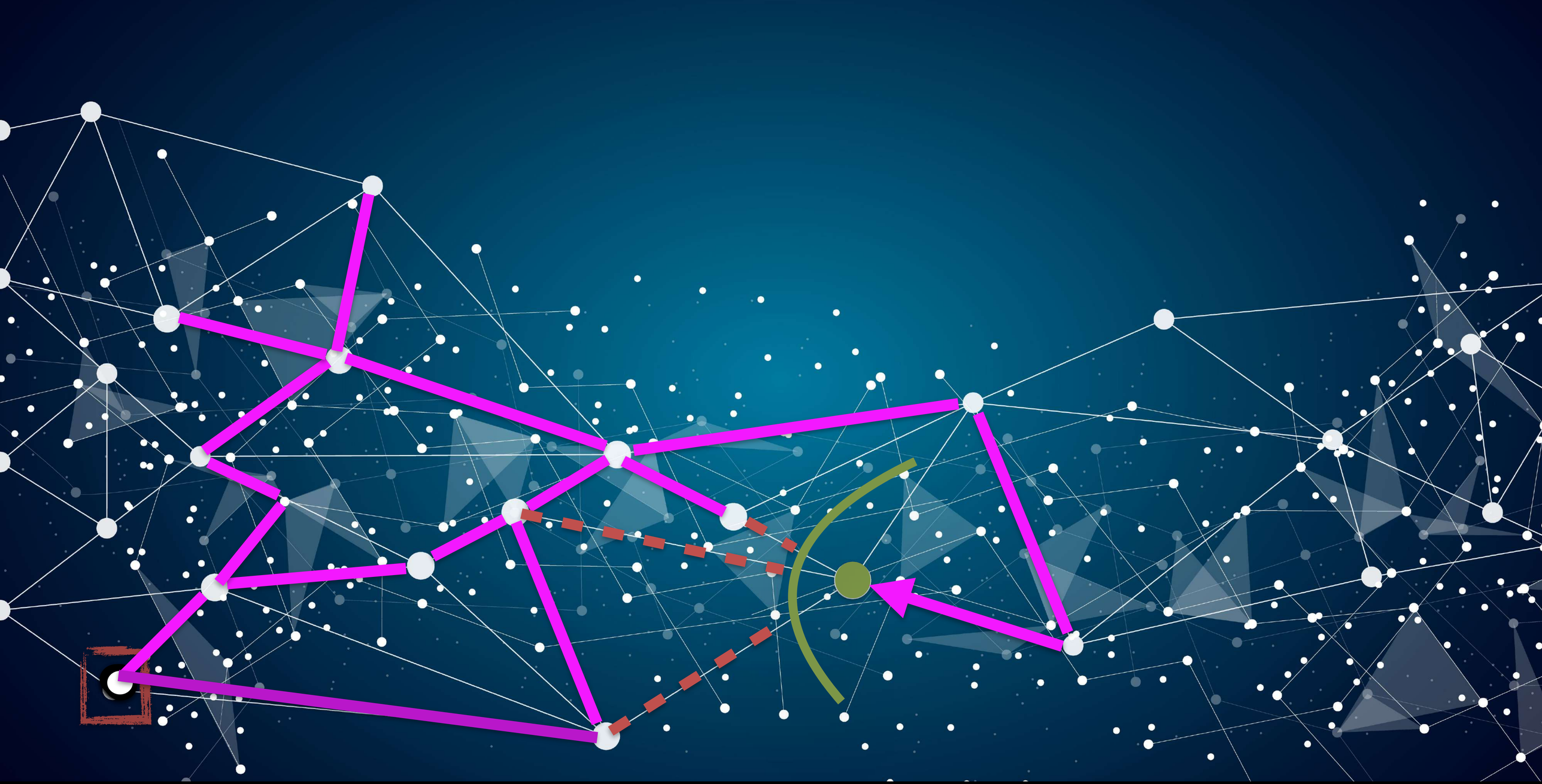
Understanding Gossip Protocols

Félix López Luis - @flopezluis

The best way to understand them is knowing the problems they solve



