Selecting your parents in the Tangle

Quentin Bramas bramas@unistra.fr

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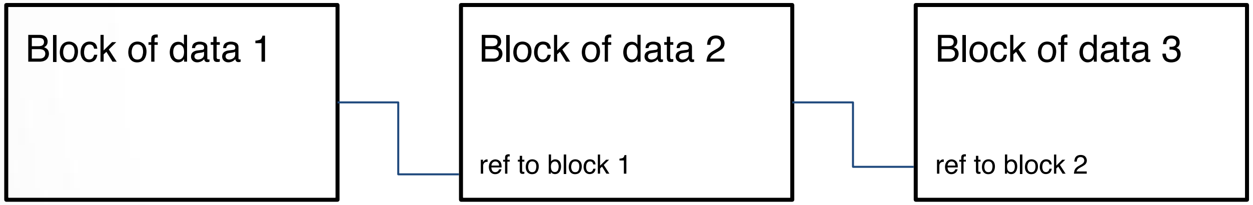
Introduction

Blockchain:



Block of data 1

Block of data 2

ref to block 1

Block of data 3

ref to block 2

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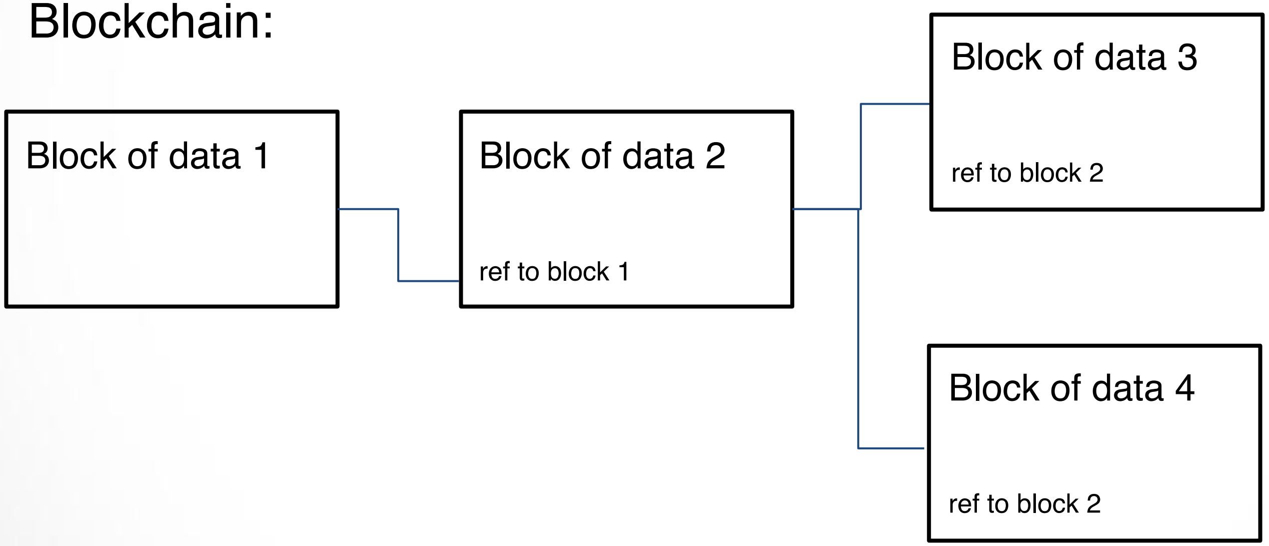

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Block of data 3

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Block of data 4

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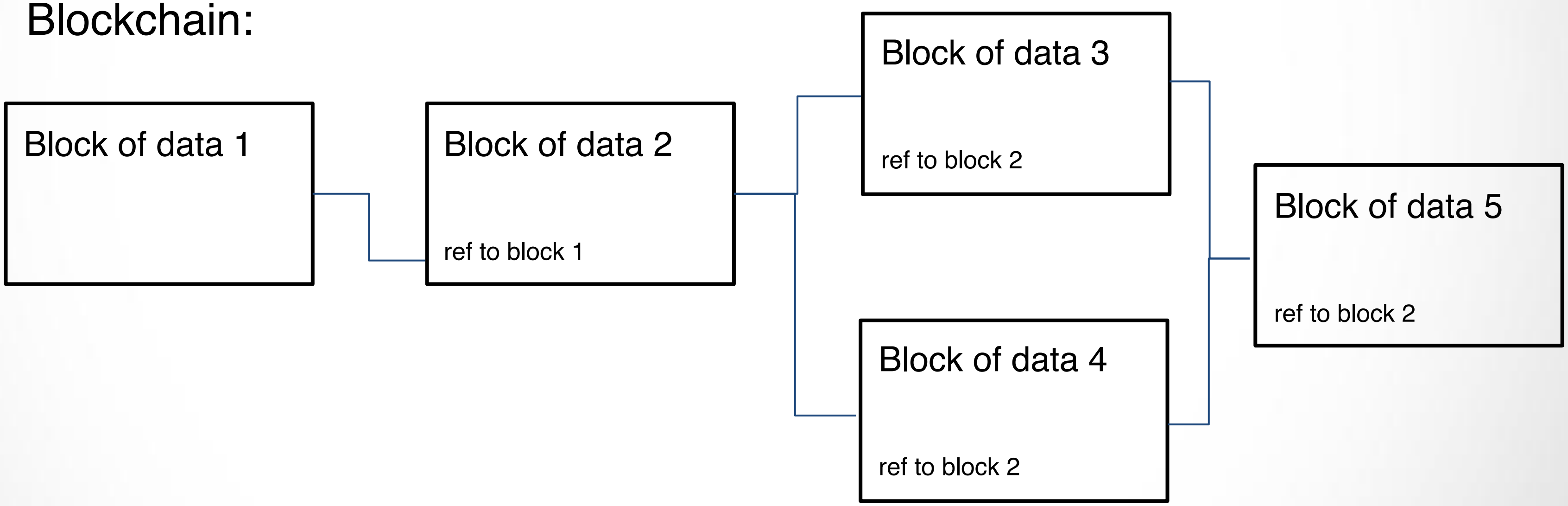

Block of data 1

Block of data 2

ref to block 1

Block of data 3

ref to block 2

Block of data 4

ref to block 2

Block of data 5

ref to block 2

The Tangle

The Tangle (IOTA)

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Each transaction is a small block that references two previous ones

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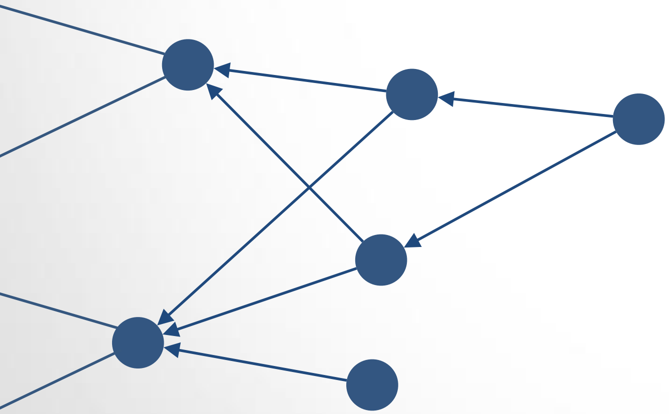

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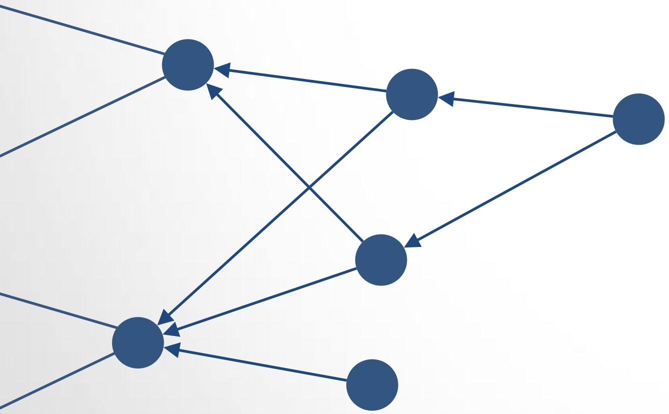

You come up with a DAG
(Directed Acyclic Graph)

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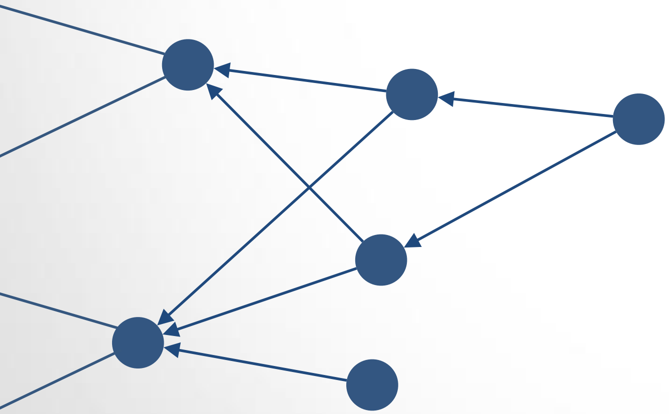

You come up with a DAG
(Directed Acyclic Graph)

You're only limited by bandwidth and storage

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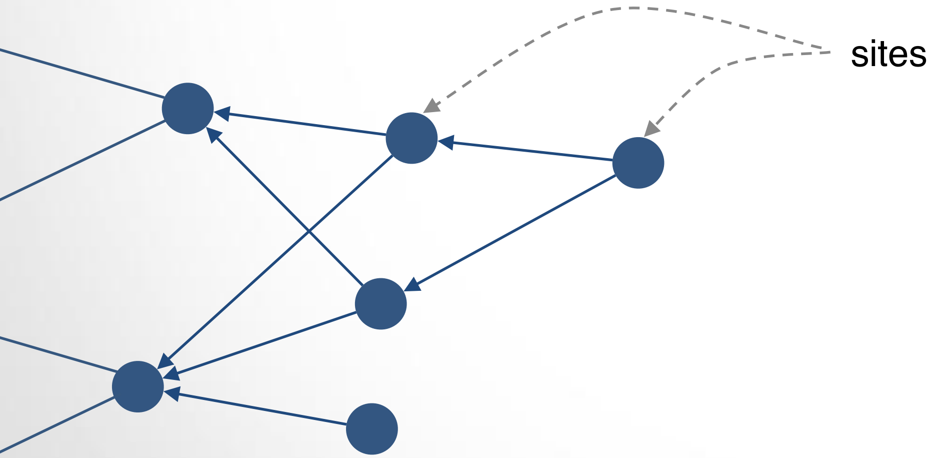

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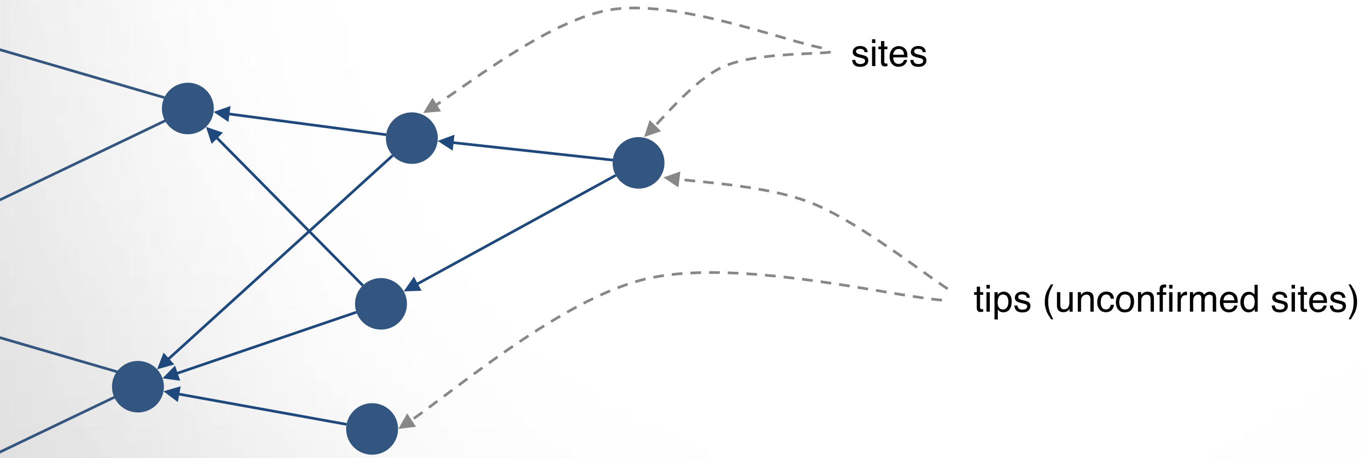

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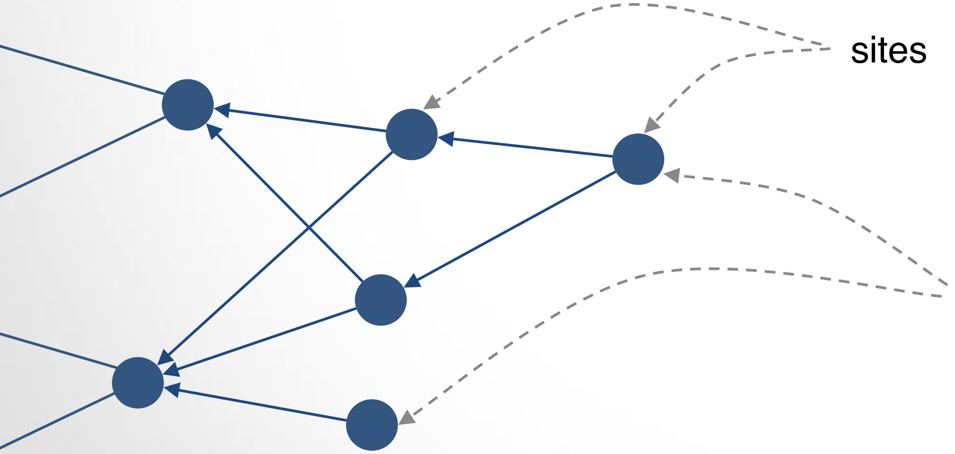

sites

tips (unconfirmed sites)

A new site and its parents should not create conflicts.

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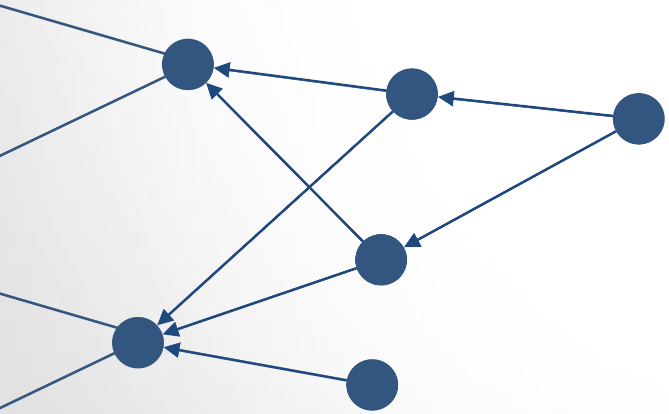
How to read a value?



