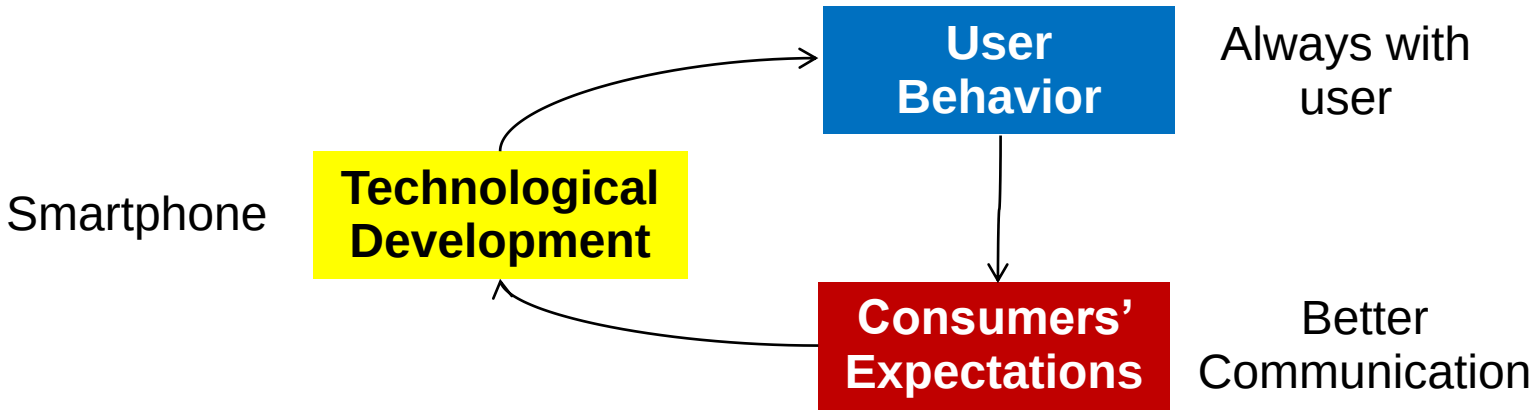

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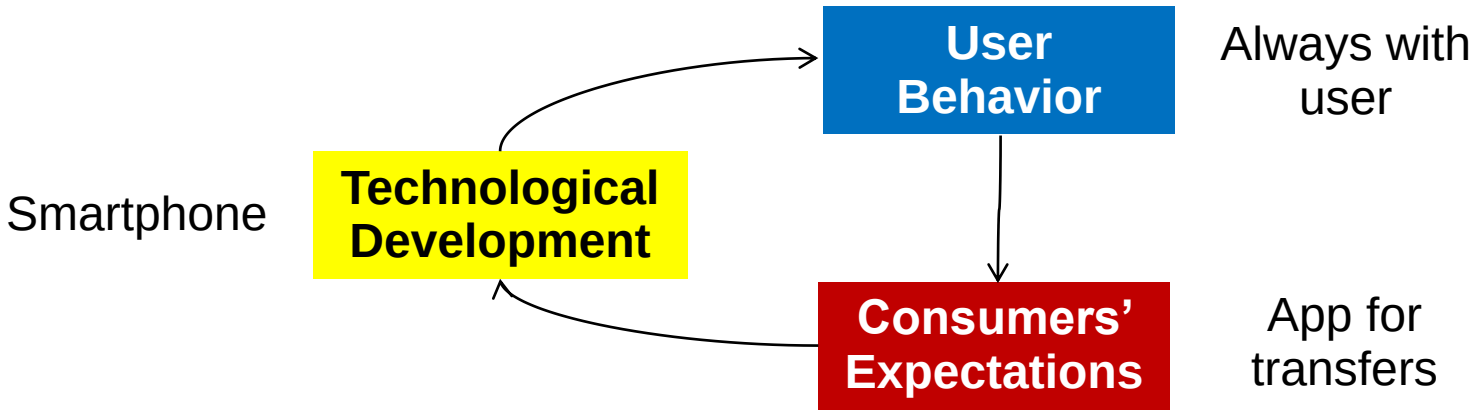

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- Digitization:
  - Analog to digital; use of computers
  - Examples:
    - ATM and ATM Cards
      - Check Balance; Financial transactions; Deposits; Withdrawals

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- Digitalization:
  - Changes to existing business models
  - Examples:
    - Online Banking
    - Mobile Banking

Stages of Transformation

- Digital Transformation:
  - Creation of novel business models
  - FinTech
  - Examples:
    - Crowdfunding
    - P2P-Lending
    - Digital Currencies
    - Decentralized Finance (DeFI)

Case Studies: (Global) Real Time Transaction Network

- $> \frac{2}{3}$ of consumer payments electronic [3]
- VisaNet:
  - Global transaction processing network
  - 65,000 transactions per second (TPS) [4]
  - Centralized

- Comparable **efficiency**, but **decentralized**?

Case Studies: (Global) Real Time Transaction Network

- Blockchain:
  - Distributed ledger
  - No third-party
  - Data structure
  - Peer-to-peer Network

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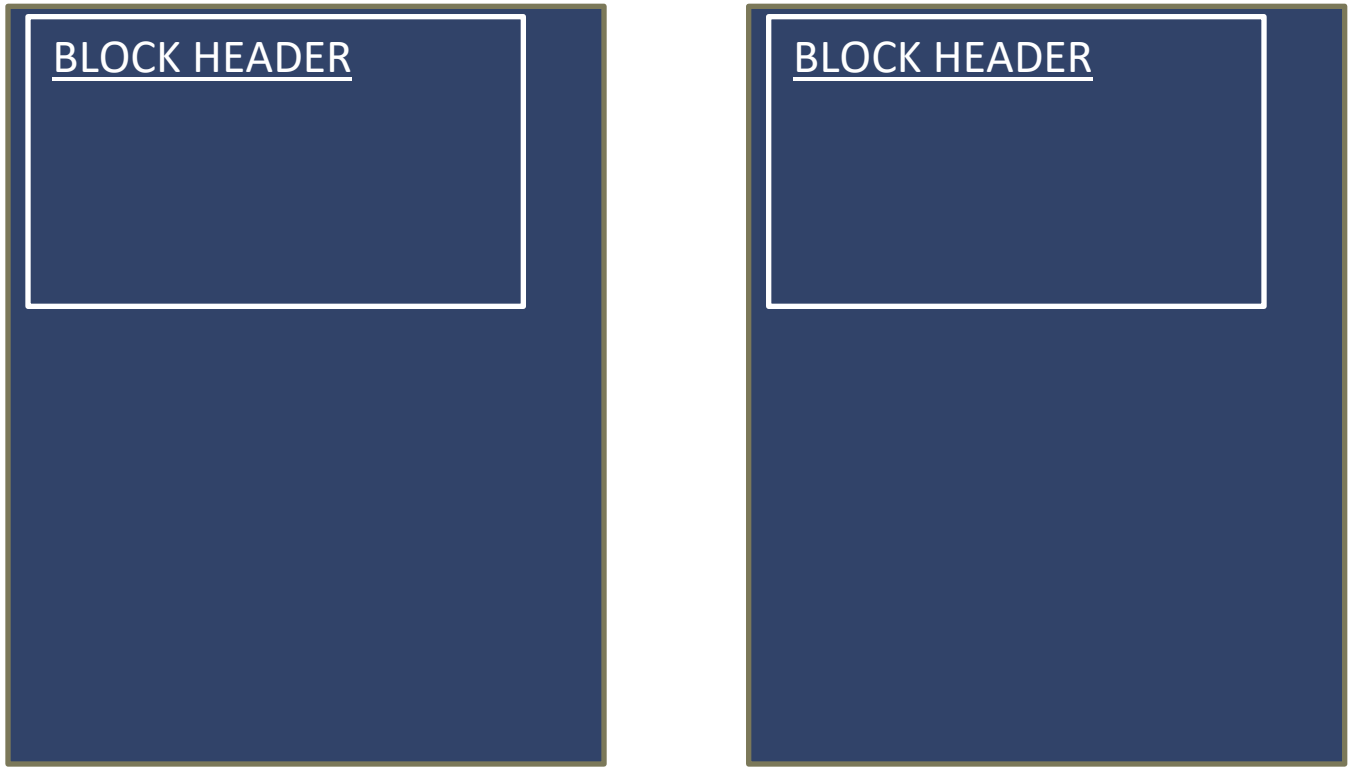

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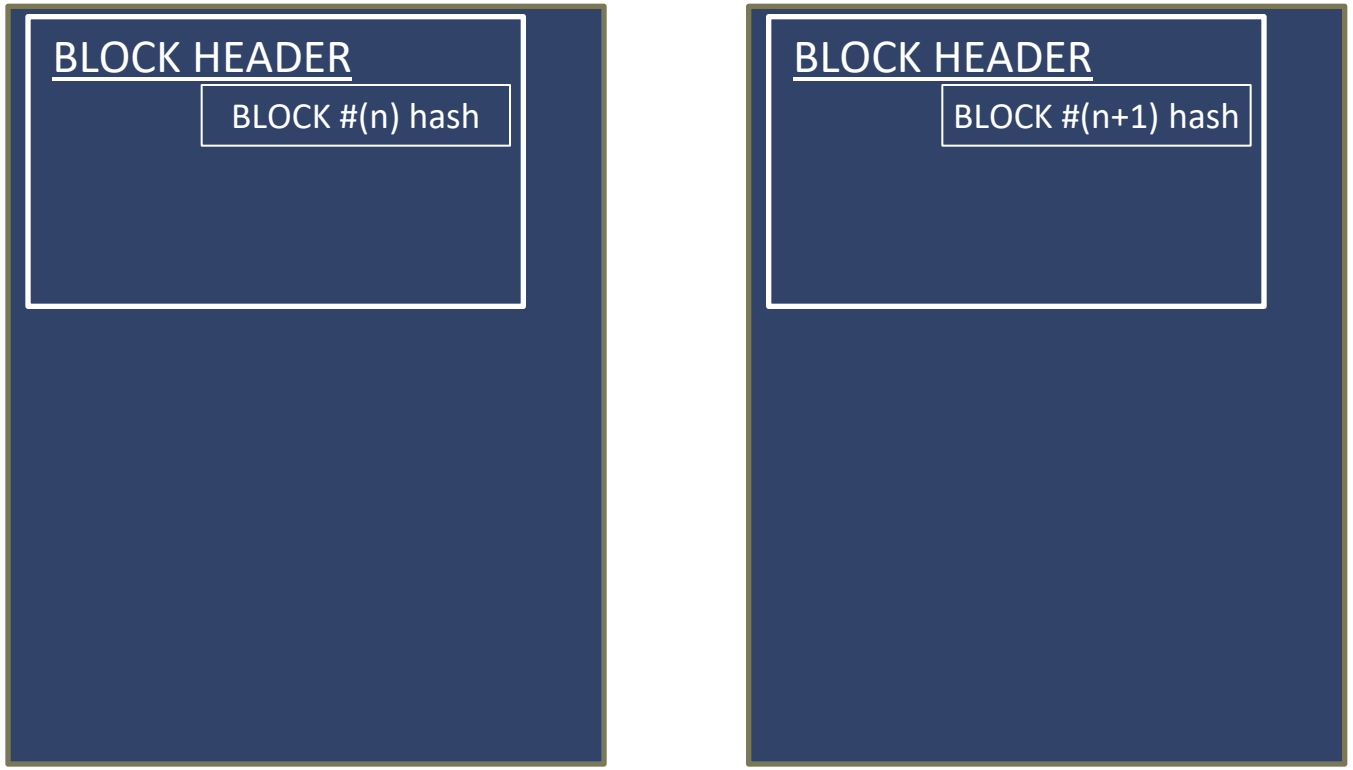

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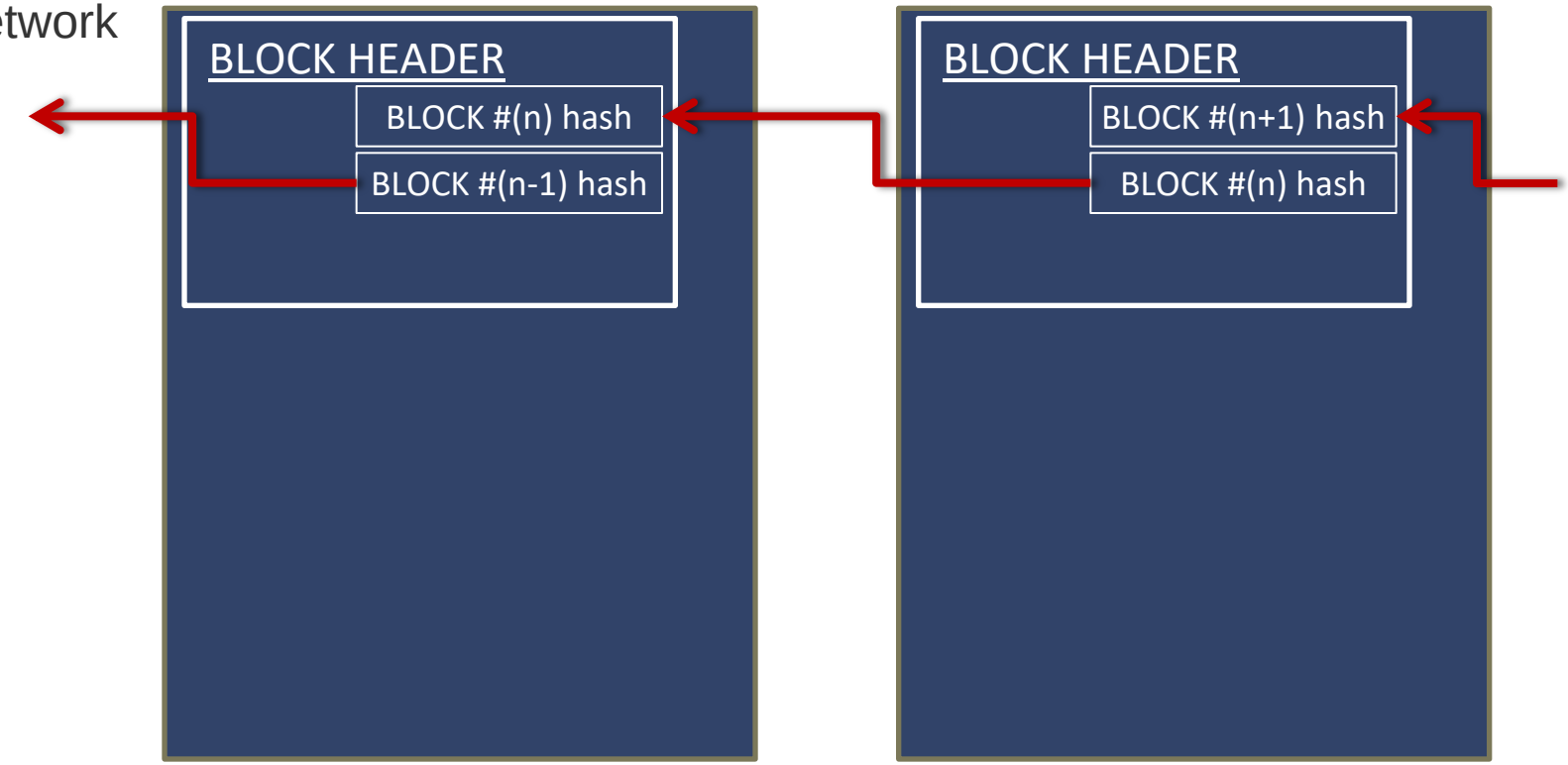

