How To Select its Parents in the Tangle

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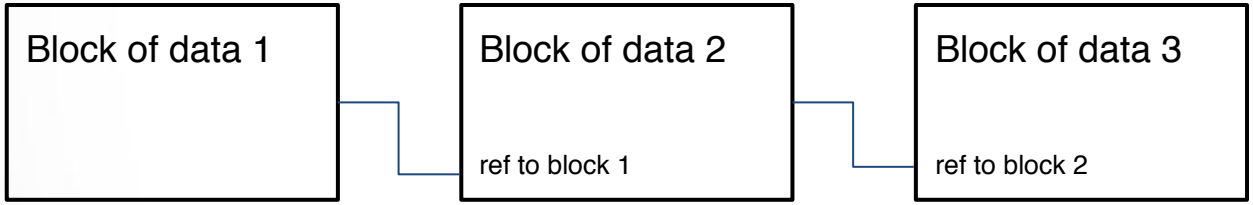
Slides available at http://bramas.fr

Introduction

Blockchain:



The Tangle

The Tangle (IOTA)

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Each transaction is a small block that references two previous ones

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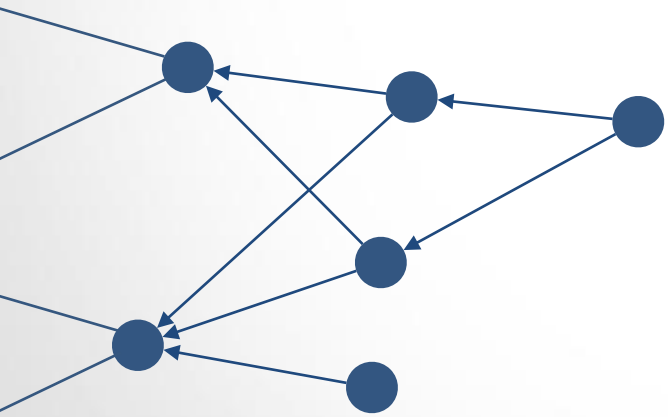

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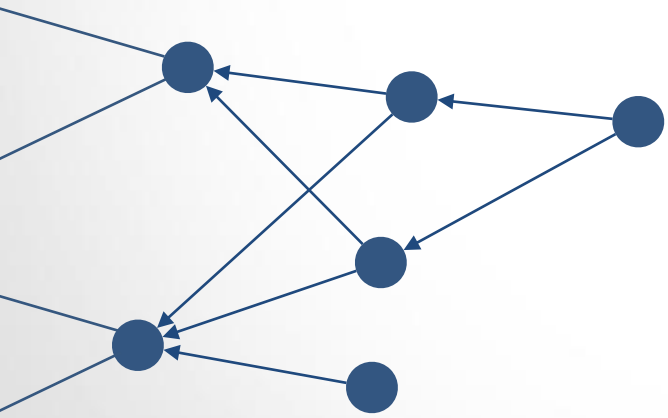

You come up with a DAG
(Directed Acyclic Graph)

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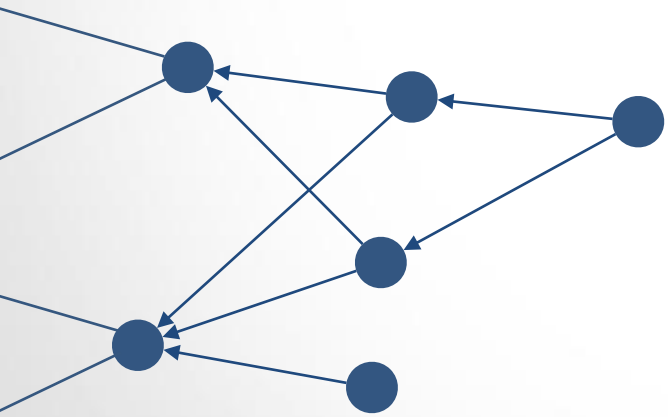

You come up with a DAG
(Directed Acyclic Graph)

You're only limited by bandwidth and storage

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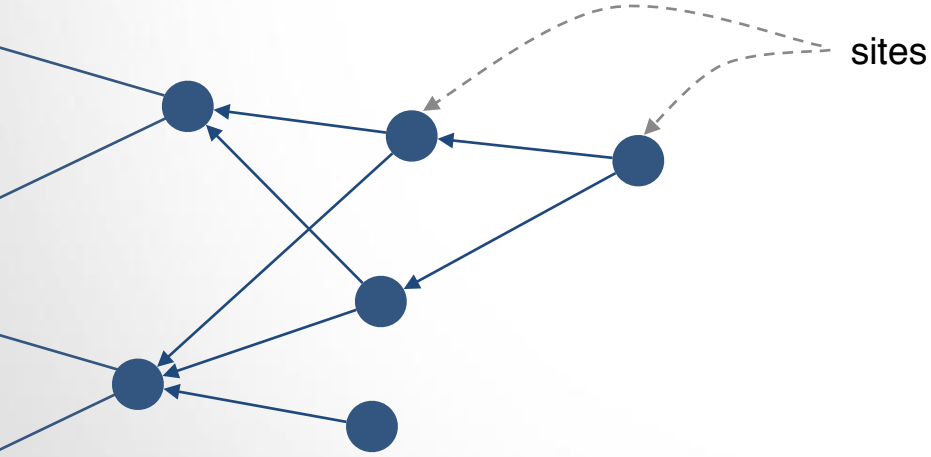

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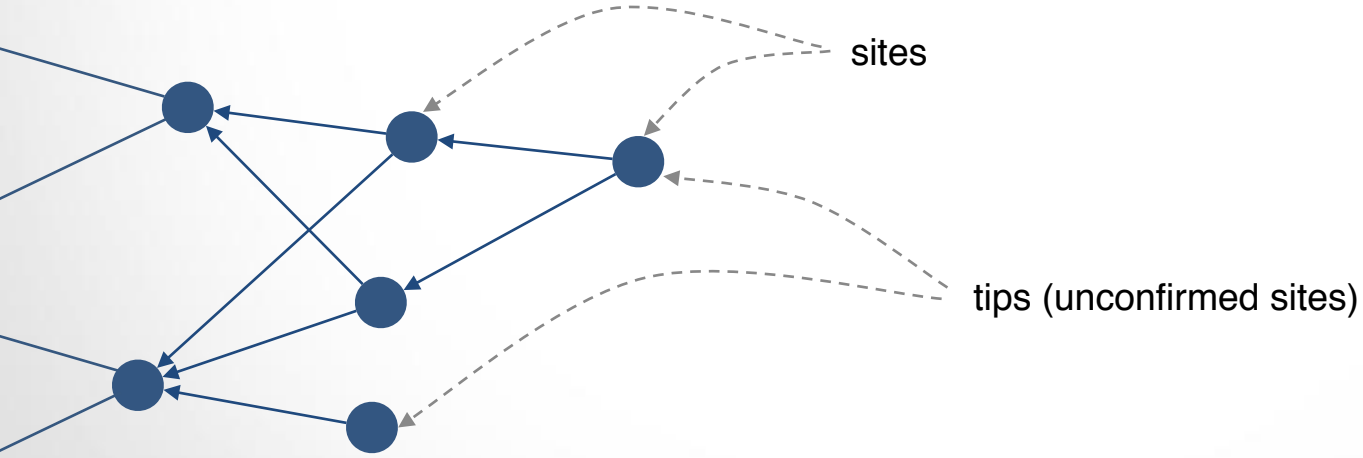

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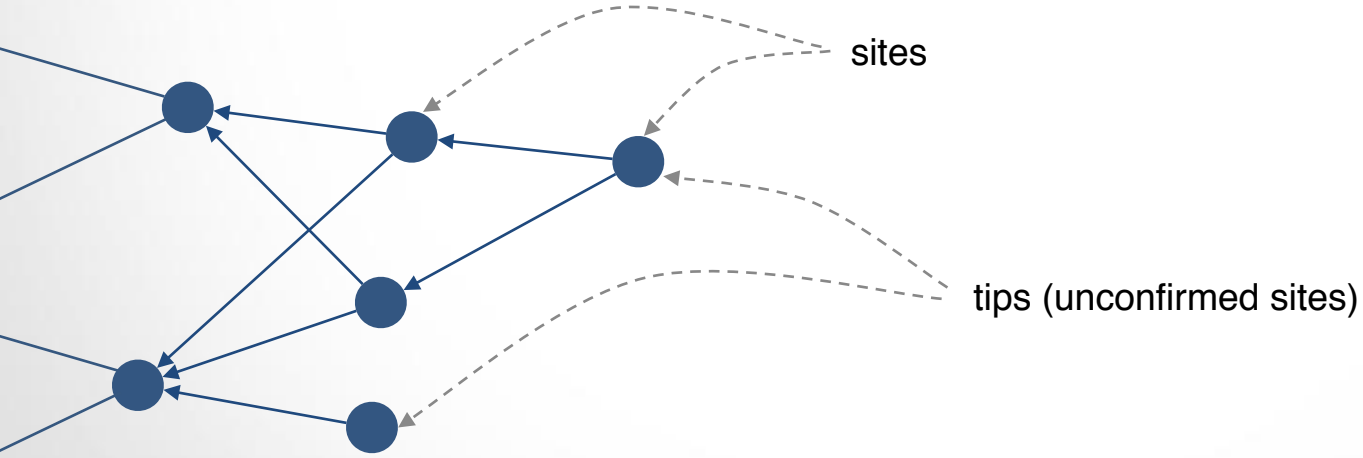

A new site and its parents should not create conflicts.

The Tangle

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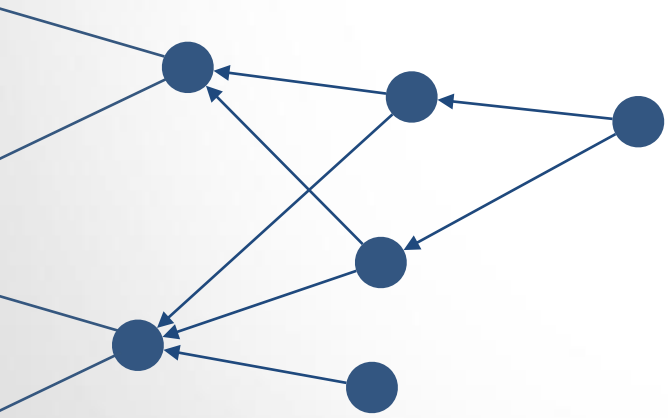
How to read a value?



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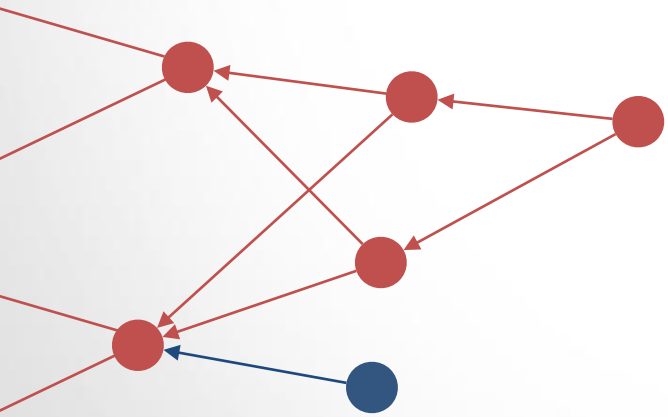


How to read a value?