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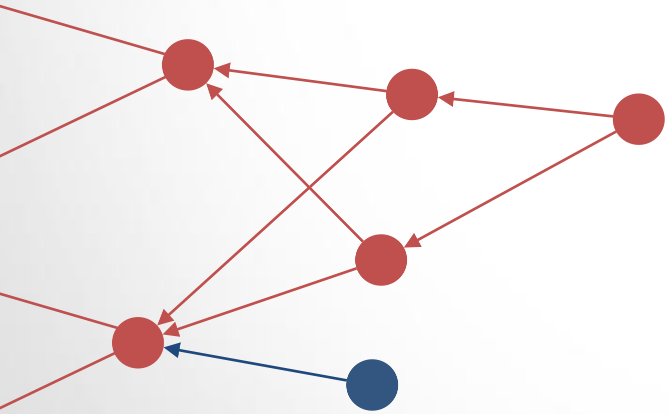


How to read a value?

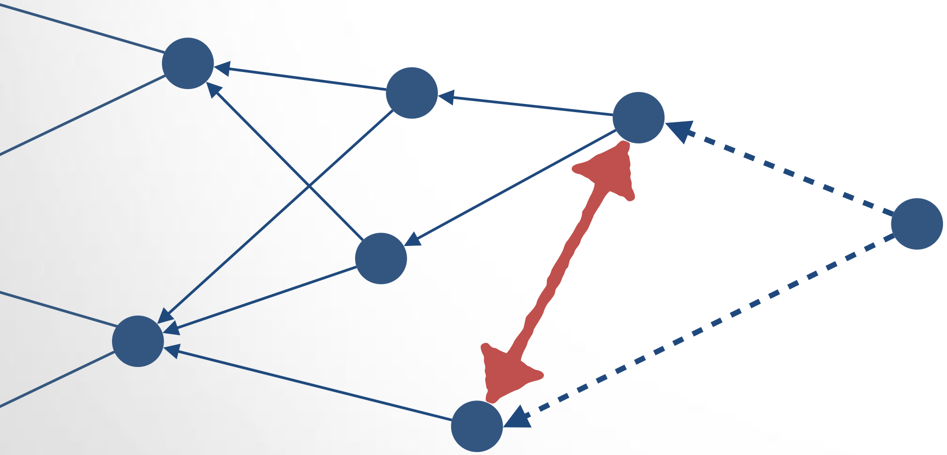
If you take a tip, you can order transactions and do the same as in a blockchain

The Tangle

The Tangle (IOTA)

How to read a value?

What if tips are conflicting?



A new site cannot confirm conflicting sites

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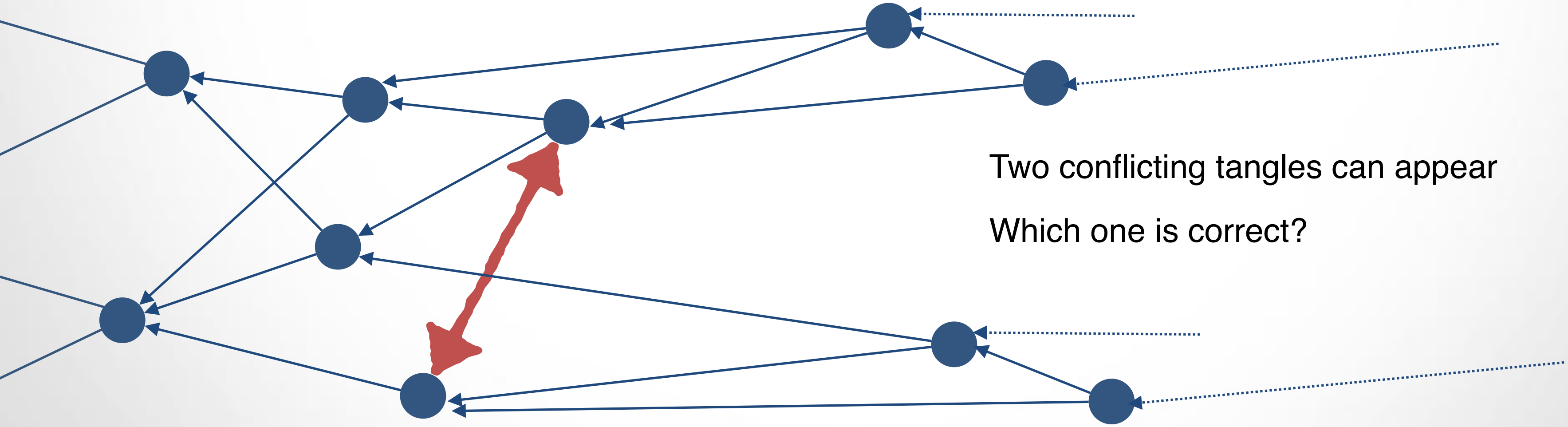

Two conflicting tangles can appear

Which one is correct?

The Tangle

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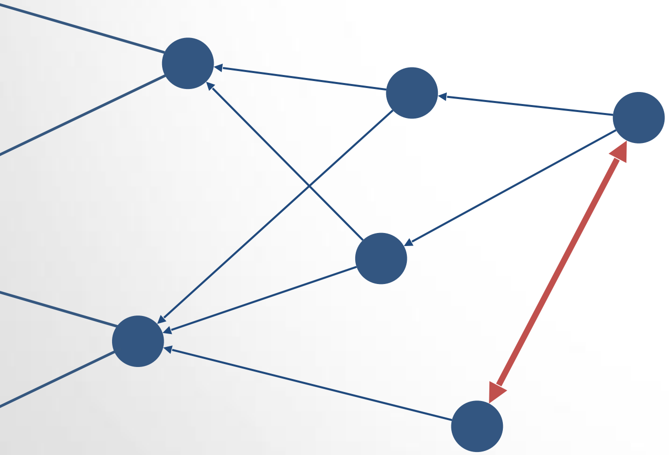
Tip Selection Algorithm (TSA):

- so we know how to read values
- so we know where to extend the Tangle



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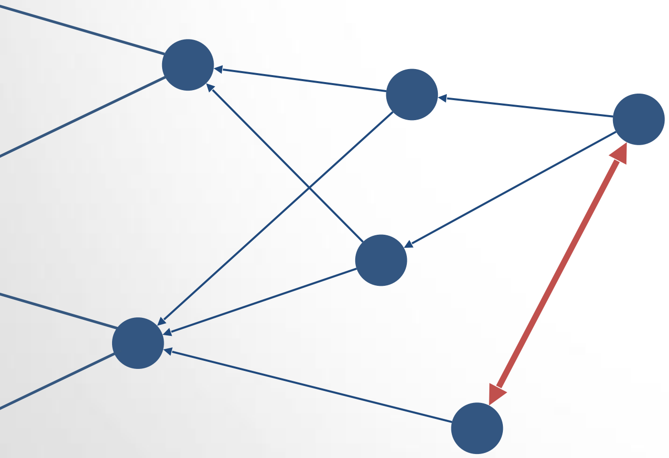

Tip Selection Algorithm (TSA):

- so we know how to read values
- so we know where to extend the Tangle

In Bitcoin, we read values from, and we try to extend, the longest chain. If you don't follow this, you'll lose money.

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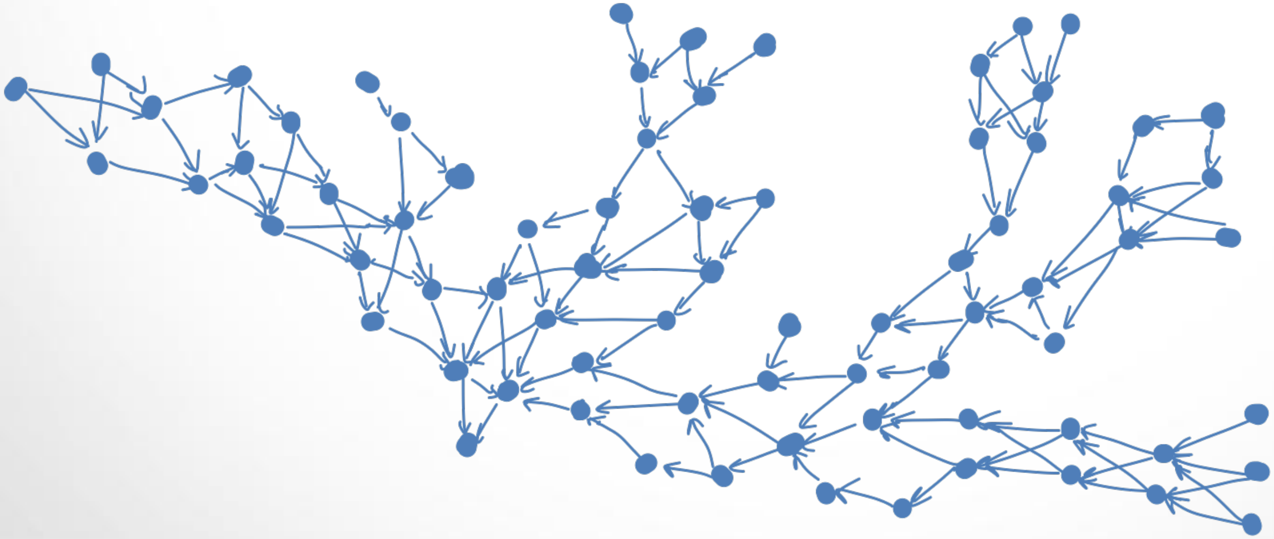

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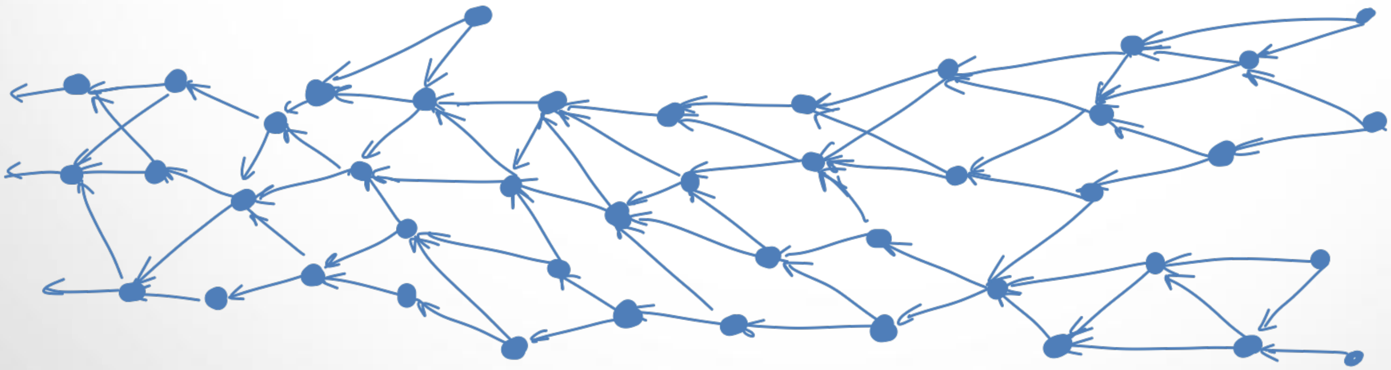
In the Tangle, forks are ok if not conflicting

So its better to have something like this



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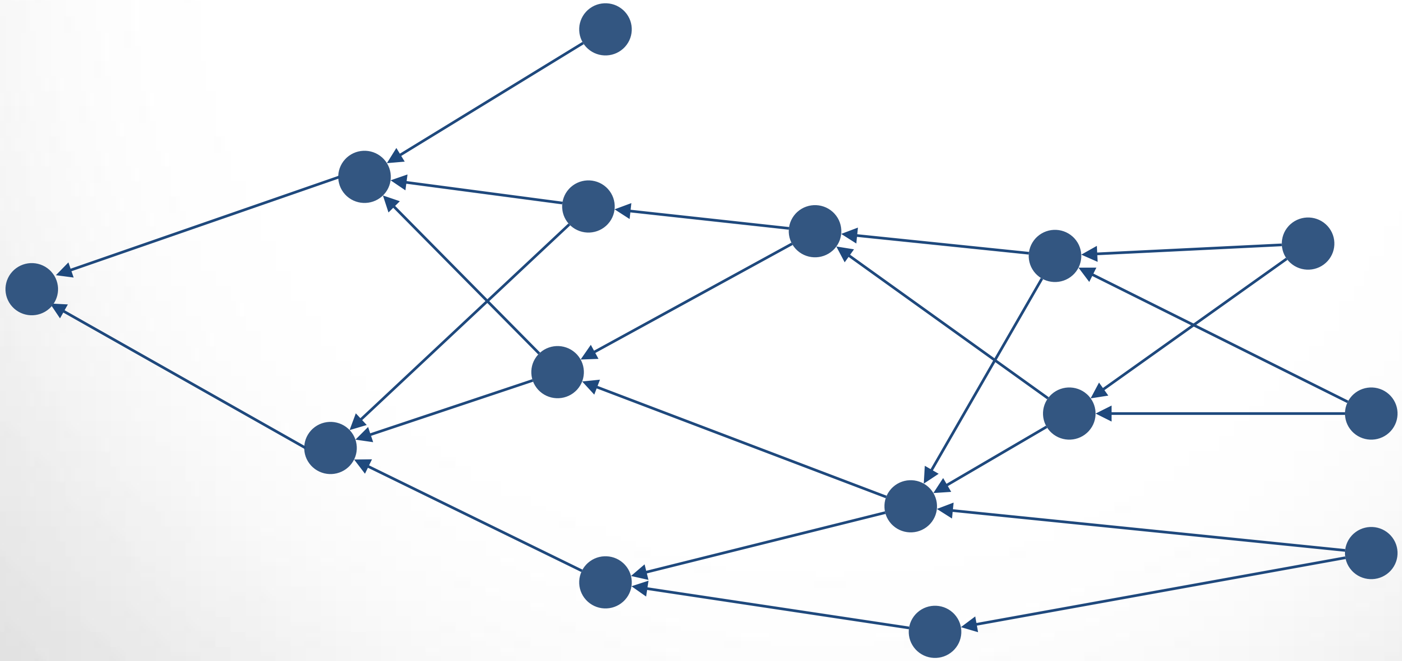