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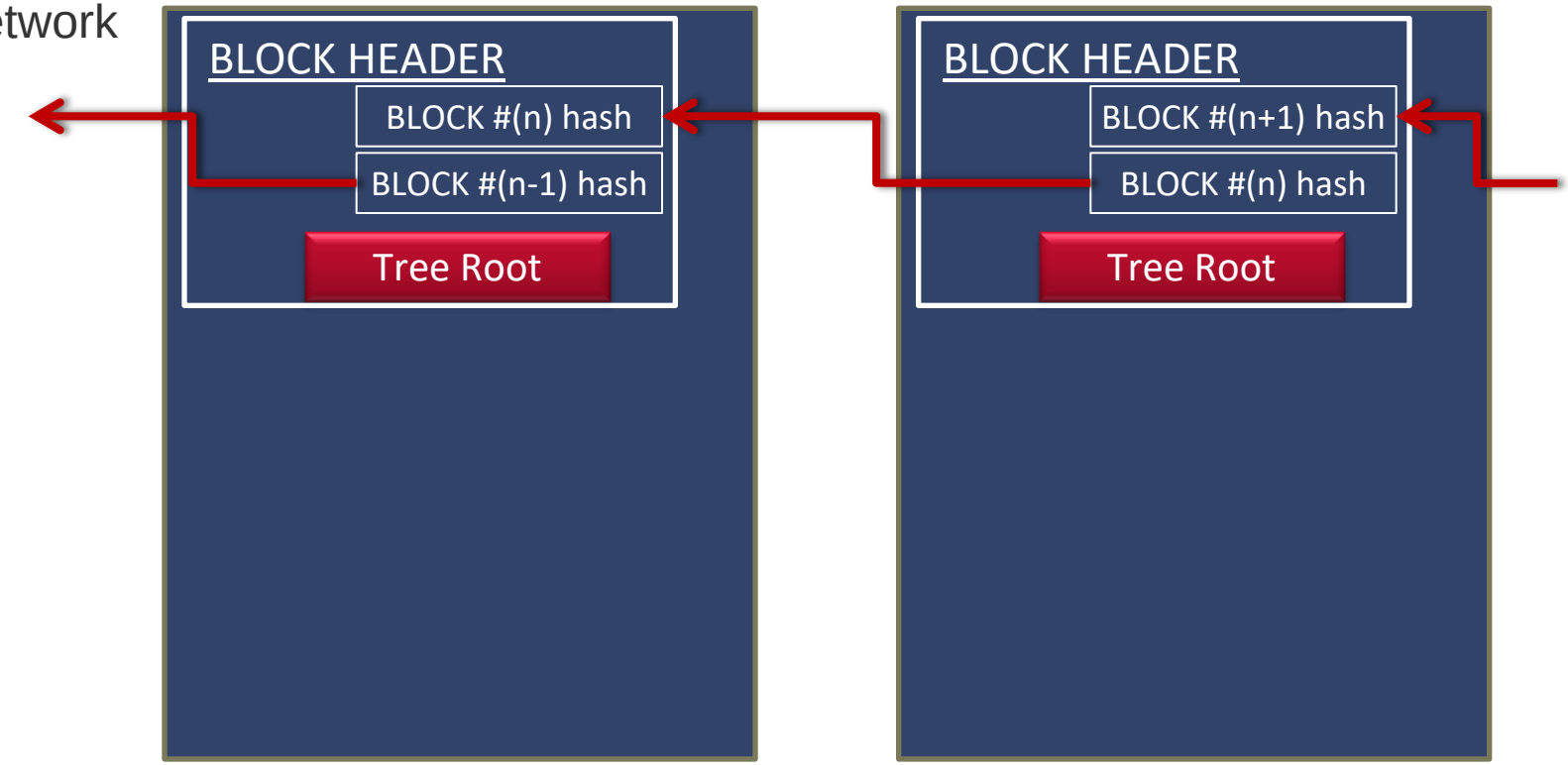

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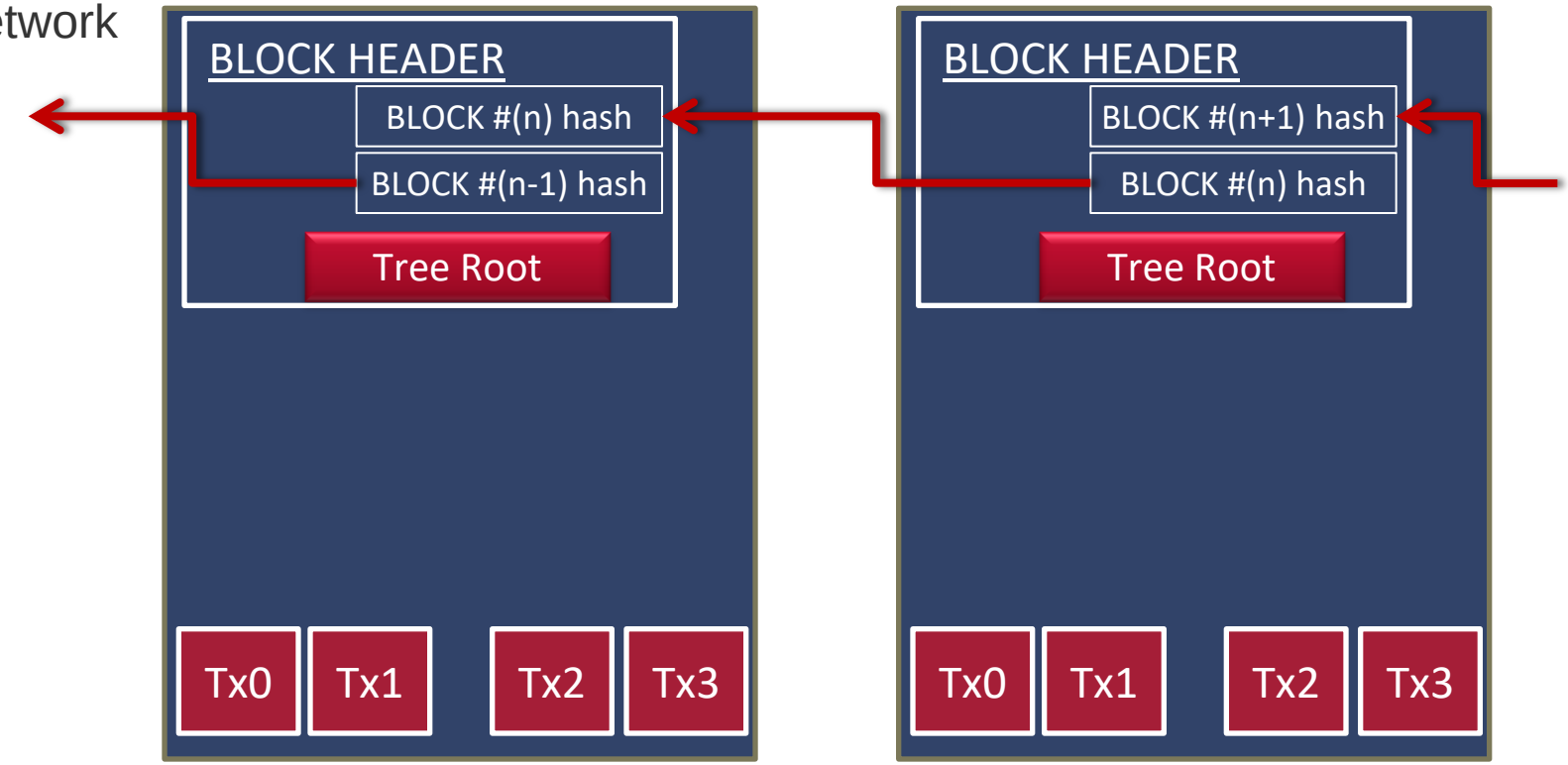

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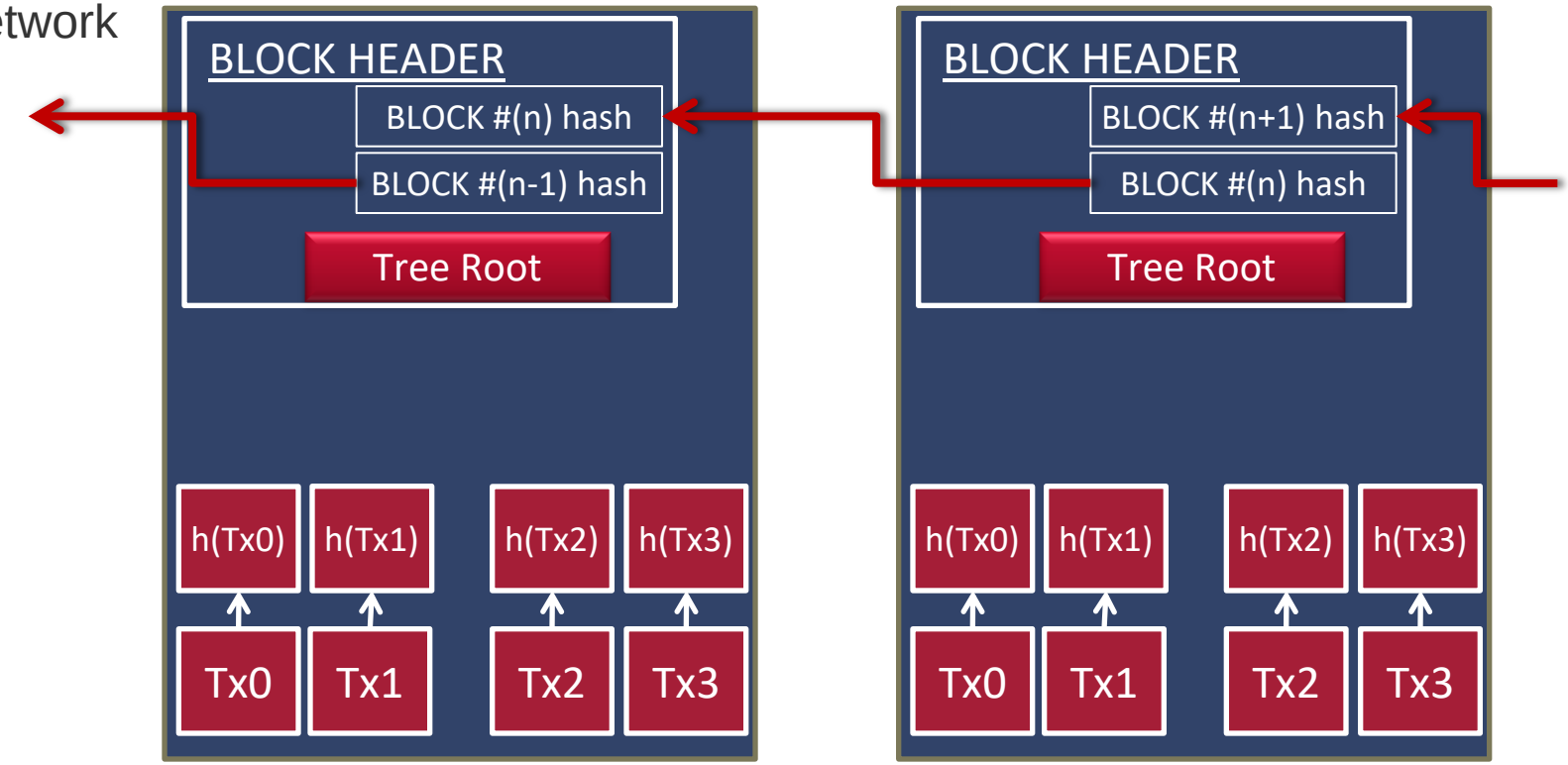

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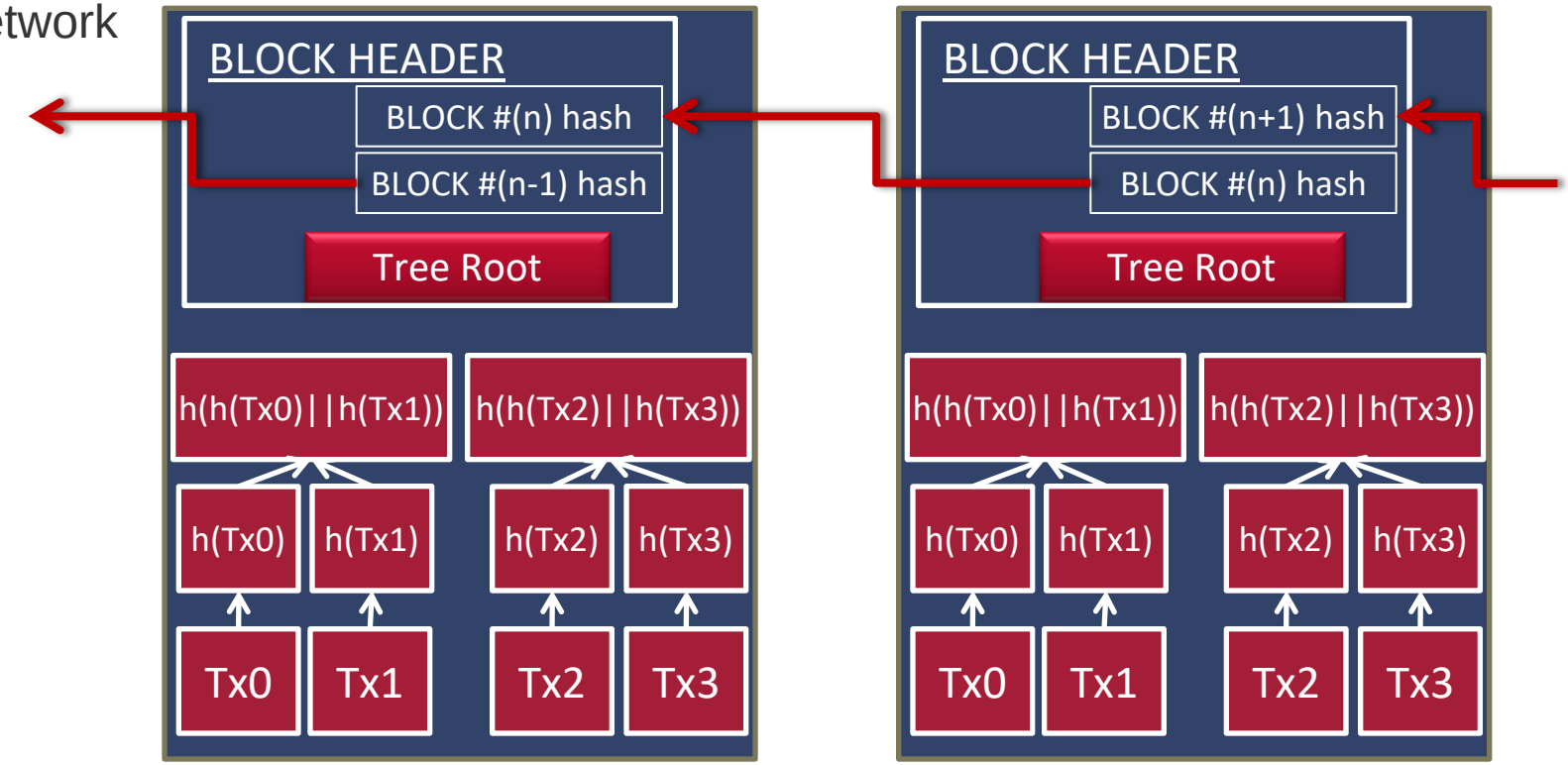