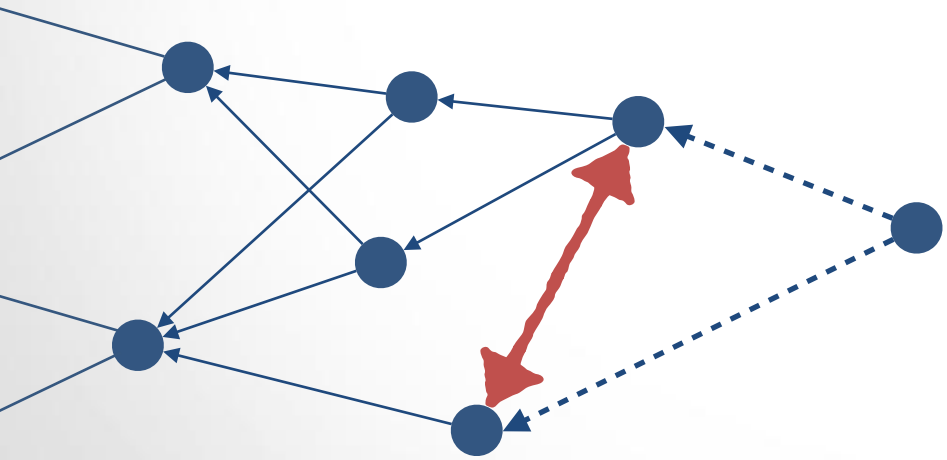
If you take a tip, you can order transactions and do the same as in a blockchain

The Tangle

The Tangle (IOTA)

How to read a value?

What if tips are conflicting?



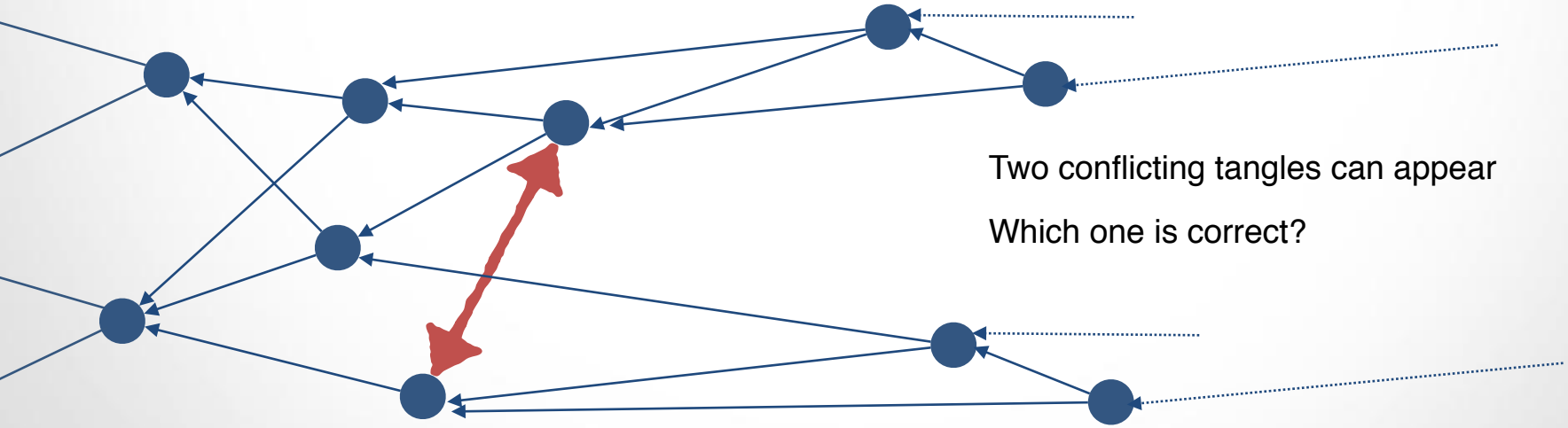
A new site cannot confirm conflicting sites

The Tangle

The Tangle (IOTA)

How to read a value?

What if tips are conflicting?



Two conflicting tangles can appear

Which one is correct?

The Tangle

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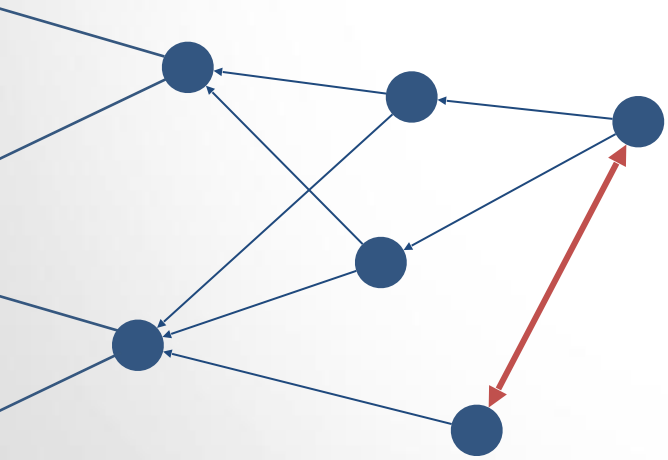
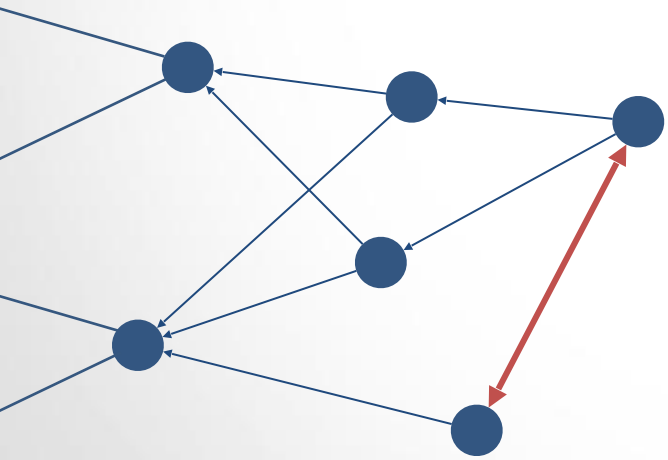


Tip Selection Algorithm (TSA):

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

The Tangle

The Tangle (IOTA)



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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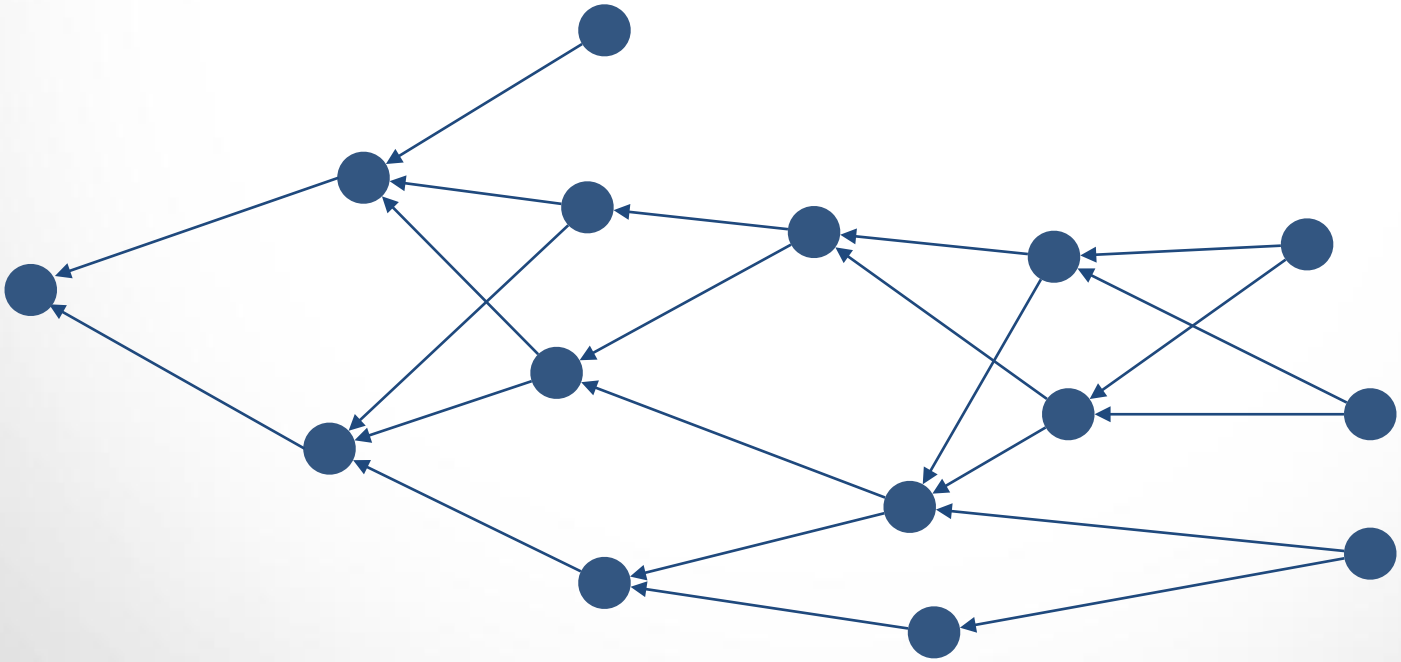

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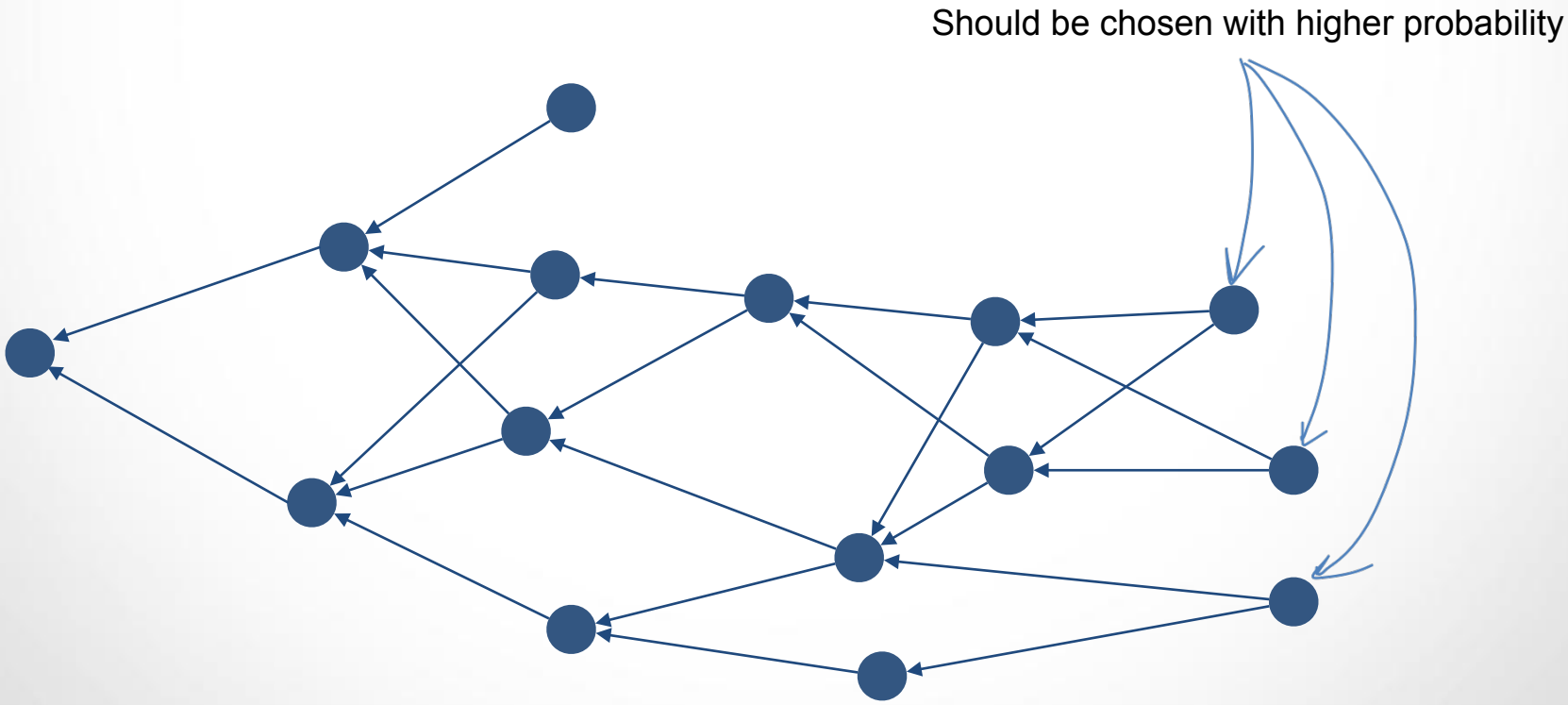
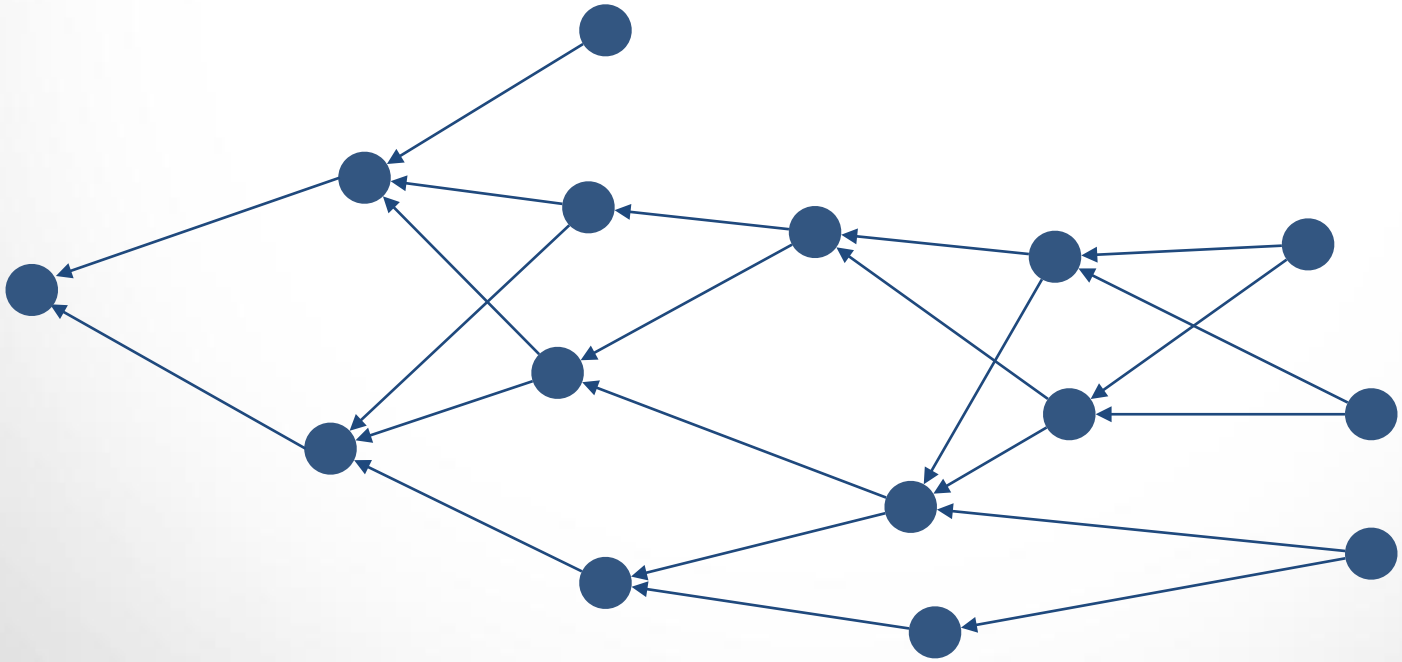