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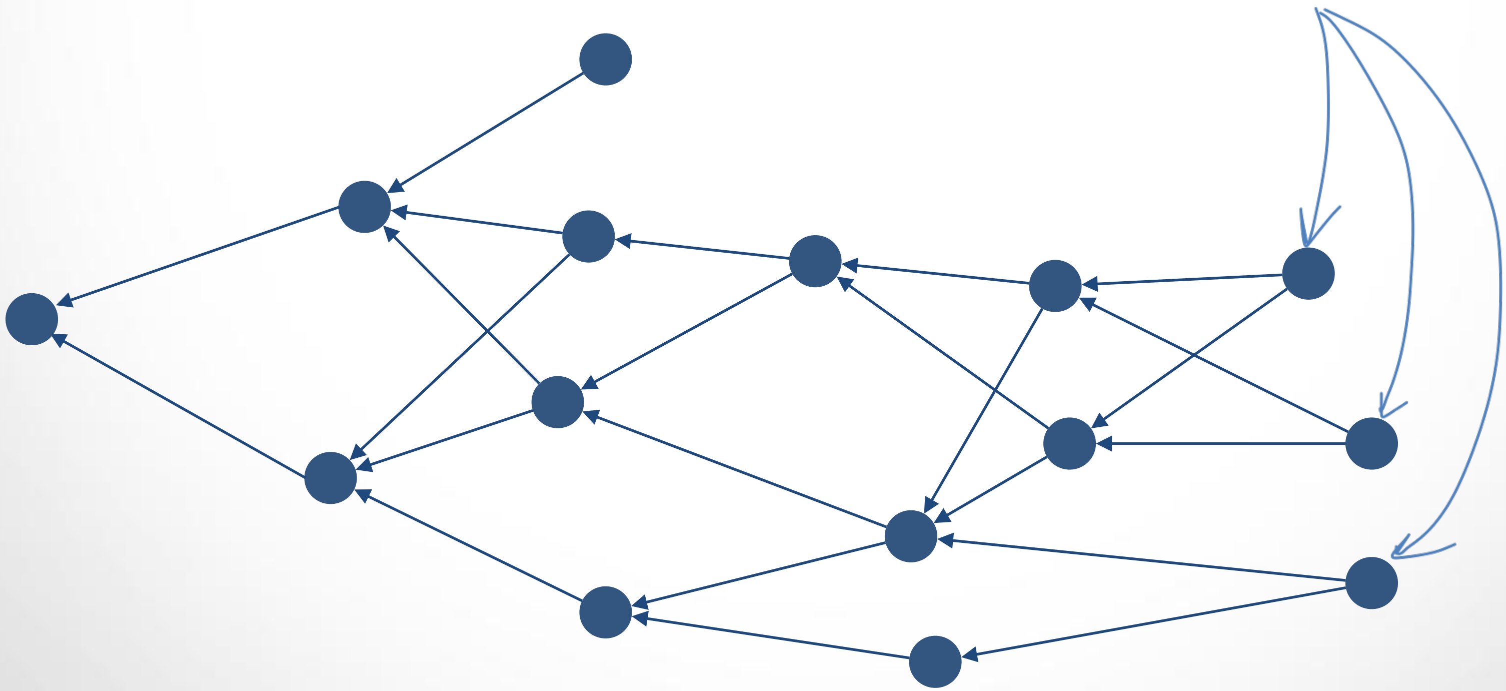

Should be chosen with higher probability

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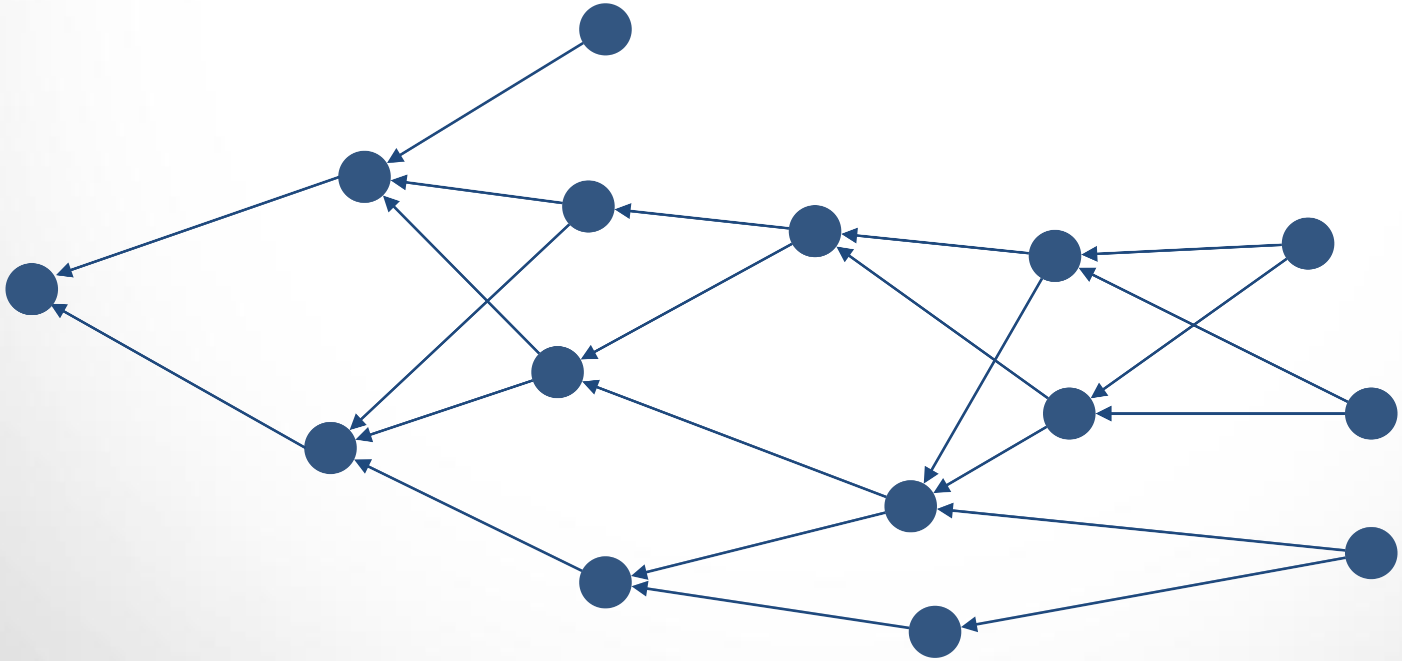
Compute cumulative weight to each site



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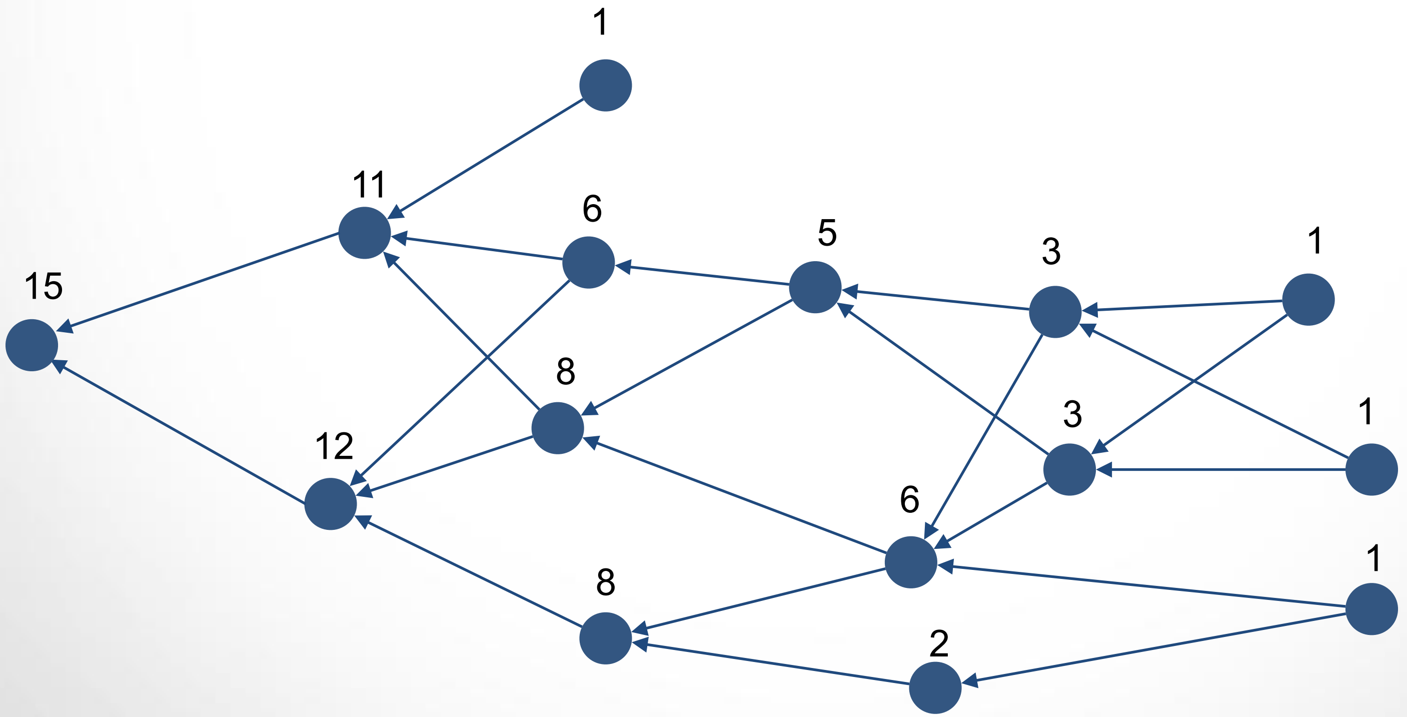

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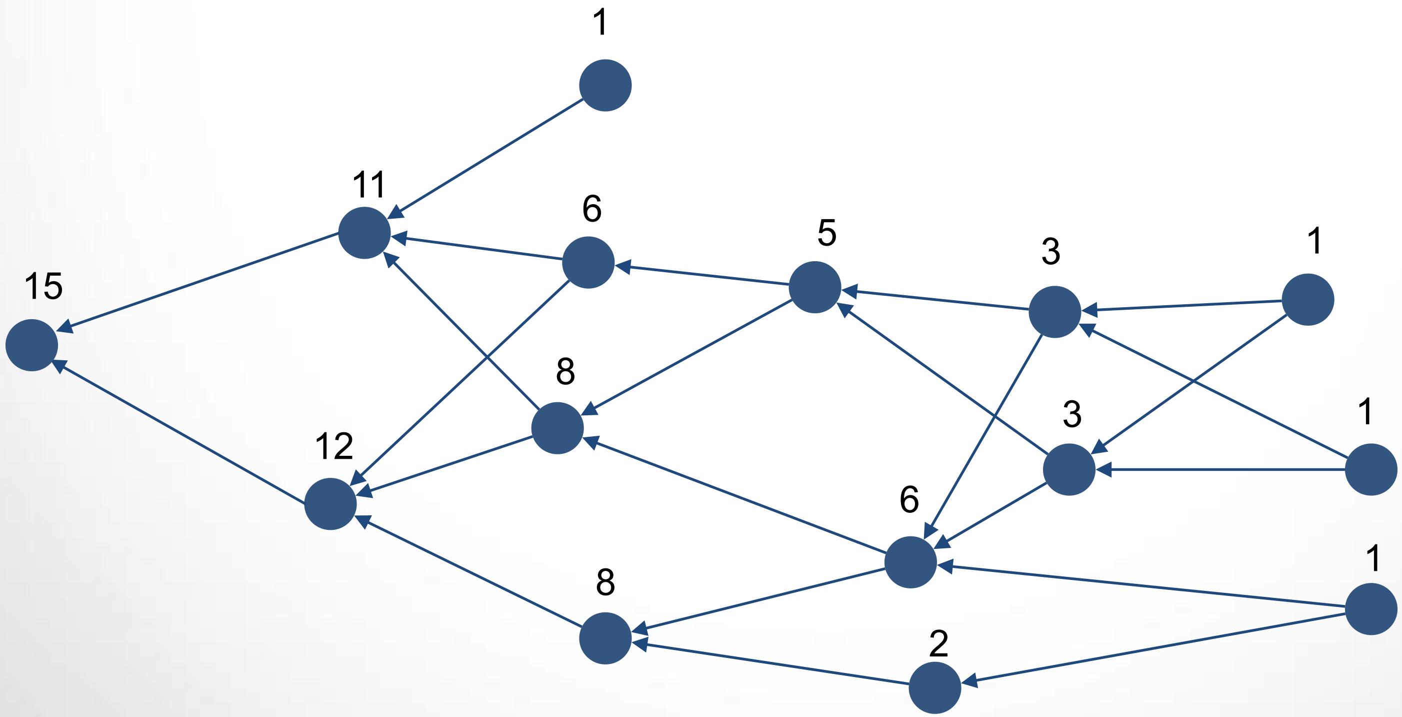
Compute cumulative weight to each site

Perform a random walk



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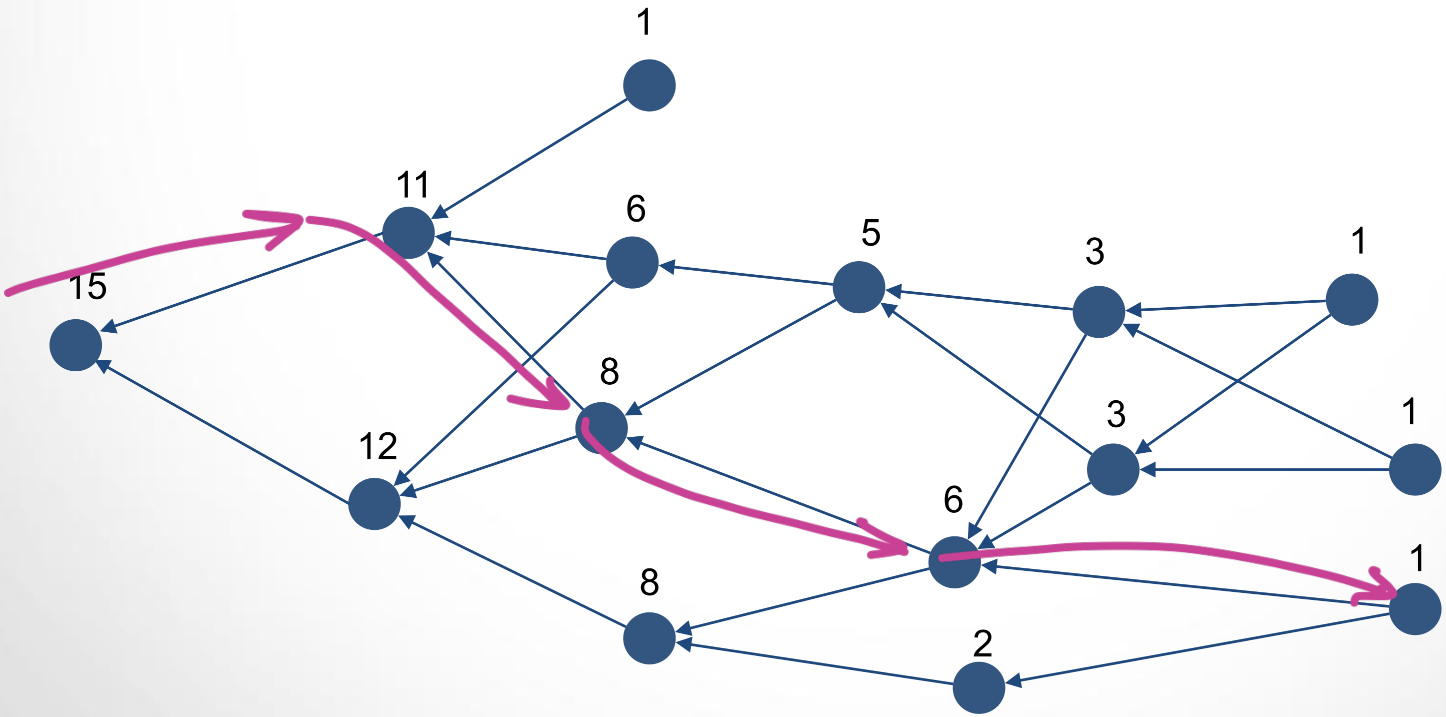