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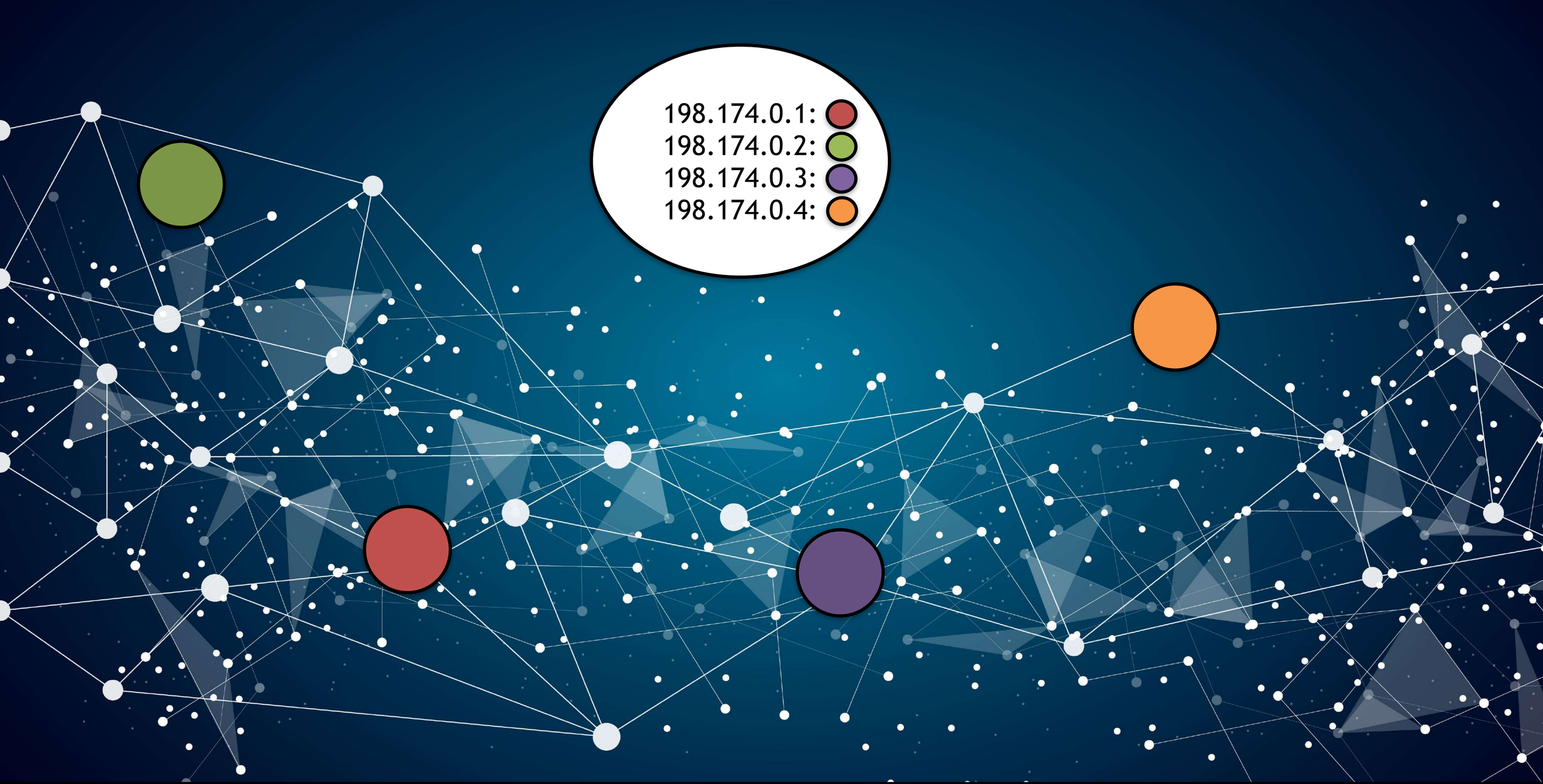
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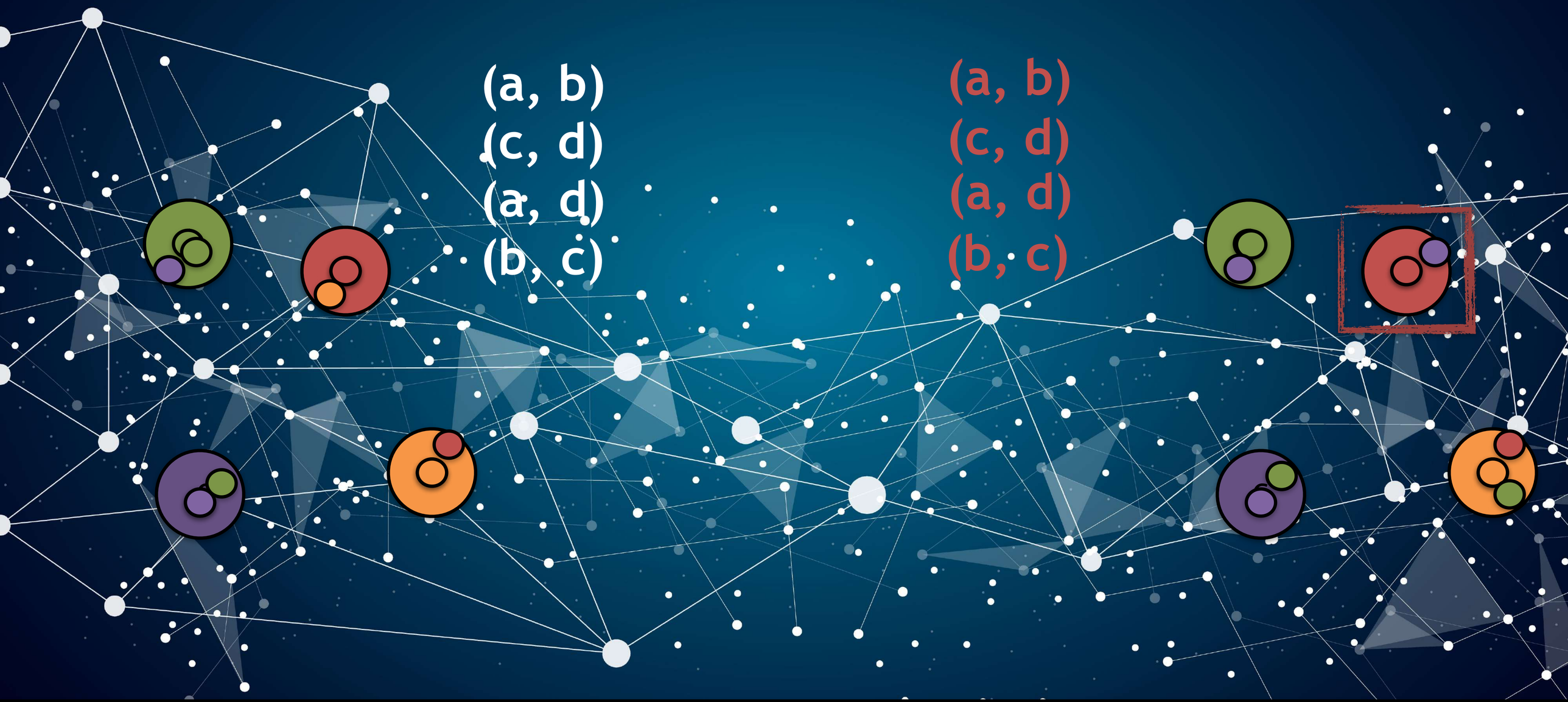

