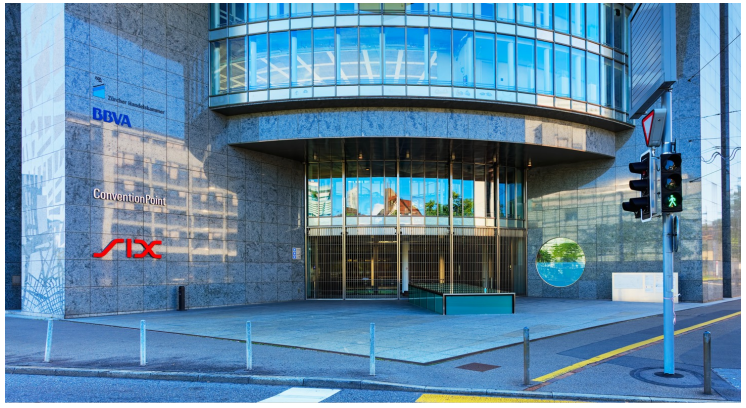
Decentralized Exchanges

Instructor: Arthur Gervais

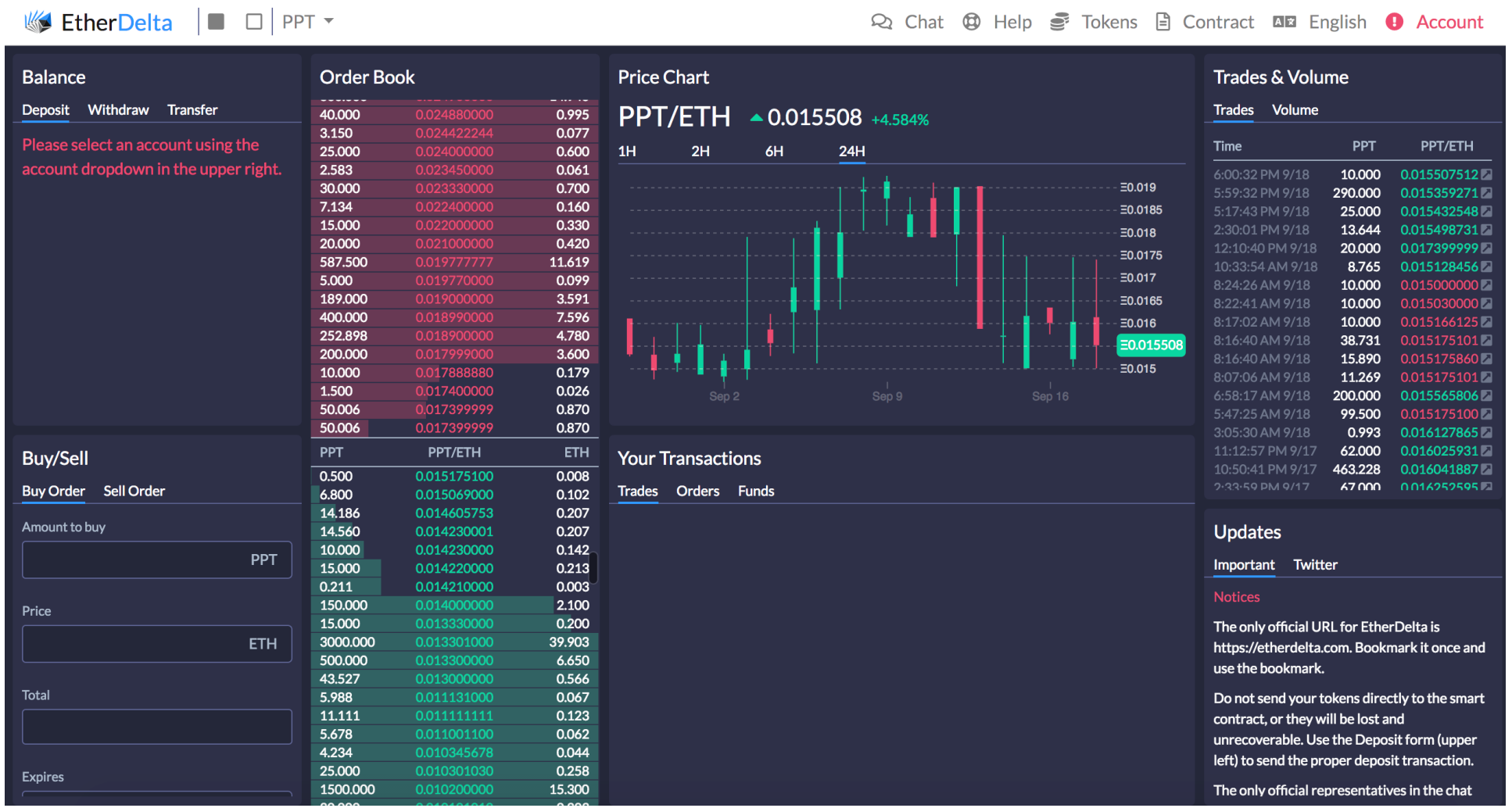
Financial Exchanges



Order Book


418.41
Mid Market Price
$418.10 $418.15 $418.20 $418.25 $418.30 $418.35 $418.40 $418.45 $418.50 $418.55 $418.60 $418.65 $418.70
ORDER BOOK
Market size Price (USD) My size
21.23336000 418.40 -
0.01000000 418.39 -
0.01000000 418.31 -
0.01000000 418.30 -
0.01000000 418.29 -
0.01000000 418.28 -
0.01000000 418.27 -
0.05000000 418.26 -
0.01000000 418.23 -
0.01000000 418.22 -
0.01000000 418.21 -
1.45900000 418.20 -
0.01000000 418.19 -
1.47000000 418.17 -
1.45800000 418.14 -
1.49000000 418.10 -
2.27100000 418.07 -
0.06000000 418.06 -
0.06000000 418.05 -
1.53300000 418.04 -
0.07000000 418.03 -
0.76670000 418.00 -
1.48500000 417.99 -
1.49300000 417.92 -
16.48700000 417.91 -
0.01000000 417.90 -
1.43800000 417.89 -
1.21400000 417.88 -
Market size Price (USD) My size
0.32578000 418.68 -
0.02256000 418.67 -
0.15730000 418.66 -
0.95597000 418.65 -
0.16940000 418.64 -
1.37110400 418.63 -
2.69360000 418.62 -
0.03200000 418.61 -
0.17200000 418.60 -
6.42753821 418.59 -
1.96500000 418.58 -
3.35532000 418.57 -
0.07500000 418.56 -
0.03750000 418.55 -
0.80500000 418.54 -
0.30670000 418.53 -
5.93968000 418.52 -
0.03500000 418.51 -
6.11465568 418.50 -
1.59490000 418.49 -
2.36500000 418.48 -
0.39489096 418.47 -
1.03616569 418.46 -
0.04434039 418.45 -
0.58720572 418.44 -
2.41500000 418.43 -
0.02500000 418.42 -
9.51880170 418.41

EtherDelta


EtherDelta
PPT
Chat
Help
Tokens
Contract
English
Account
Balance
Deposit
Withdraw
Transfer
Please select an account using the account dropdown in the upper right.
Buy/Sell
Buy Order
Sell Order
Amount to buy
PPT
Price
ETH
Total
Expires
Order Book
40.000 0.024880000 0.995
3.150 0.024422244 0.077
25.000 0.024000000 0.600
2.583 0.023450000 0.061
30.000 0.023330000 0.700
7.134 0.022400000 0.160
15.000 0.022000000 0.330
20.000 0.021000000 0.420
587.500 0.019777777 11.619
5.000 0.019770000 0.099
189.000 0.019000000 3.591
400.000 0.018990000 7.596
252.898 0.018900000 4.780
200.000 0.017999000 3.600
10.000 0.017888880 0.179
1.500 0.017400000 0.026
50.006 0.017399999 0.870
50.006 0.017399999 0.870
PPT PPT/ETH ETH
0.500 0.015175100 0.008
6.800 0.015069000 0.102
14.186 0.014605753 0.207
14.560 0.014230001 0.207
10.000 0.014230000 0.142
15.000 0.014220000 0.213
0.211 0.014210000 0.003
150.000 0.014000000 2.100
15.000 0.013330000 0.200
3000.000 0.013301000 39.903
500.000 0.013300000 6.650
43.527 0.013000000 0.566
5.988 0.011131000 0.067
11.111 0.011111111 0.123
5.678 0.011001100 0.062
4.234 0.010345678 0.044
25.000 0.010301030 0.258
1500.000 0.010200000 15.300
Price Chart
PPT/ETH 0.015508 +4.584%
1H 2H 6H 24H
Ξ0.019
Ξ0.0185
Ξ0.018
Ξ0.0175
Ξ0.017
Ξ0.0165
Ξ0.016
Ξ0.015508
Ξ0.015
Sep 2
Sep 9
Sep 16
Your Transactions
Trades
Orders
Funds
Trades & Volume
Trades
Volume
Time PPT PPT/ETH
6:00:32 PM 9/18 10.000 0.015507512
5:59:32 PM 9/18 290.000 0.015359271
5:17:43 PM 9/18 25.000 0.015432548
2:30:01 PM 9/18 13.644 0.015498731
12:10:40 PM 9/18 20.000 0.017399999
10:33:54 AM 9/18 8.765 0.015128456
8:24:26 AM 9/18 10.000 0.015000000
8:22:41 AM 9/18 10.000 0.015030000
8:17:02 AM 9/18 10.000 0.015166125
8:16:40 AM 9/18 38.731 0.015175101
8:16:40 AM 9/18 15.890 0.015175860
8:07:06 AM 9/18 11.269 0.015175101
6:58:17 AM 9/18 200.000 0.015565806
5:47:25 AM 9/18 99.500 0.015175100
3:05:30 AM 9/18 0.993 0.016127865
11:12:57 PM 9/17 62.000 0.016025931
10:50:41 PM 9/17 463.228 0.016041887
Updates
Important
Twitter
Notices
The only official URL for EtherDelta is https://etherdelta.com. Bookmark it once and use the bookmark.
Do not send your tokens directly to the smart contract, or they will be lost and unrecoverable. Use the Deposit form (upper left) to send the proper deposit transaction.
The only official representatives in the chat

LOB DEX: Lessons Learned

- Advantages:
  - No KYC/AML
  - No fees paid to the exchange
  - No impermanent loss (explained later in AMM)

- Disadvantages:
  - Fees for deposit, withdraw, trade creation/cancel
  - Slow execution
  - Not fully decentralized (mediating server)

Settlement Layer

Exchange

Trade Matching

Non-Custodial
Trade Settlement

Why do we need DEX?

Alice is rich
(aka a “whale”)

Alice wants to provide her money to traders to earn fees

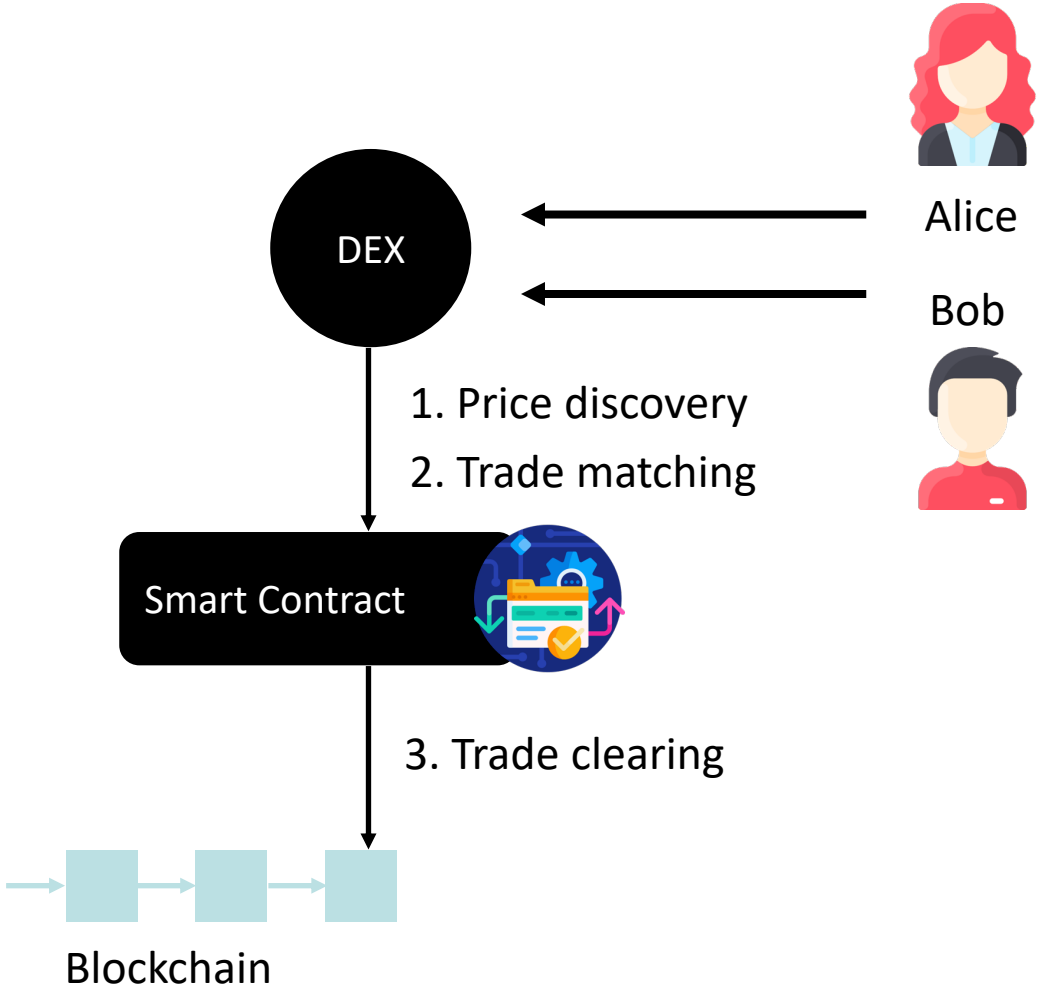
..but has to trust someone to manage her money