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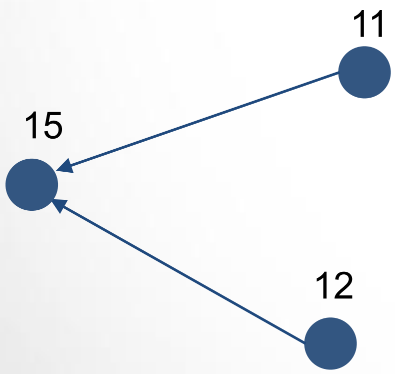

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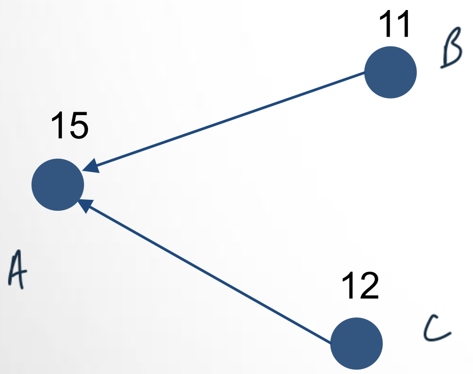

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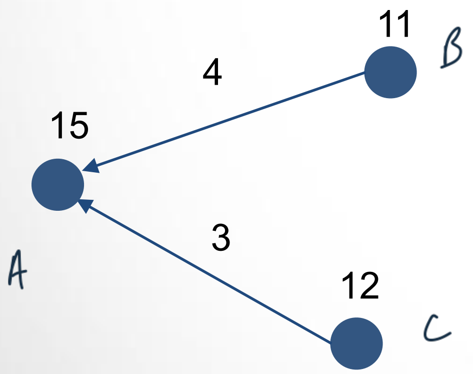

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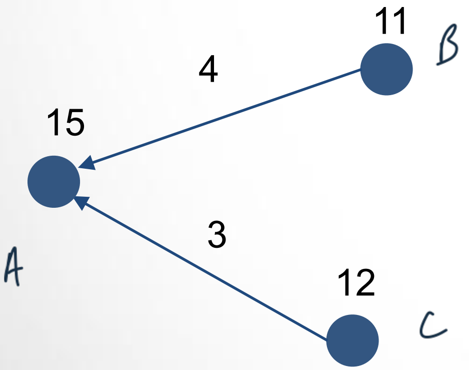

Transition function:

$$\mathbb{P}(A \rightsquigarrow B) = \frac{f(\Delta_{A,B})}{f(\Delta_{A,B}) + f(\Delta_{A,C})}$$

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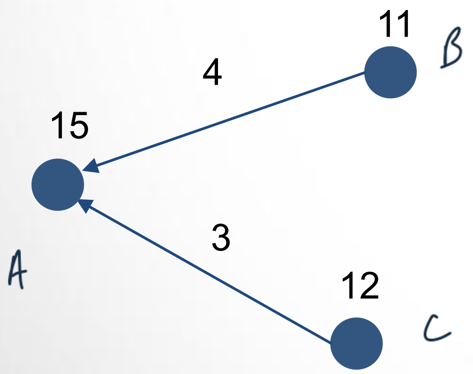

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MCMC

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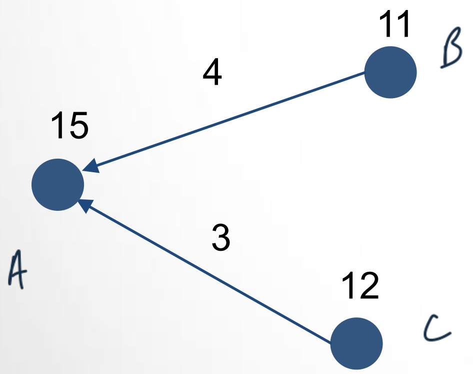

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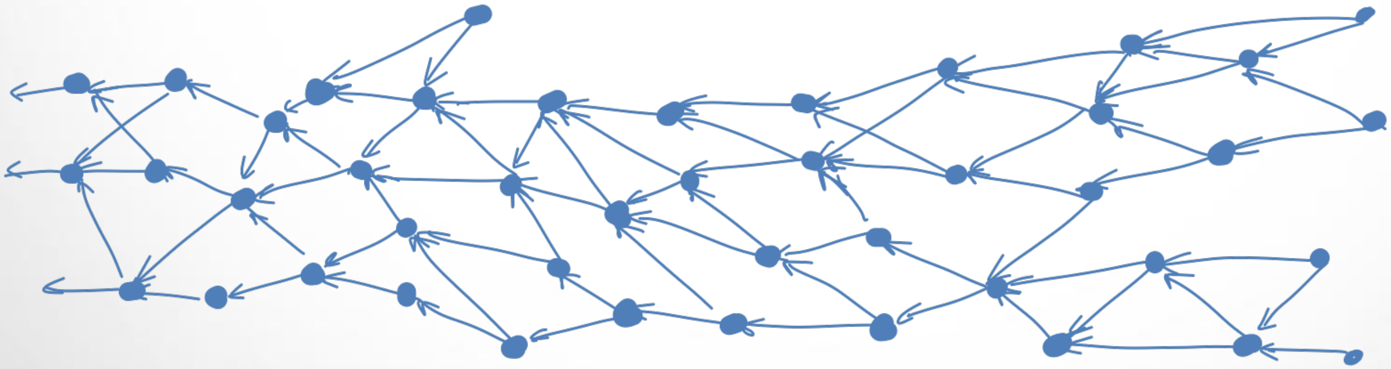

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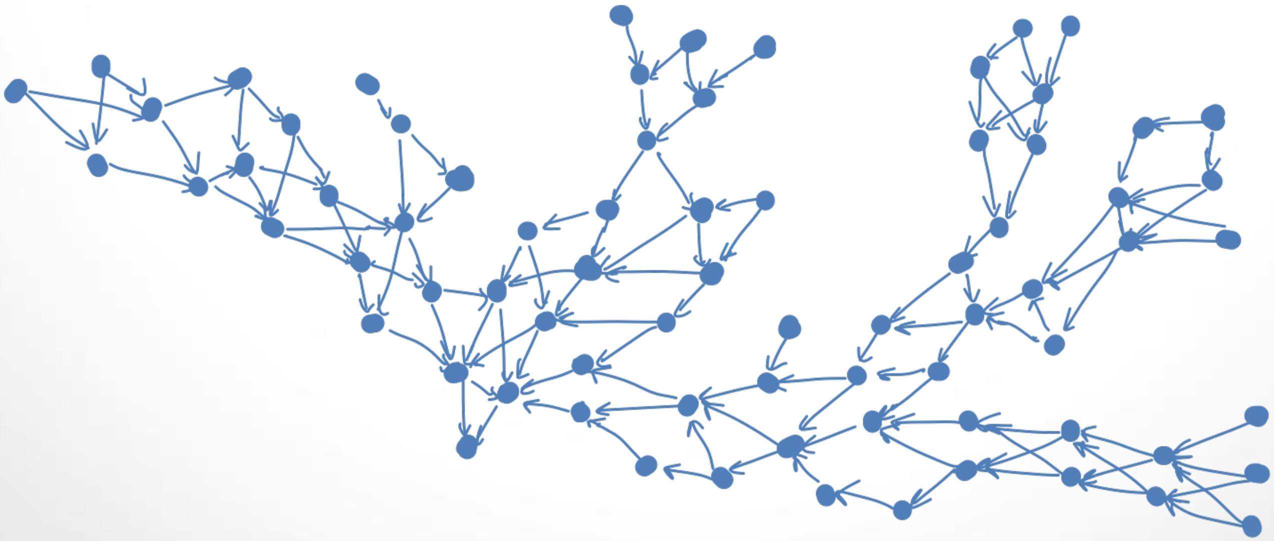

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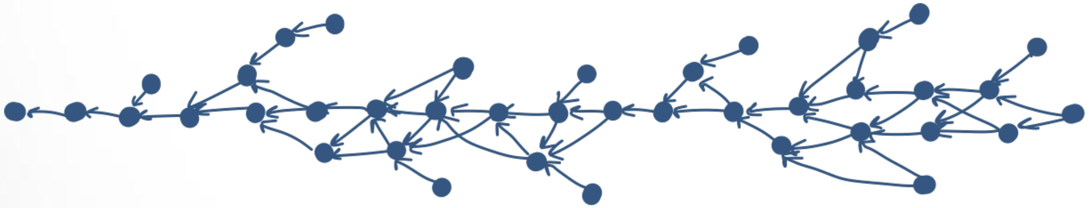

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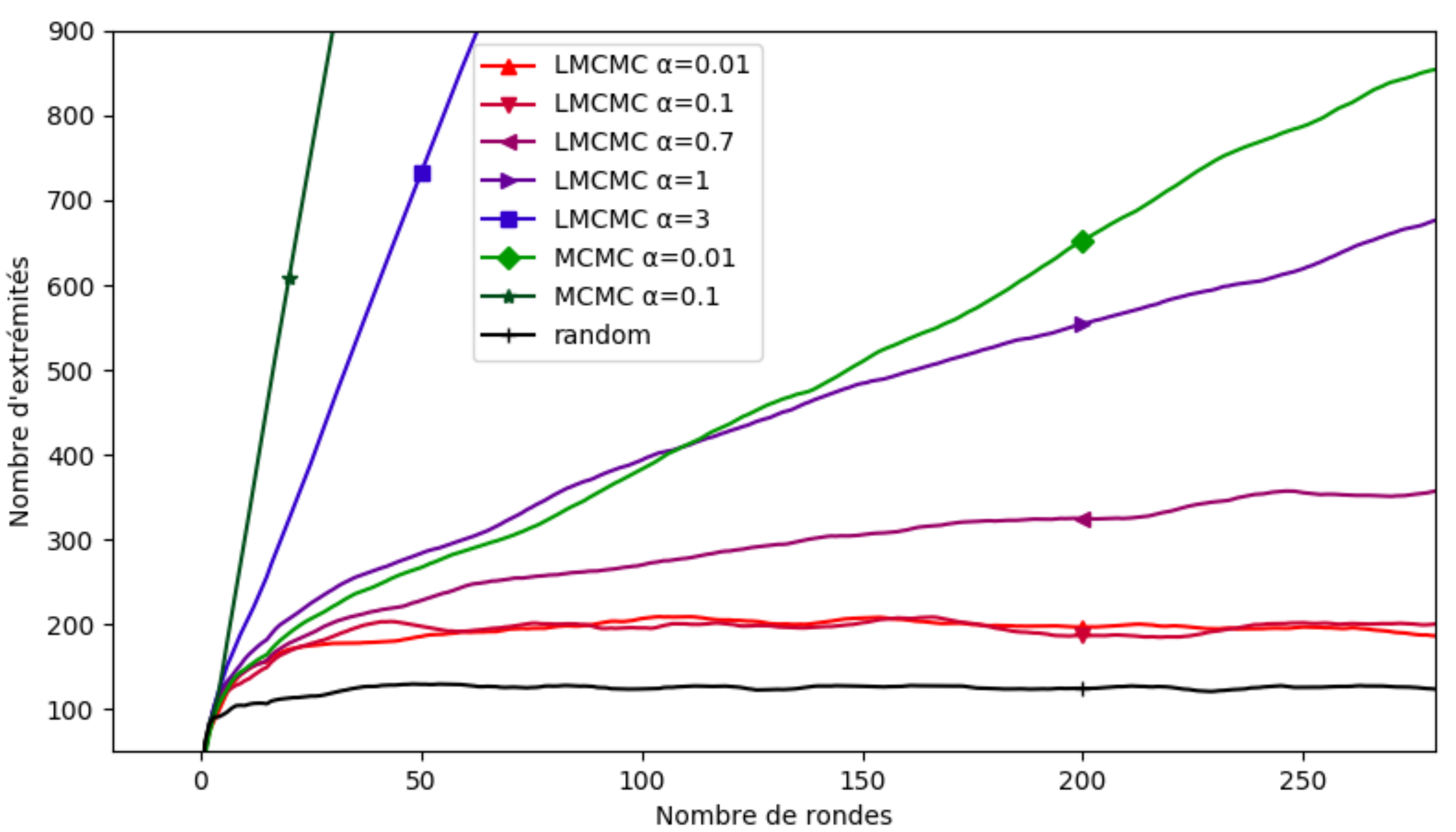