MCMC Tip selection algorithm

MCMC Tip selection algorithm

The Tangle (IOTA)

Compute cumulative weight to each site



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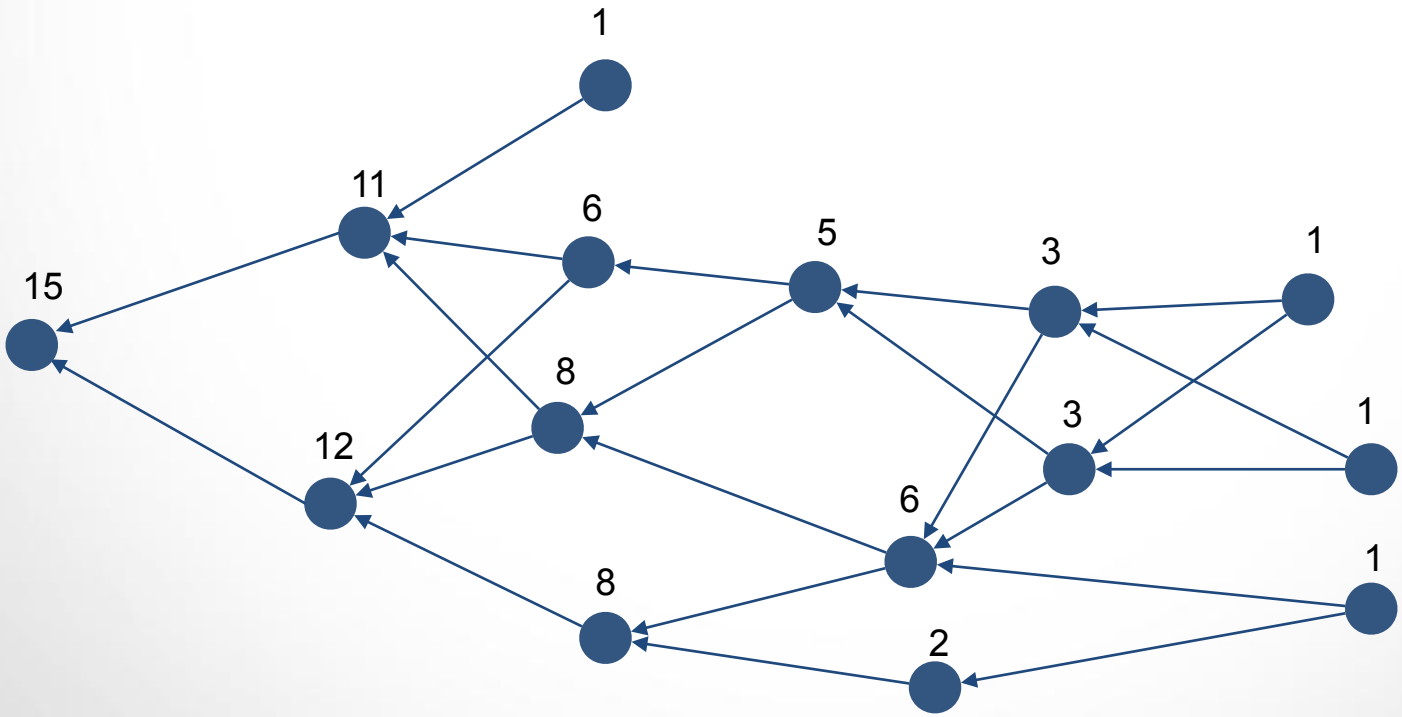

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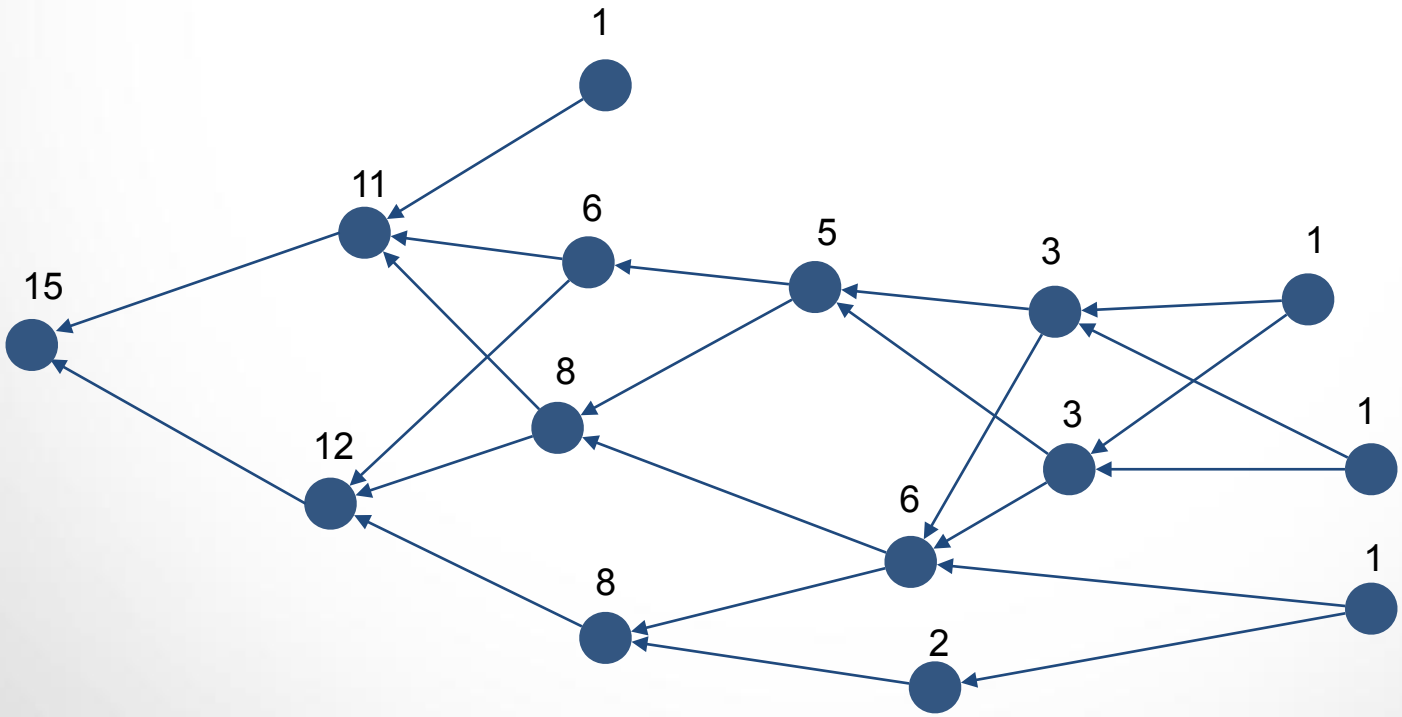
Perform a random walk



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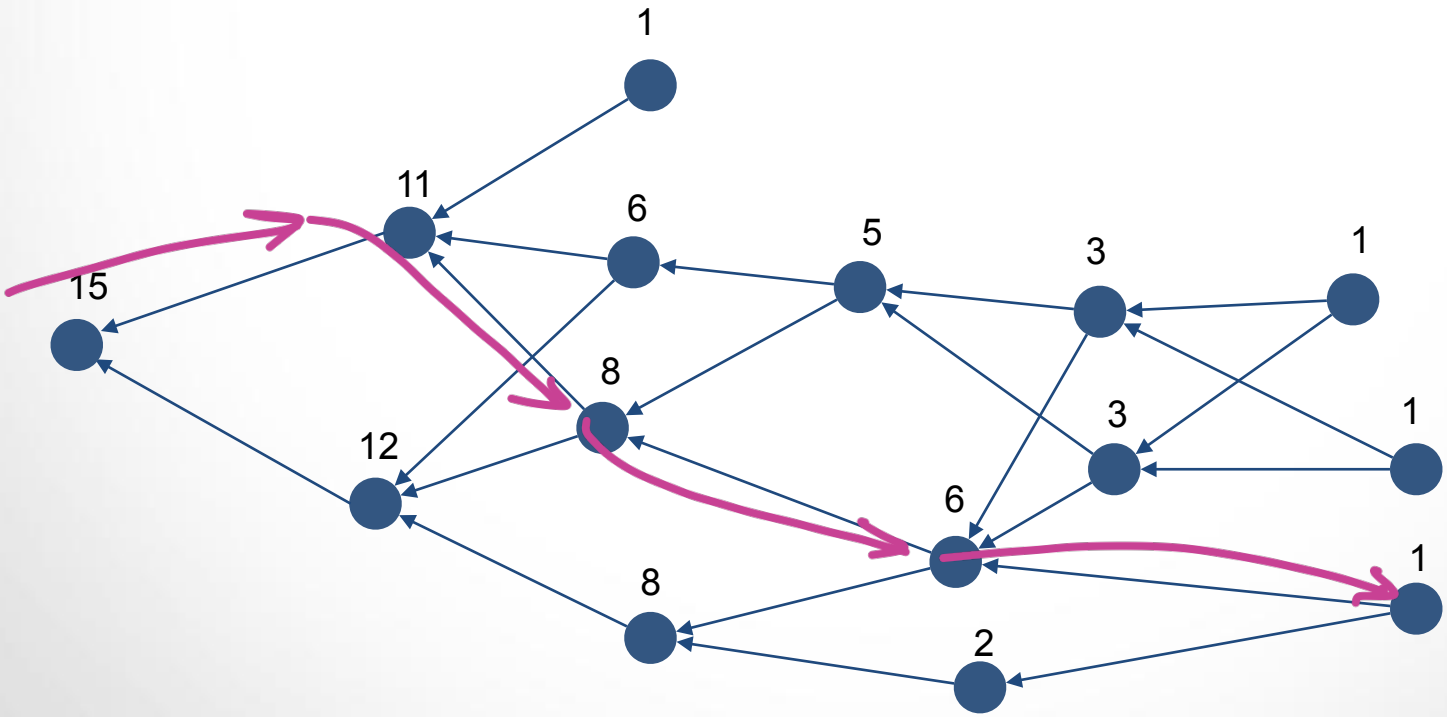