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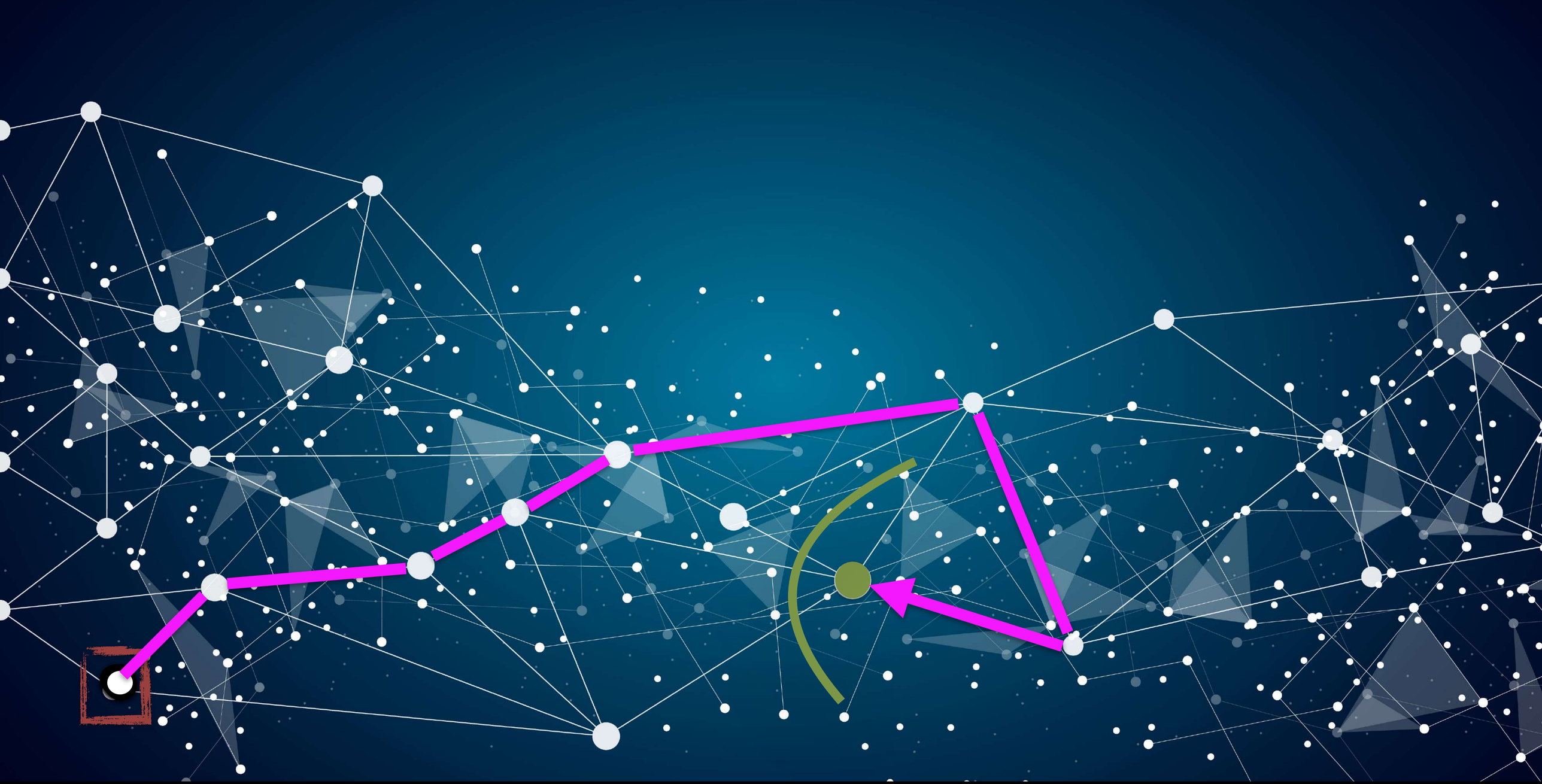