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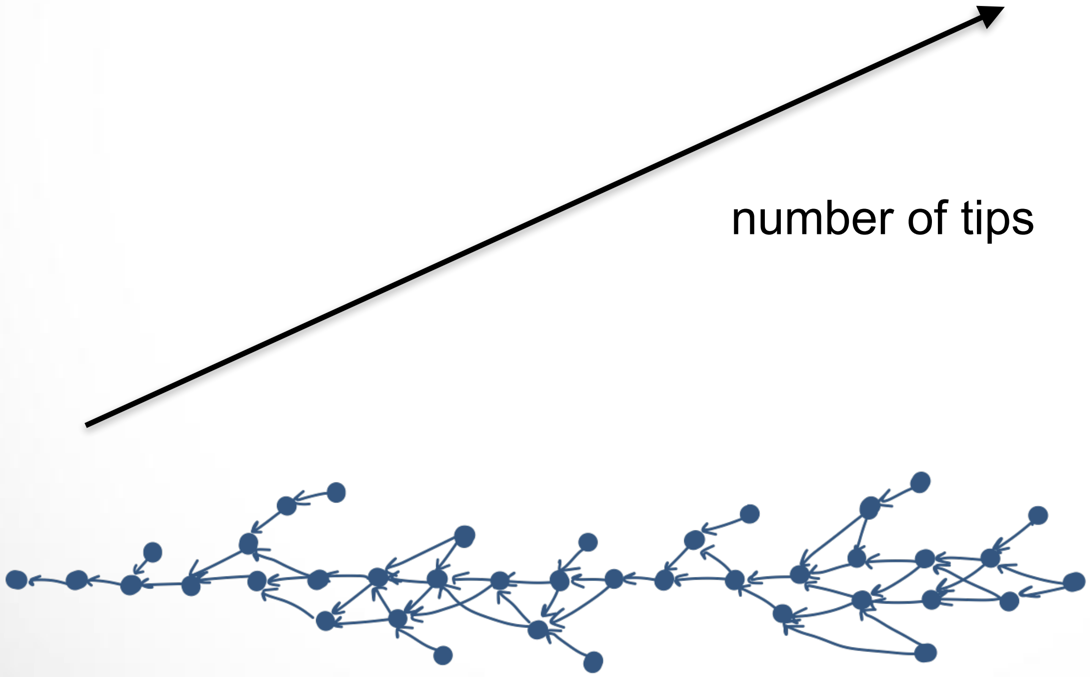

Parasite Chain Attack

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Double Spending Attack

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- Alice sends 10 IOTA to Bob for a sandwich

Parasite Chain Attack

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- Alice sends 10 IOTA to Bob for a sandwich
- Bob waits to see the transaction in the Tangle

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- Bob waits to see the transaction in the Tangle
- Bob gives Alice the sandwich
- Alice generates a lots of transactions so that her first transaction is discarded

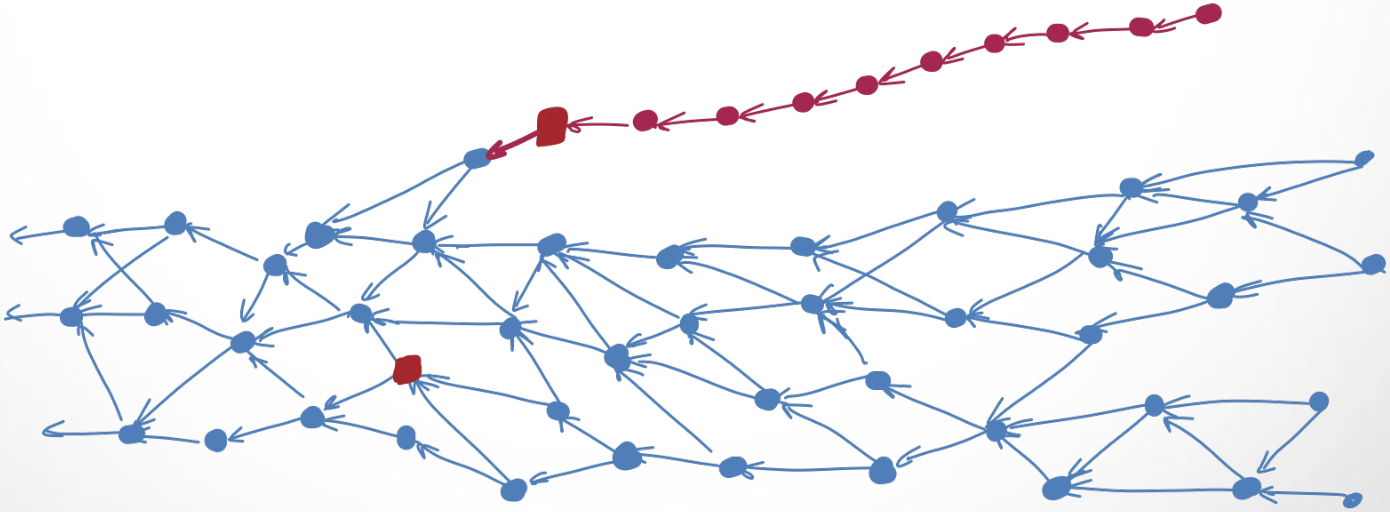
Parasite Chain Attack

Double Spending Attack

- Alice sends 10 IOTA to Bob for a sandwich
- Bob waits to see the transaction in the Tangle
- Bob gives Alice the sandwich
- Alice generates a lots of transactions so that her first transaction is discarded
- Alice eats the sandwich

Parasite Chain Attack

The parasite chain attack

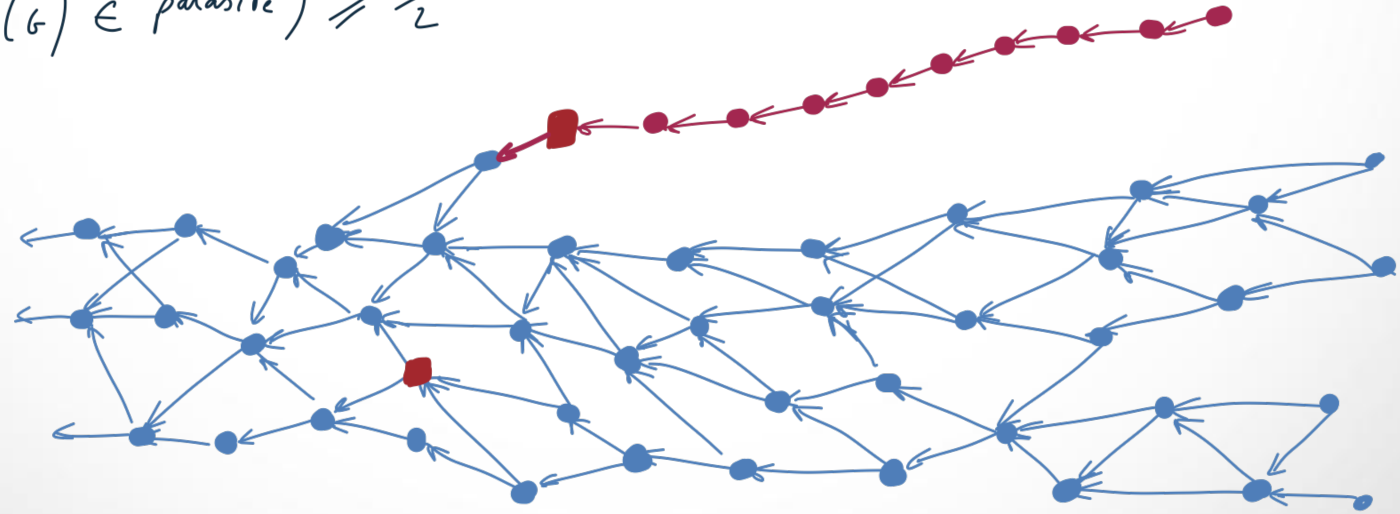


Parasite Chain Attack

The parasite chain attack

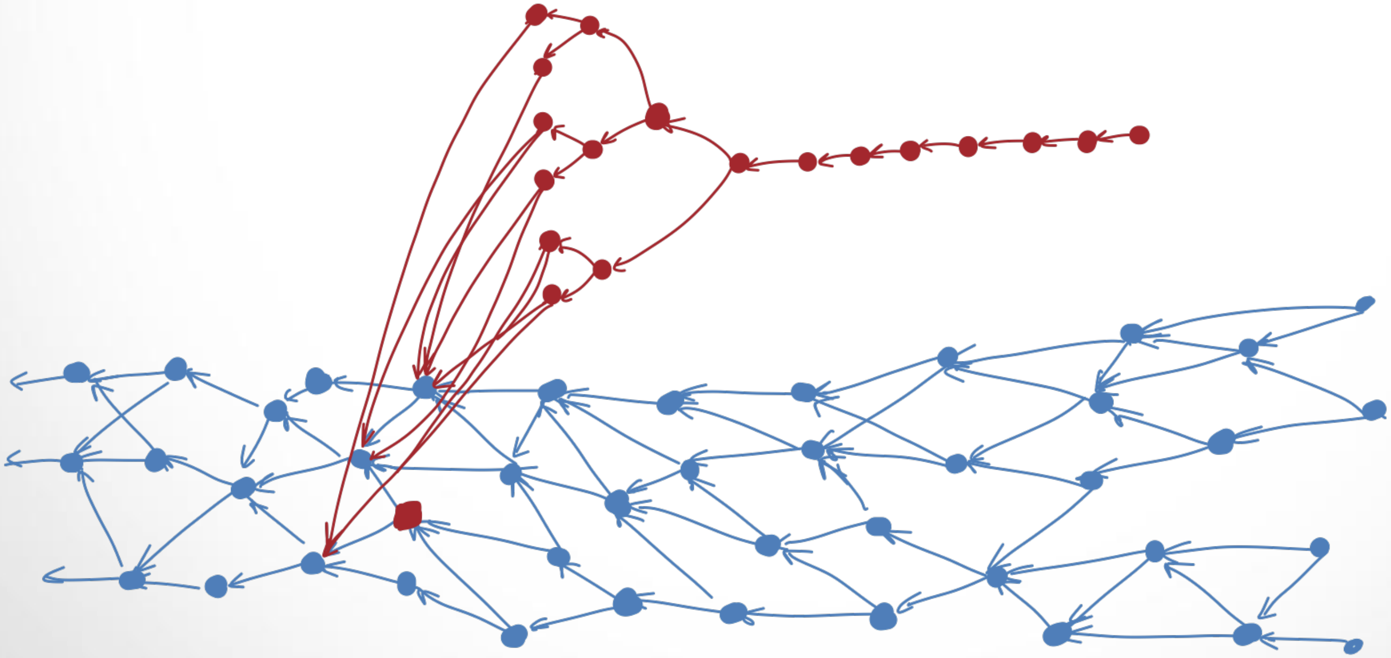
How many red site so that:

$$P(TSA(G) \in \text{parasite}) \geqslant 1/2$$



Parasite Chain Attack

Theoretical analysis



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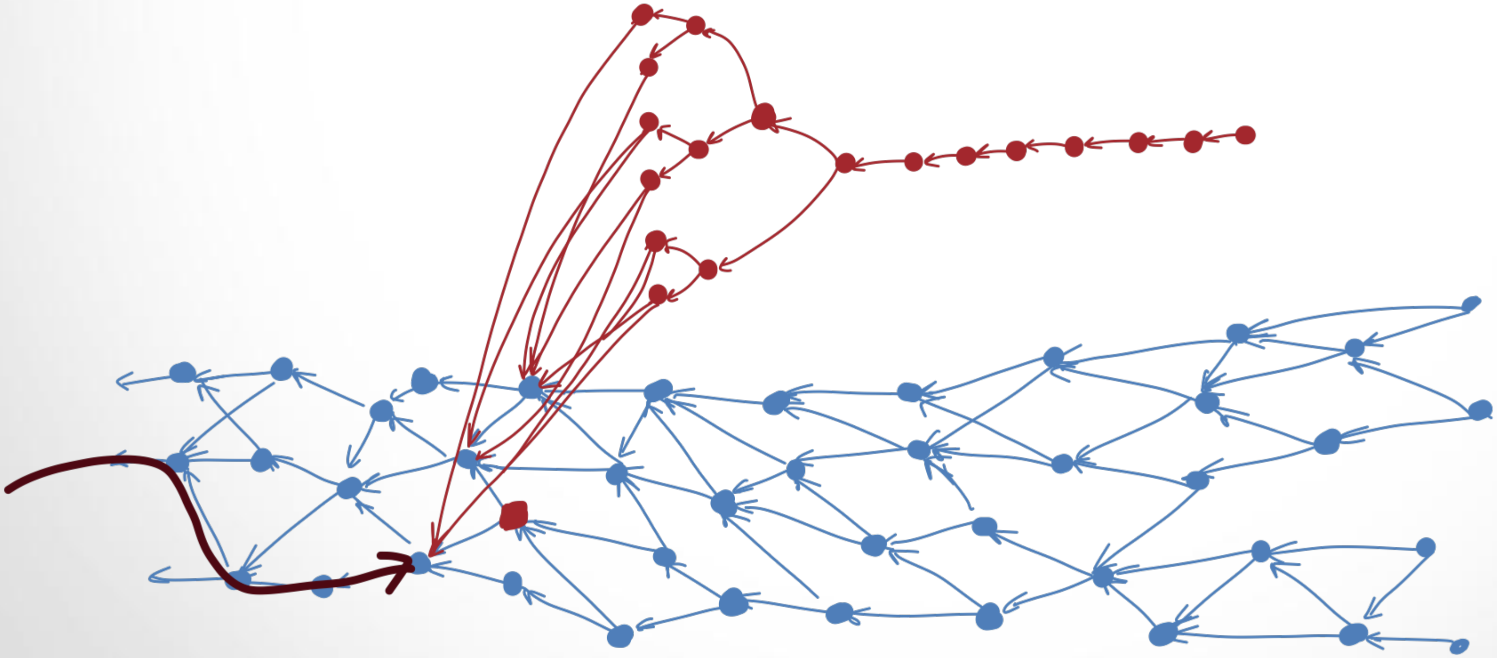

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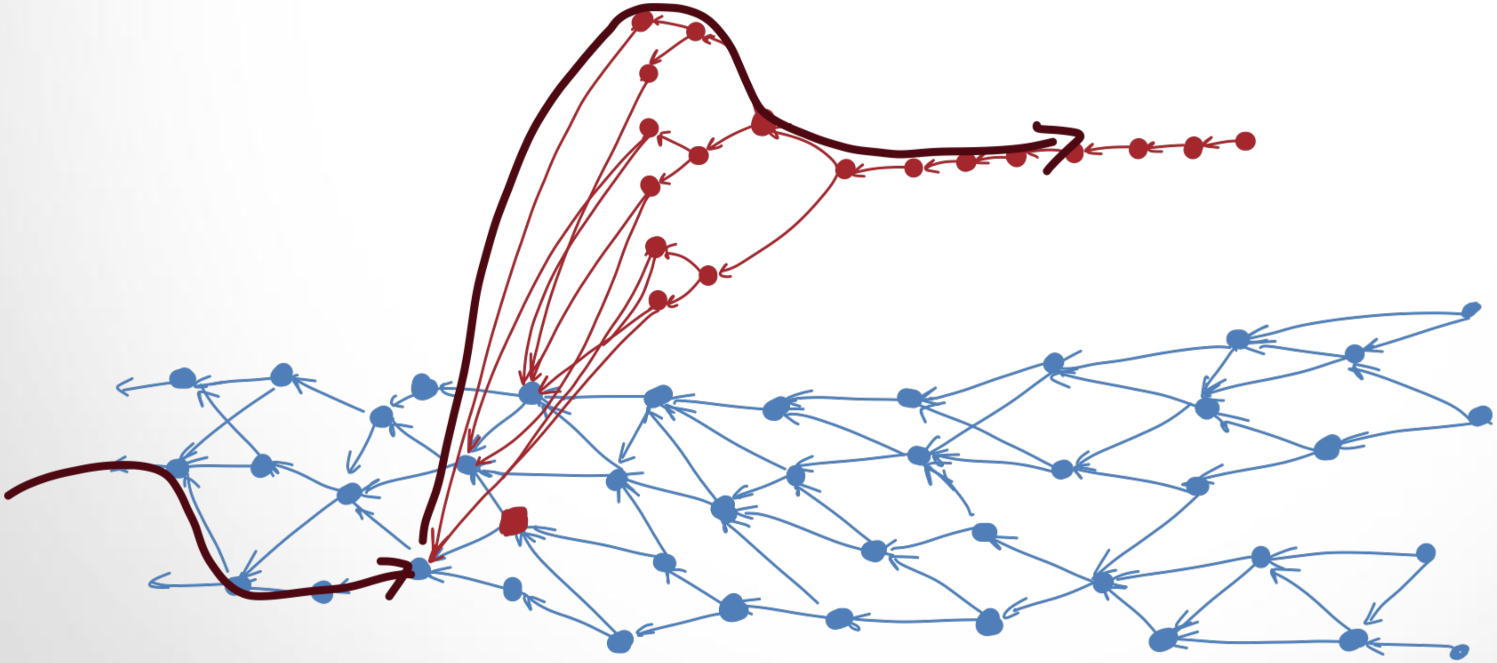

