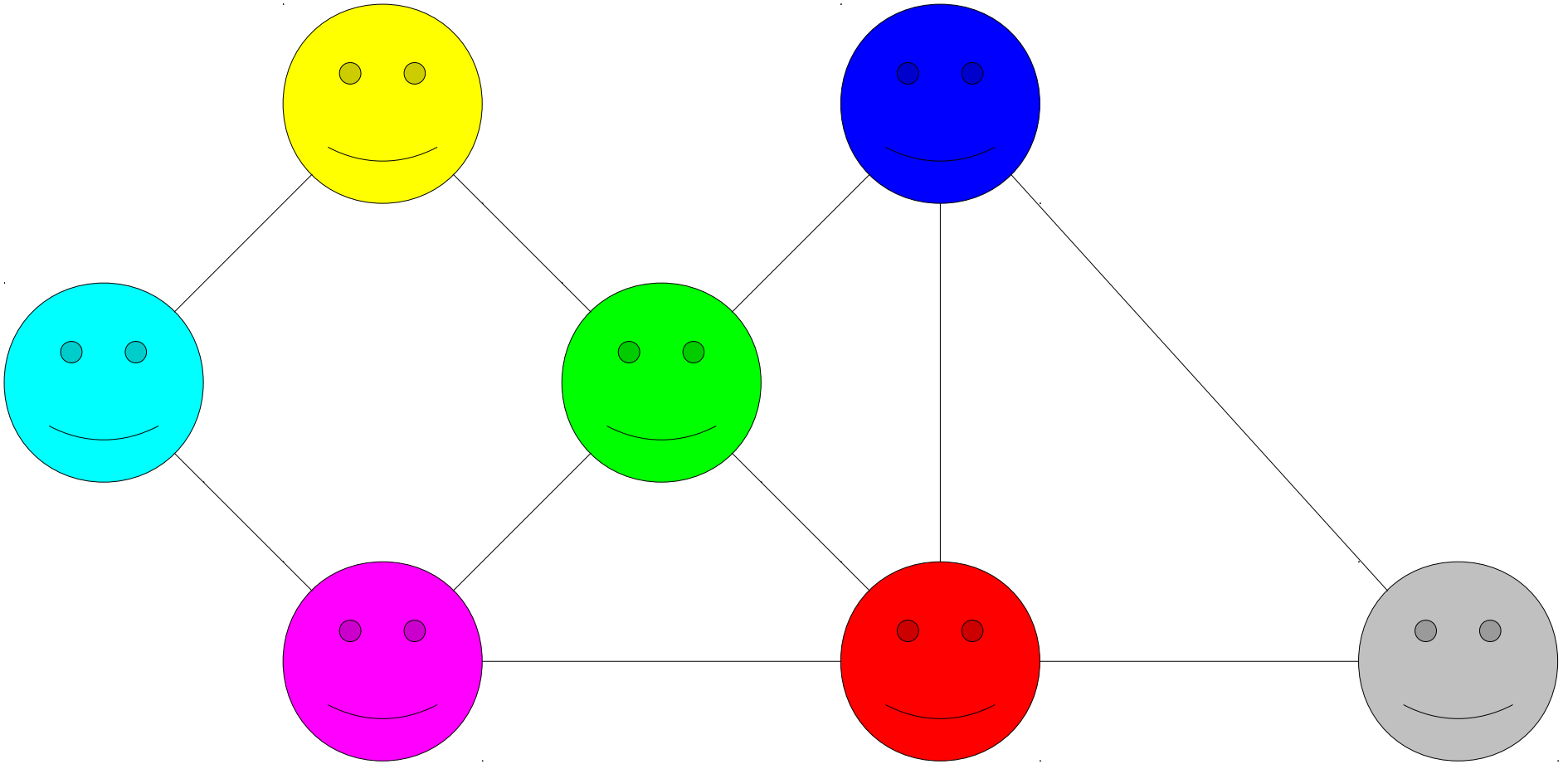