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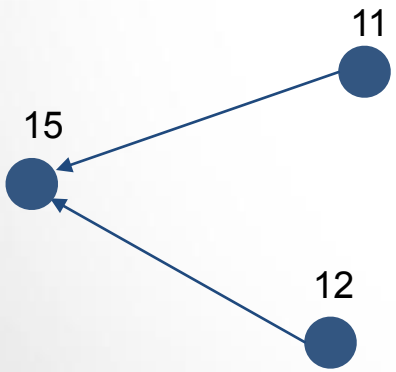

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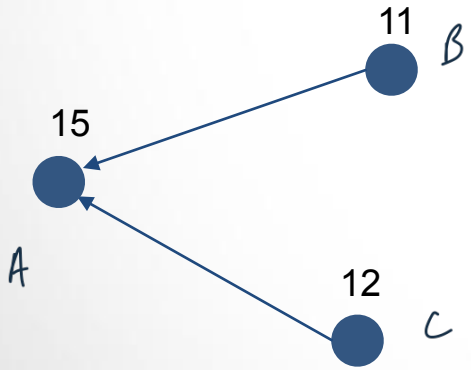

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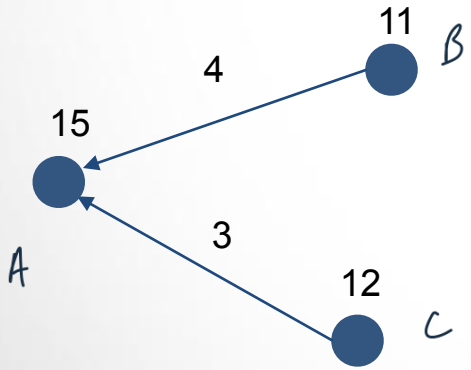

MCMC Tip selection algorithm

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Compute cumulative weight to each site

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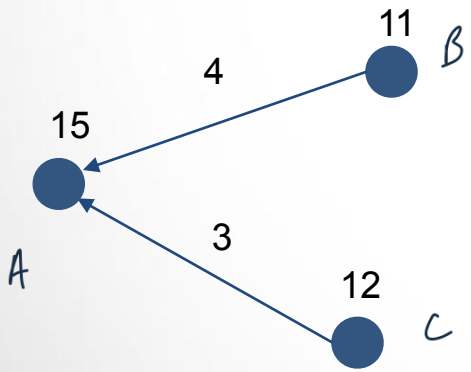
Transition function:

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



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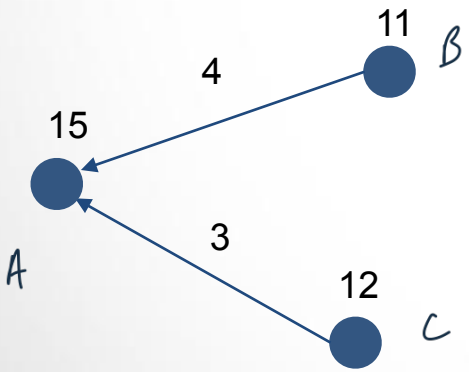

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MCMC

$$f(\Delta) = e^{-\alpha\Delta}$$

MCMC Tip selection algorithm

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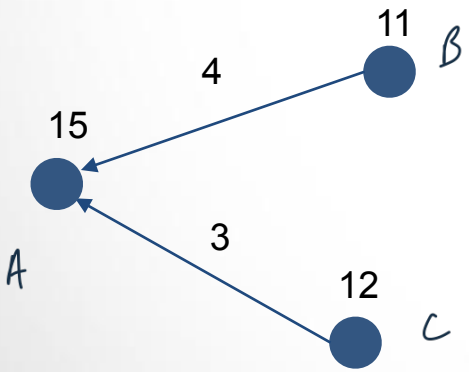

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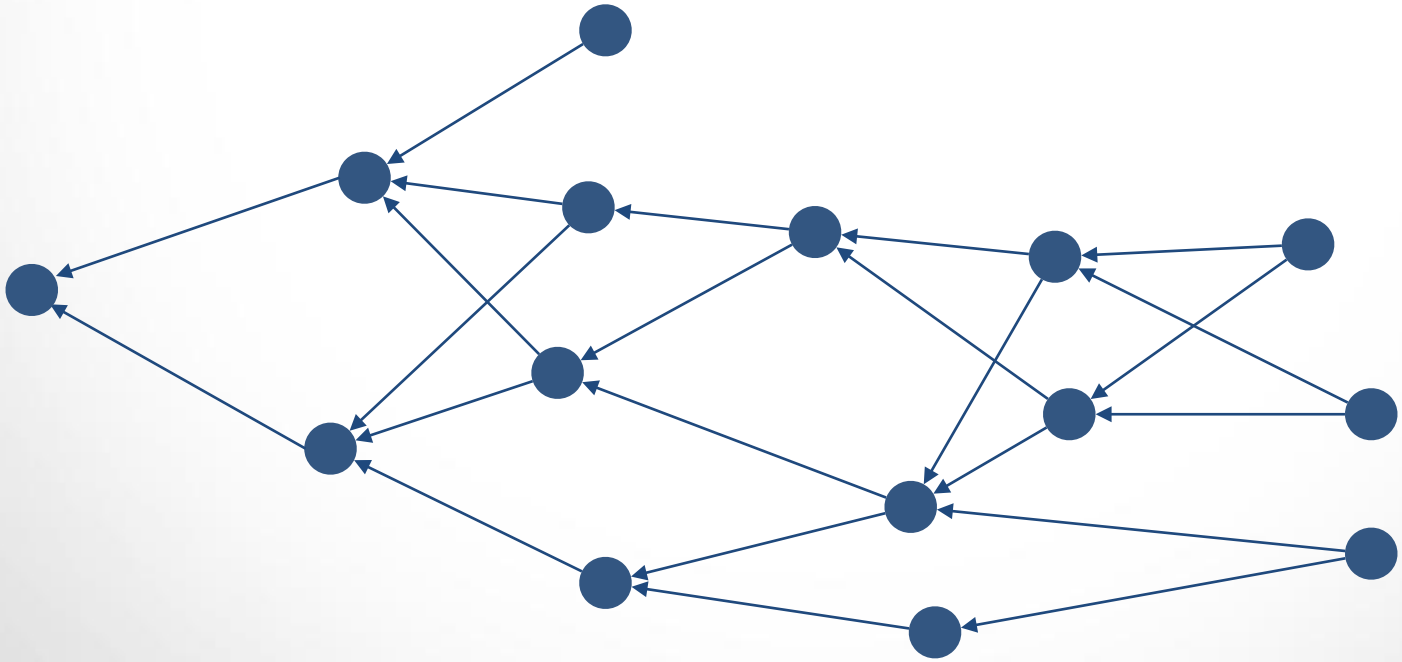
LMCMC

$$f(\Delta) = \Delta^{-\alpha}$$

Real cumulative weight

$$w(u) = 1 + \sum_{c \in \text{children}} w(c)/2$$



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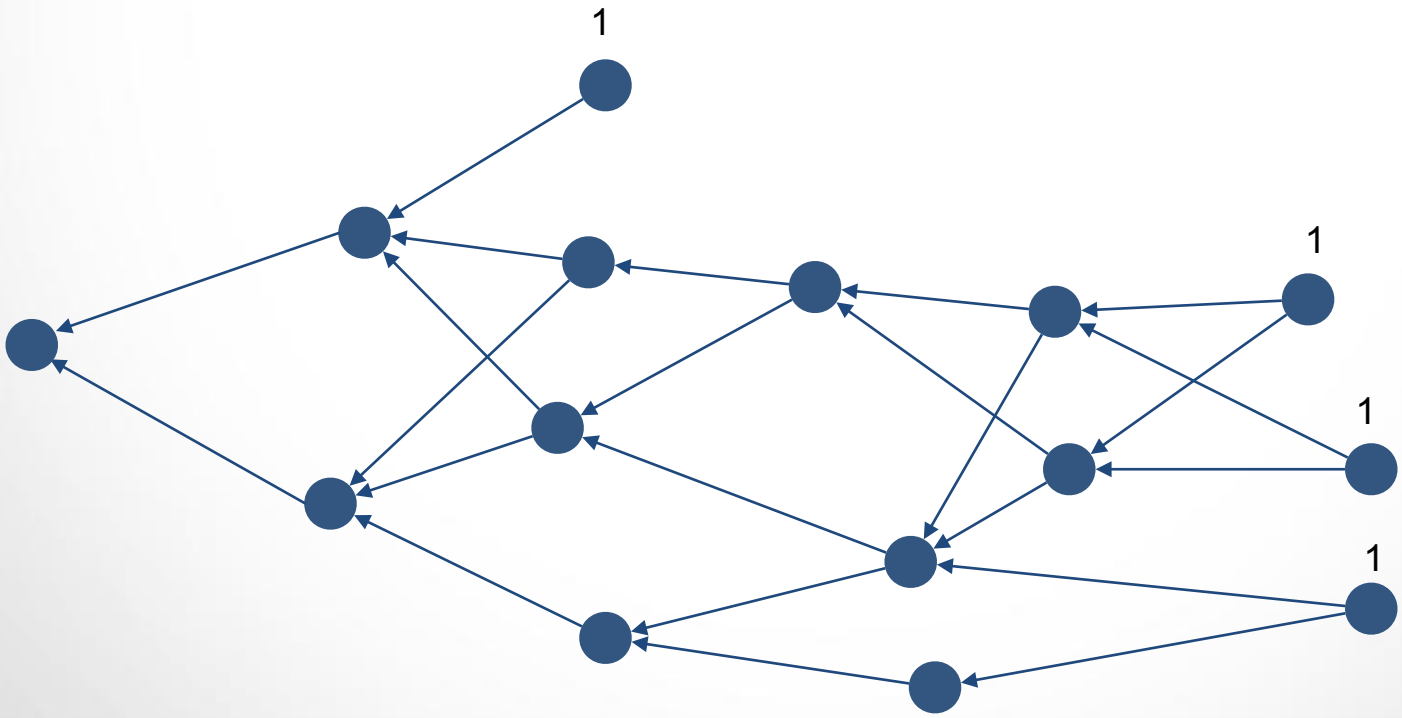