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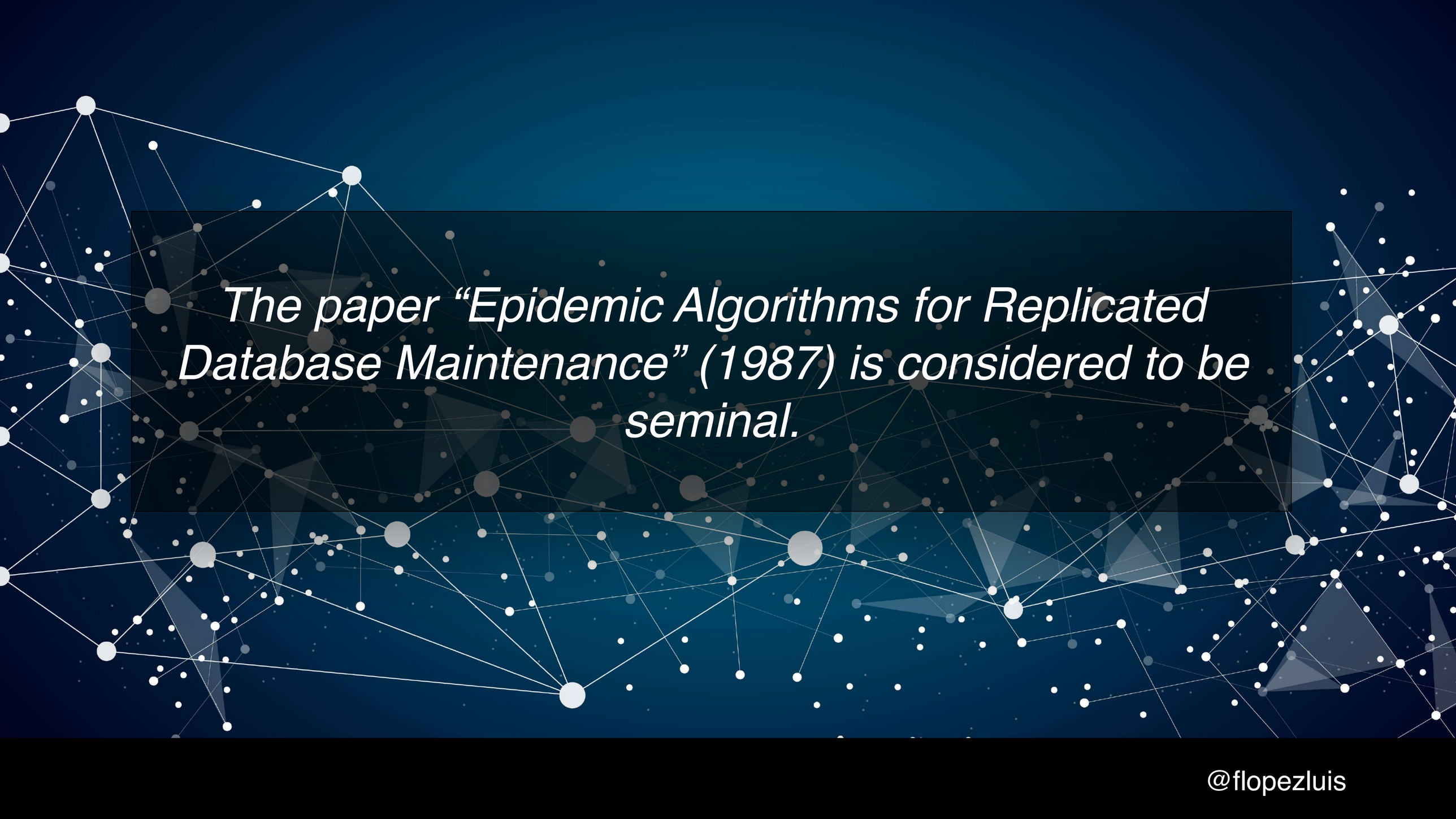
What are they?


They are a communication protocol, a broadcast protocol. We want to communicate a message to all the nodes in the network.