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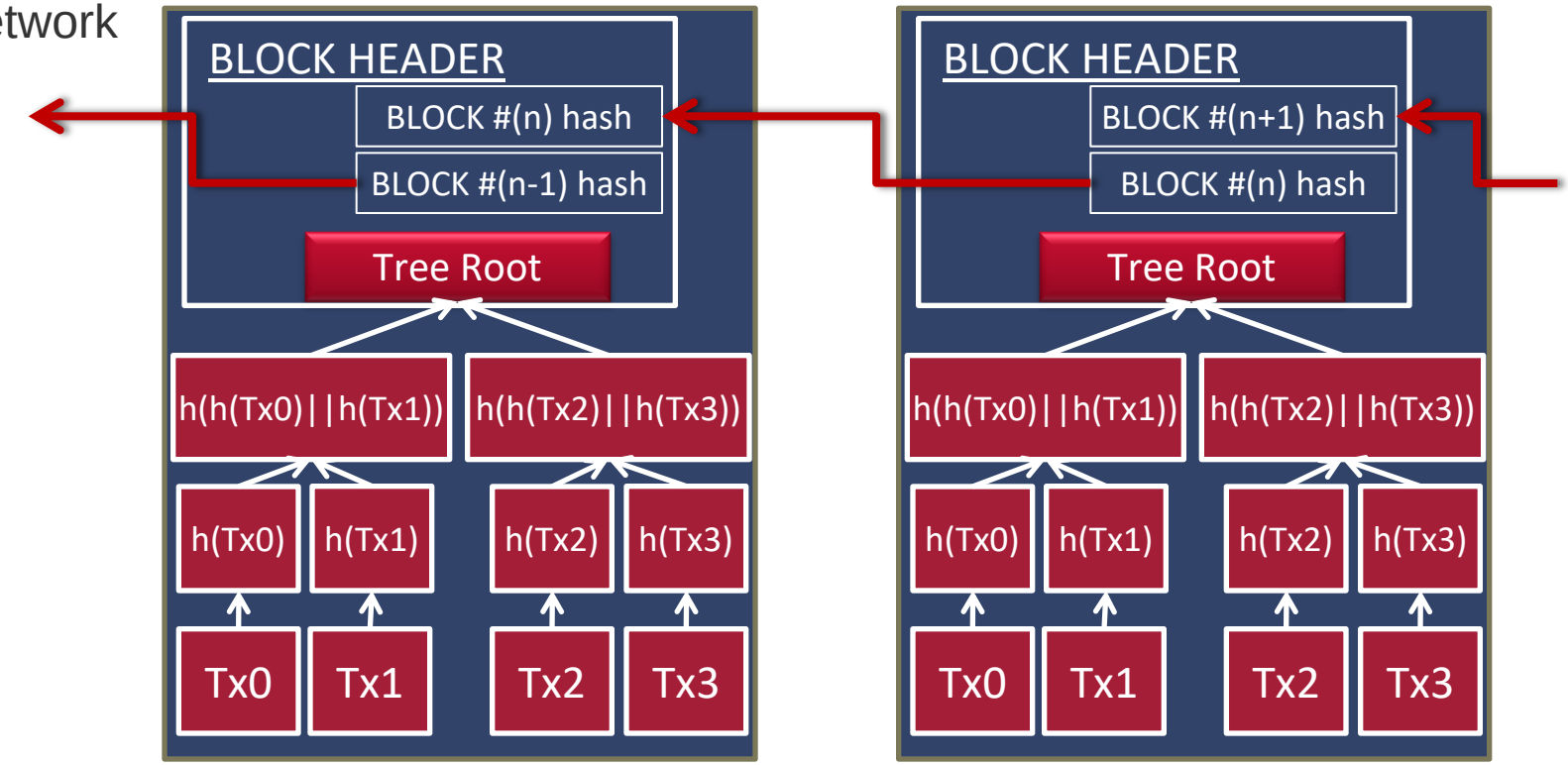

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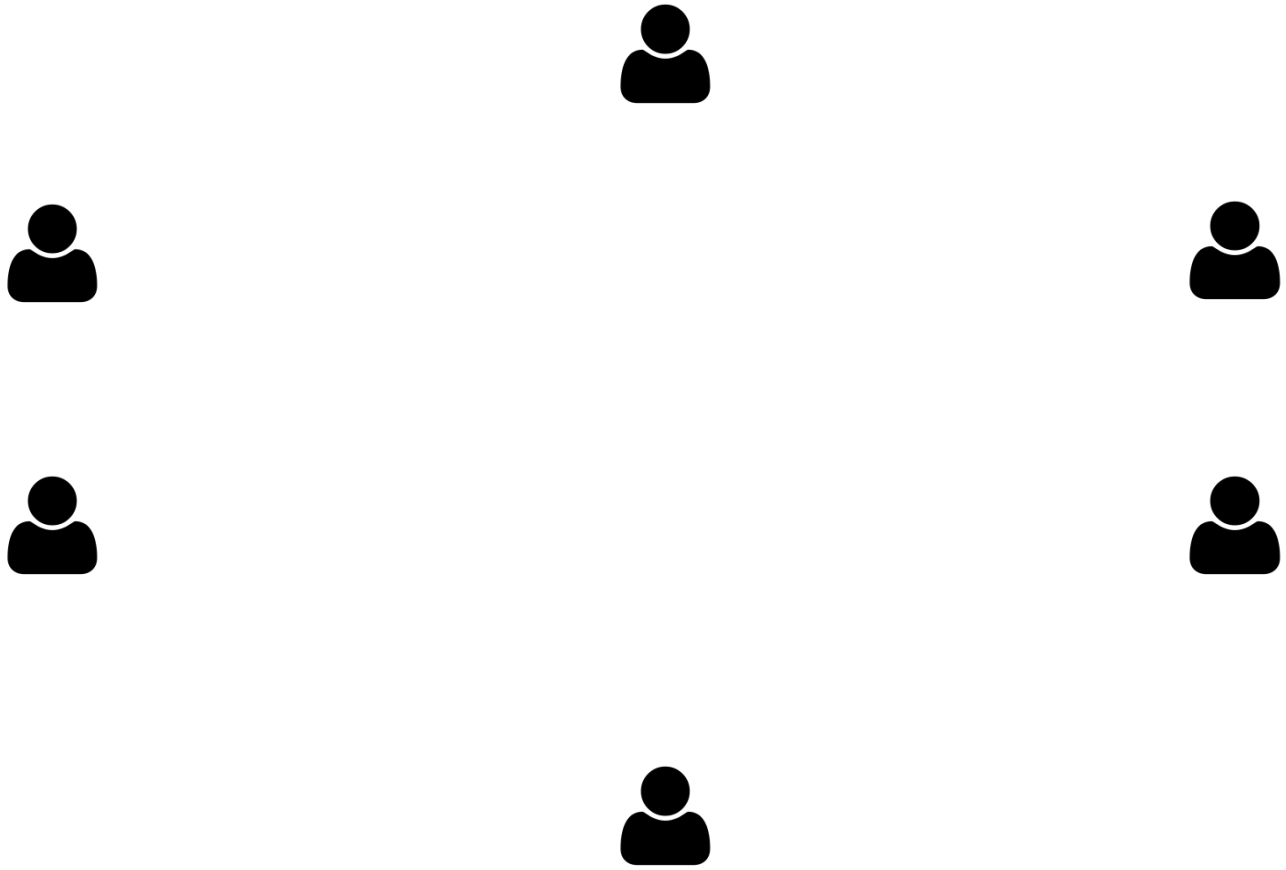

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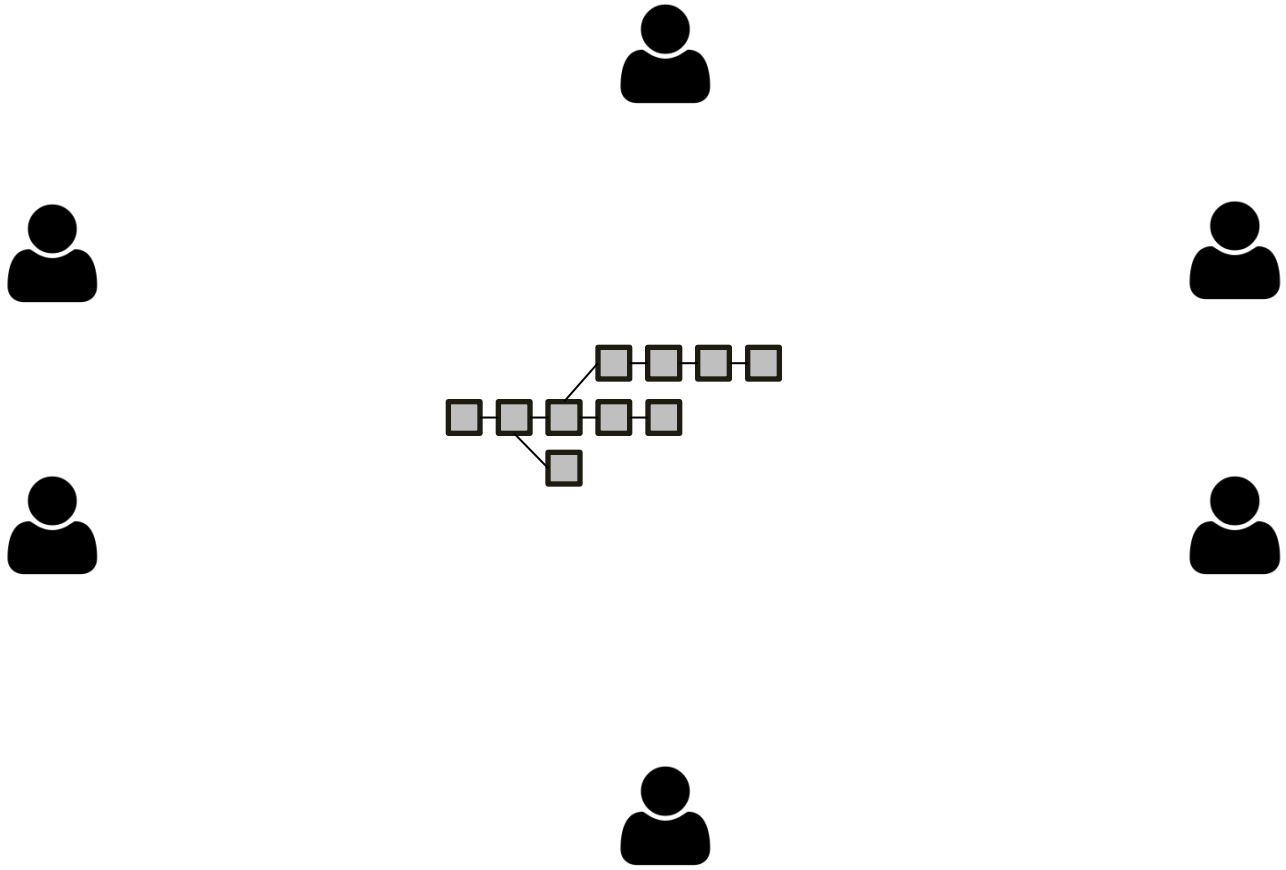

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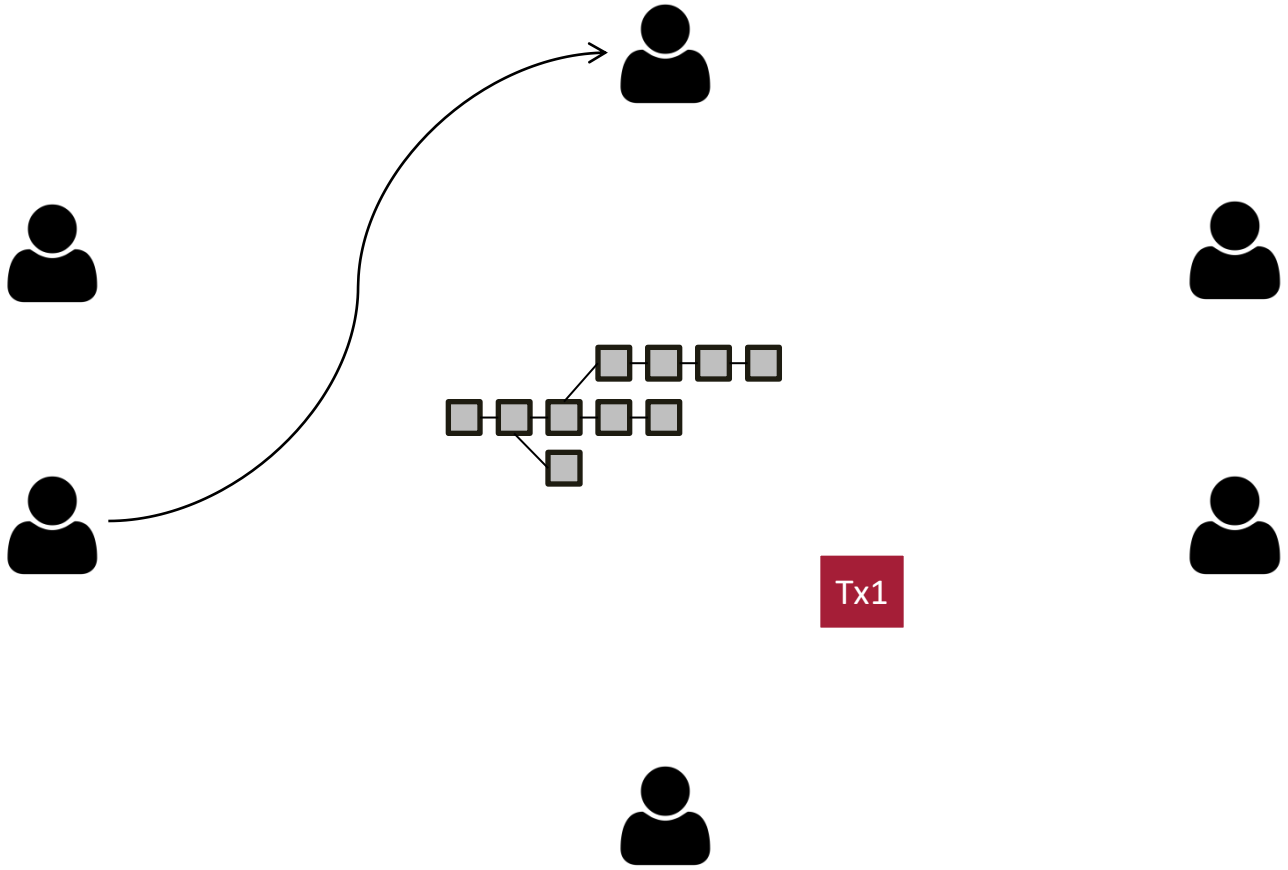