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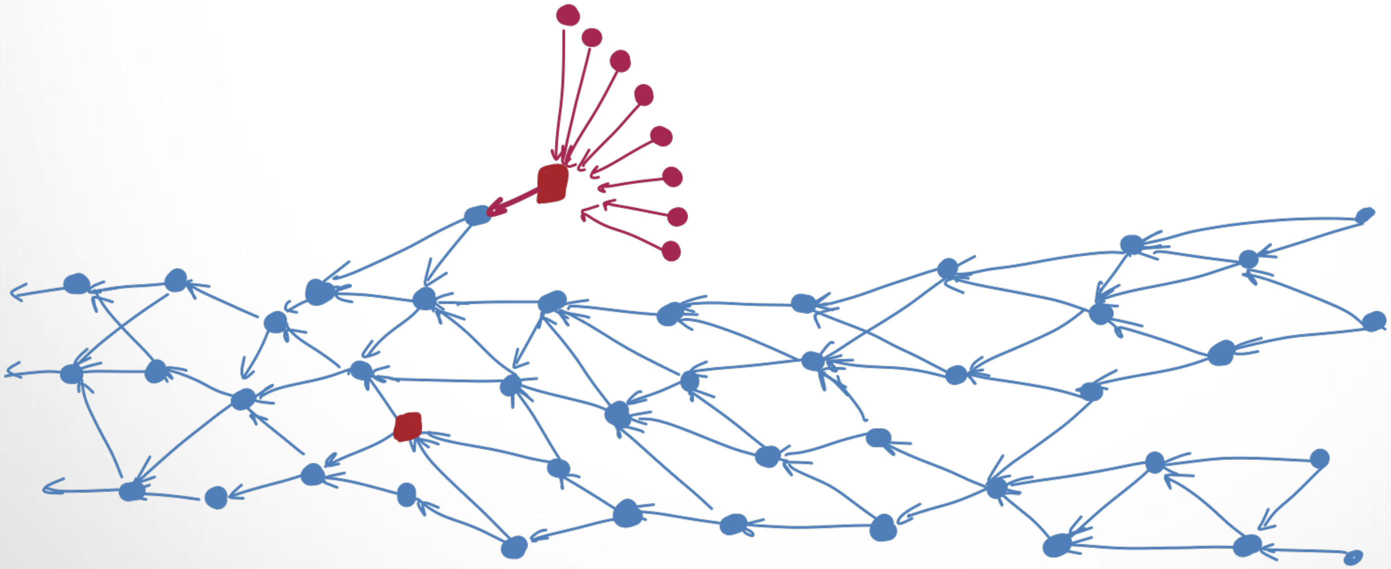

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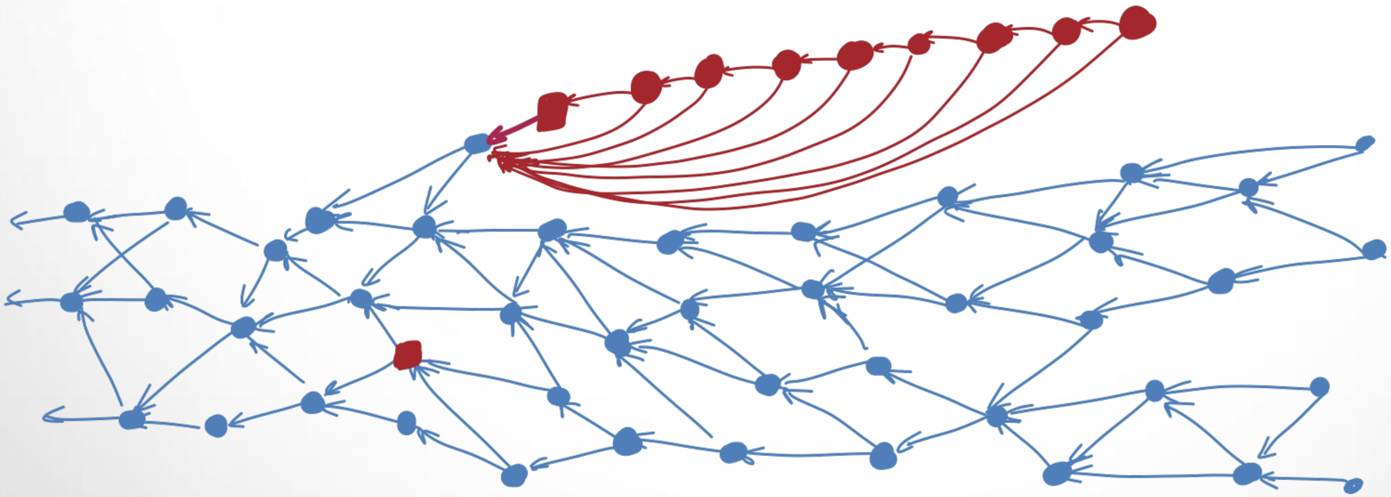
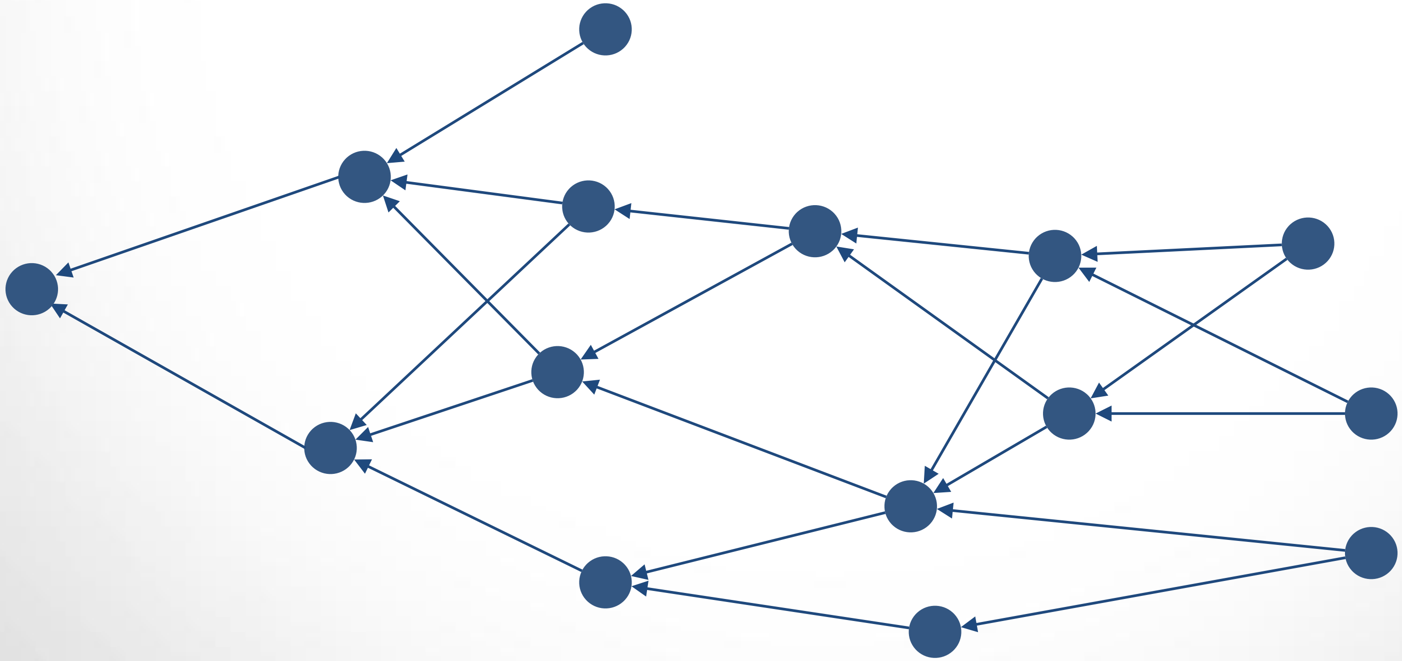


Real cumulative weight



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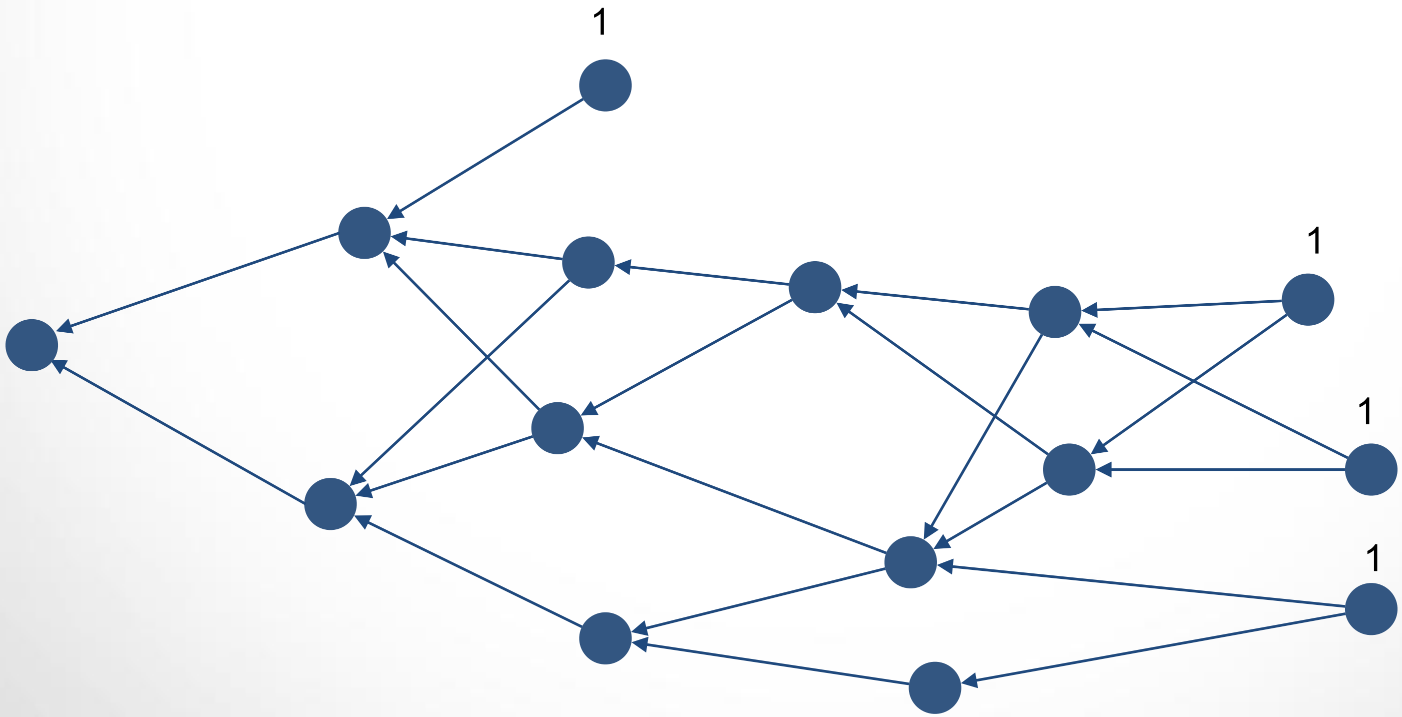

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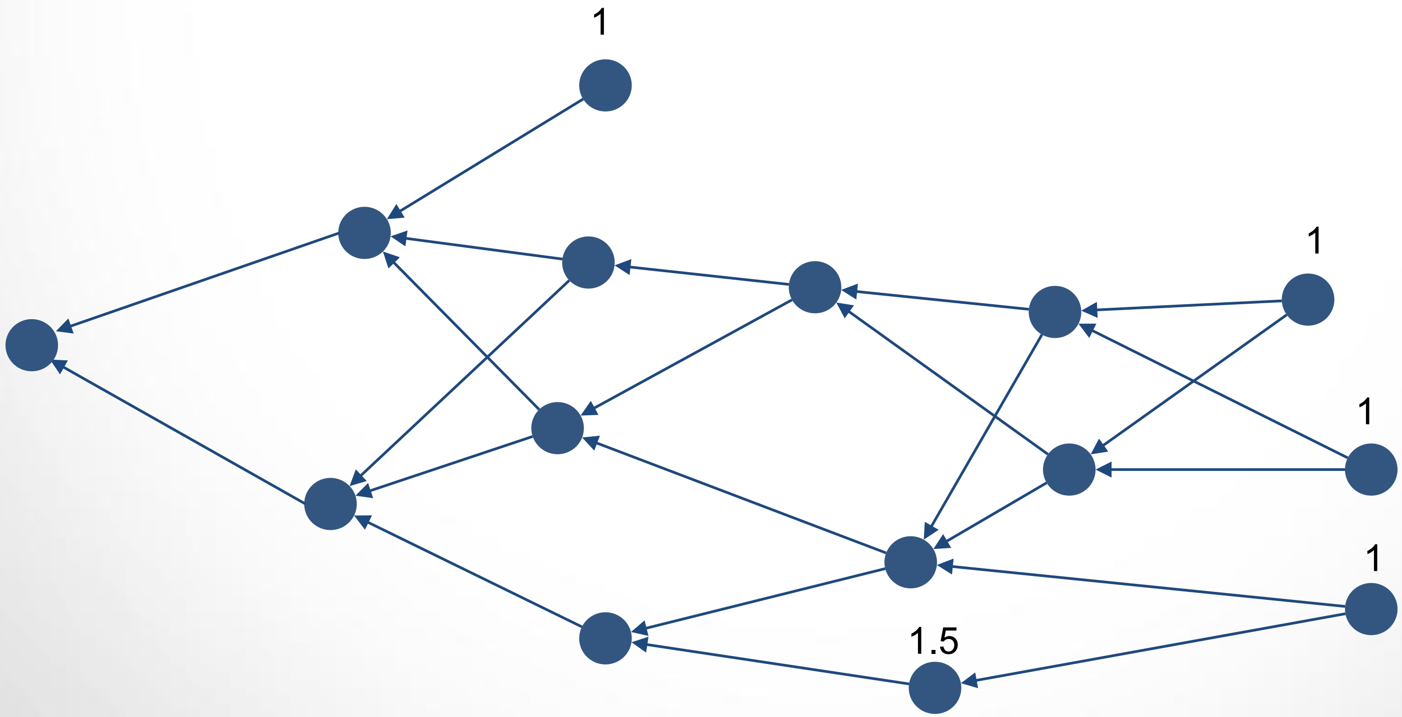