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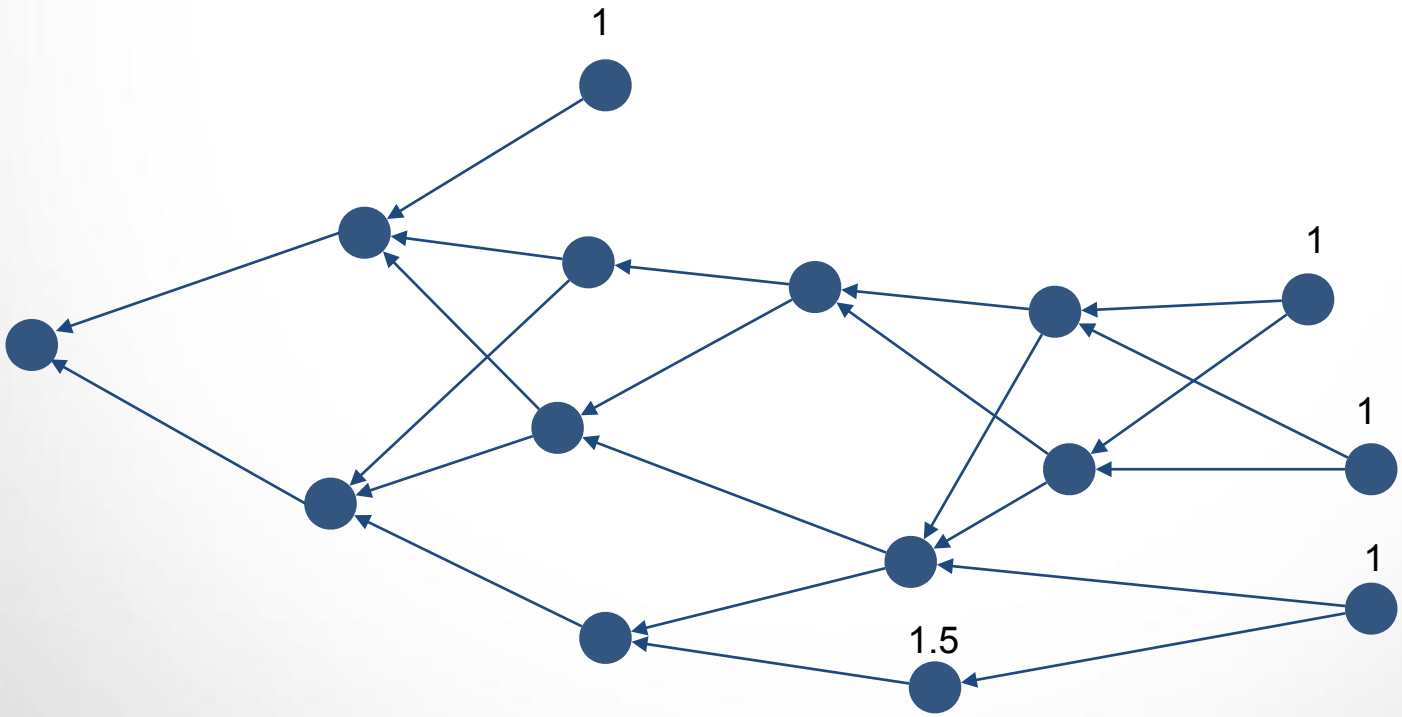

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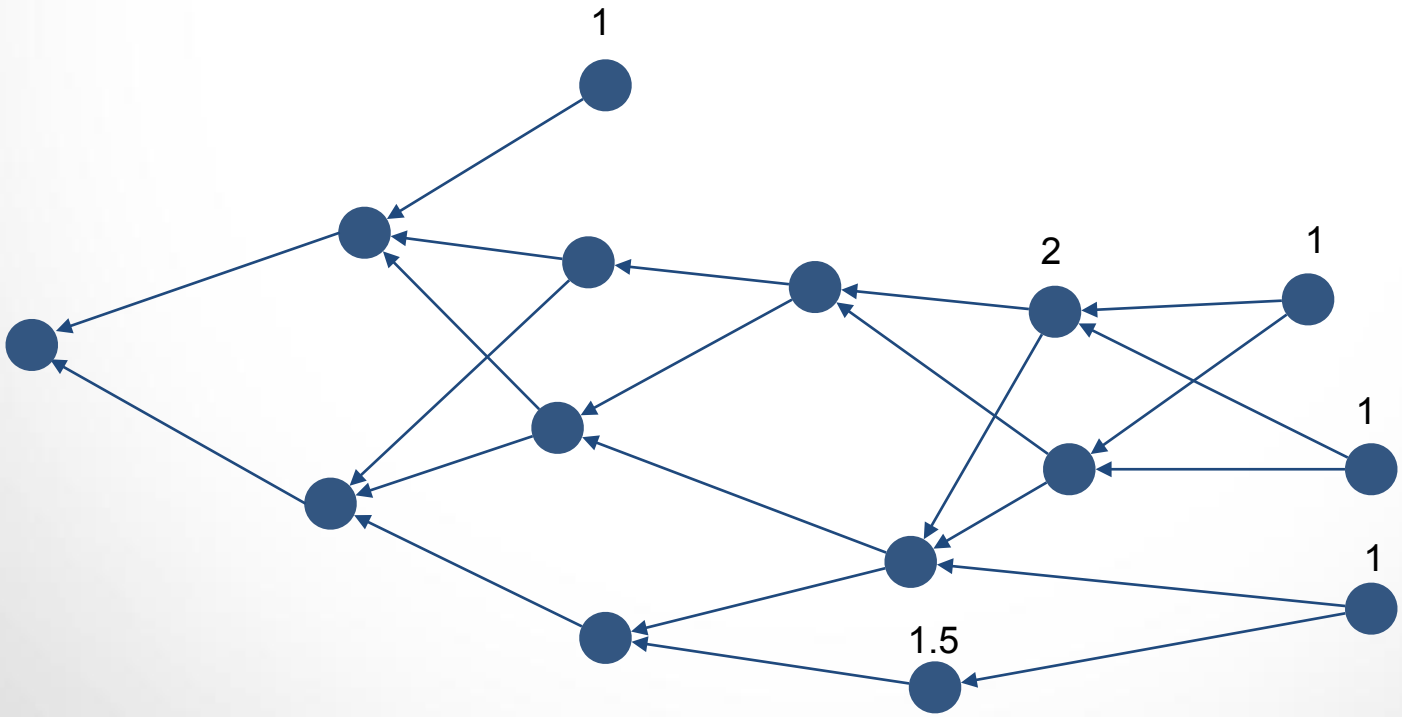

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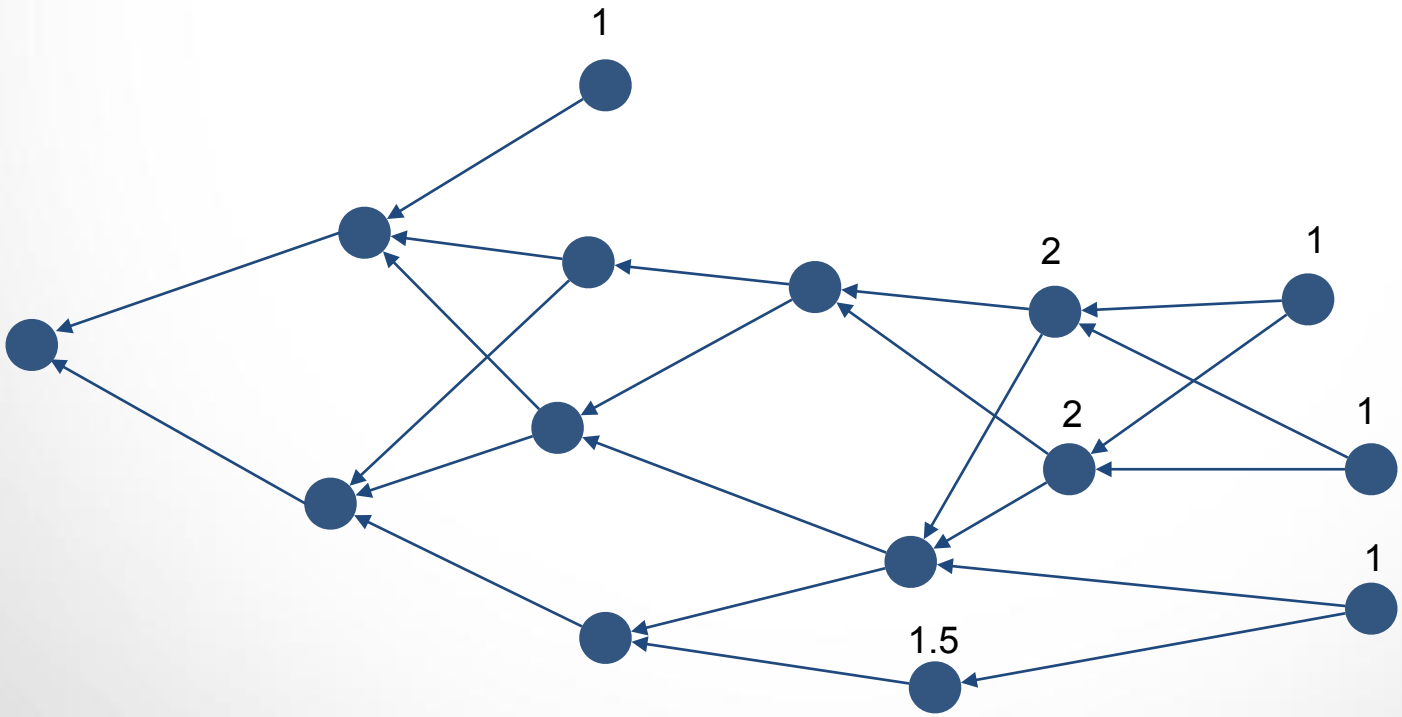

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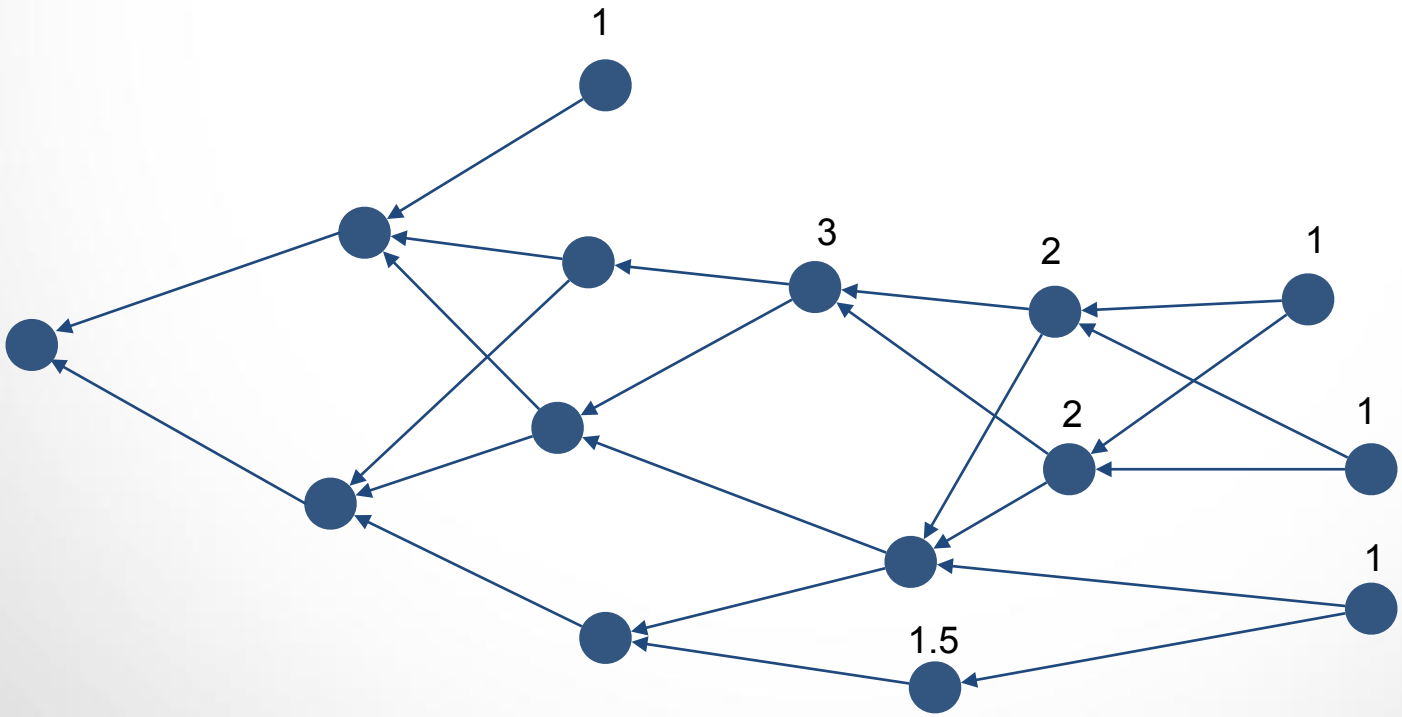