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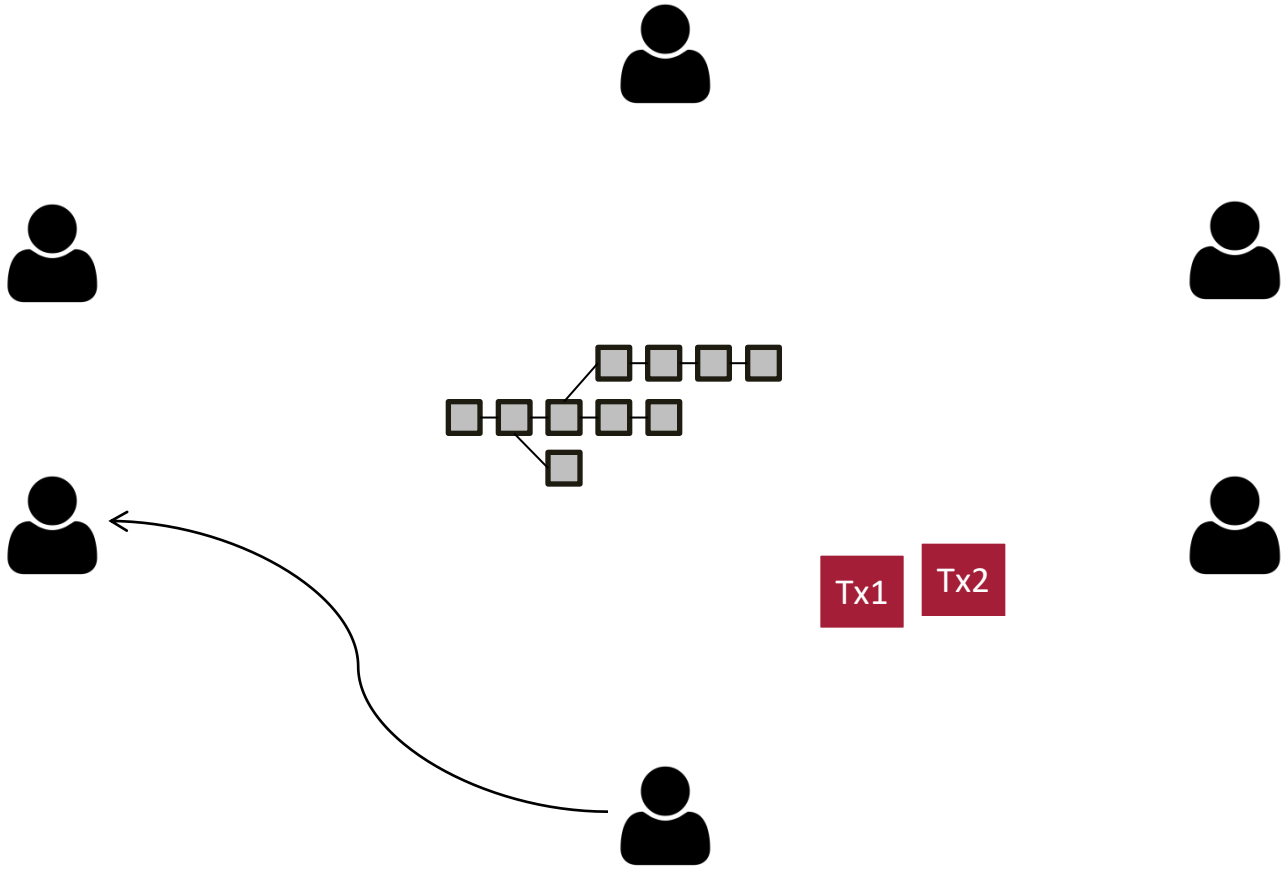

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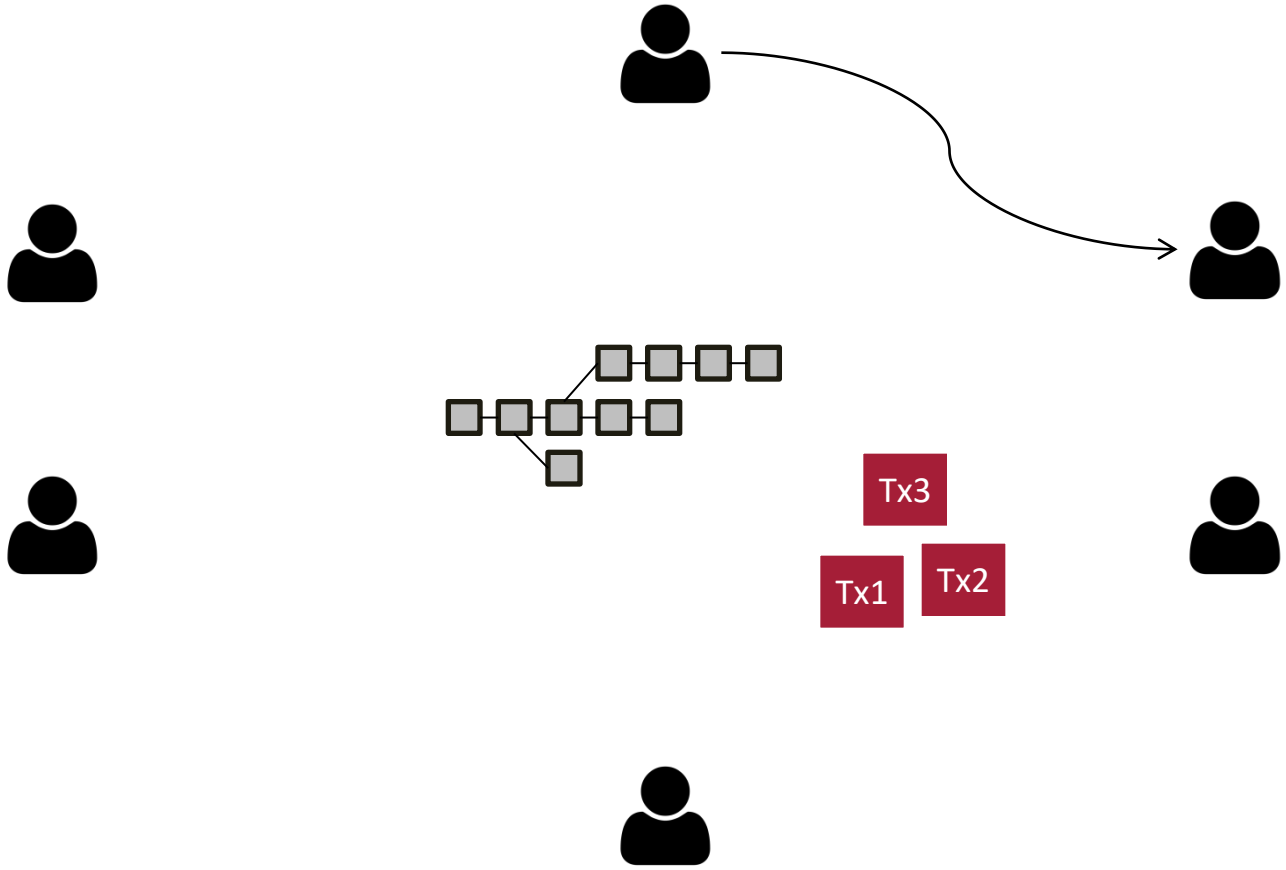

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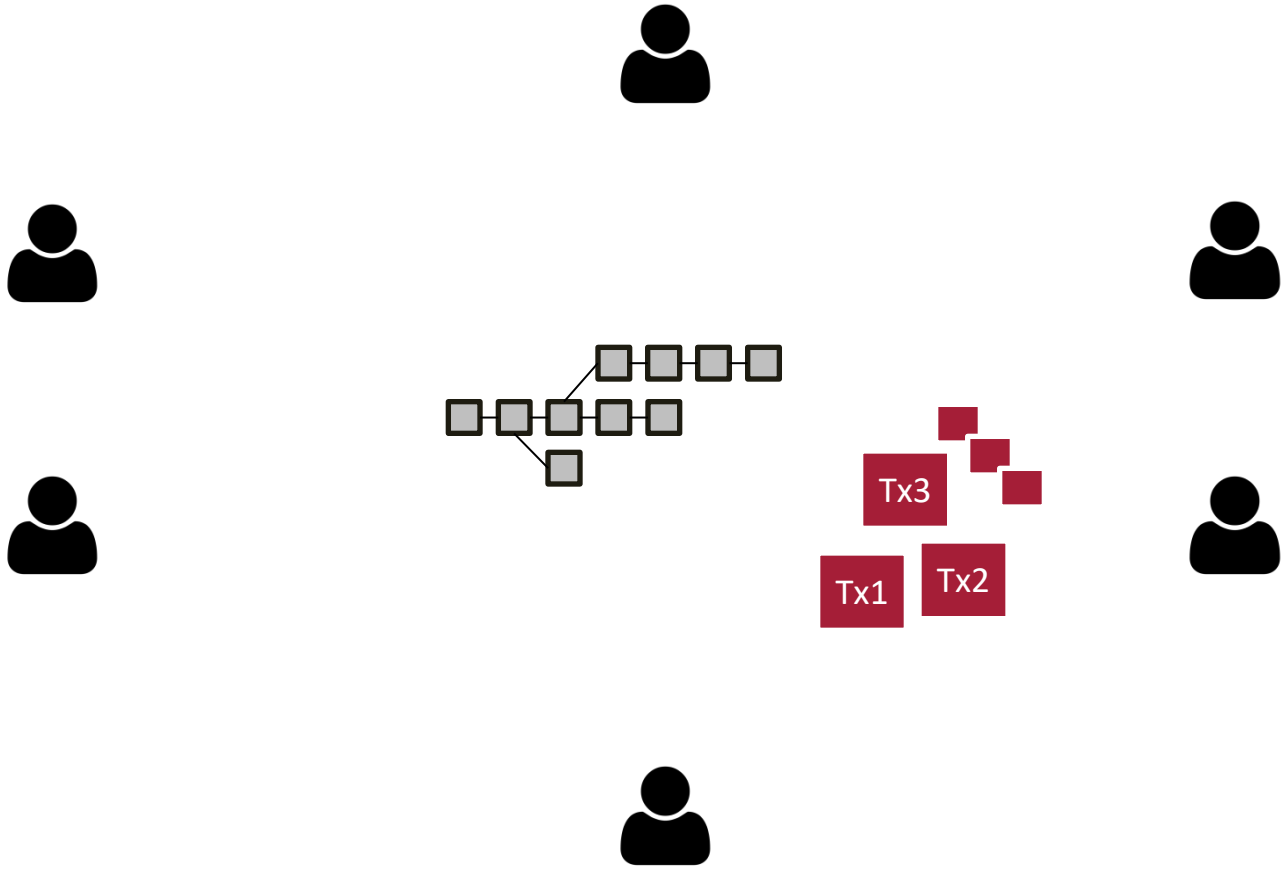

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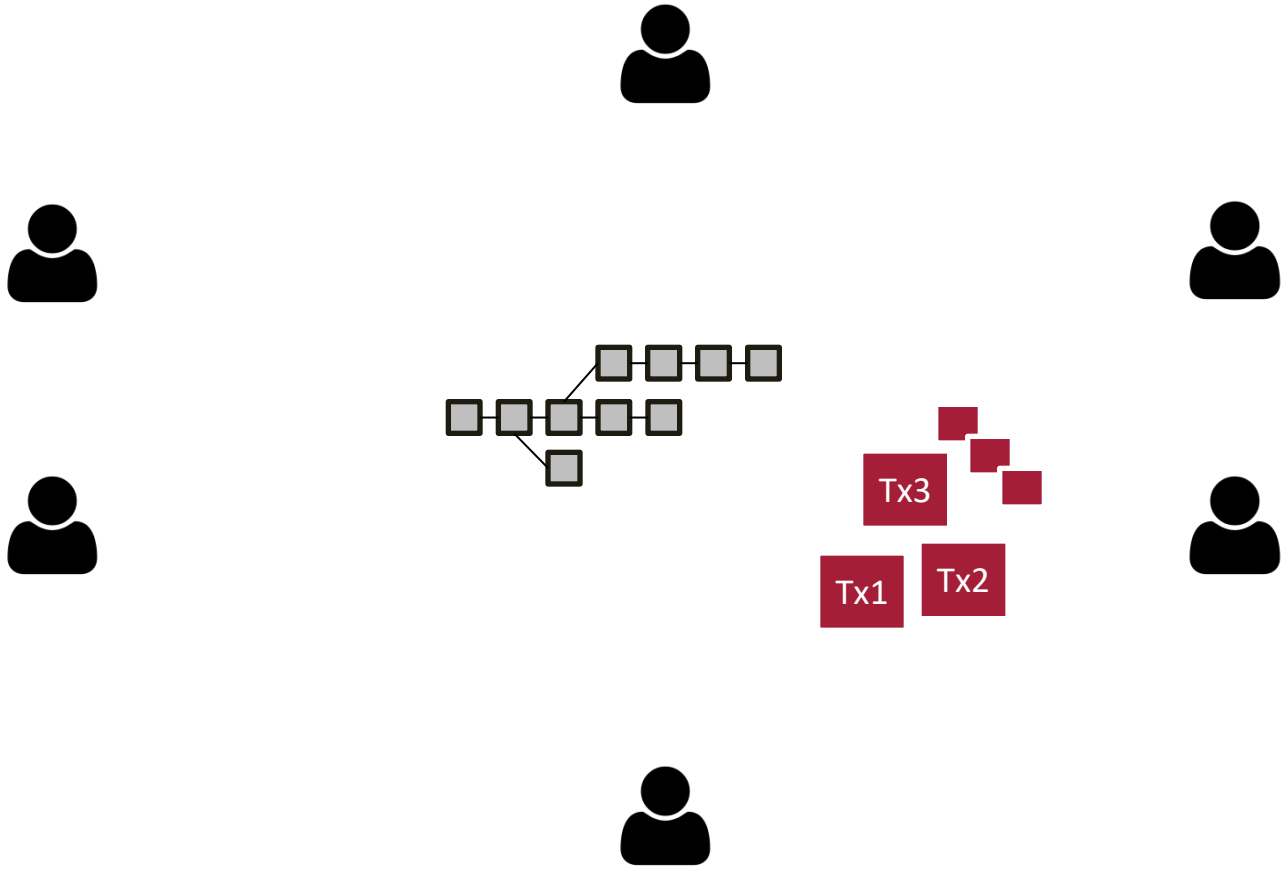