Bob is nifty trader

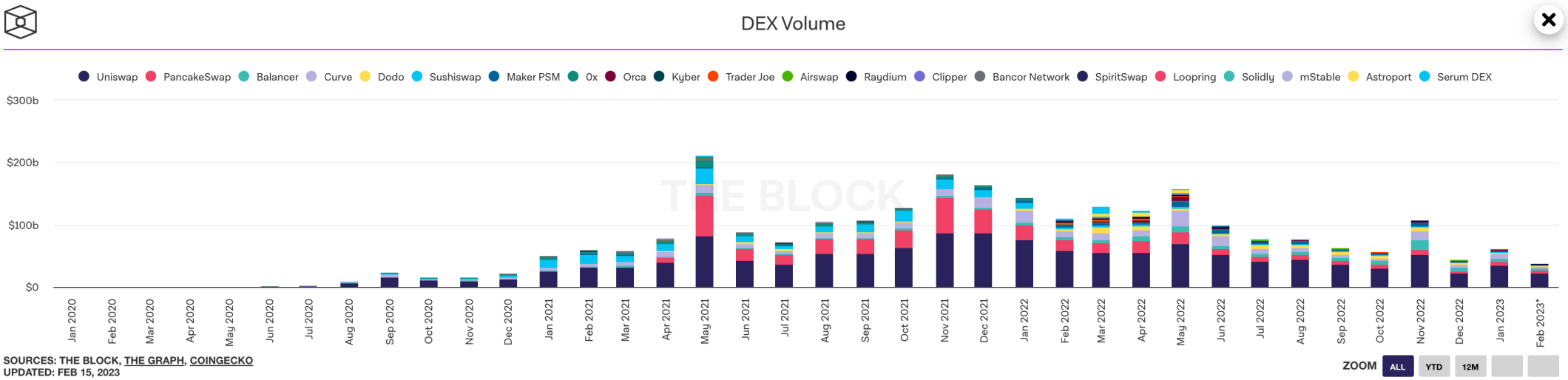
Bob wants to buy the latest coins

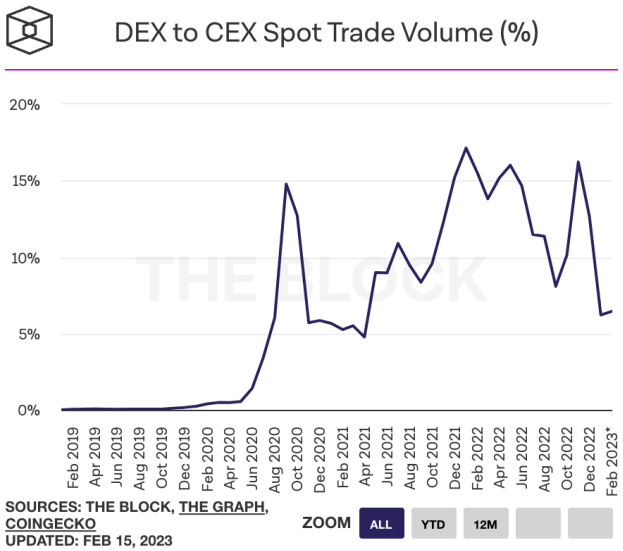
..but struggles to find a trusted source to buy

DEX System Architecture



DEX trading volume

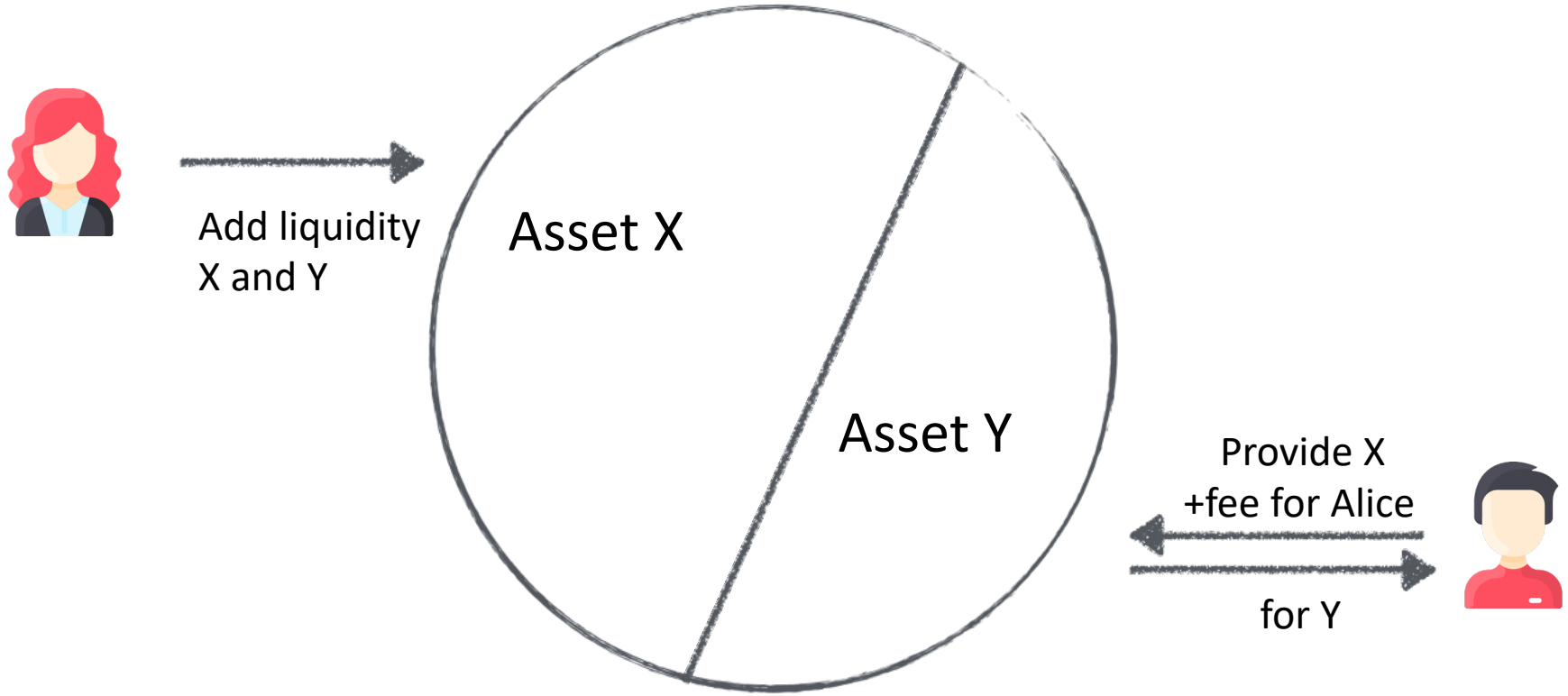





Automated Market Maker
https://defi-learning.org

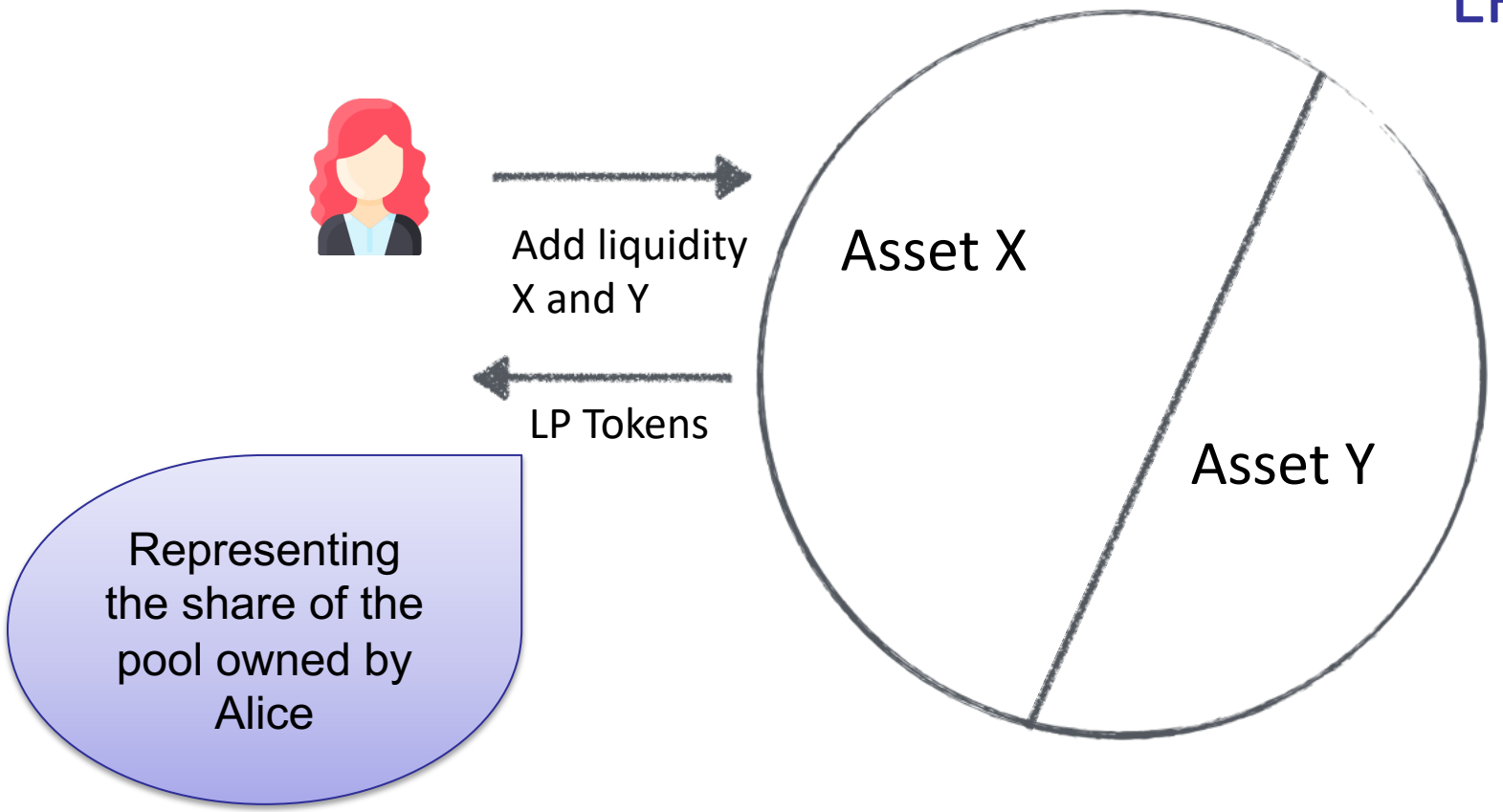
Liquidity Pool

Idea: Let a smart contract do the market making.



smart contract pool

Liquidity Provider (LP) Token



LP Tokens:

- Accounting
- Fungible or NFT
  - Sellable on 2ndary markets
- Reuse in other contracts
- Staking

AMM – Automated Market Maker

Idea: Let a smart contract do the market making.