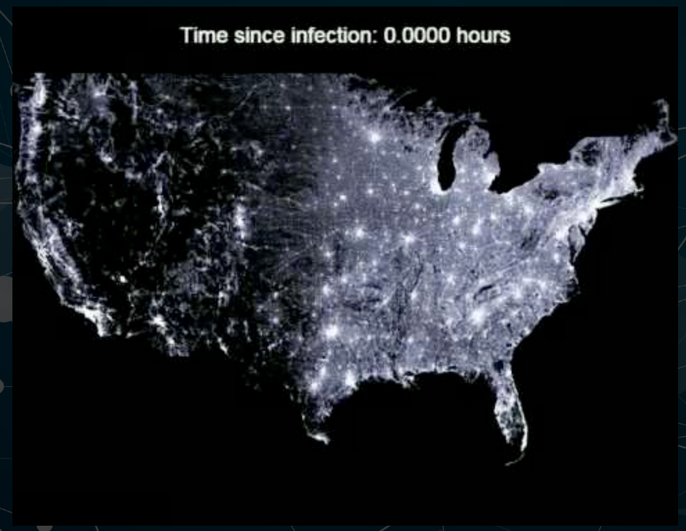

The paper “Epidemic Algorithms for Replicated Database Maintenance” (1987) is considered to be seminal.

- *They were trying to build a distributed K/V*
- *It lays the foundations of Gossip Protocols.*
- *Lots of concepts that we use today come from them.*
  - *Anti-entropy*
  - *Rumor Mongering*
  - *push / pull strategies*
  - *Fanout*
- *First analysis of reliability of these protocols.*


They’re inspired by:
Epidemics, human gossip, social networks


Anyone can start a rumor, but none can stop one.
~ American proverb

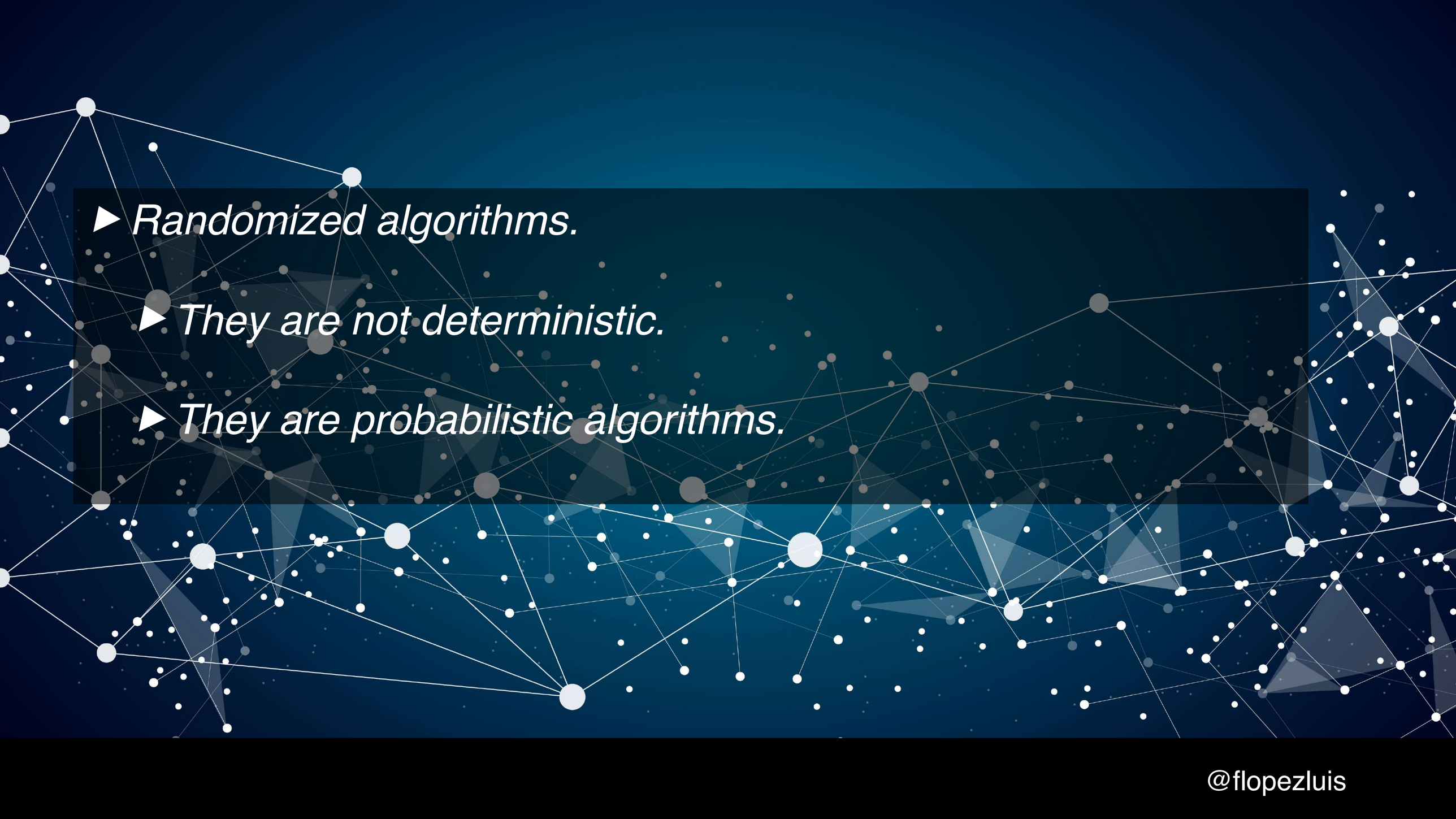
Epidemic theory shows that starting with a single infected the time to infect the entire population is proportional to the log of the population size.