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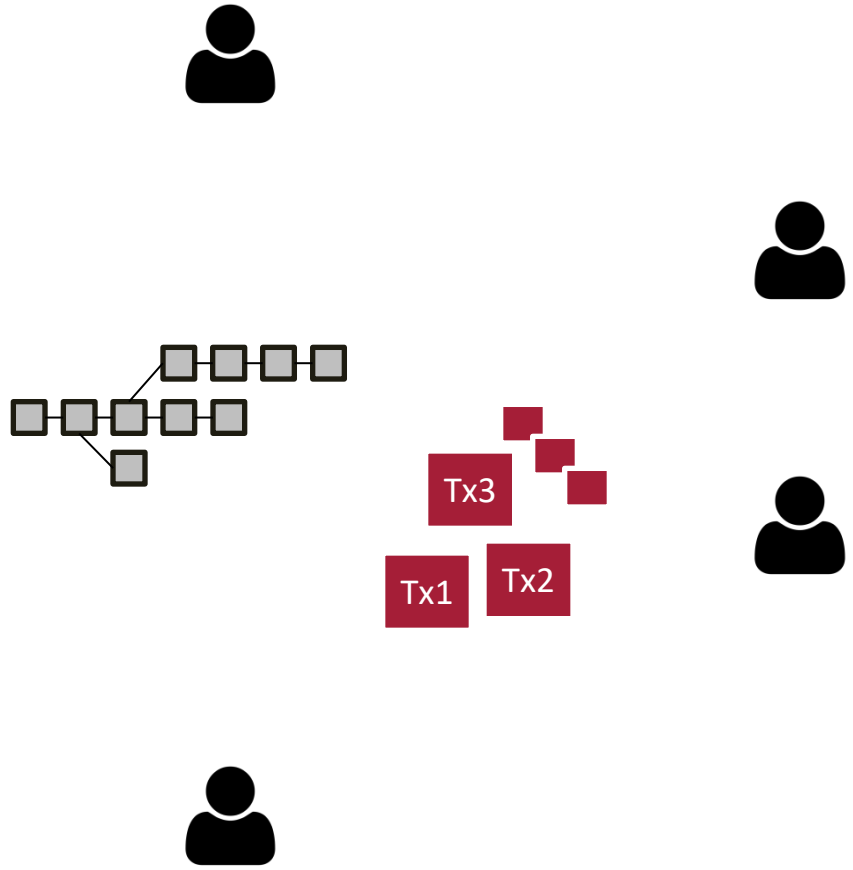

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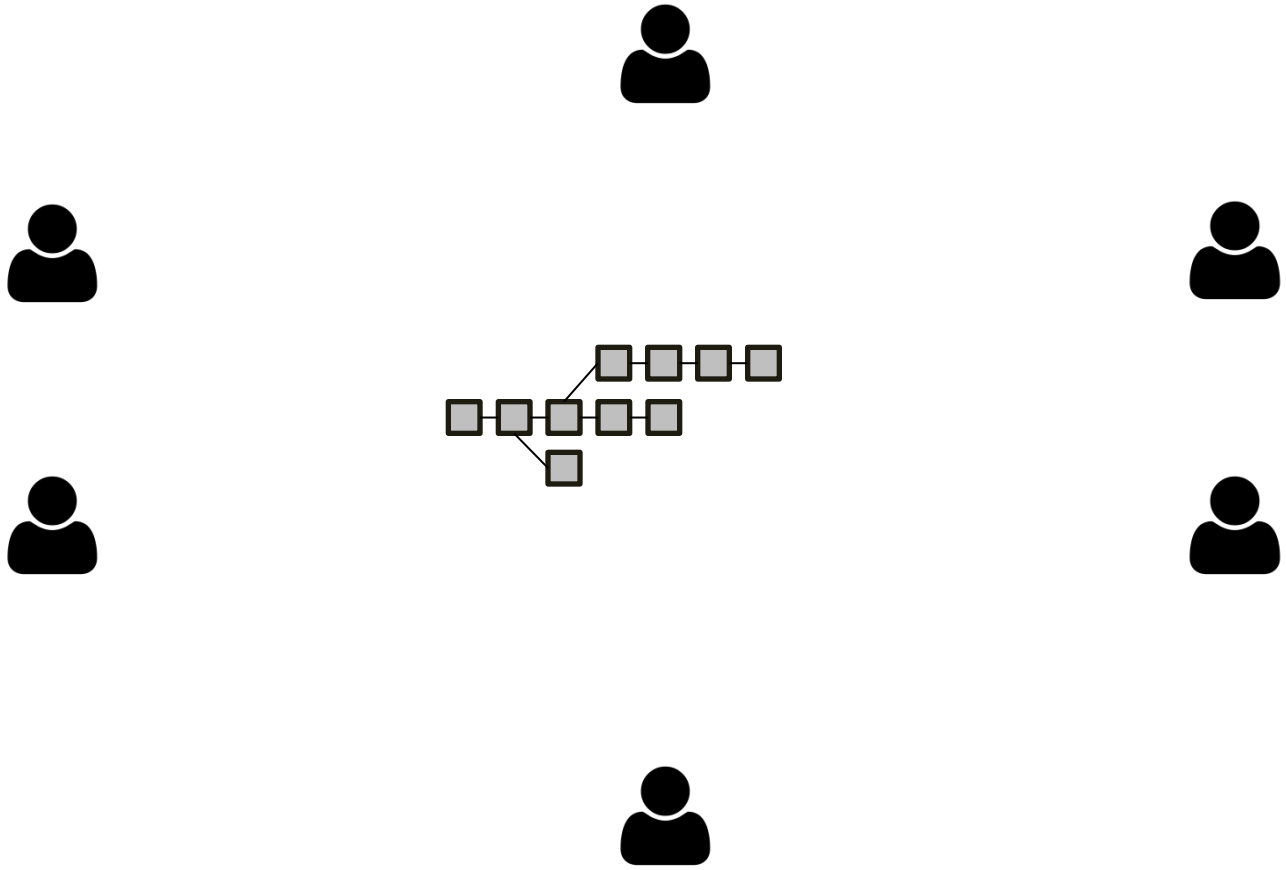

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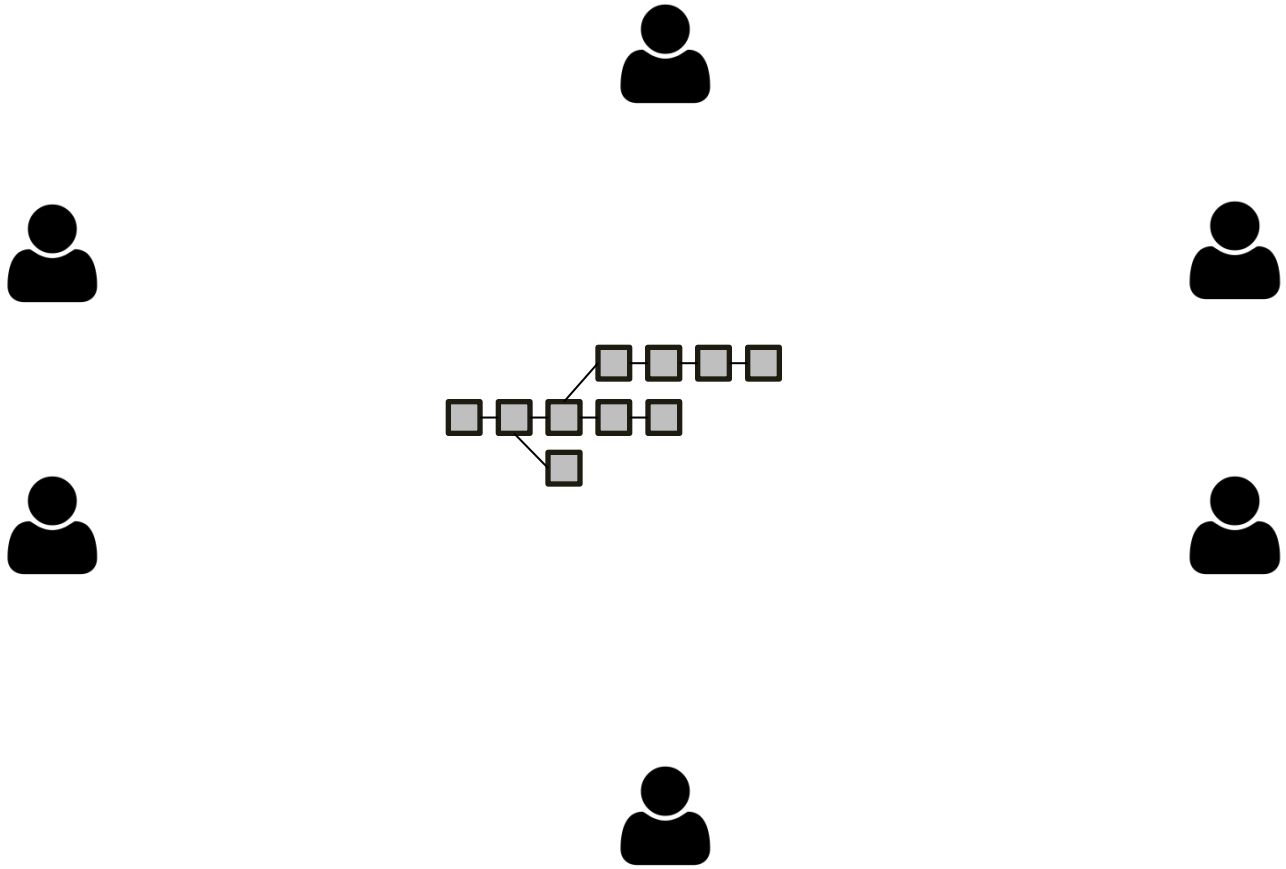

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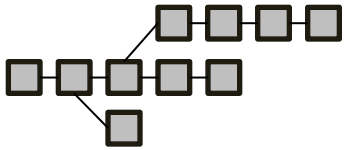


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Proof of Work (PoW) – D is set

$$h\left(\text{BLOCK HEADER}\ [\text{BLOCK \#(n) hash}\ |\ \text{Tree Root}]\ ,\ \text{nonce}\right) < D$$

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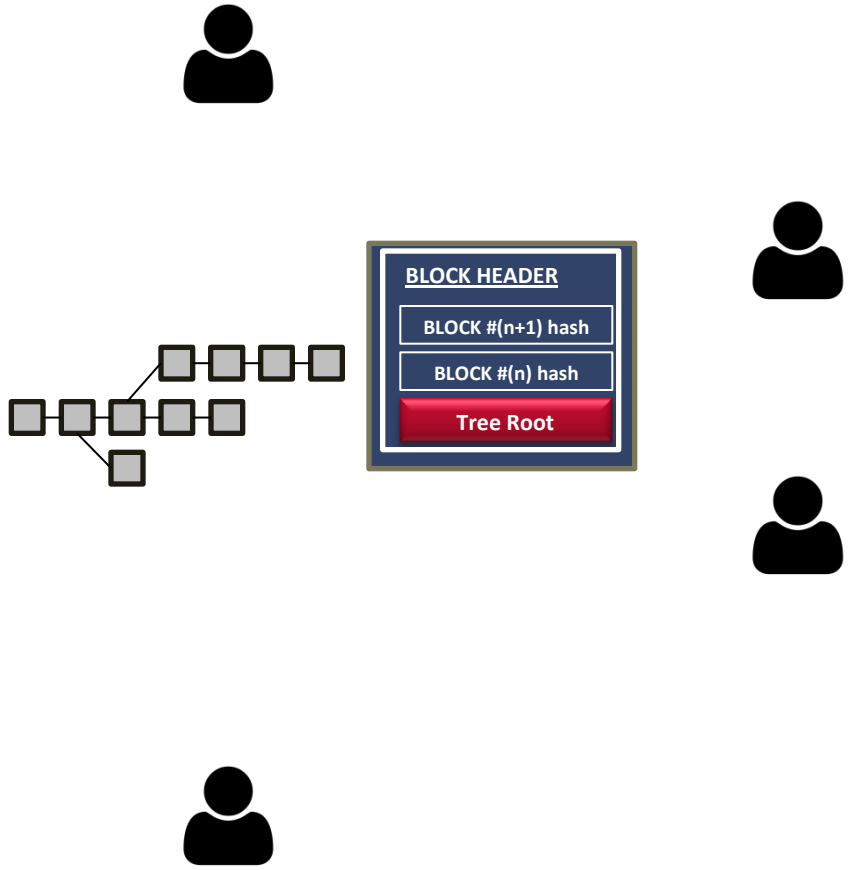