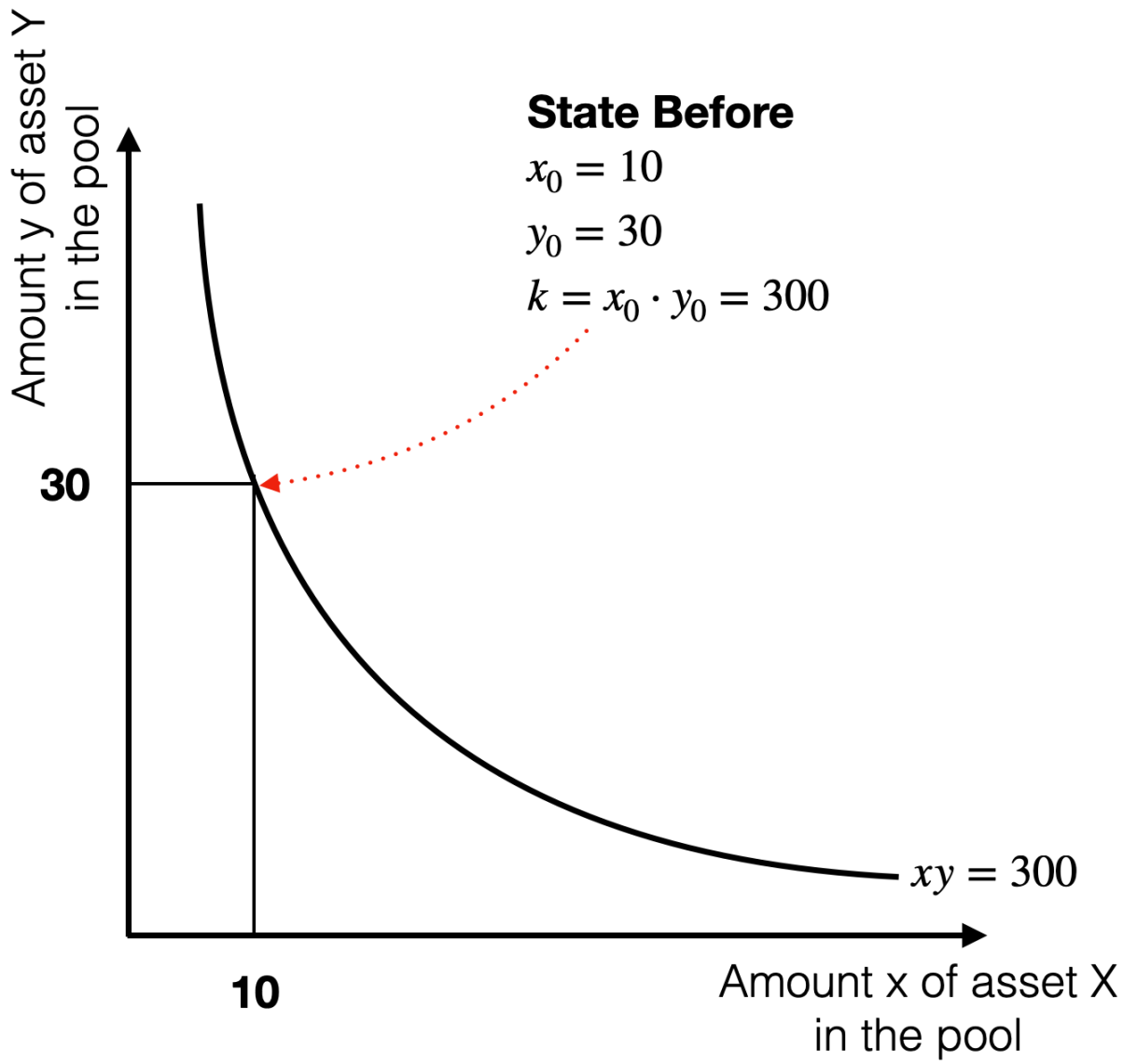
$$x \times y = k$$

- x: Asset X quantity
- y: Asset Y quantity
- k: constant

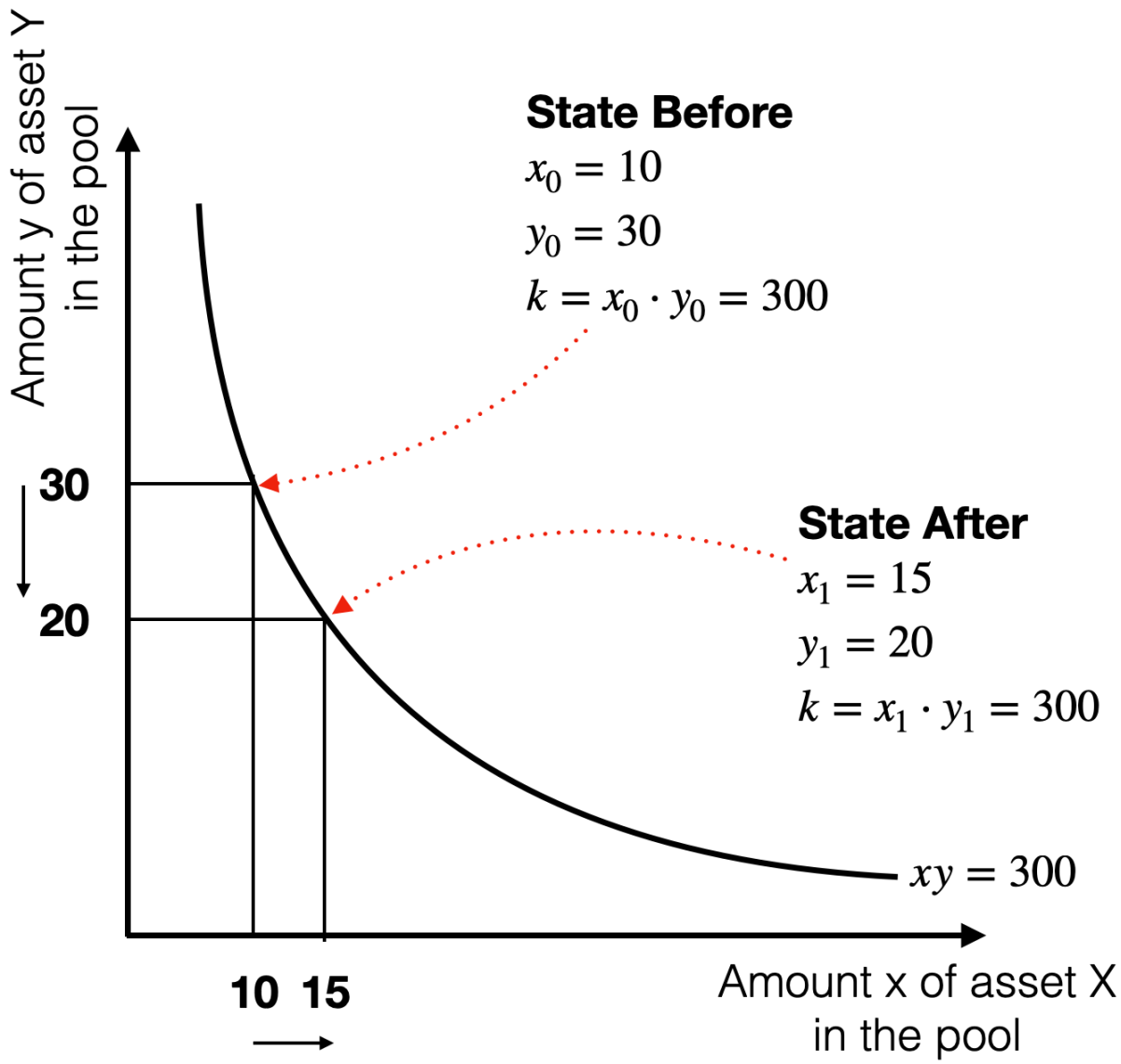
Properties:

- Instant liquidity, irrespective of the trade size
- Purchase of asset X increases price of X and decreases the price of Y
- Ratio of asset X and Y sets the price
- Known as Constant Product (CP) AMM

AMM Example

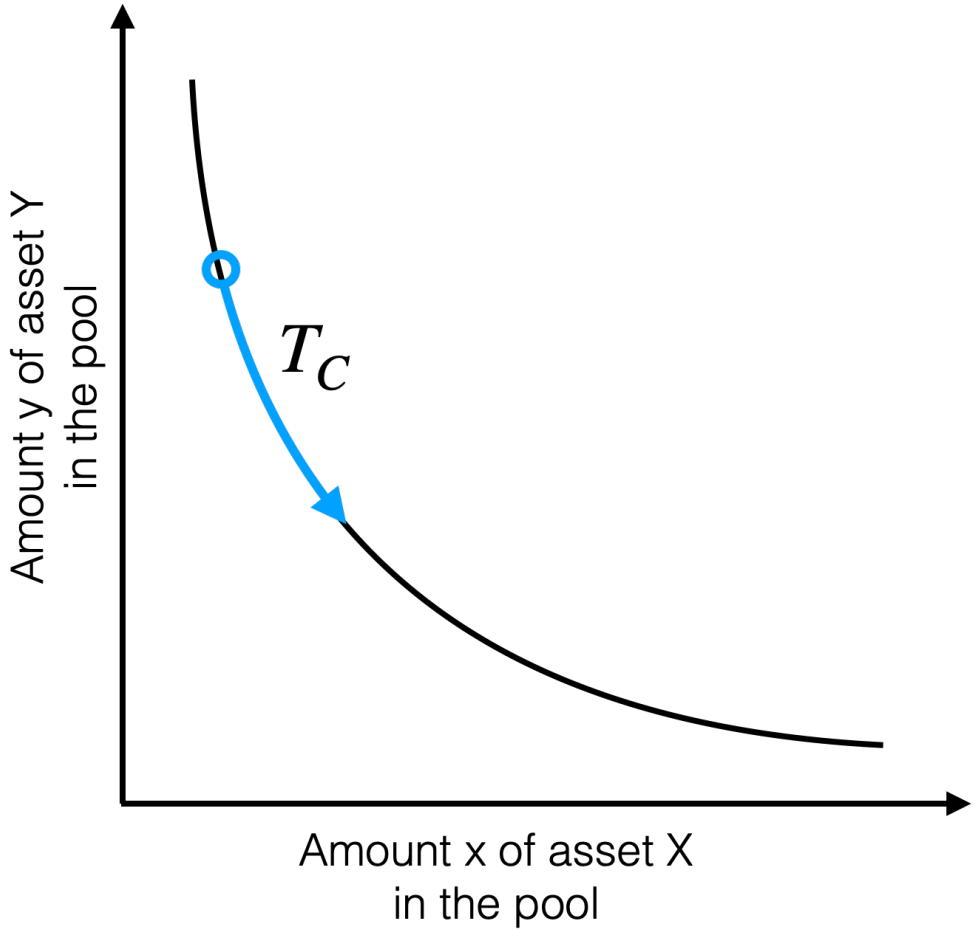

Amount y of asset Y
in the pool
State Before
$x_0 = 10$
$y_0 = 30$
$k = x_0 \cdot y_0 = 300$
30
$xy = 300$
10
Amount x of asset X
in the pool

AMM Example

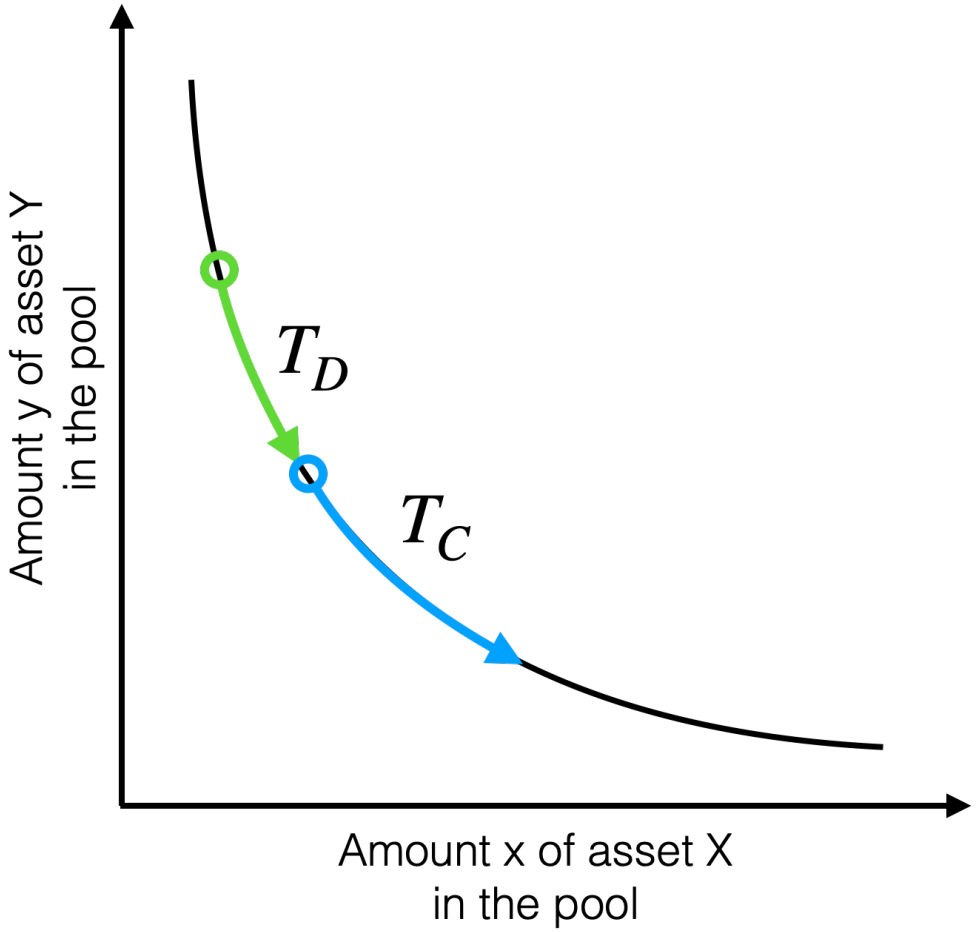

Amount y of asset Y
in the pool
State Before
$x_0 = 10$
$y_0 = 30$
$k = x_0 \cdot y_0 = 300$
30
20
State After
$x_1 = 15$
$y_1 = 20$
$k = x_1 \cdot y_1 = 300$
$xy = 300$
10 15
Amount x of asset X
in the pool