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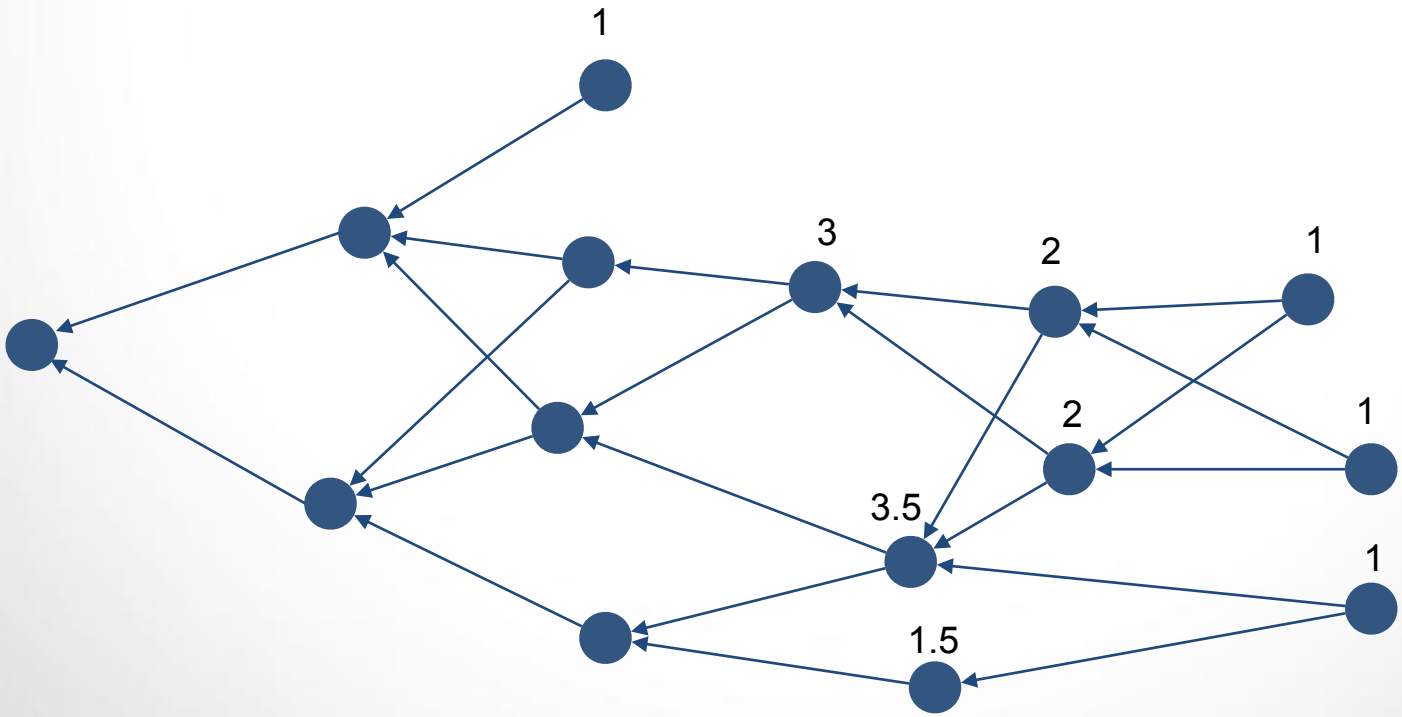

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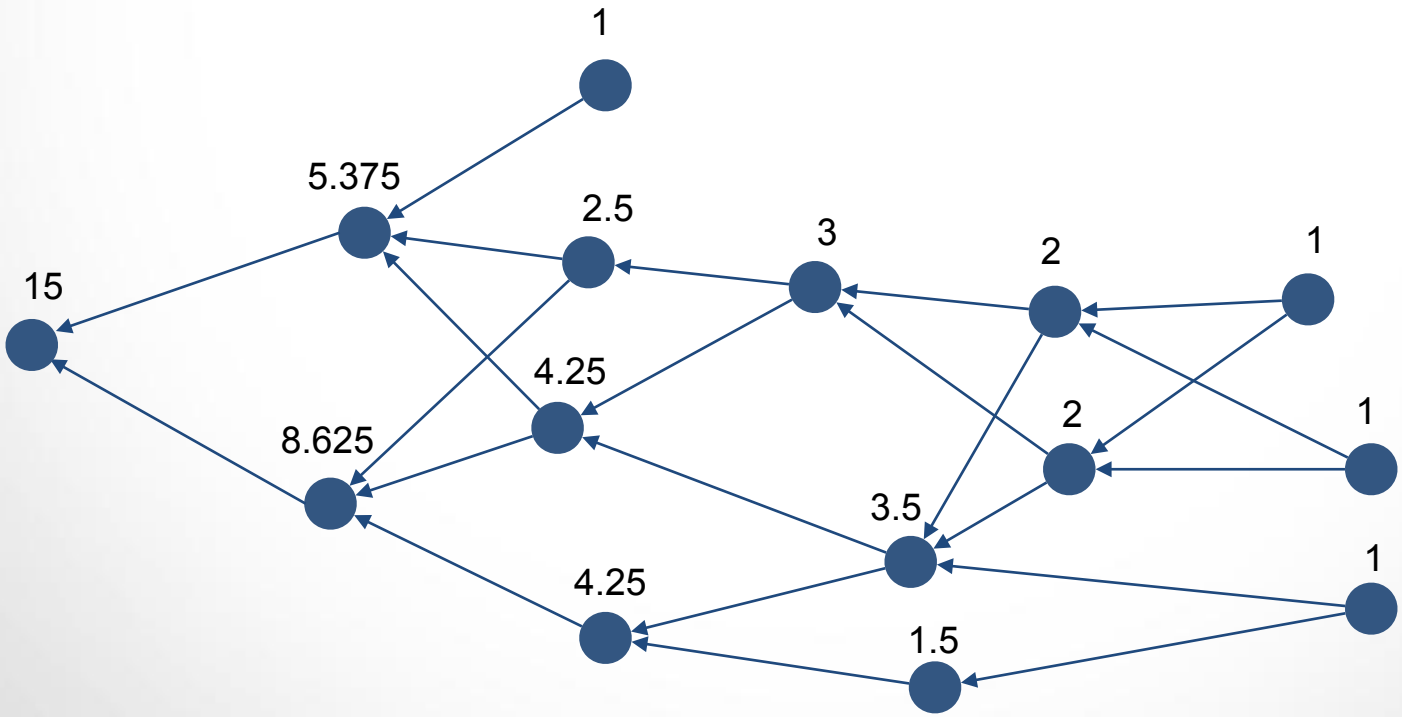
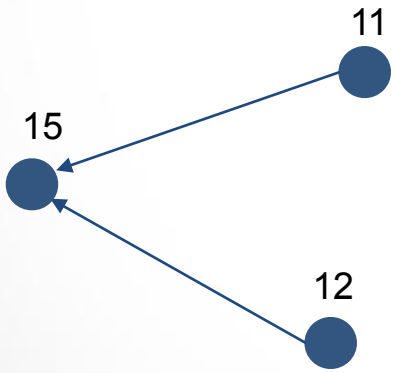


Random Walk

Transition function:



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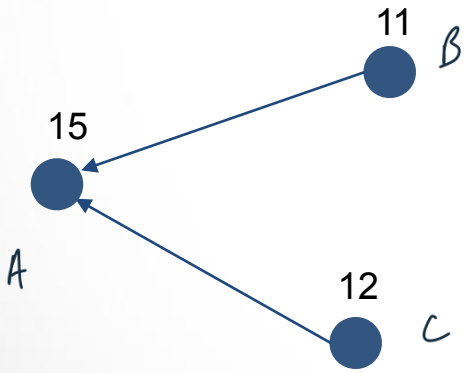


Transition function:

$$P_{A \to B} = \frac{11}{11+12}$$

Comparison

Number of tips

How many tips are left behind ?

Number of tips

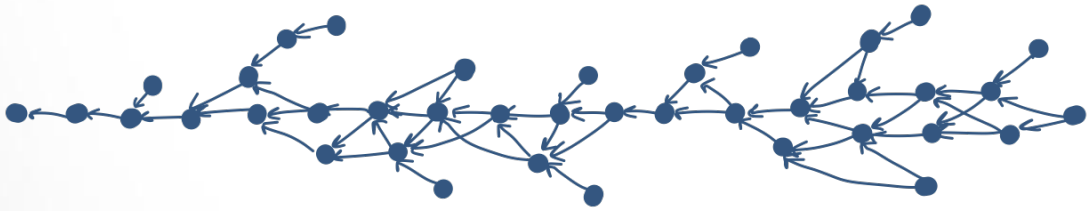
How many tips are left behind ?

How many tips over the time ?

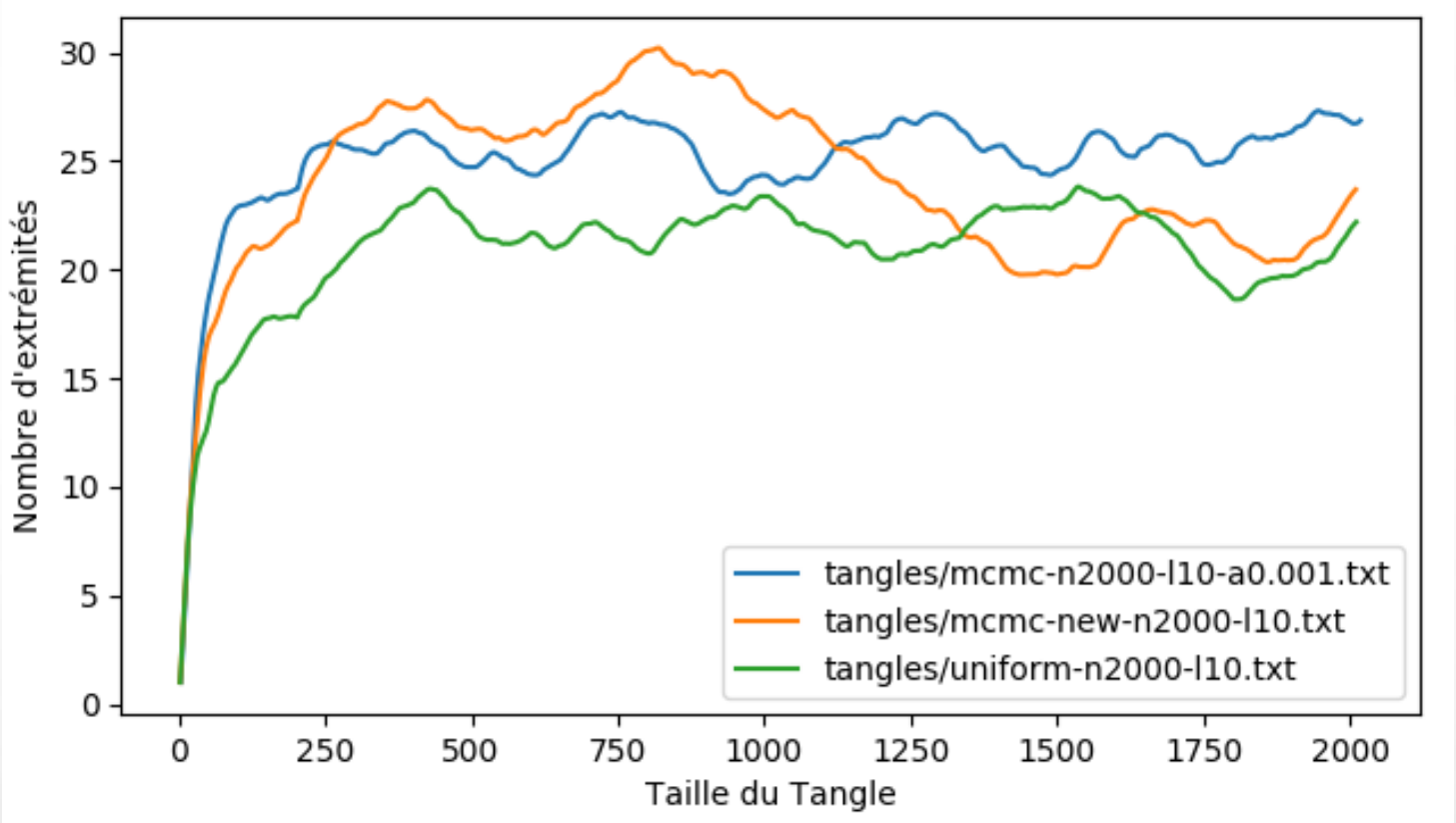
Number of tips

How many tips are left behind ?