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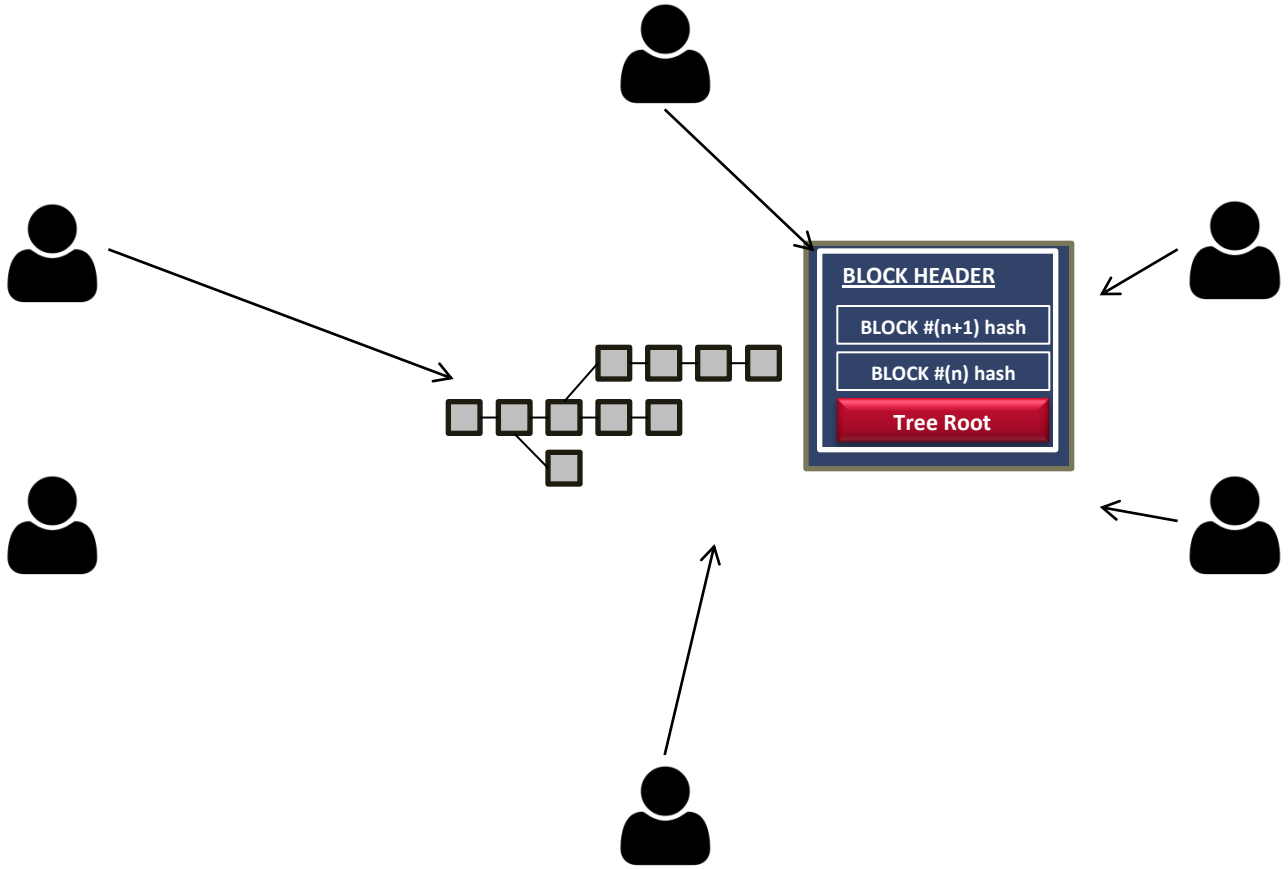

Next Block?

Proof of Work (PoW) – D is set

Validation:

1. Hash of new block < D?
2. Correct hash of the previous block?

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- **Bitcoin:**
  - Blockchain network
  - Decentralized
  - PoW → **Not sustainable**
  - **3 to 6 TPS** [4]

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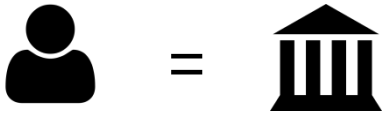
- **RippleNet:**
  - Blockchain network
  - 1,500 TPS (claim they can match VisaNet) [4]
  - **Partly** decentralized



Ethereum 2.0:

- Blockchain network
- **Decentralized**
- Proof of Stake:
  - Next block according to coin amount
  - Sustainable
  - Needed for ‘Sharding’ which allows:
  - **100,000 TPS** [6]

Borrowers: 

Lenders: 

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Lenders:

$$= x_2 = \begin{pmatrix} Income = 4{,}210 \\ Expenses = 4{,}525 \\ \vdots \end{pmatrix}$$

Borrowers:

Lenders:

$$= x_1 = \begin{pmatrix} Income = 4{,}500 \\ Expenses = 4{,}325 \\ \vdots \end{pmatrix}$$

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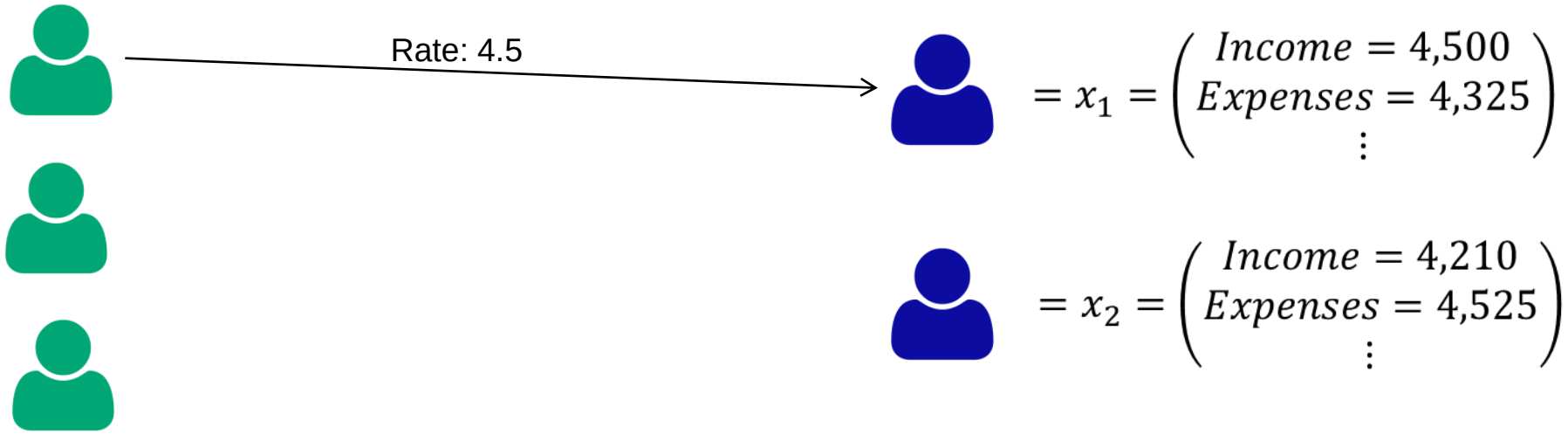

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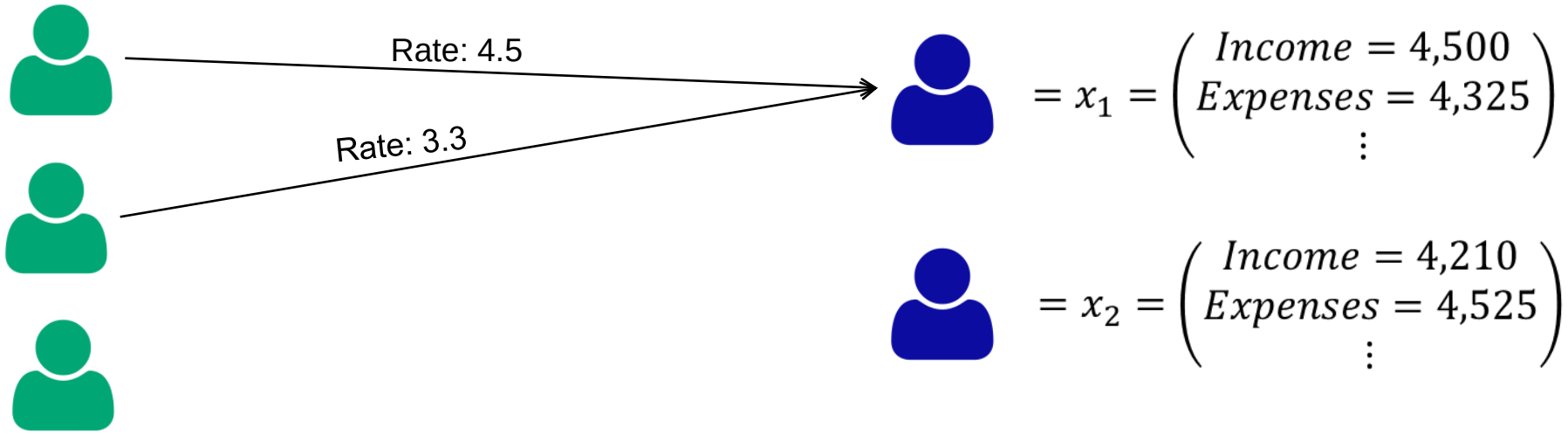

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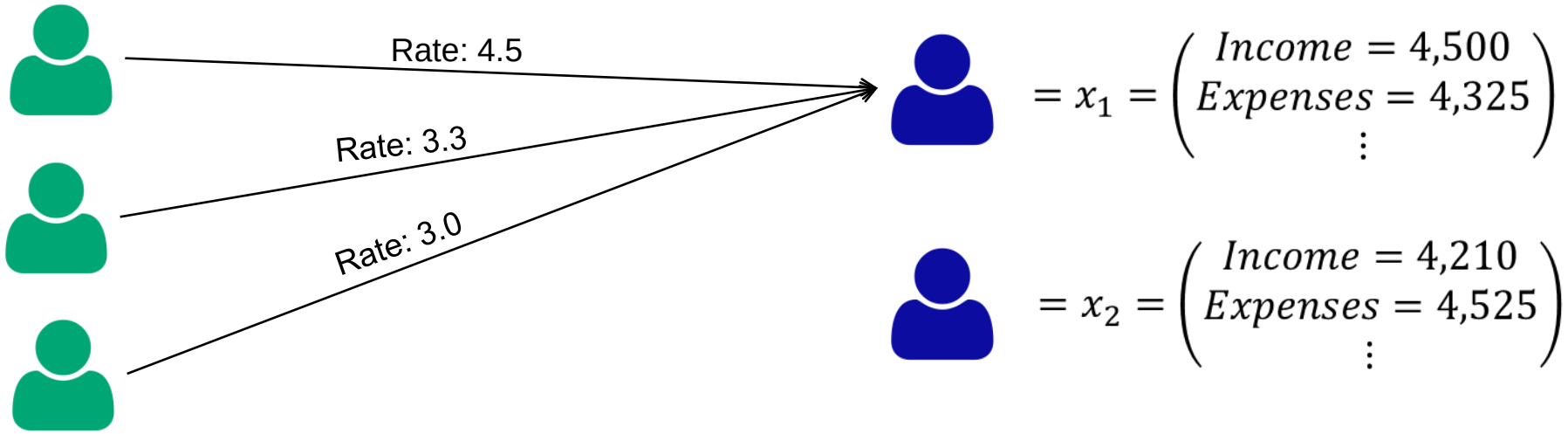

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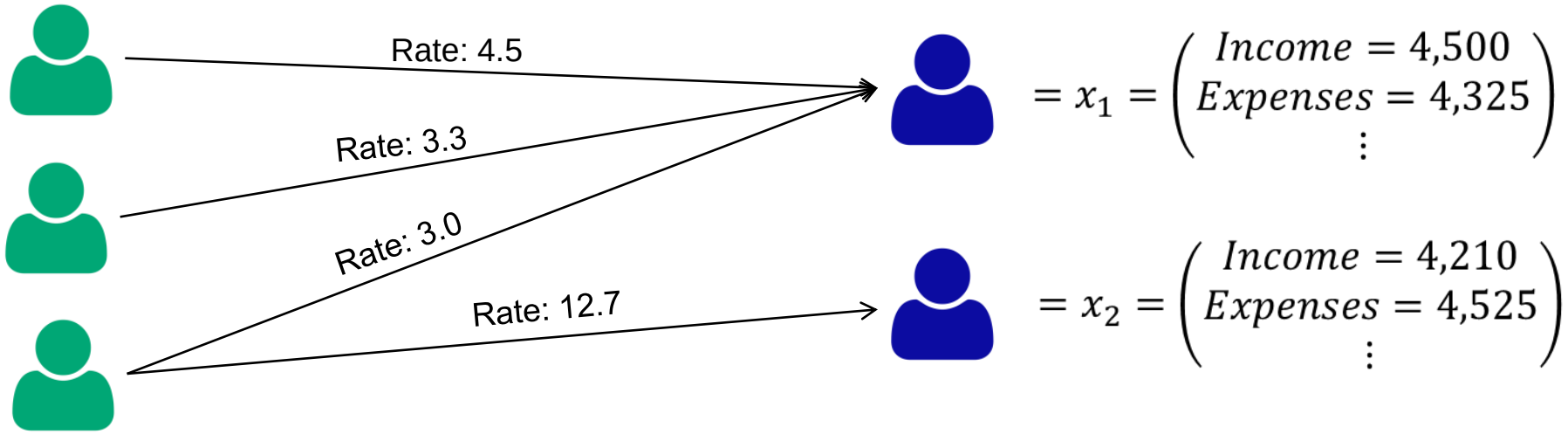

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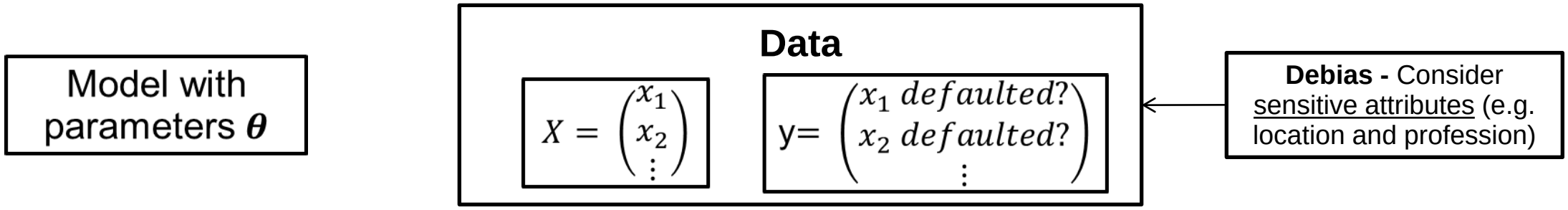
  - Increase accessibility
    - Competition
    - Broader supply and demand
  - Increase decentralization
    - Decreased hurdles for lenders
  - Through use of machine learning and big data:
    - Decision automation
    - Increased efficiency
    - Improved fairness