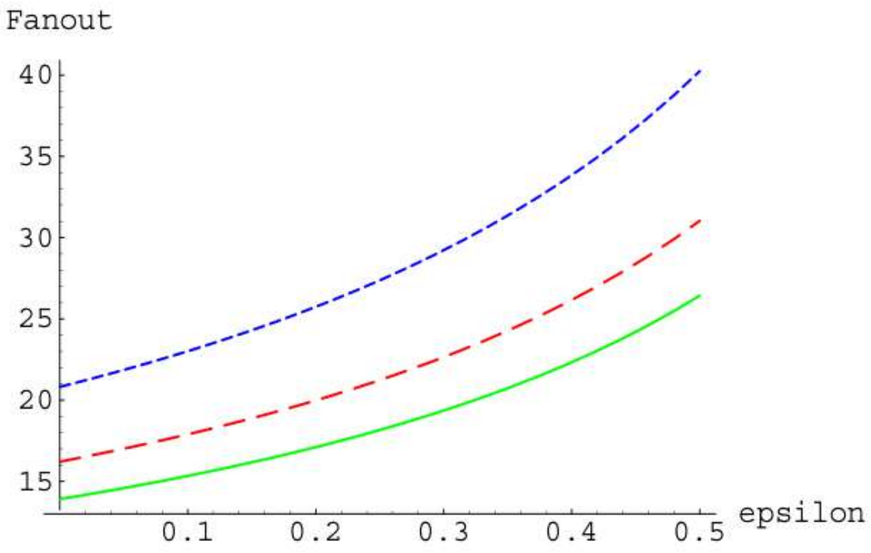
How do they work?

In general they have these properties:

- *Node selection must be random, or at least guarantee enough peer diversity*
- *Only local information is available at all nodes*
- *Communication is round-based (periodic)*
- *Transmission and processing capacity per round is limited*
- *All nodes run the same protocol*


- *Randomized algorithms.*
  - *They are not deterministic.*
  - *They are probabilistic algorithms.*

Probabilistic

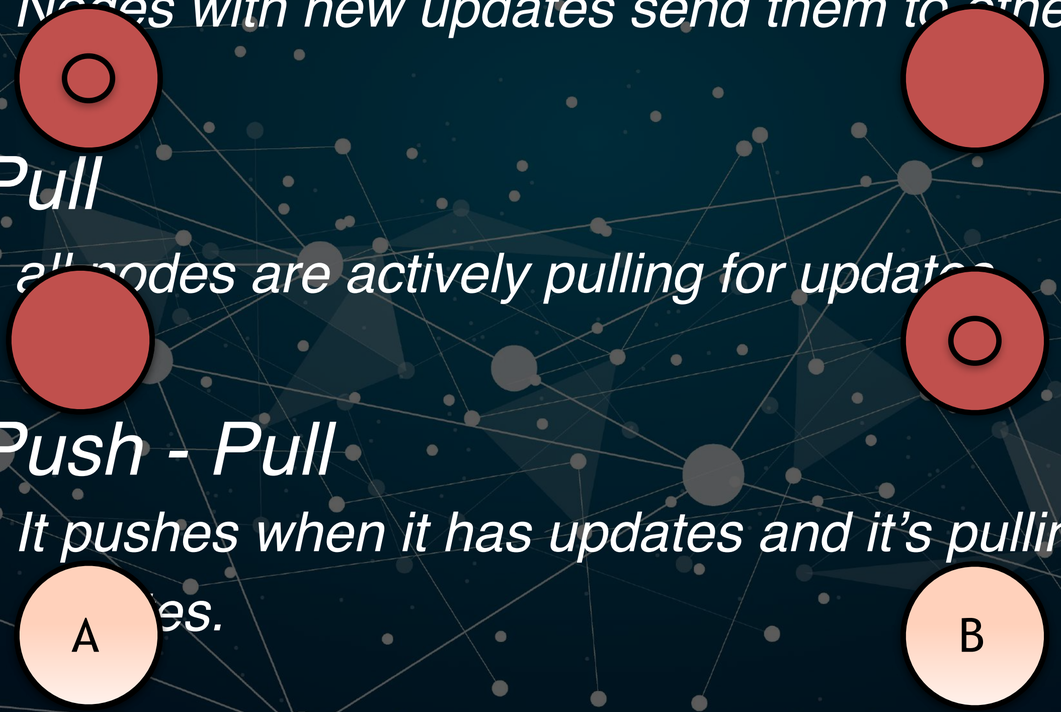


Fanout required versus probability of node failure, for n=1000,10000,100000.