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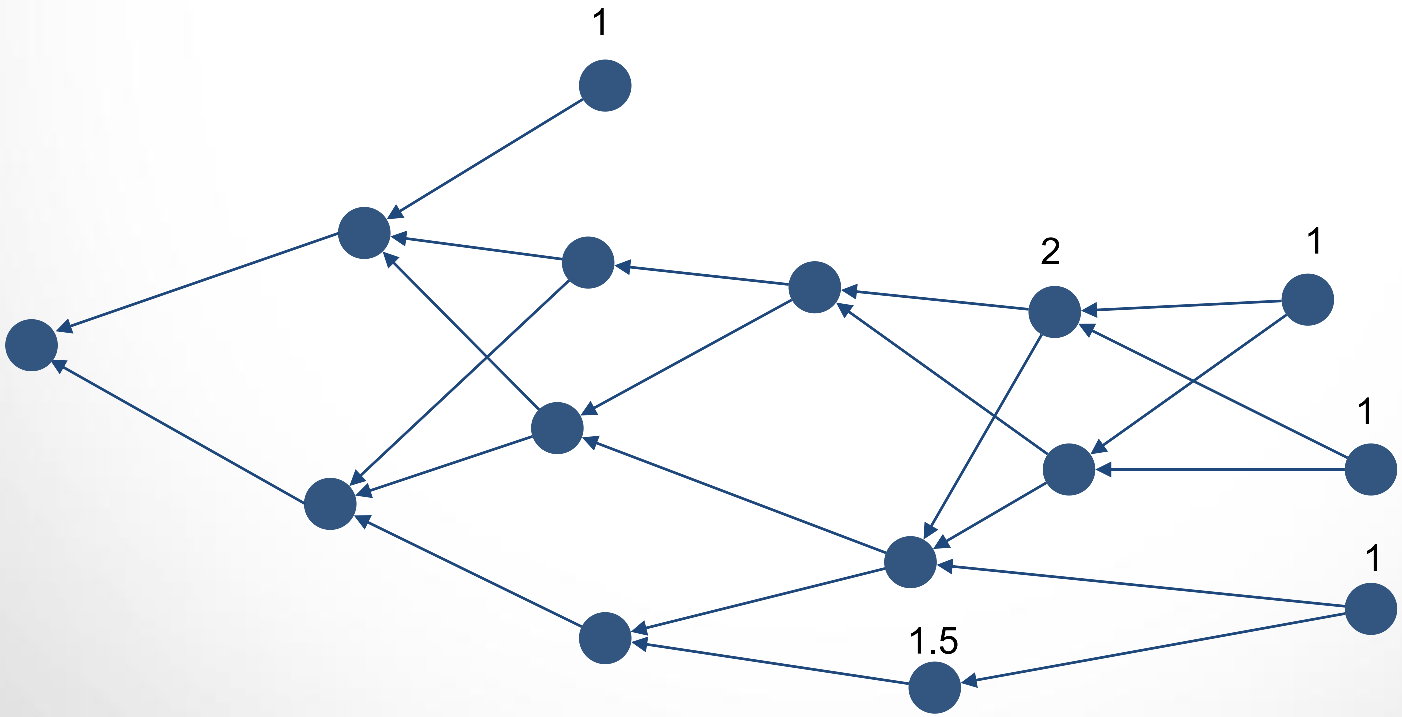

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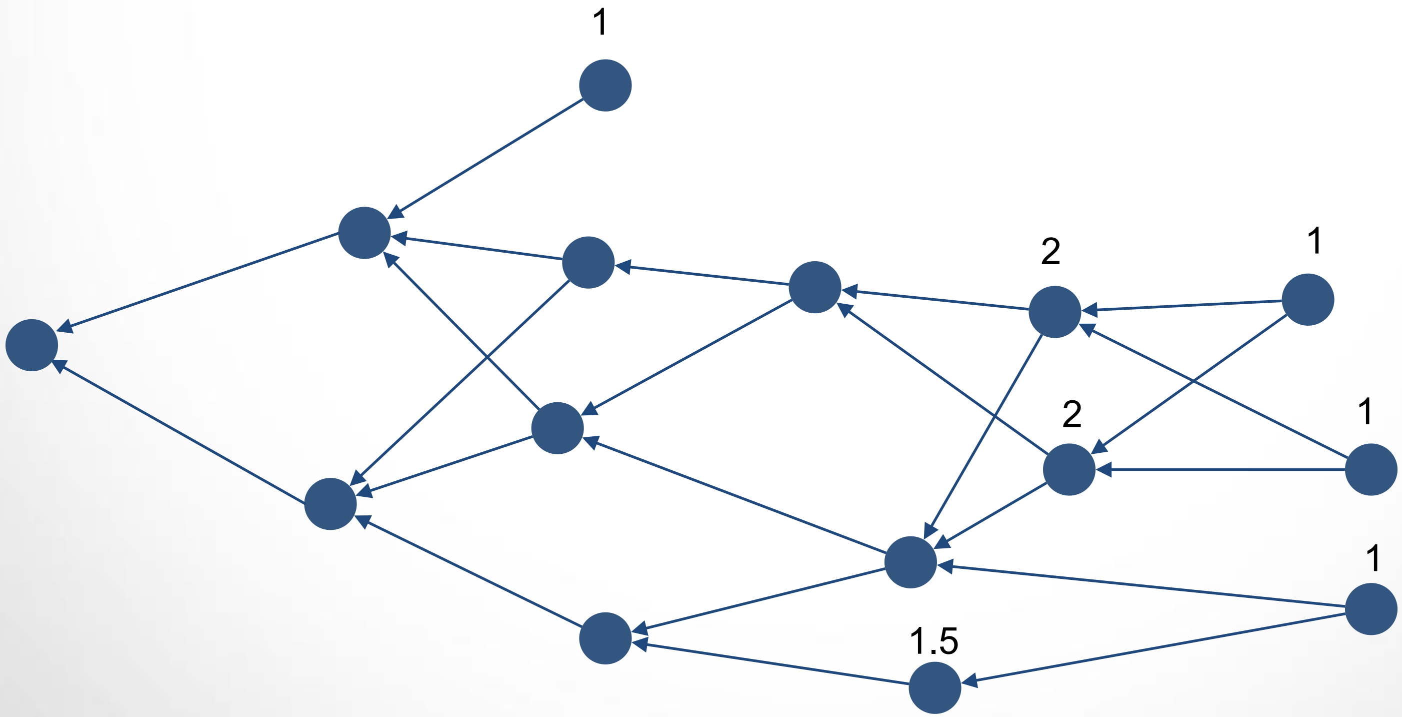

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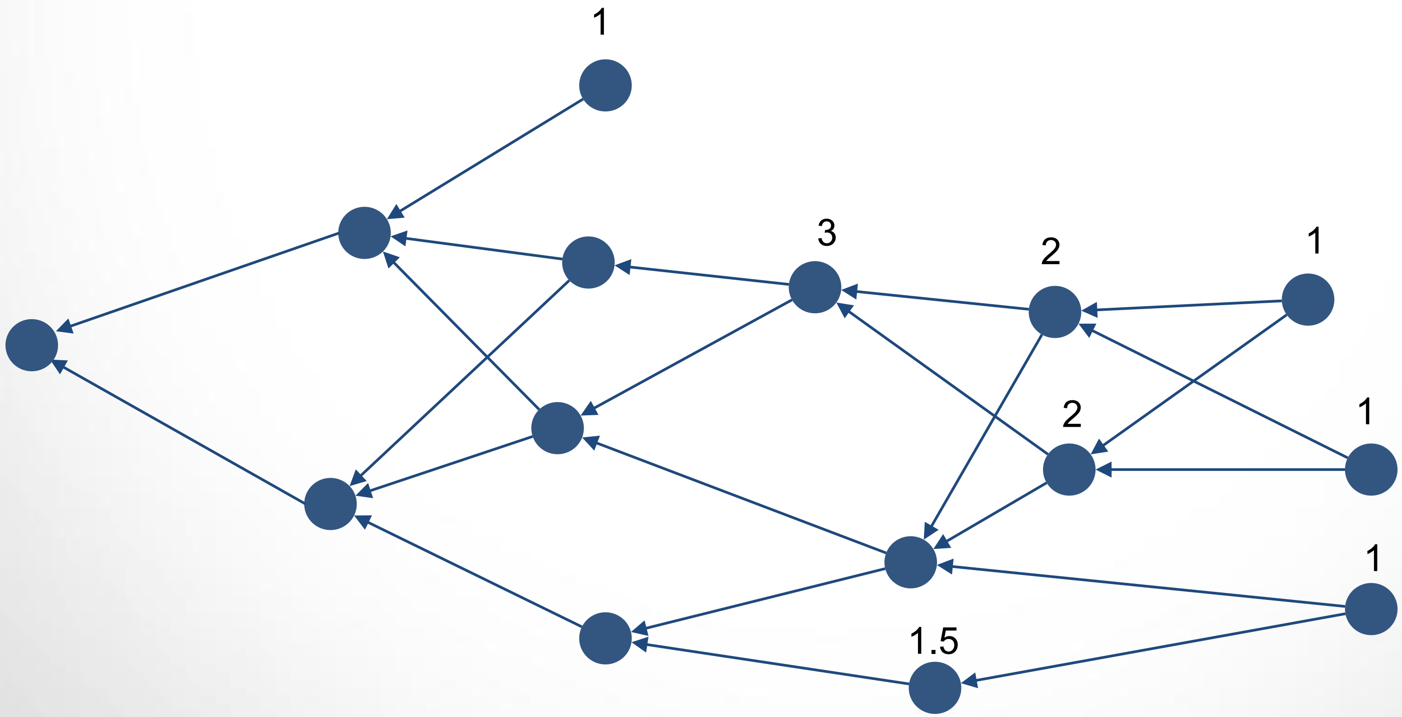

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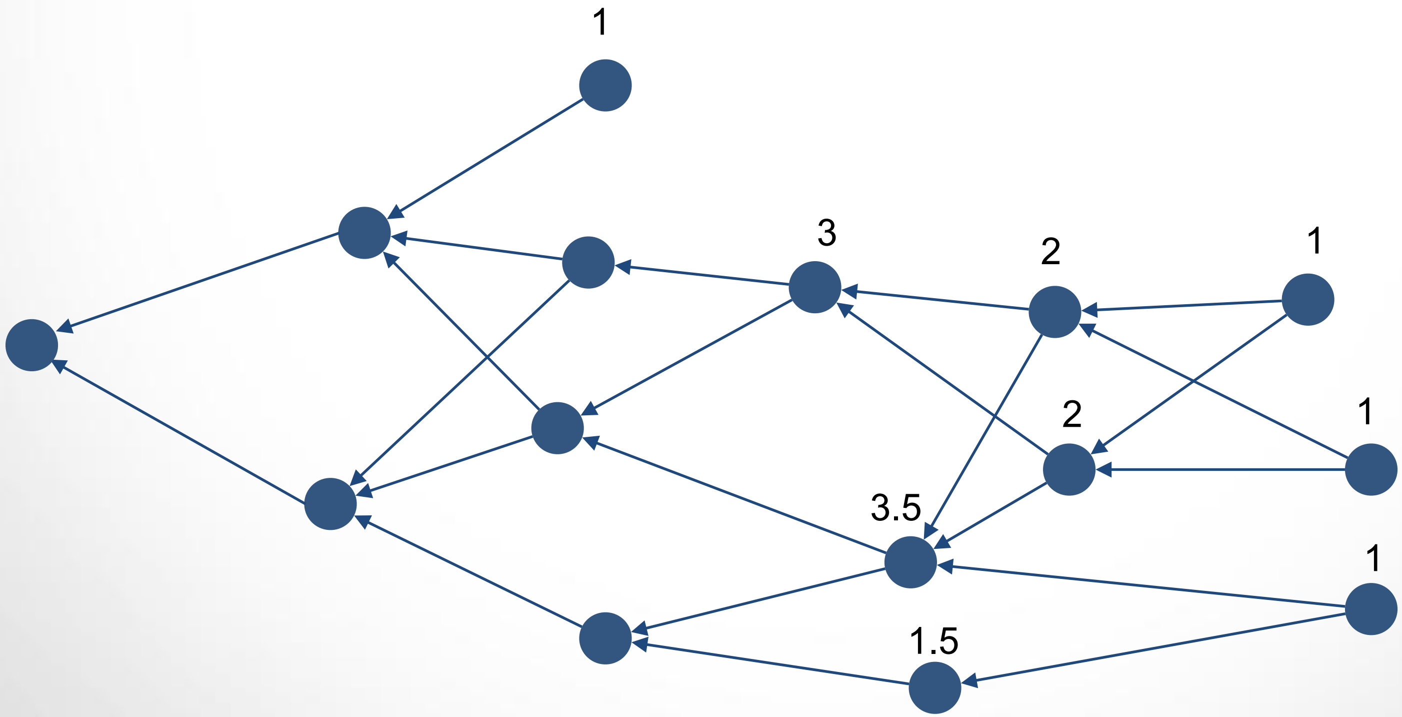