Model with parameters $\boldsymbol{\theta}$

Data

$$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \end{pmatrix}$$

$$y = \begin{pmatrix} x_1\ defaulted? \\ x_2\ defaulted? \\ \vdots \end{pmatrix}$$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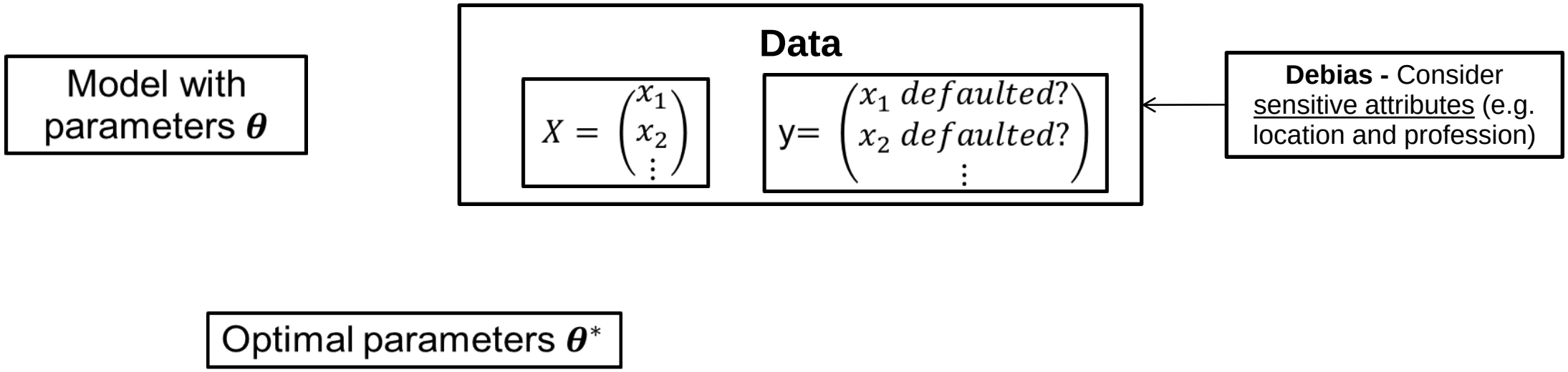
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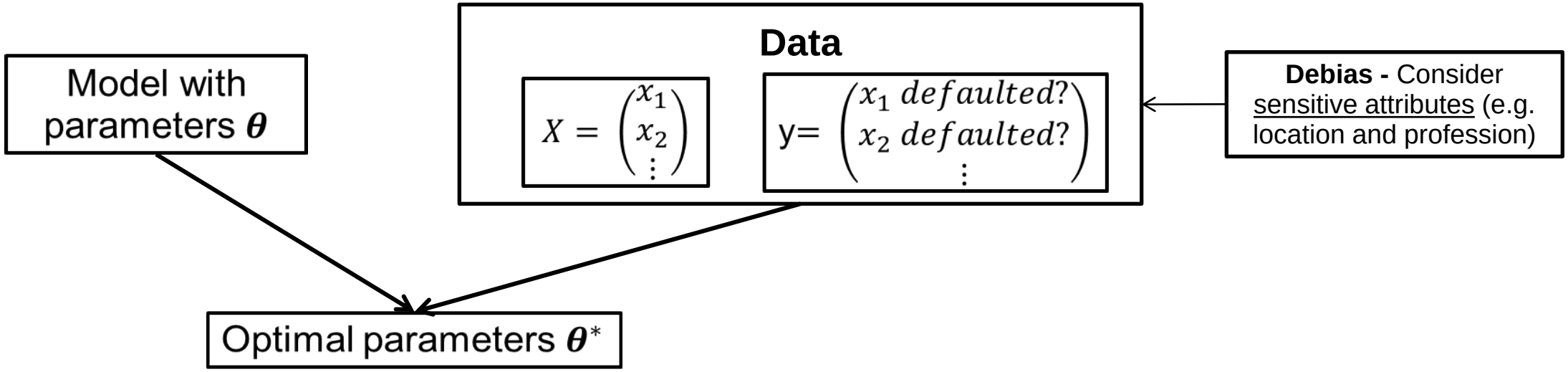
Optimal parameters $\boldsymbol{\theta}^*$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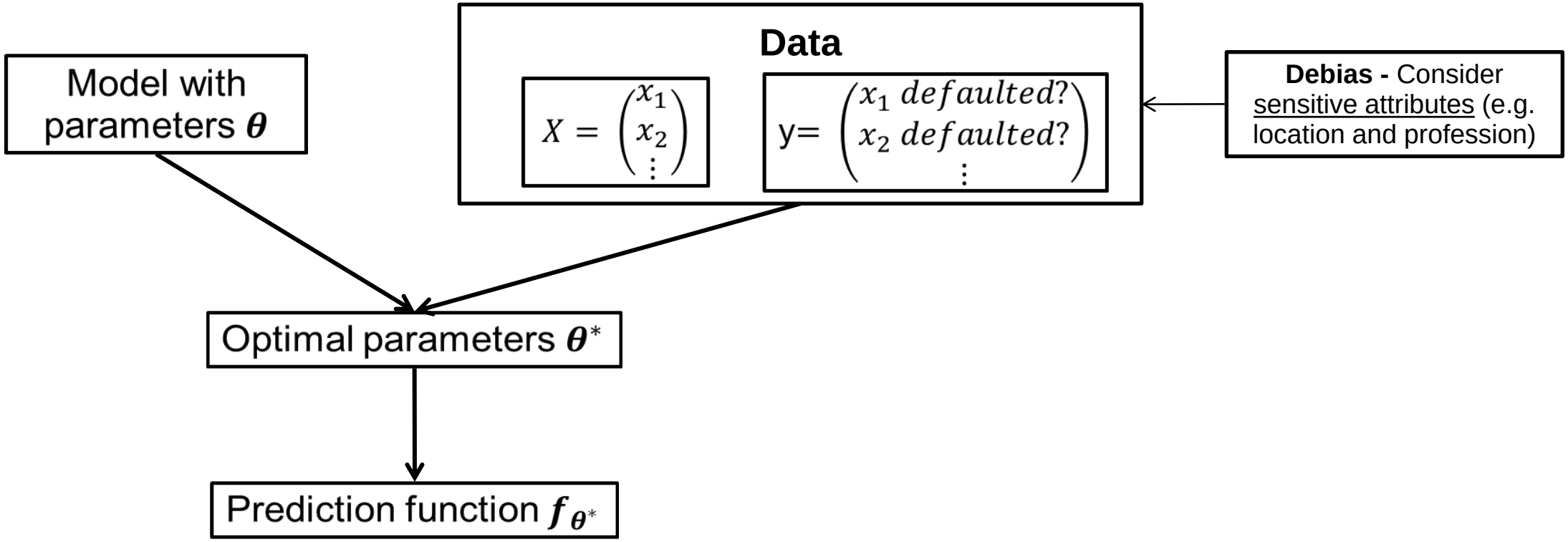
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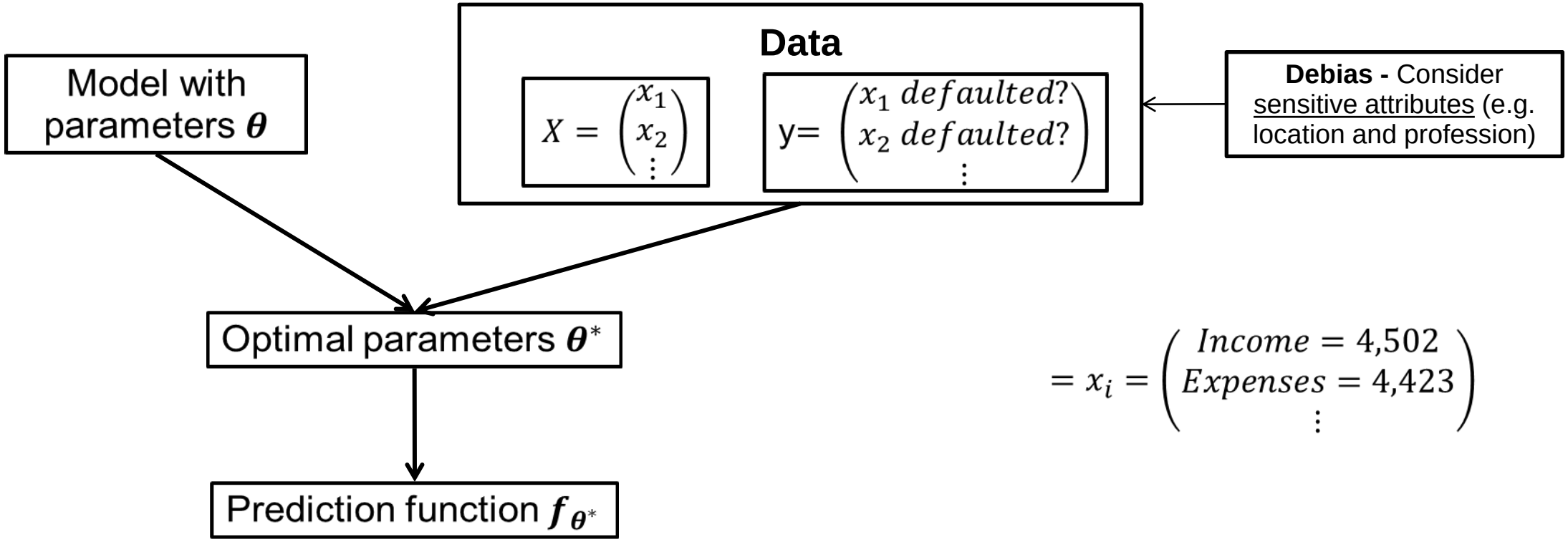
Prediction function $\boldsymbol{f}_{\boldsymbol{\theta}^*}$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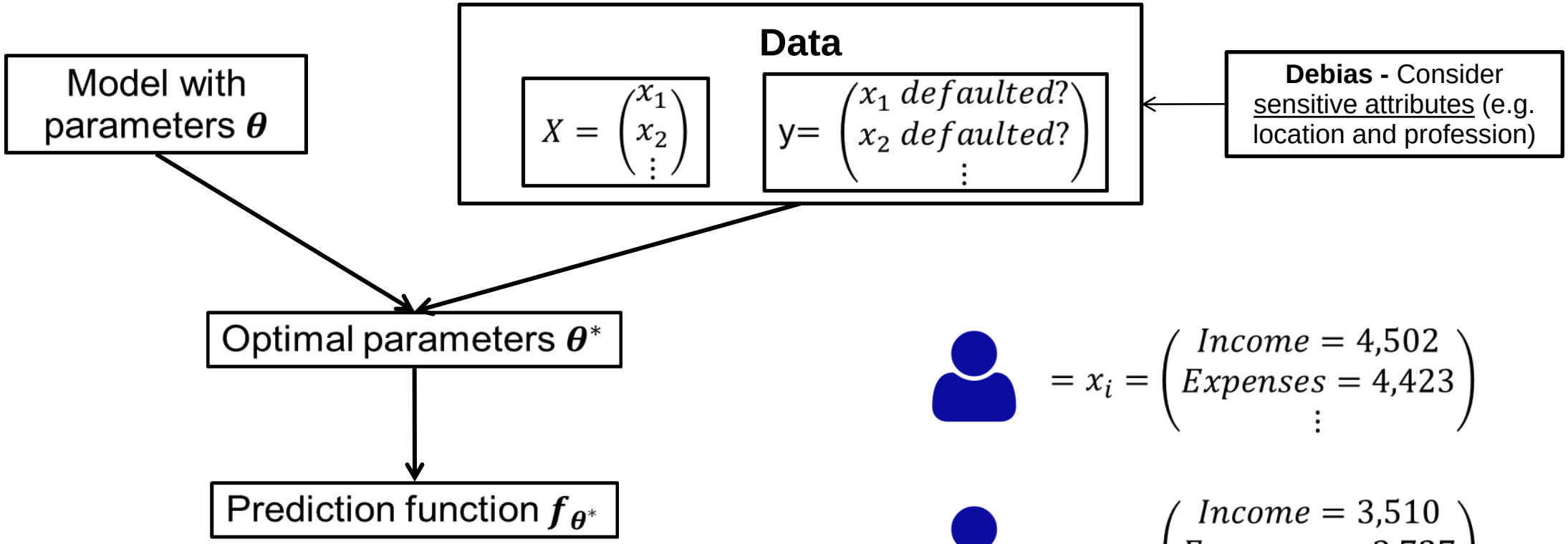
Prediction function $\boldsymbol{f}_{\boldsymbol{\theta}^*}$
$= x_i = \begin{pmatrix} Income = 4{,}502 \\ Expenses = 4{,}423 \\ \vdots \end{pmatrix}$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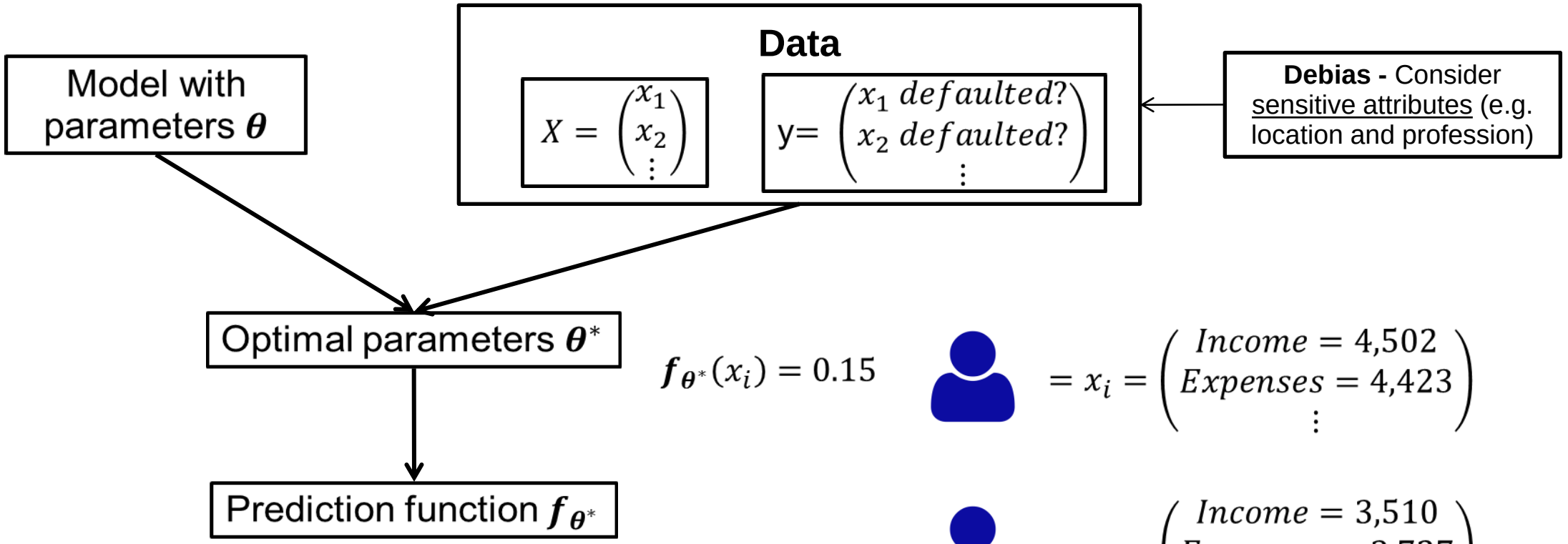
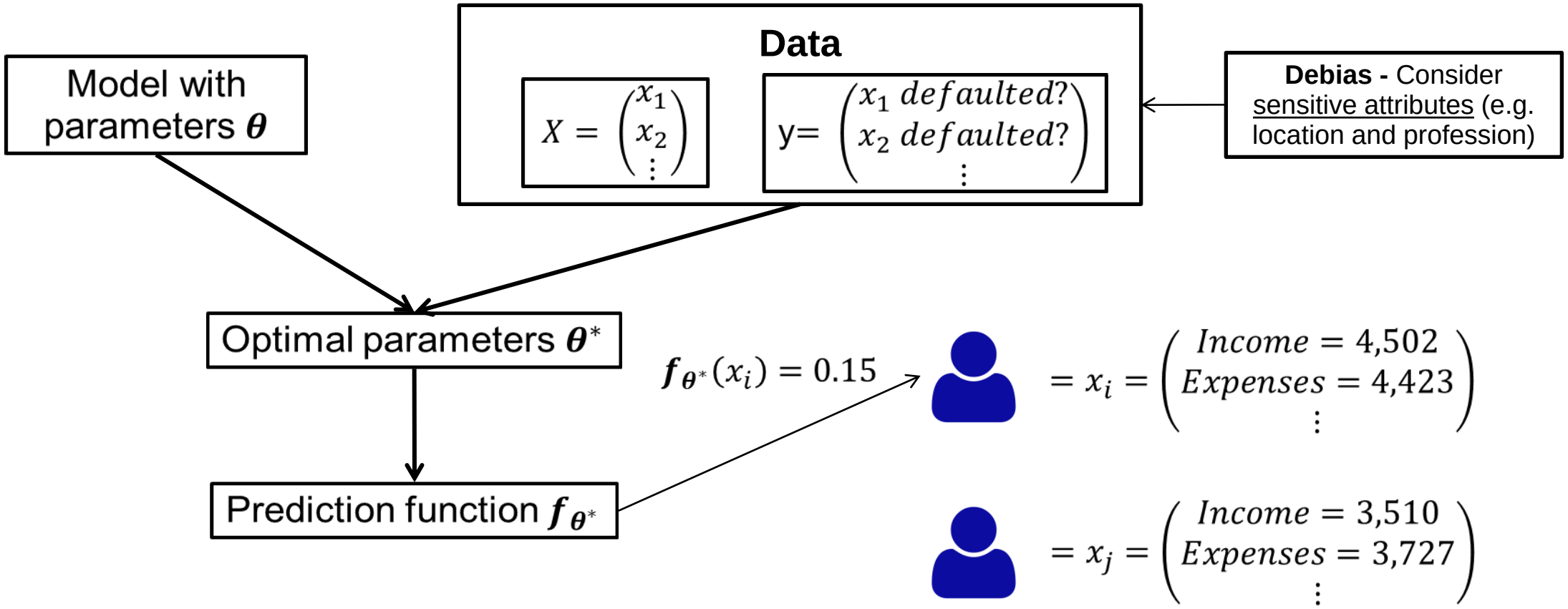
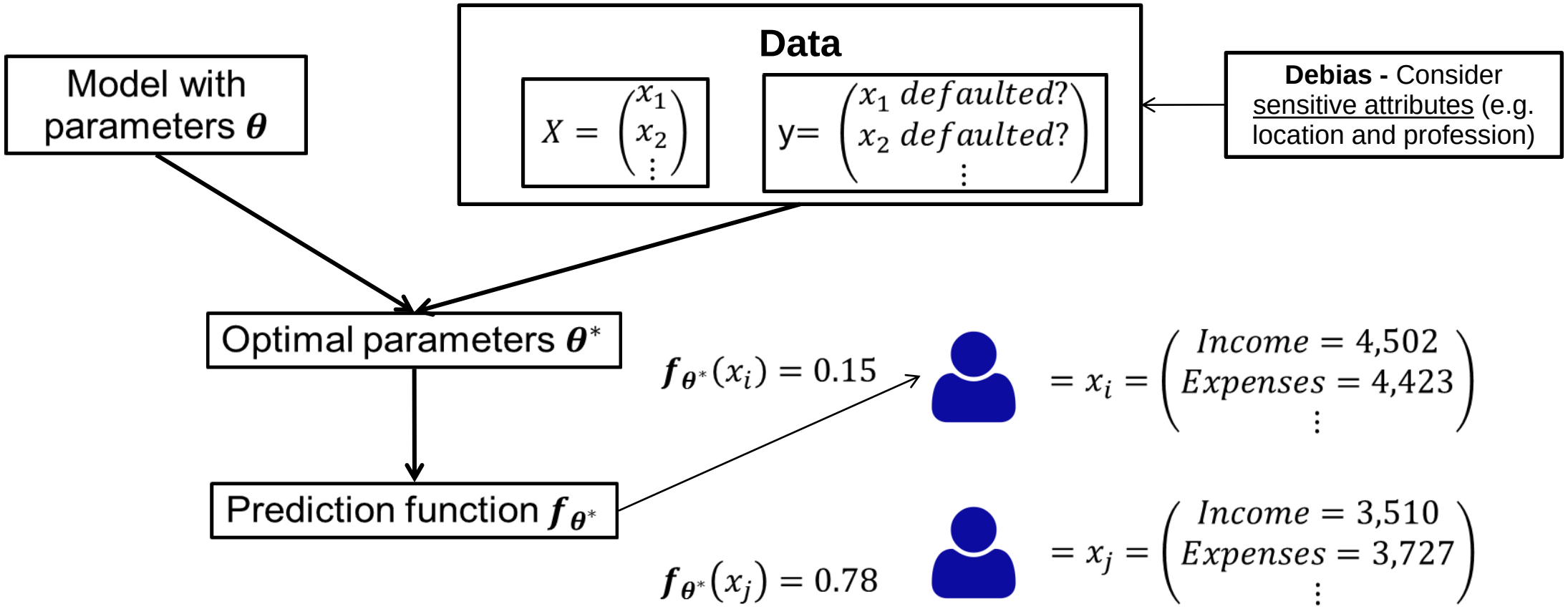
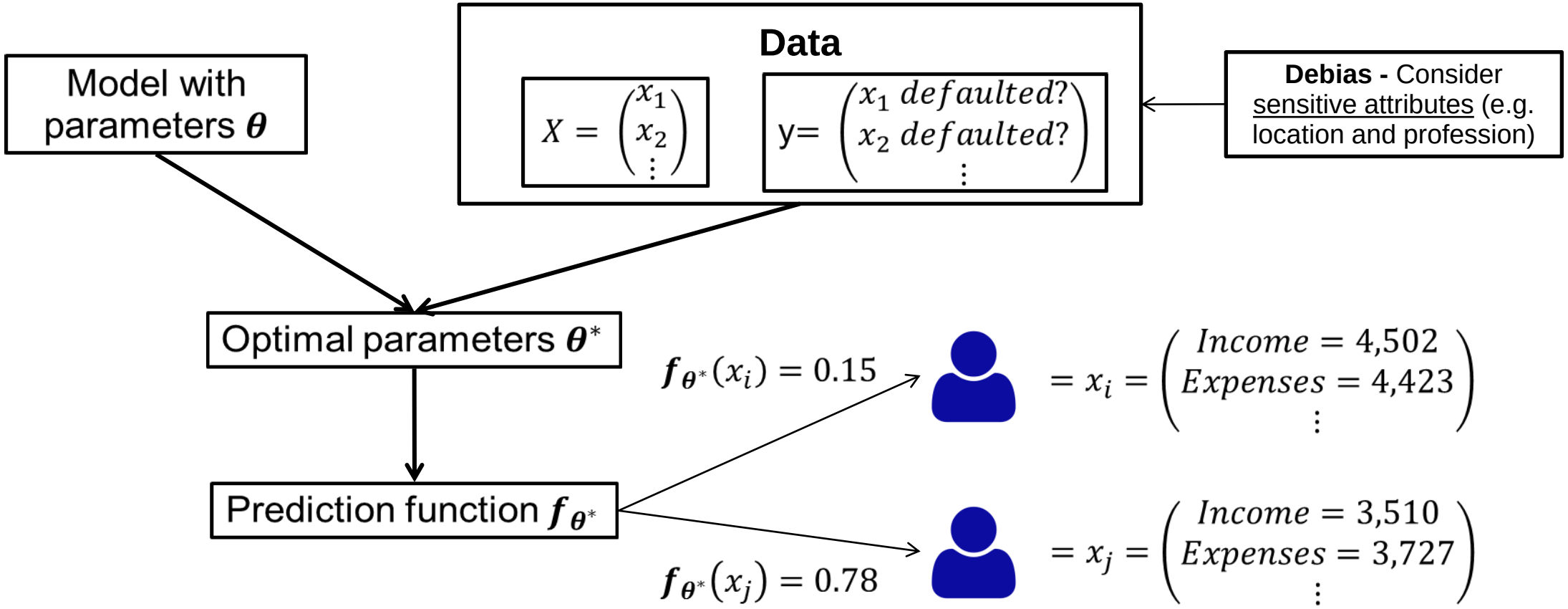
$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \end{pmatrix}$
$y = \begin{pmatrix} x_1\ defaulted? \\ x_2\ defaulted? \\ \vdots \end{pmatrix}$
Debias - Consider sensitive attributes (e.g. location and profession)
Optimal parameters $\boldsymbol{\theta}^*$
Prediction function $\boldsymbol{f}_{\boldsymbol{\theta}^*}$
$= x_i = \begin{pmatrix} Income = 4{,}502 \\ Expenses = 4{,}423 \\ \vdots \end{pmatrix}$
$= x_j = \begin{pmatrix} Income = 3{,}510 \\ Expenses = 3{,}727 \\ \vdots \end{pmatrix}$