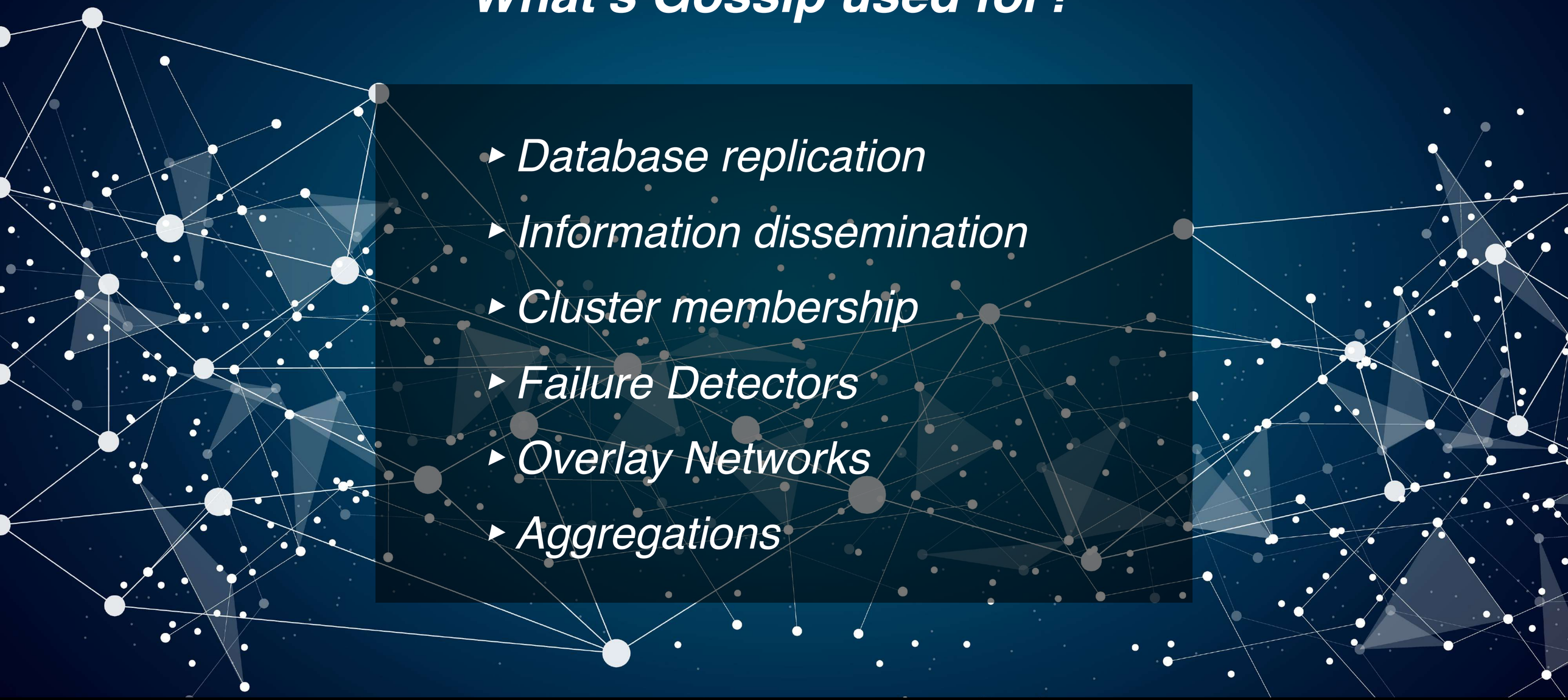
**From "Probabilistic reliable dissemination in large-scale system"*

Messaging strategies

- *Push*
  - *Nodes with new updates send them to other nodes.*
- *Pull*
  - *all nodes are actively pulling for updates*
- *Push - Pull*
  - *It pushes when it has updates and it's pulling for new updates.*



What's Gossip used for?



- *Database replication*
- *Information dissemination*
- *Cluster membership*
- *Failure Detectors*
- *Overlay Networks*
- *Aggregations*

Who using Gossip?

- *RIAK*
- *CASSANDRA*
- *DYNAMO*
- *CONSUL*
- *Amazon s3*
- *Docker Swarm*
- *ElasticSearch*

- *Hazelcast*
- *Redis Cluster*
- *AKKA*
- *Flume (cloudera)*
- *Blockchain*
- *Dynomite*
- *Tribler*

Strengths of Gossip

- *Scalable*
- *Fault-tolerance.*
- *Robust*
- *Convergent consistency.*
- *Extremely decentralized form of information discovery.*
- *Little code and complexity*

Strengths of Gossip

- *Little code and complexity*

Active thread (peer P):

```
(1) selectPeer(&Q);
(2) selectToSend(&bufs);
(3) sendTo(Q, bufs);                  ----->
(4)
(5) receiveFrom(Q, &bufr);            <-----
(6) selectToKeep(cache, bufr);
(7) processData(cache);
```

Passive thread (peer Q):

```
(1)
(2)
(3) receiveFromAny(&P, &bufr);
(4) selectToSend(&bufs);
(5) sendTo(P, bufs);
(6) selectToKeep(cache, bufr);
(7) processData(cache)
```