Expected Slippage

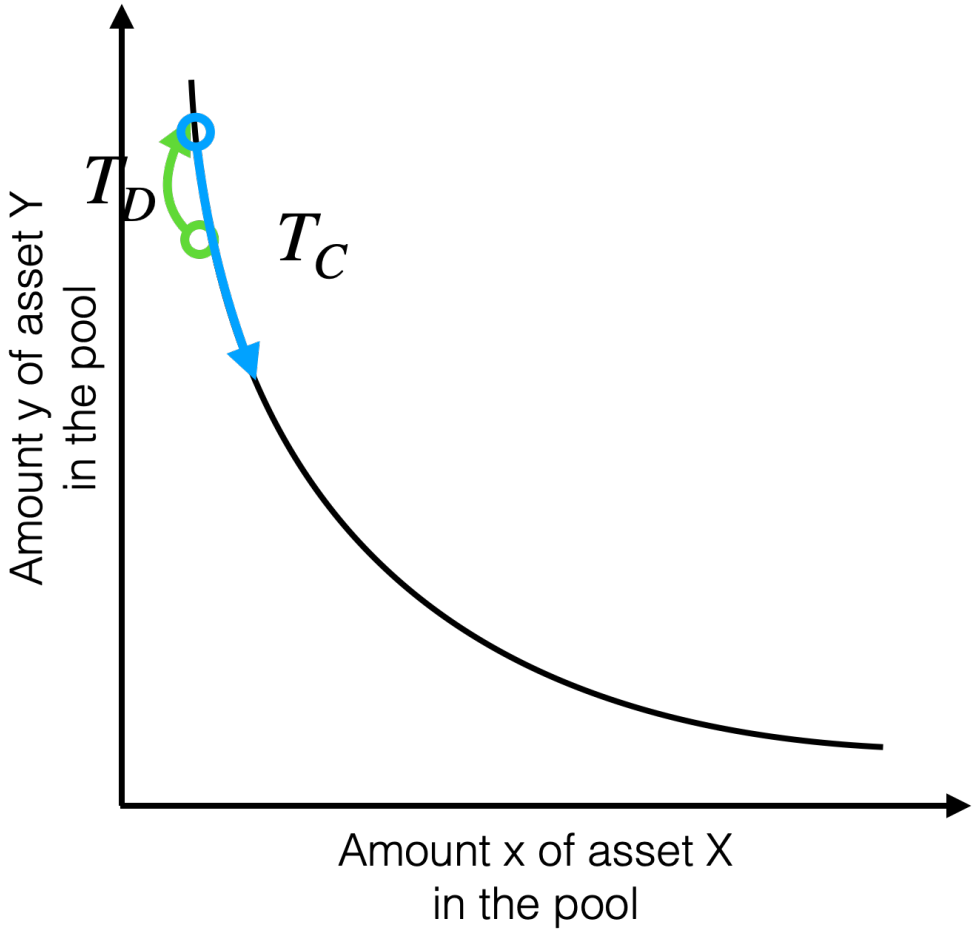
The expected increase or decrease in price based on the trading volume and available liquidity.



Unexpected Slippage → Worse Execution Price

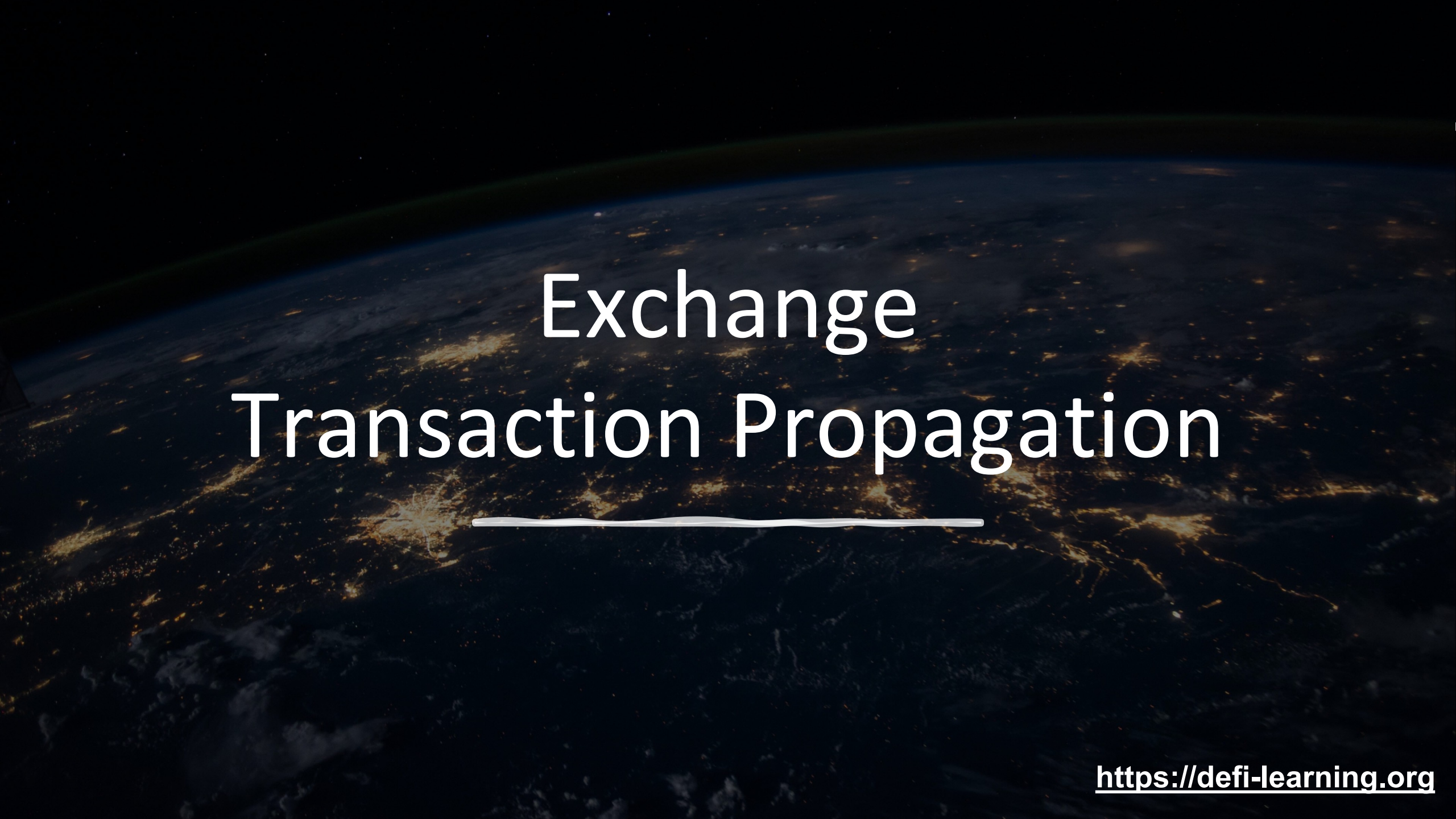


Unexpected Slippage → Better Execution Price



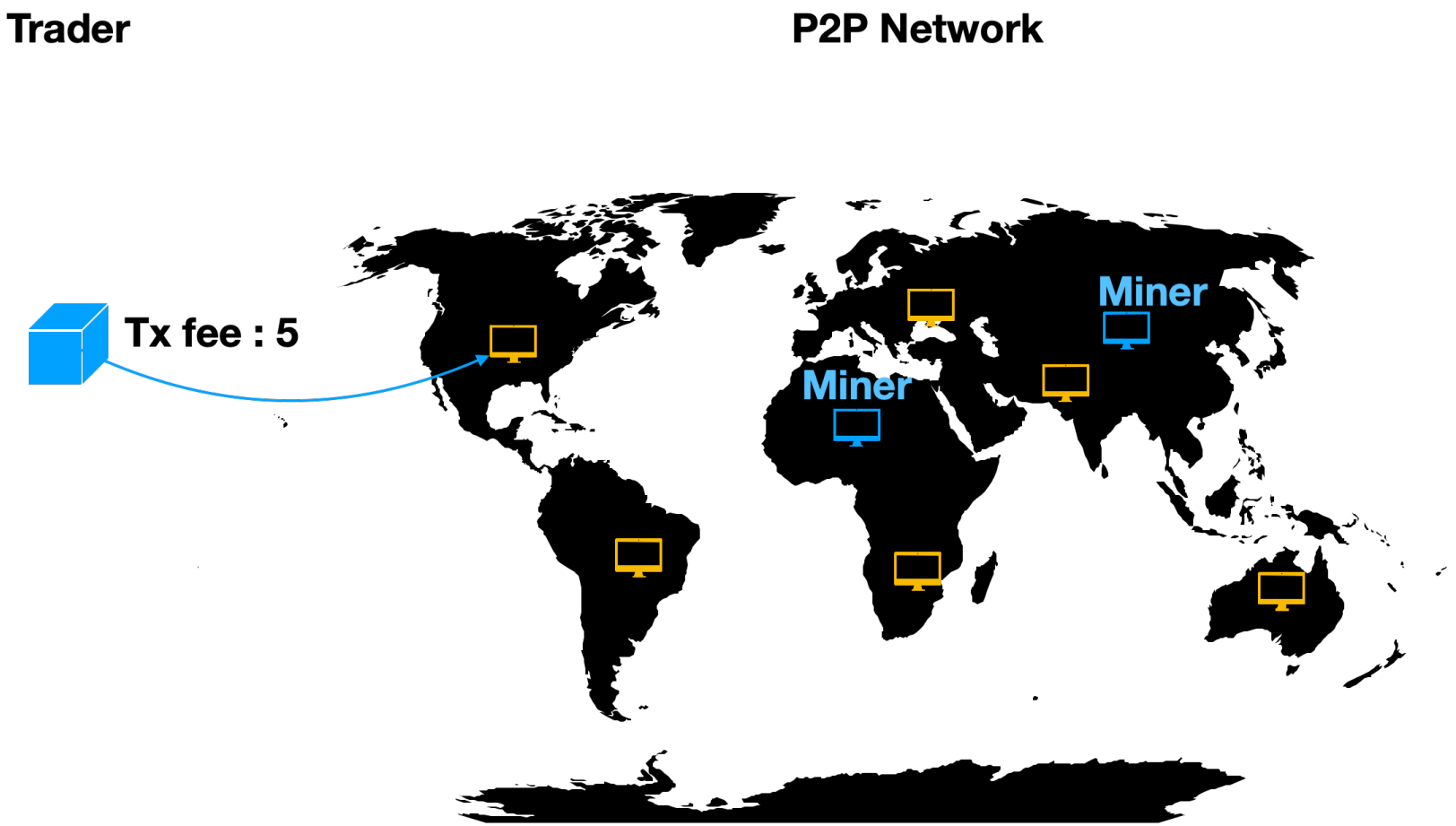
Pros and Cons of an AMM

- (+) No Order Book maintenance
  - But arbitrage required
- (+) Simple implementation for CP AMM
  - Low gas costs
- (-) Danger of impermanent loss/coin de-peg
  - Total loss of funds possible
- (-) High slippage for low liquidity markets
  - Please do observe your slippage tolerance
- (-) Users vulnerable to sandwich attacks