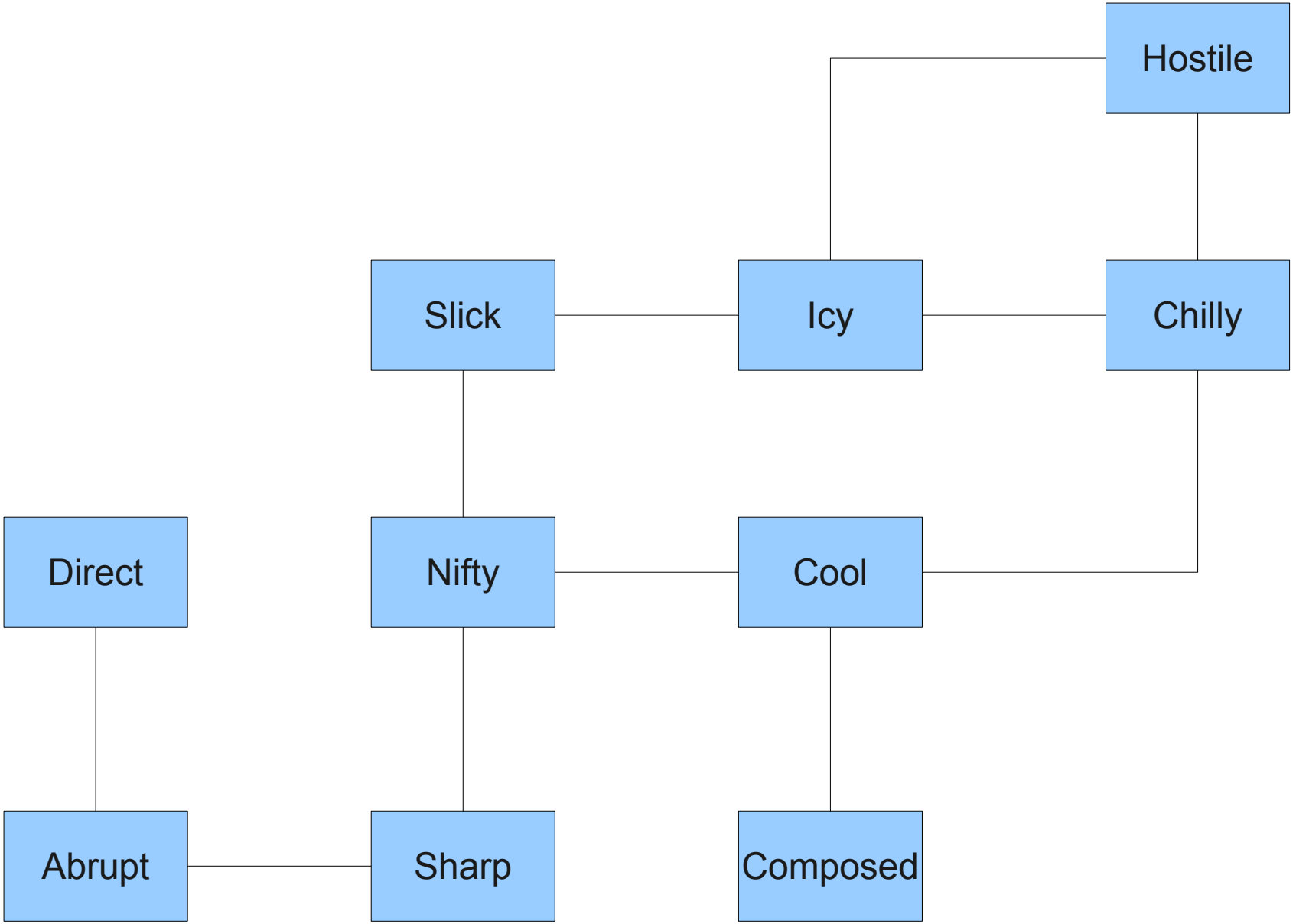
Graphs and Networks