Model with parameters $\boldsymbol{\theta}$
Data
$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \end{pmatrix}$
$y = \begin{pmatrix} x_1\ defaulted? \\ x_2\ defaulted? \\ \vdots \end{pmatrix}$
Debias - Consider sensitive attributes (e.g. location and profession)
Optimal parameters $\boldsymbol{\theta}^*$
Prediction function $\boldsymbol{f}_{\boldsymbol{\theta}^*}$
$\boldsymbol{f}_{\boldsymbol{\theta}^*}(x_i) = 0.15$
$= x_i = \begin{pmatrix} Income = 4{,}502 \\ Expenses = 4{,}423 \\ \vdots \end{pmatrix}$
$= x_j = \begin{pmatrix} Income = 3{,}510 \\ Expenses = 3{,}727 \\ \vdots \end{pmatrix}$


Model with parameters $\boldsymbol{\theta}$
Data
$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \end{pmatrix}$
$y = \begin{pmatrix} x_1\ defaulted? \\ x_2\ defaulted? \\ \vdots \end{pmatrix}$
Debias - Consider sensitive attributes (e.g. location and profession)
Optimal parameters $\boldsymbol{\theta}^*$
Prediction function $\boldsymbol{f}_{\boldsymbol{\theta}^*}$
$\boldsymbol{f}_{\boldsymbol{\theta}^*}(x_i) = 0.15$
$= x_i = \begin{pmatrix} Income = 4{,}502 \\ Expenses = 4{,}423 \\ \vdots \end{pmatrix}$
$= x_j = \begin{pmatrix} Income = 3{,}510 \\ Expenses = 3{,}727 \\ \vdots \end{pmatrix}$


Model with parameters $\boldsymbol{\theta}$
Data
$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \end{pmatrix}$
$y = \begin{pmatrix} x_1\ defaulted? \\ x_2\ defaulted? \\ \vdots \end{pmatrix}$
Debias - Consider sensitive attributes (e.g. location and profession)
Optimal parameters $\boldsymbol{\theta}^*$
Prediction function $\boldsymbol{f}_{\boldsymbol{\theta}^*}$
$\boldsymbol{f}_{\boldsymbol{\theta}^*}(x_i) = 0.15$
$= x_i = \begin{pmatrix} Income = 4{,}502 \\ Expenses = 4{,}423 \\ \vdots \end{pmatrix}$
$\boldsymbol{f}_{\boldsymbol{\theta}^*}(x_j) = 0.78$
$= x_j = \begin{pmatrix} Income = 3{,}510 \\ Expenses = 3{,}727 \\ \vdots \end{pmatrix}$


Model with parameters $\boldsymbol{\theta}$
Data
$X = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \end{pmatrix}$
$y = \begin{pmatrix} x_1\ defaulted? \\ x_2\ defaulted? \\ \vdots \end{pmatrix}$
Debias - Consider sensitive attributes (e.g. location and profession)
Optimal parameters $\boldsymbol{\theta}^*$
Prediction function $\boldsymbol{f}_{\boldsymbol{\theta}^*}$
$\boldsymbol{f}_{\boldsymbol{\theta}^*}(x_i) = 0.15$
$= x_i = \begin{pmatrix} Income = 4{,}502 \\ Expenses = 4{,}423 \\ \vdots \end{pmatrix}$
$\boldsymbol{f}_{\boldsymbol{\theta}^*}(x_j) = 0.78$
$= x_j = \begin{pmatrix} Income = 3{,}510 \\ Expenses = 3{,}727 \\ \vdots \end{pmatrix}$

Thank you!

References:

[1] P. C. Verhoef, T. Broekhuizen, Y. Bart, A. Bhattacharya, J. Q. Dong, N. Fabian, and M. Haenlein. “Digital transformation: A multidisciplinary reflection and research agenda”. In: Journal of Business Research 122 (Jan. 2021), pp. 889–901. doi: 10.1016/j.jbusres.2019.09.022.

[2] Schindler, John (2017). “FinTech and Financial Innovation: Drivers and Depth,” Finance and Economics Discussion Series 2017-081. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.081.

[3] https://usa.visa.com/dam/VCOM/download/corporate/media/visanet-technology/visa-net-booklet.pdf

[4] https://ripple.com/xrp/

[5] https://xrpl.org/consensus-protections.html

[6] https://ethereum.org/en/eth2/shard-chains/

[7] R. Fu, Y. Huang, and P. V. Singh. “Crowds, lending, machine, and bias”. In: Information Systems Research 32.1 (2021), pp. 72–92. doi: 10.1287/isre.2020.0990.