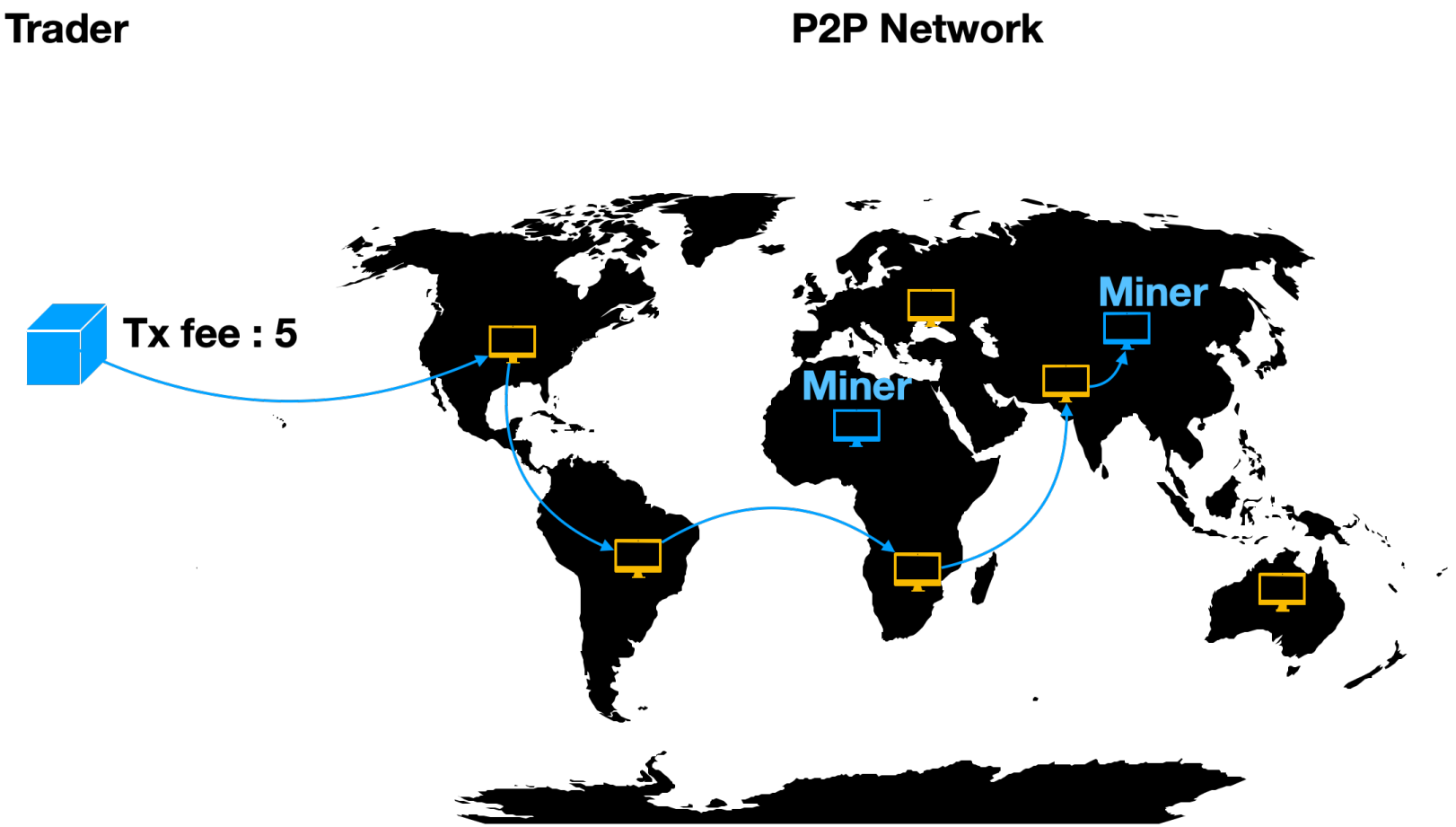


https://defi-learning.org

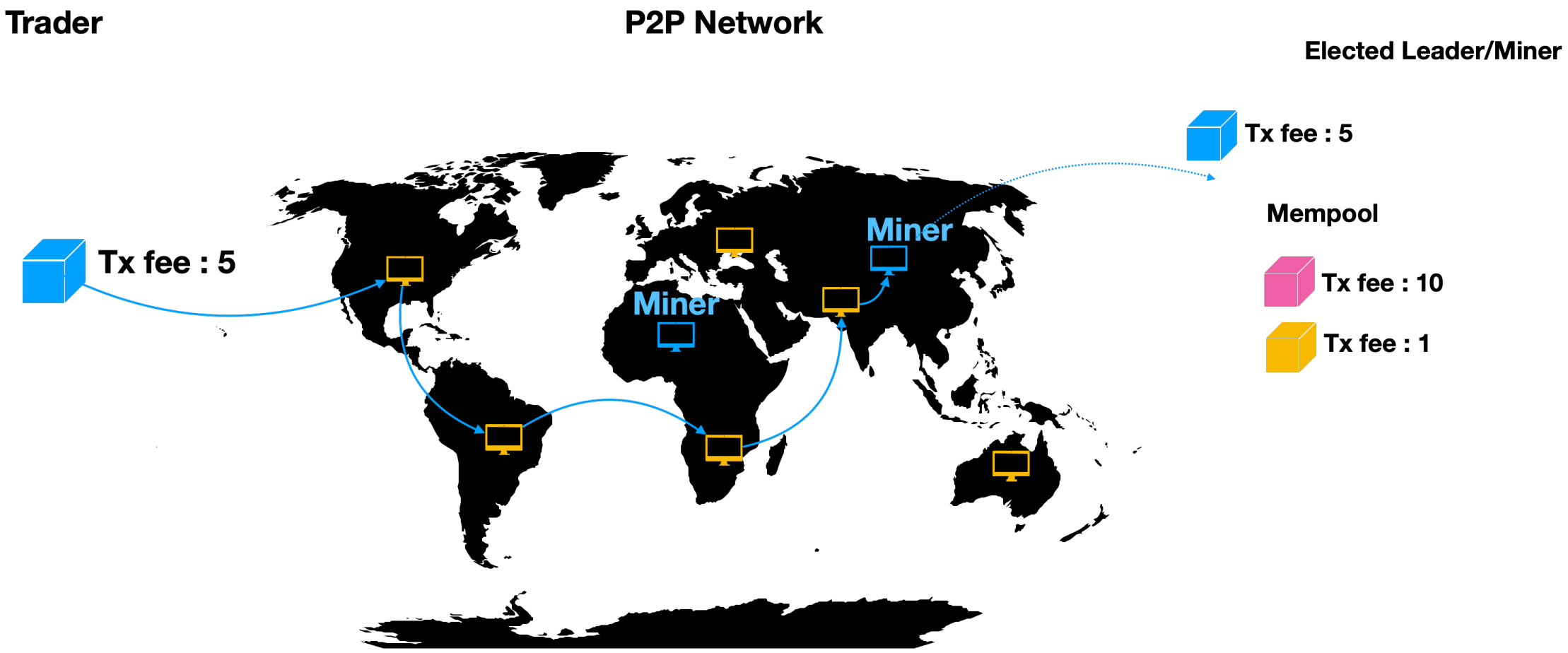
Exchange Transaction Propagation



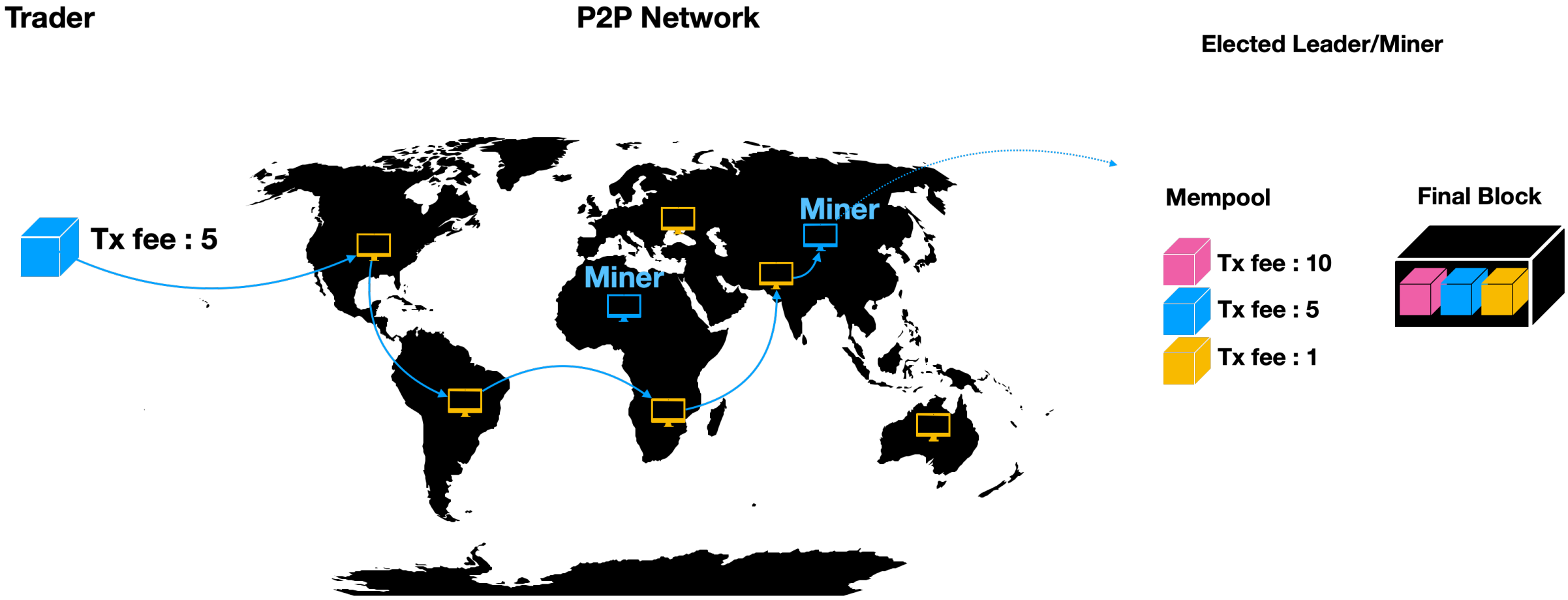
Exchange Transaction Propagation



Exchange Transaction Propagation

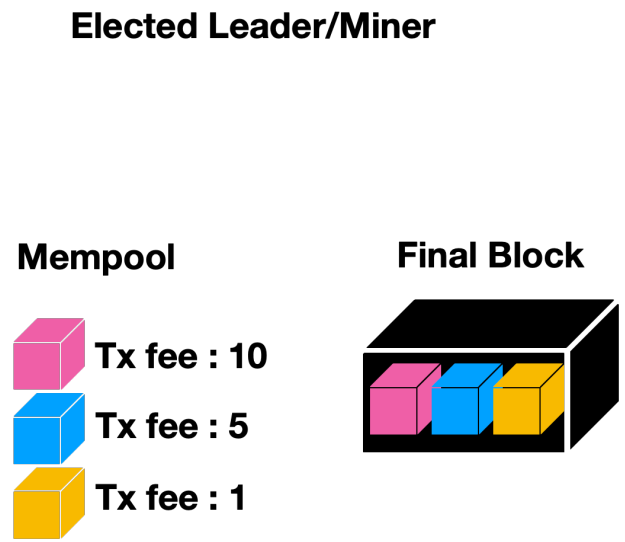


Exchange Transaction Propagation



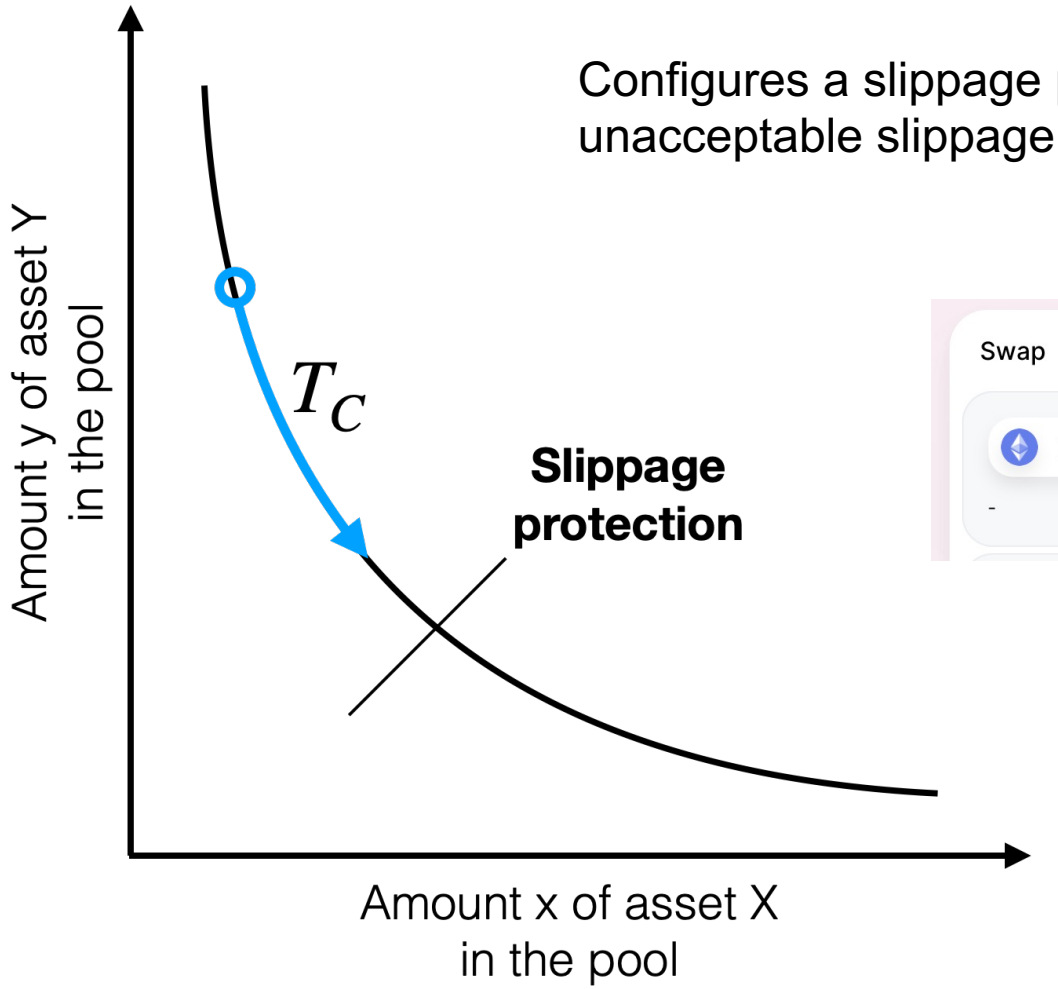
Exchange Transaction Propagation

- Asynchronous Blockchain P2P Network
  - Best effort propagation
  - Transparency
  - High-Frequency Trading
- Inclusion based on a fee auction
  - Price Gas Auction (PGA)
    - On the public P2P network
  - Sealed Bid Gas Auction (SGA)
    - On centralized network relay services