How many tips over the time ?



Tips over time



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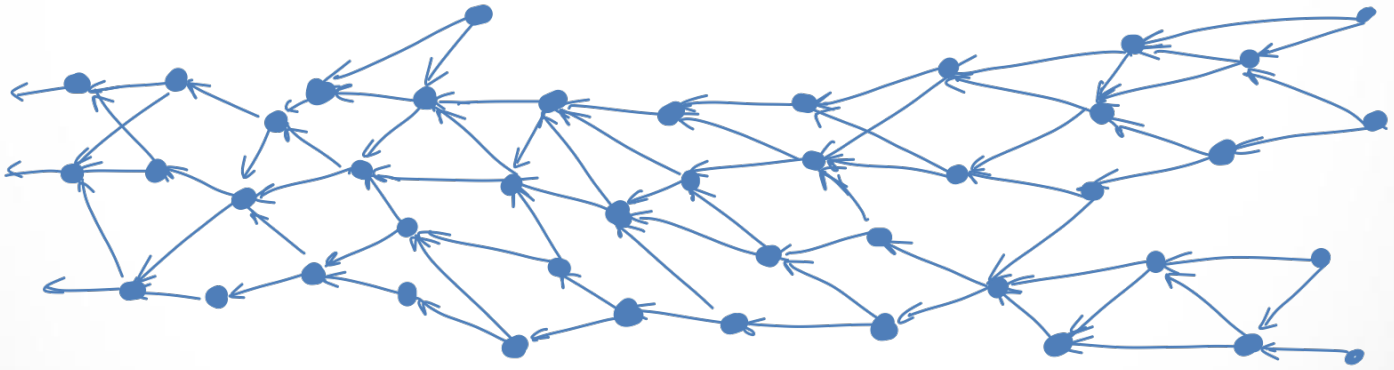

Parasite Chain Attack

Parasite Chain Attack

Double Spending Attack

Parasite Chain Attack

Double Spending Attack

- 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

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

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

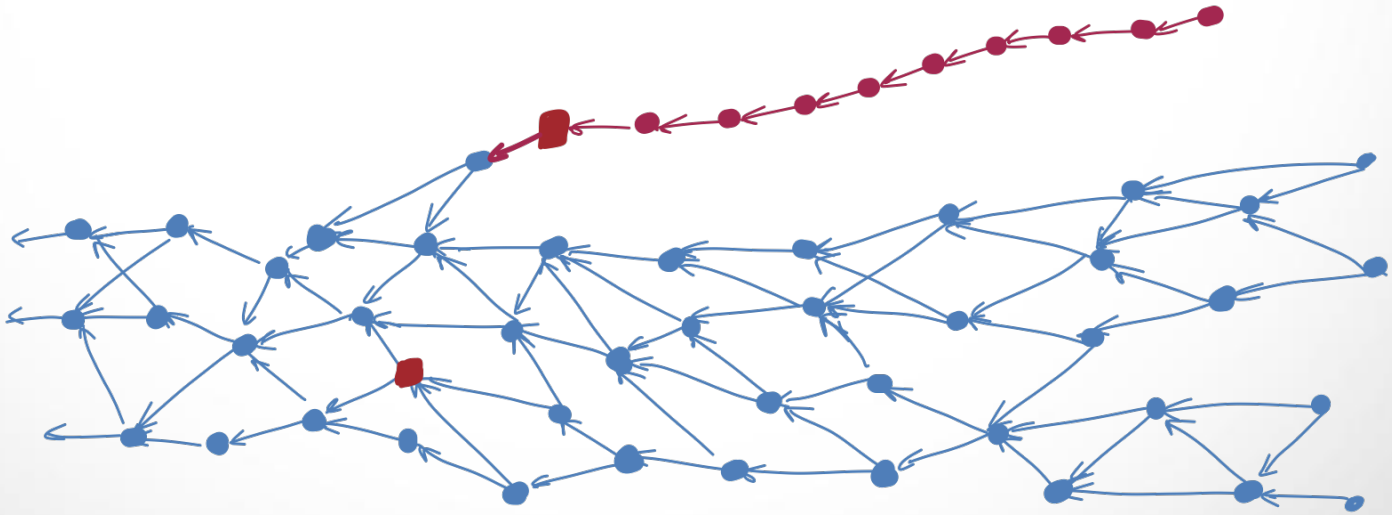
Parasite Chain Attack

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

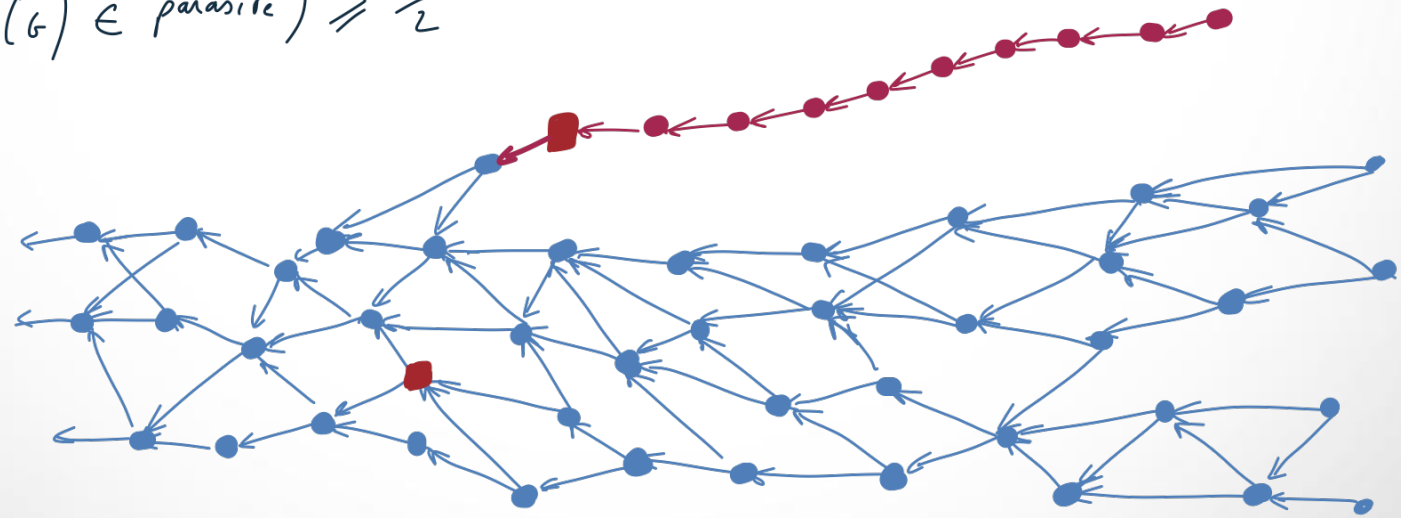


Parasite Chain Attack

The parasite chain attack

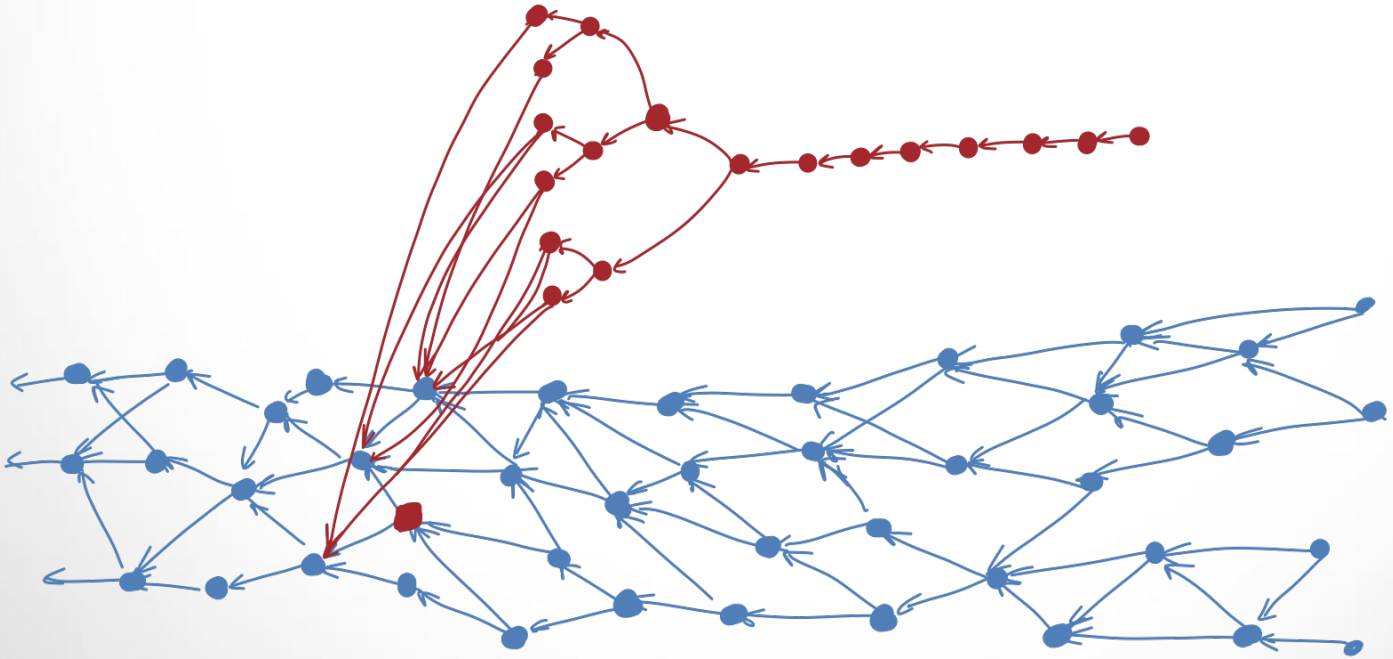
How many red site so that:

$$\mathbb{P}(TSA(G) \in \text{parasite}) \geq \frac{1}{2}$$



Parasite Chain Attack

Against MCMC



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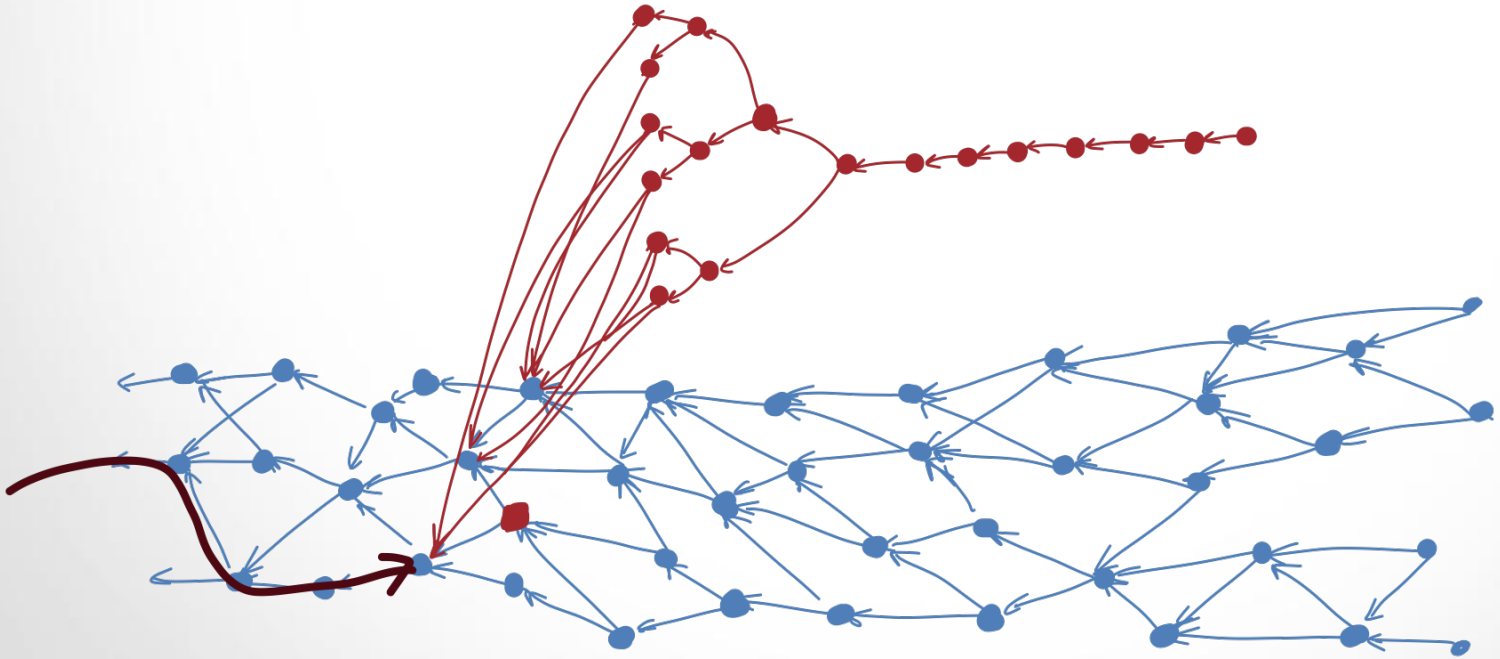

Parasite Chain Attack

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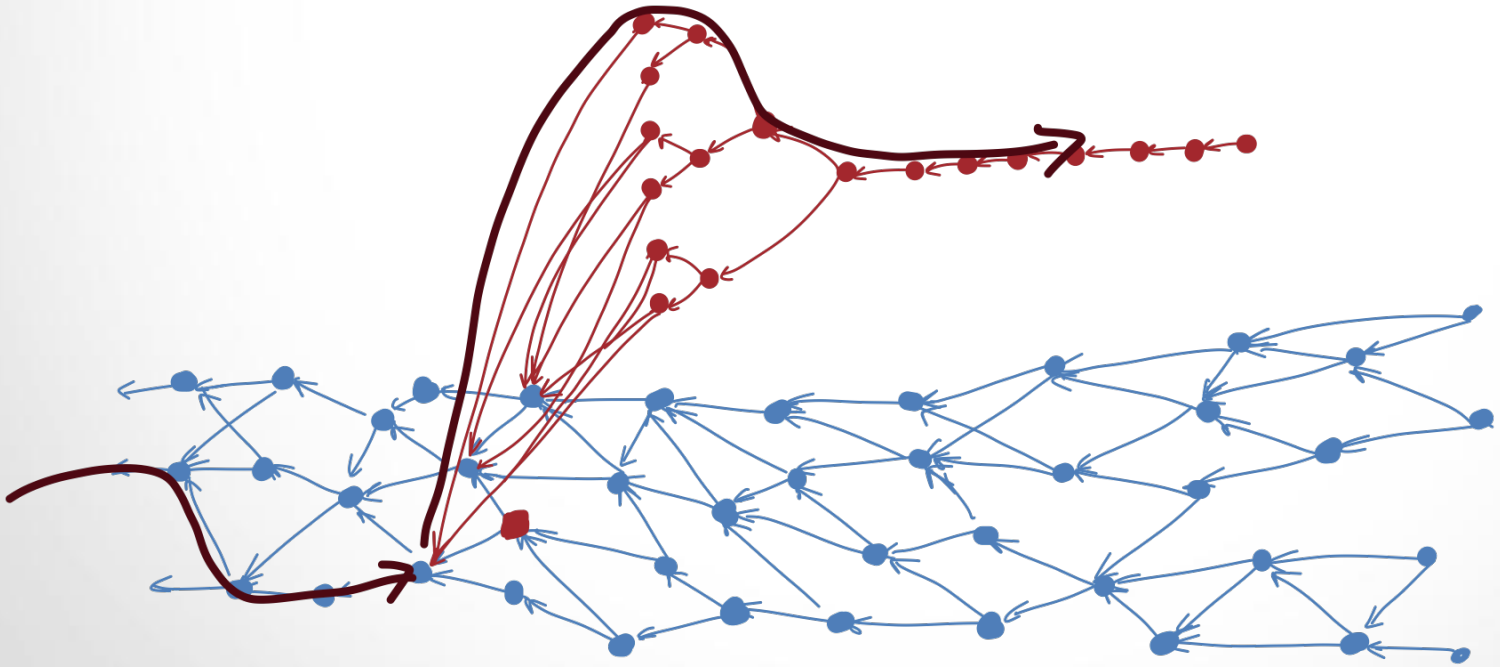
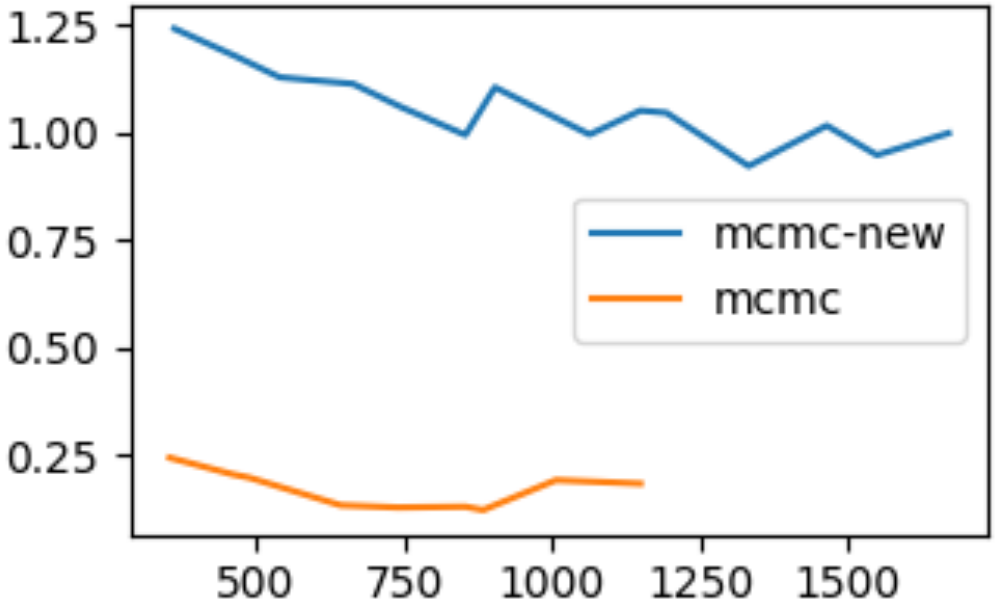
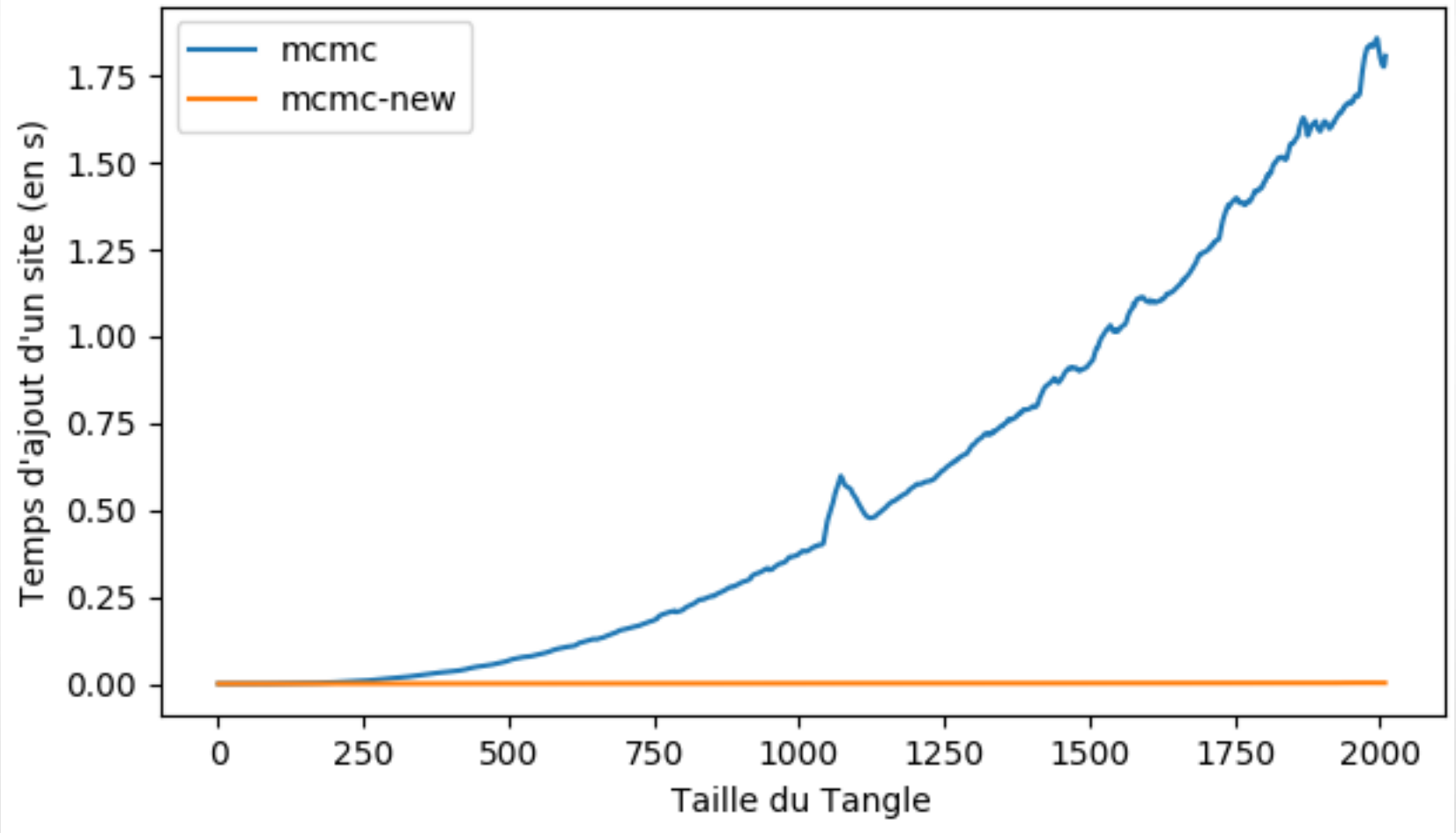


Resistance to parasite chain

Security factor



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

Conclusion

Future Work

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We defined a good tip selection algorithm

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Future Work

Even better tip selection algorithms

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Future Work

Even better tip selection algorithms

Thank you for your attention!