**From "Gossiping in Distributed Systems"*

Weaknesses of Gossip protocols

- *Not very efficient. Messages can arrive several times to a node.*
- *Gossip protocols are slow.*
- *Latency.*
- *Hard to reproduce and debug. Unexpected problems that arise at runtime*
- *Gossip protocols can't scale well in some situations.*
- *Most of them rely on non-scalable membership protocol.*

Peer Sampling Service

Active thread (peer P):

```
(1) selectPeer(&Q);
(2) selectToSend(&bufs);
(3) sendTo(Q, bufs);                    ----->
(4)
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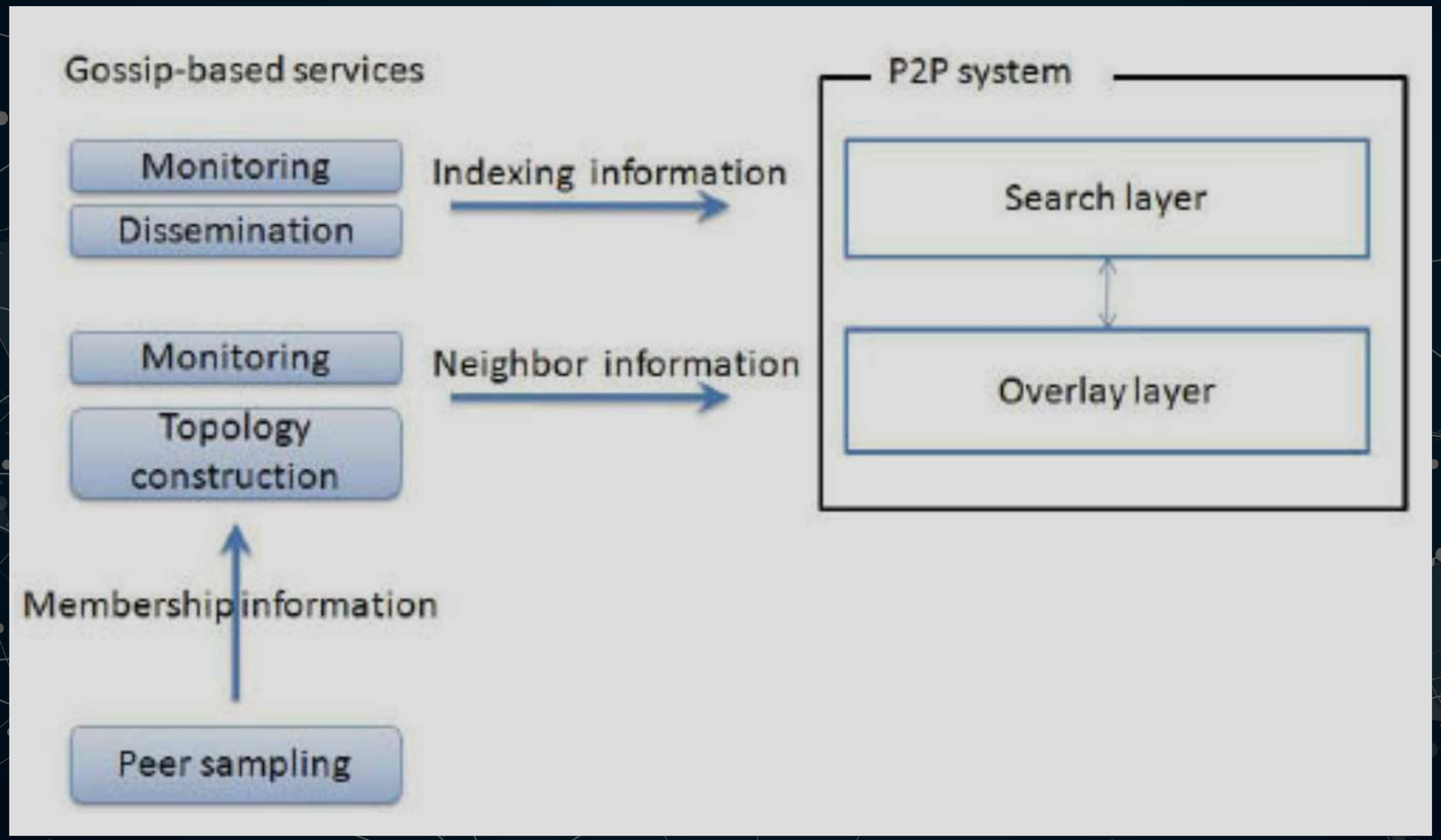
Peer Sampling Service



*From “P2P Techniques for decentralized applications”

FAQ

- *Partial view vs full view*
- *When nodes stop sharing an update/info?*
- *Gossip vs Raft/Paxos…*
- *Is it Gossip affected by partitions?*
- *Does Gossip tolerate Byzantine failures?*

Summary

- *Simple to implement, robust and resilient.*
- *Designed to deal with continuous changes.*
- *Reliable despite peer failures and message loss.*
- *Nodes are autonomous.*
- *They are PROBABILISTIC.*

“Success is not final, failure is not fatal: it is the courage to continue that counts”
Winston Churchill

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