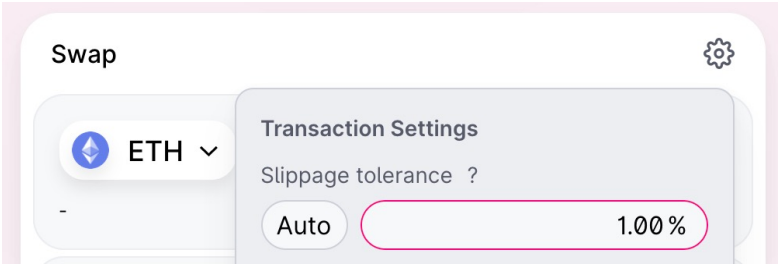



Sandwich Attacks
https://defi-learning.org

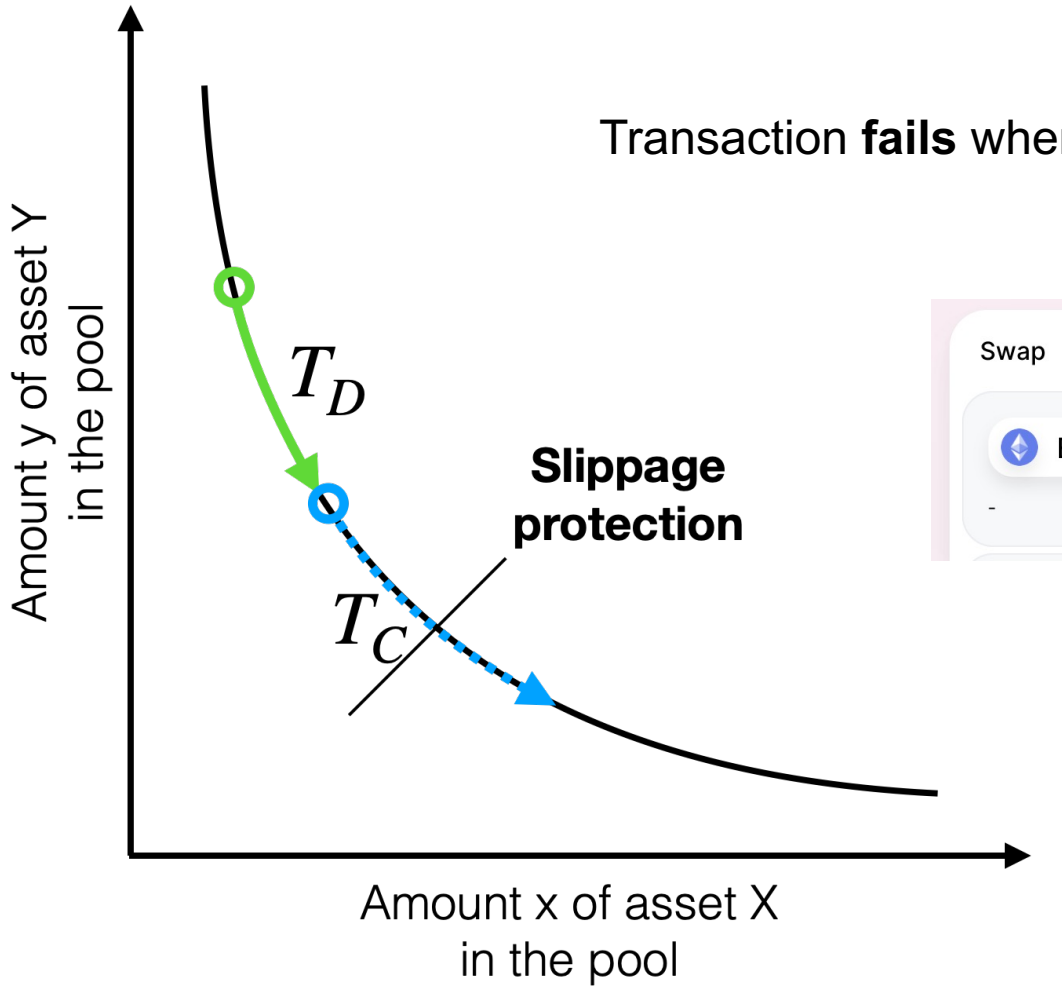
Slippage Protection



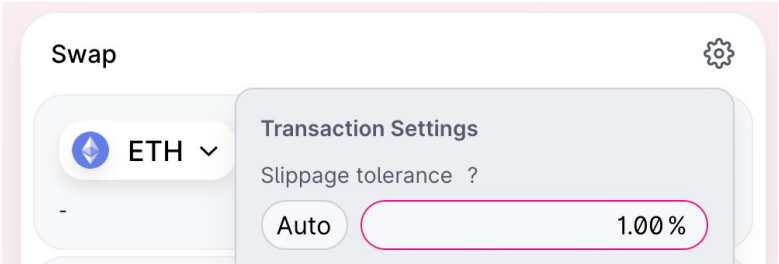
Configures a slippage protection threshold to prevent unacceptable slippage



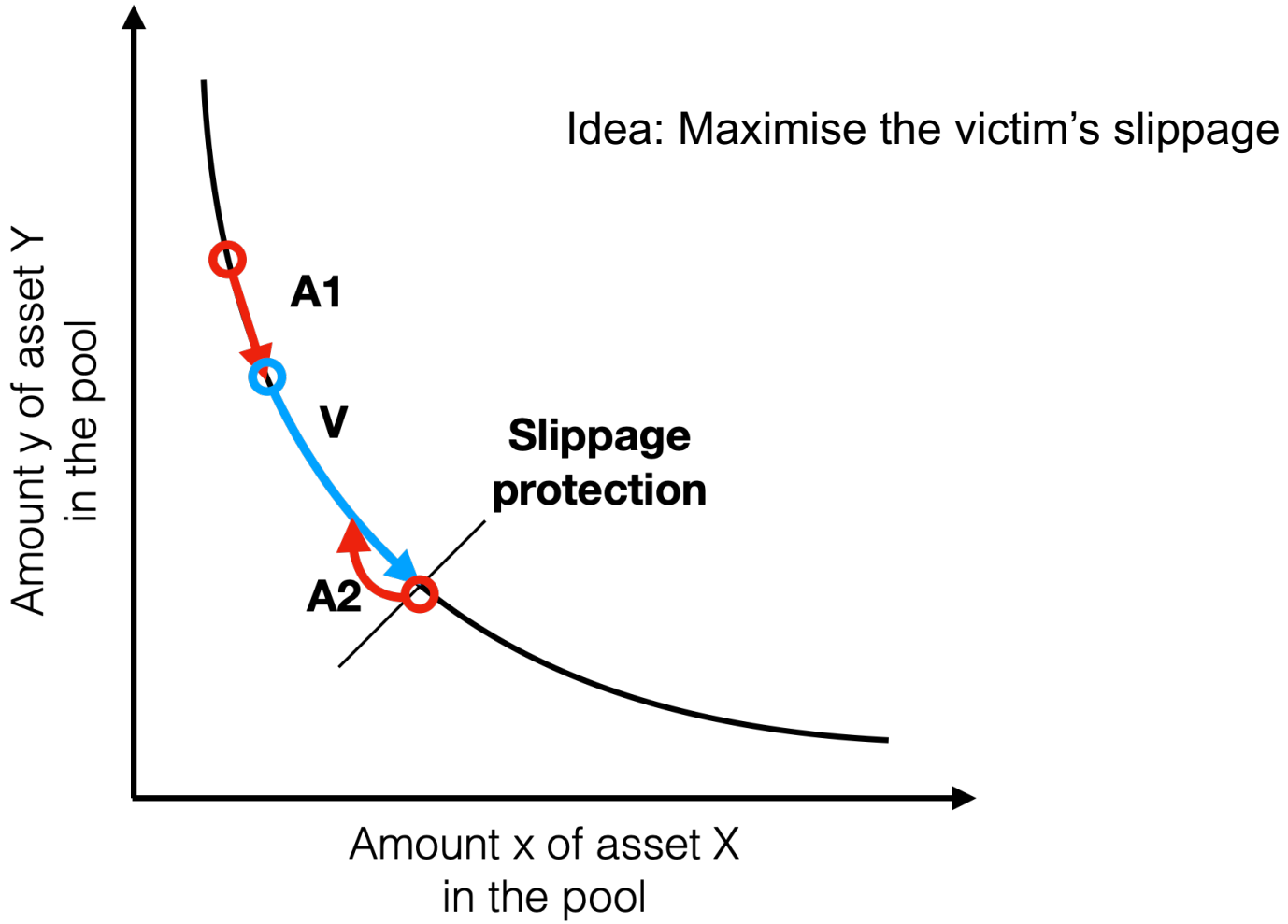
Slippage Protection



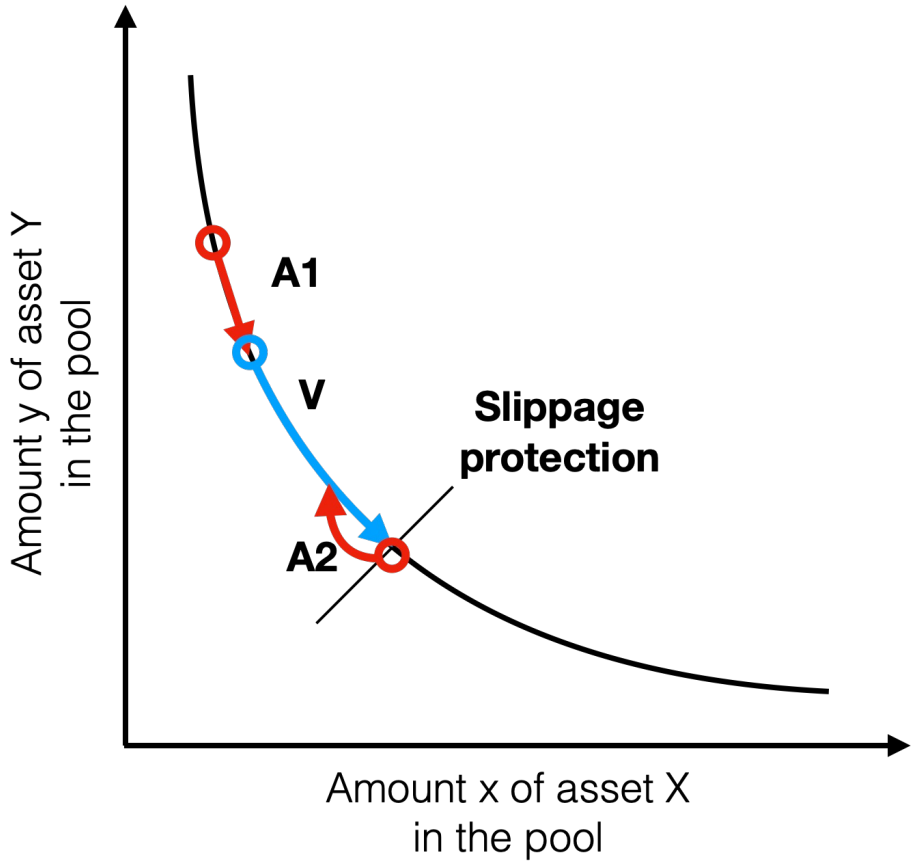
Transaction **fails** when crossing the slippage limit.