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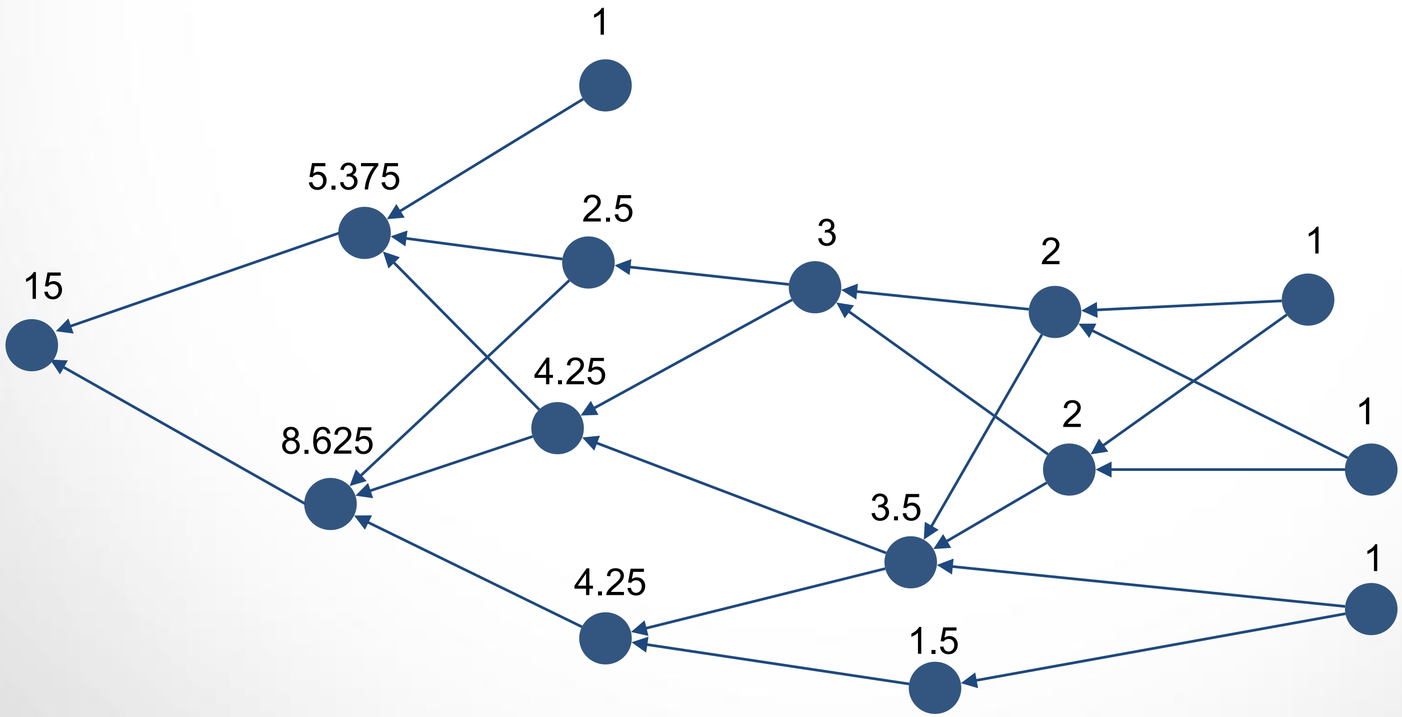
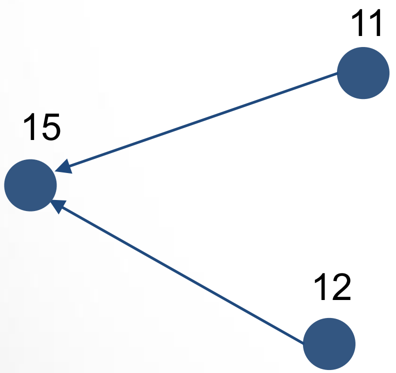


Random Walk



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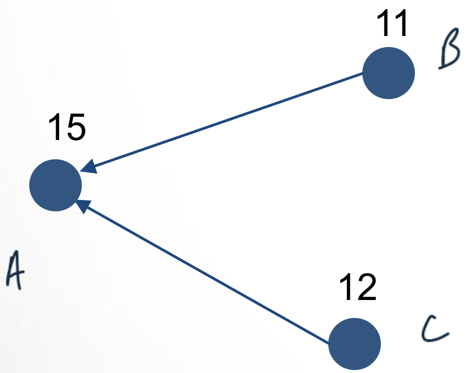

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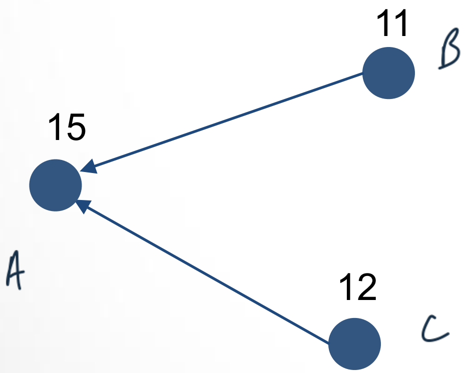
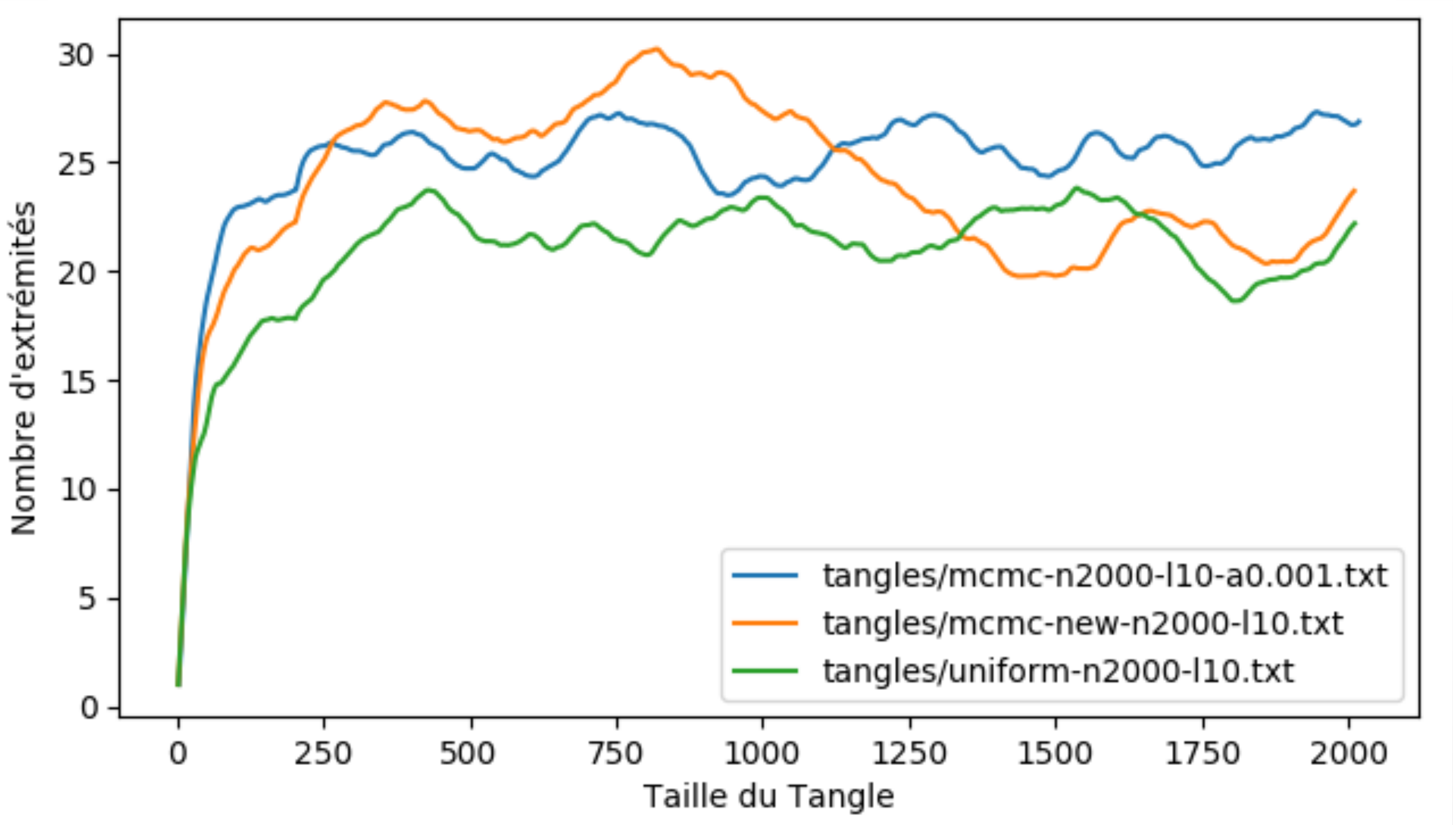
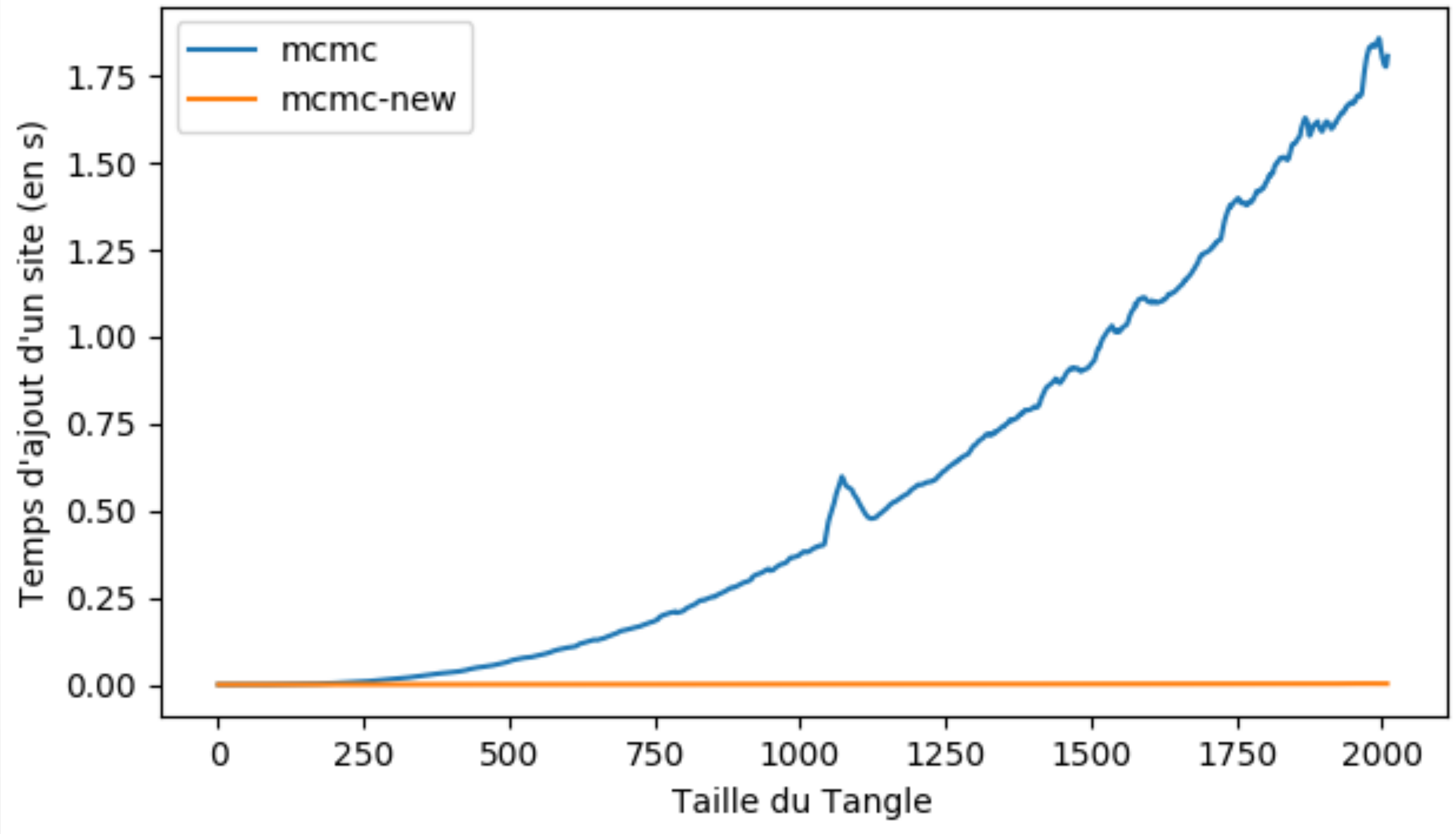


Transition function:

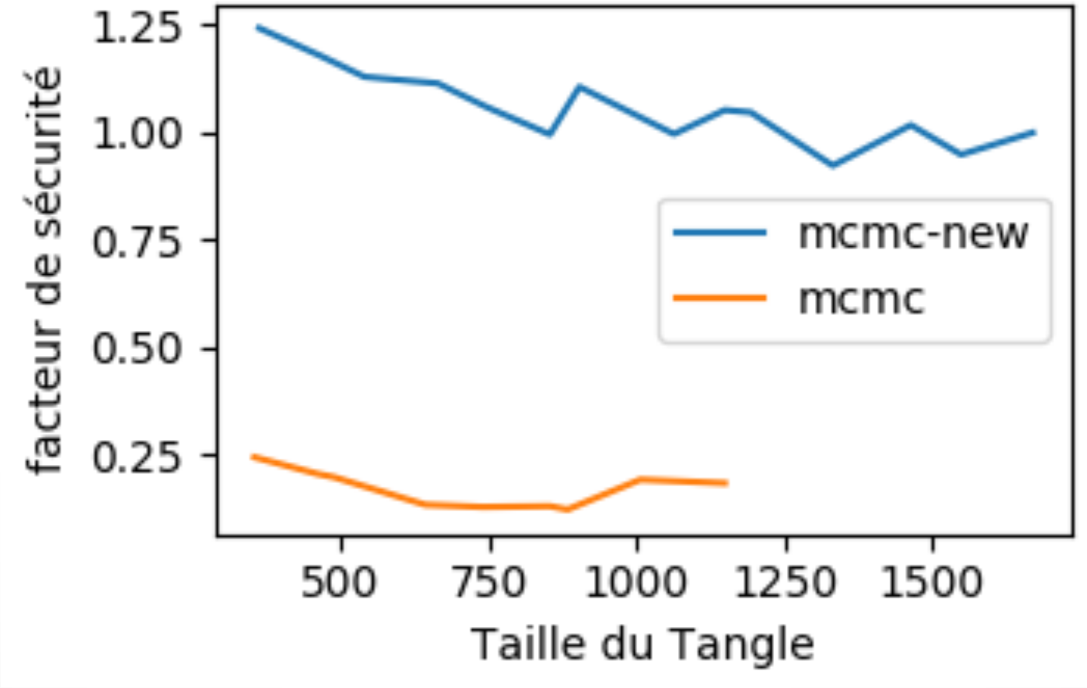
Tips over time



Complexity


mcmc
mcmc-new
Temps d'ajout d'un site (en s)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
250
500
750
1000
1250
1500
1750
2000
Taille du Tangle

Resistance to parasite chain



Conclusion

Future Work

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How to attach the parasite chain?

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Number of tips $\overset{?}{\longleftrightarrow}$ Resistance to parasite chain attack

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Even better tip selection algorithms