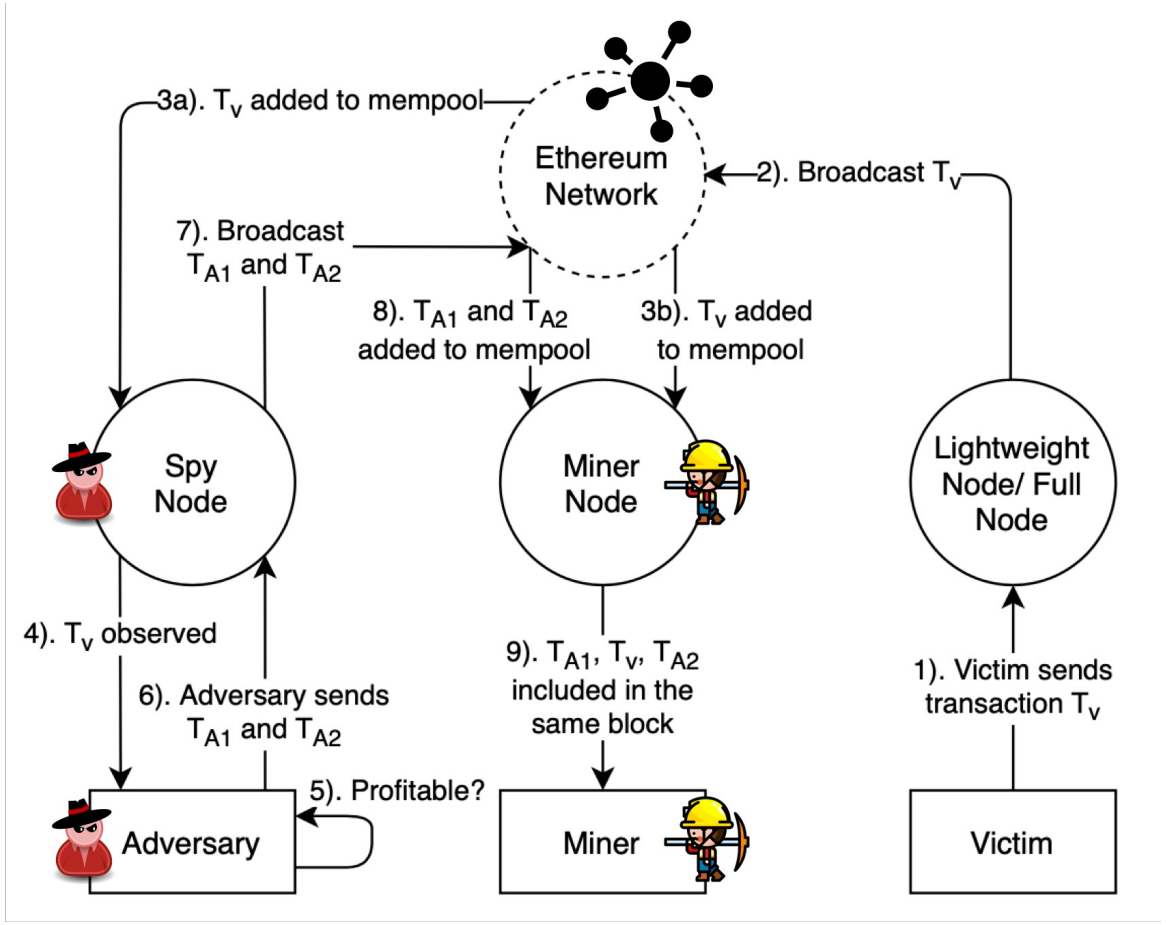


Sandwich Attack Against Taker

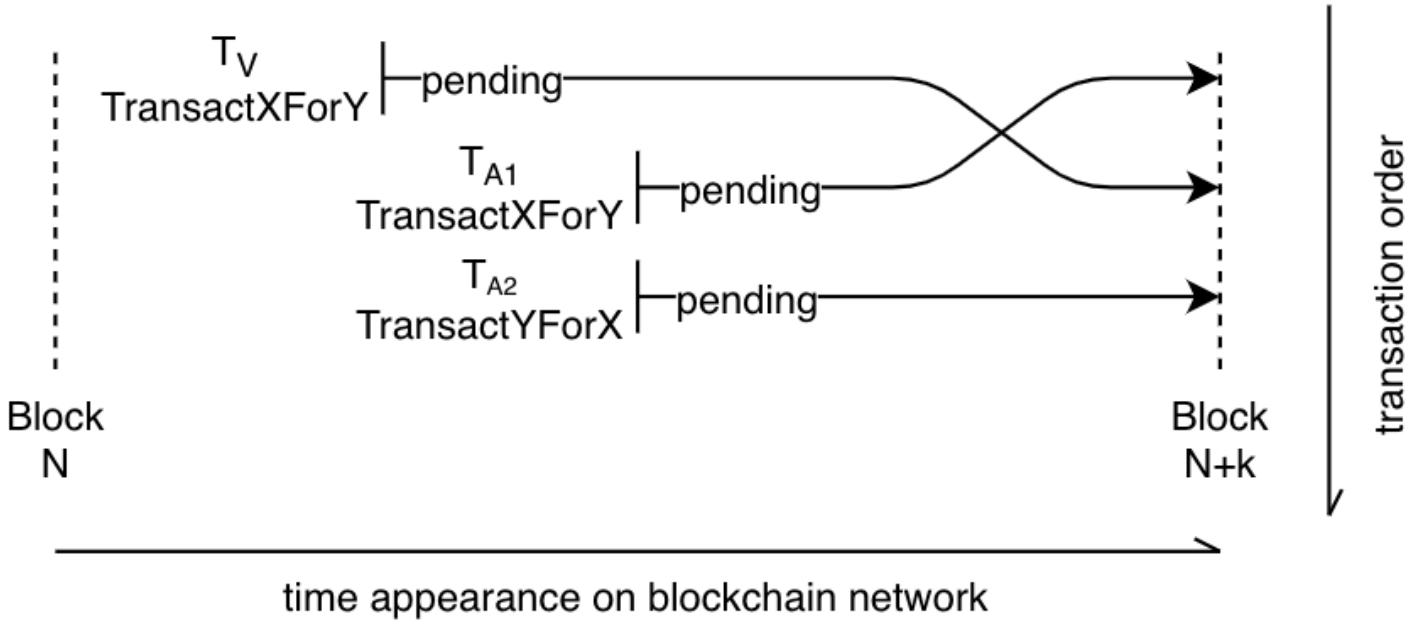


Network layer + DeFi protocol layer

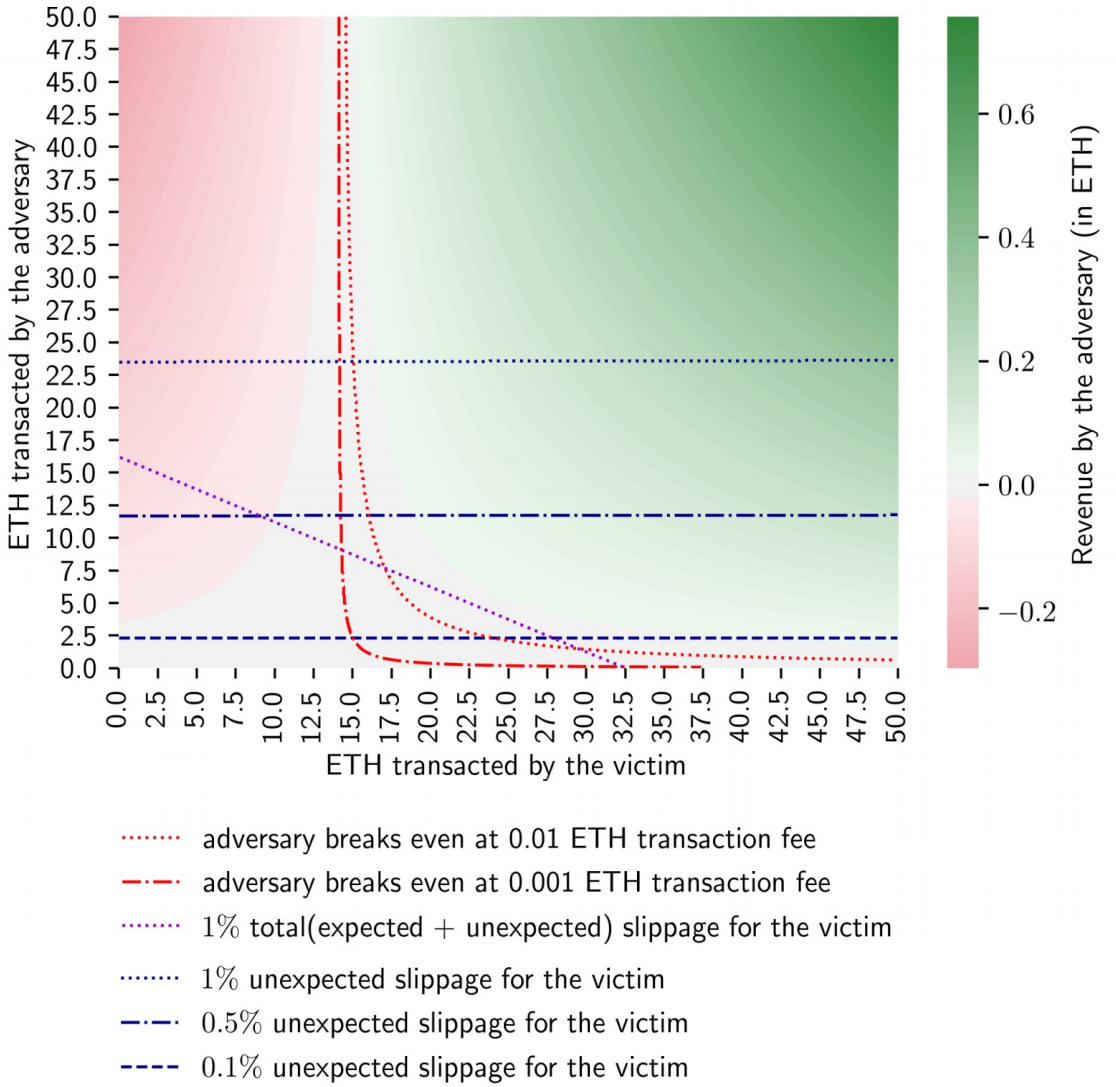




Sandwich Attack

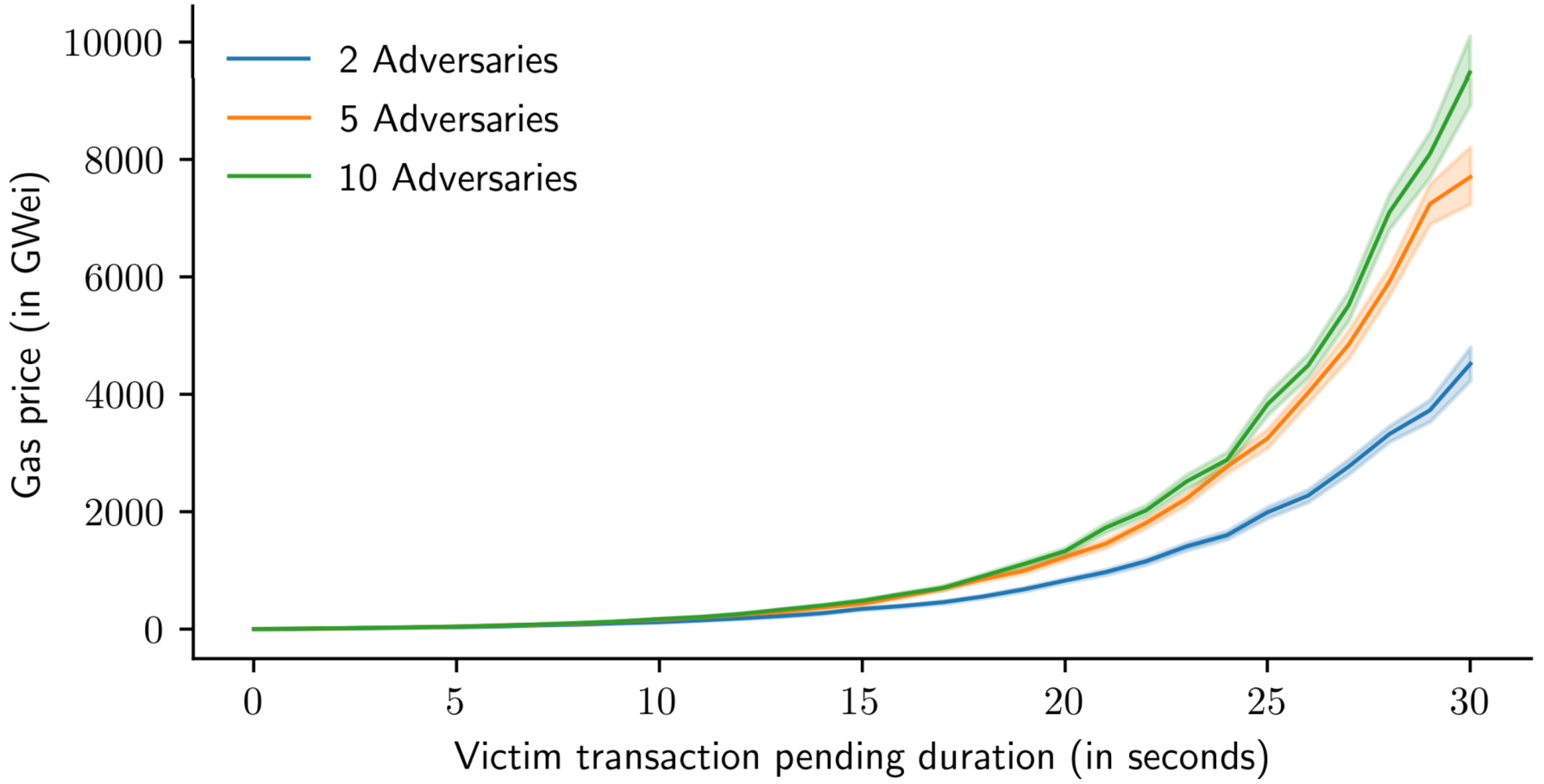


Sandwich attack profitability



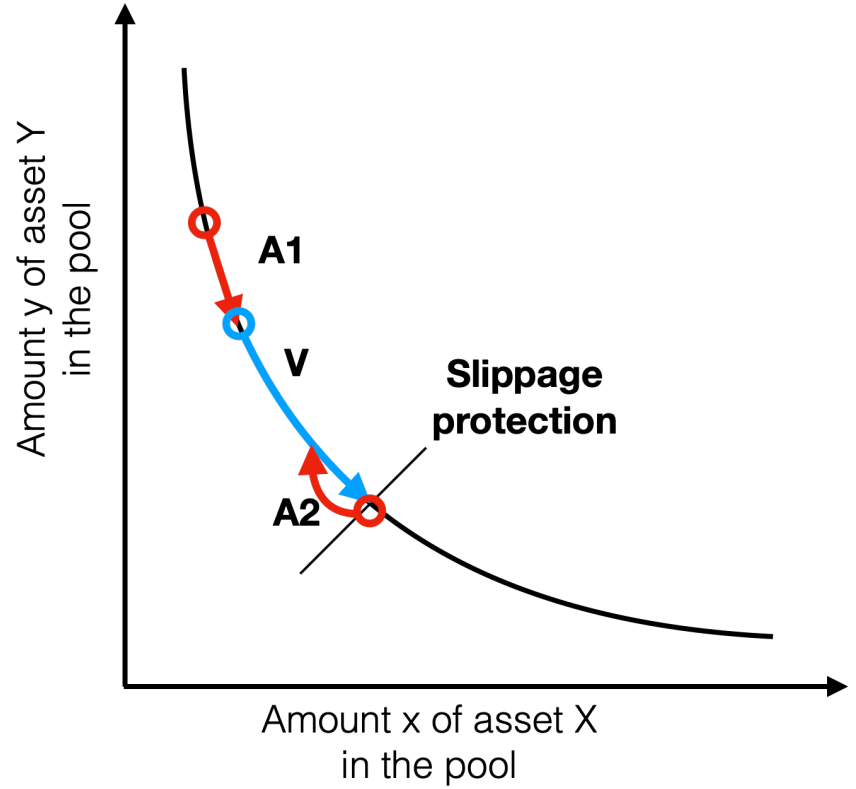
Multiple Adversaries

Break-even of the attacker becomes harder to attain

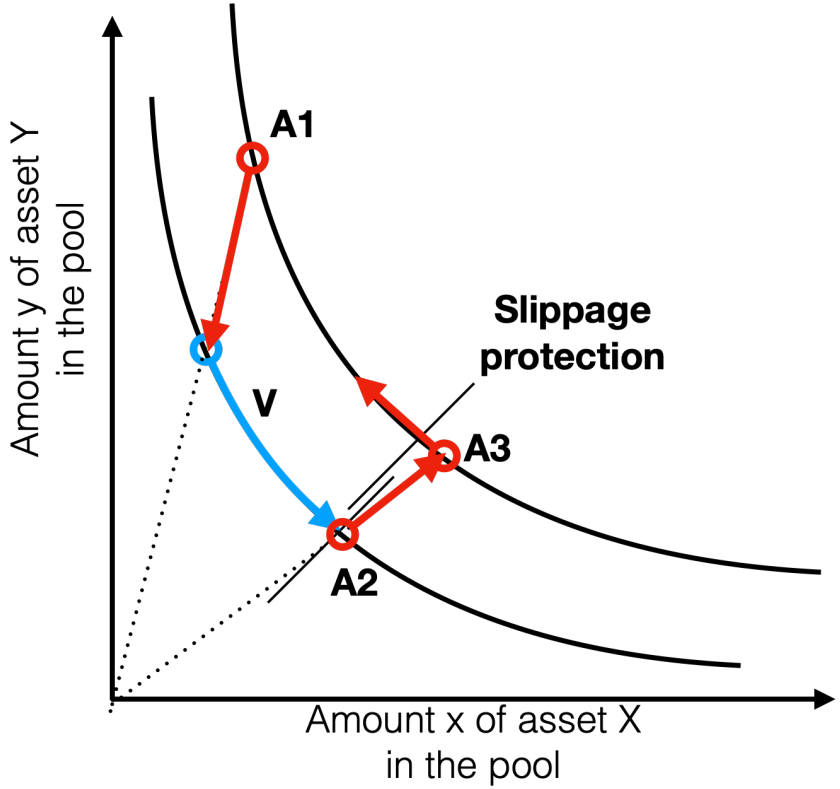


Advanced Sandwich Attack

Taker attacks Taker



Provider attacks Taker




AMM Arbitrage
https://defi-learning.org

Arbitrage

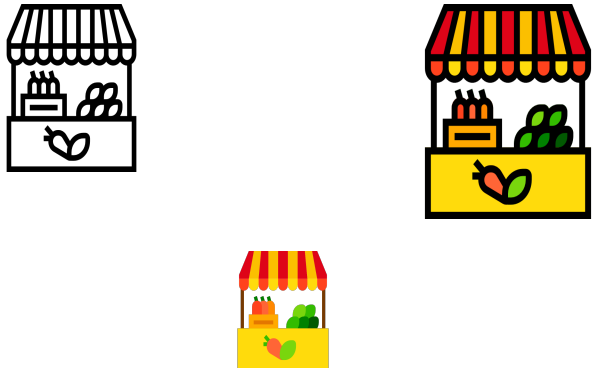
BTC/USD

BTC/USD

BTC/USD

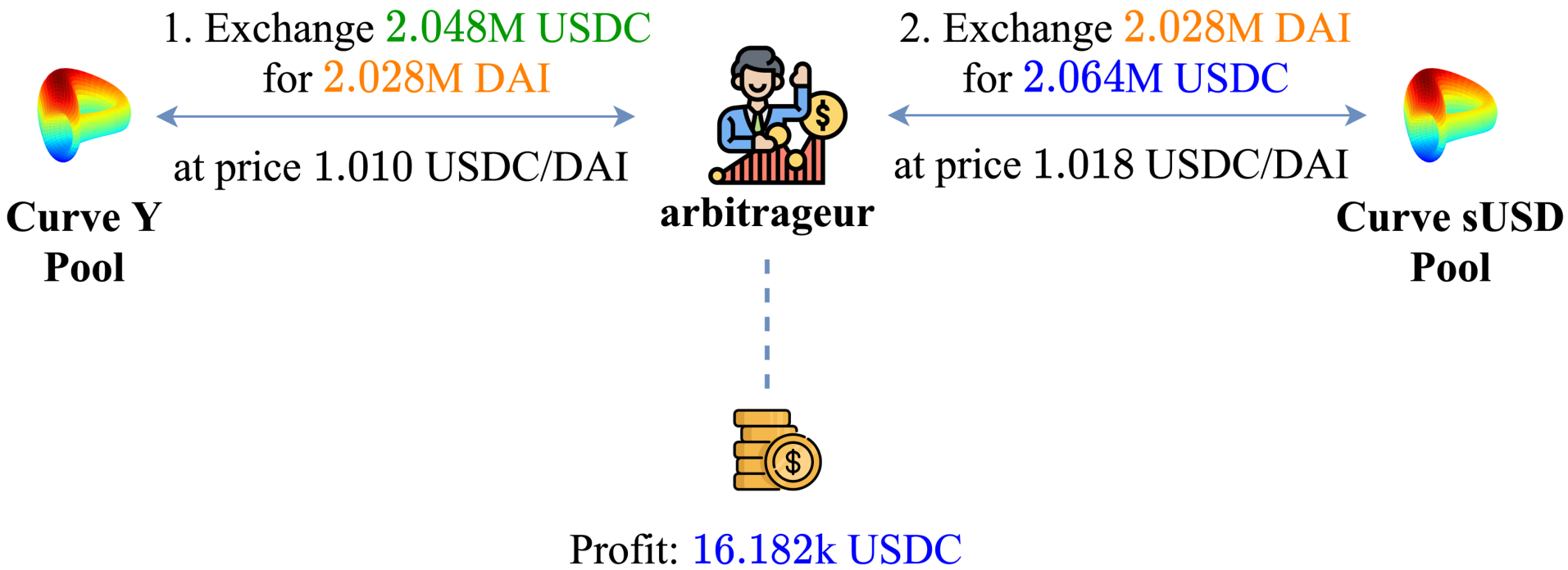
Arbitrage

- Multiple Markets with
  - the same assets X and Y
  - different prices for X and Y

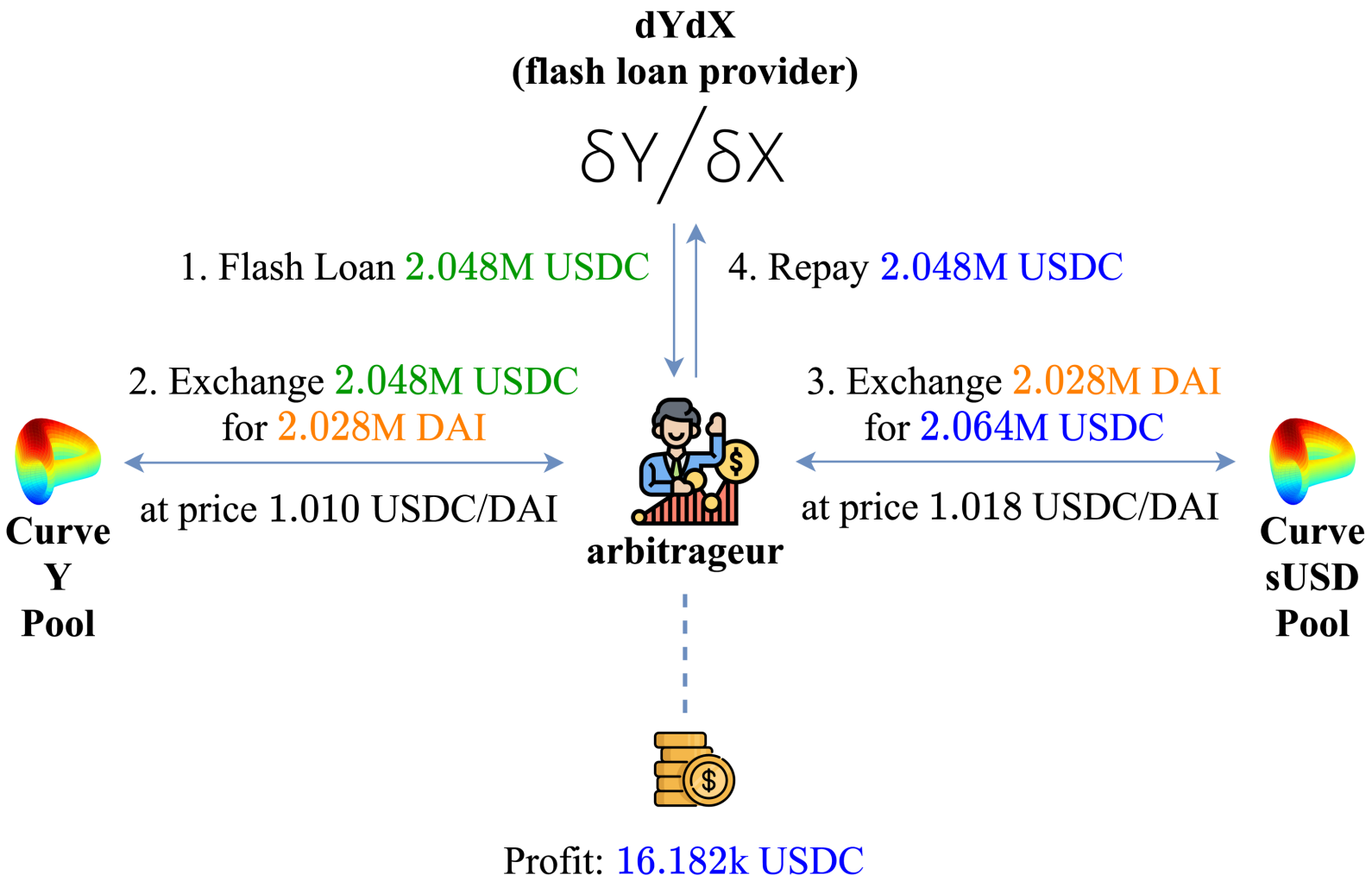


- Prices are synchronized by “arbitrageurs”
  - Profit from the price difference
    - Also referred to as “spread”
  - Requires to perform at least one transaction

Arbitrage on two markets



Arbitrage (with Flash Loan)



How to detect arbitrage/profitable opportunities?

- Bellman Ford Algorithm
  - Negative cycle detection
  - Works among multiple markets
  - Used in traditional finance and DeFi

- Theorem Solver (SMT) [DeFiPoser, S&P'21]
  - Needs to encode the DeFi model
  - Apply heuristics for path pruning

AMM Impermanent Loss

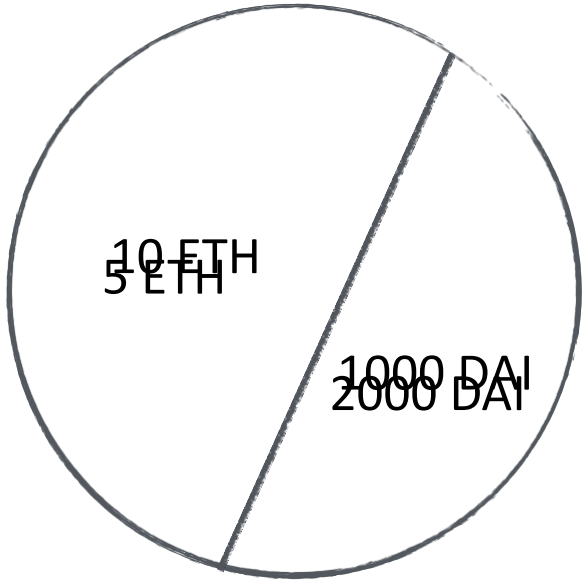
https://defi-learning.org

Impermanent Loss Example

2. Price increase of ETH
1 ETH == 400 DAI

1 ETH == 100 DAI

1. Add liquidity
1 ETH, 100 DAI
== 200 USD
== 10% of pool



ETH/DAI Pool

ETH

for DAI

Arbitrage

Realisation of IL:
1 ETH + 100 USD == 500 USD
→ Alice „lost“ 100 USD

3. Withdraw liquidity
10%== 0.5 ETH, 200 DAI
== 400 USD

Impermanent Loss

- Impermanent == not permanent
  - Realized upon withdraw only!
- IL can result in total loss
  - Trading fees may compensate
  - Liquidity mining may compensate
- Possible Solutions?
  - Challenging
  - Change of the bonding curve