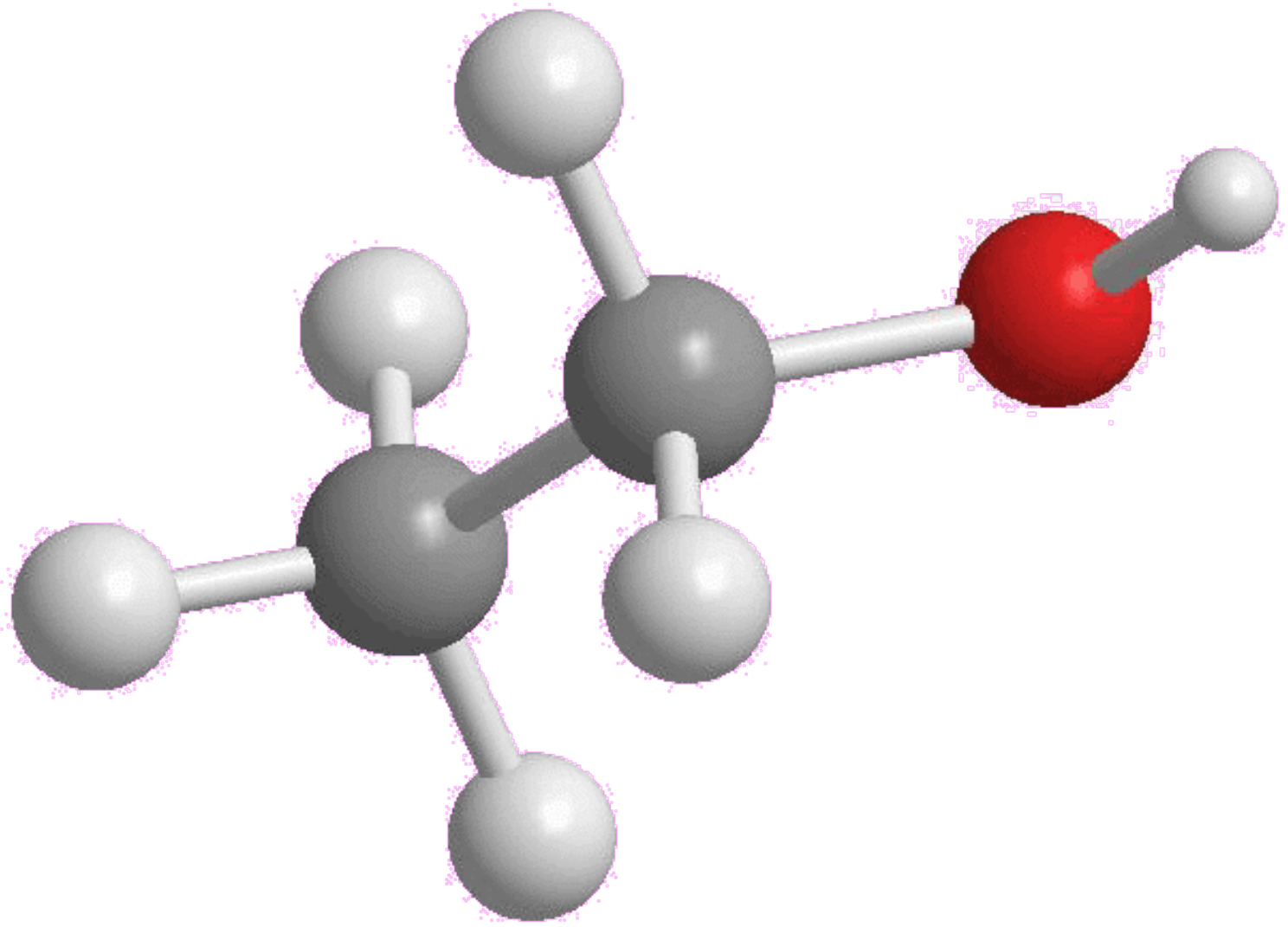
A Social Network



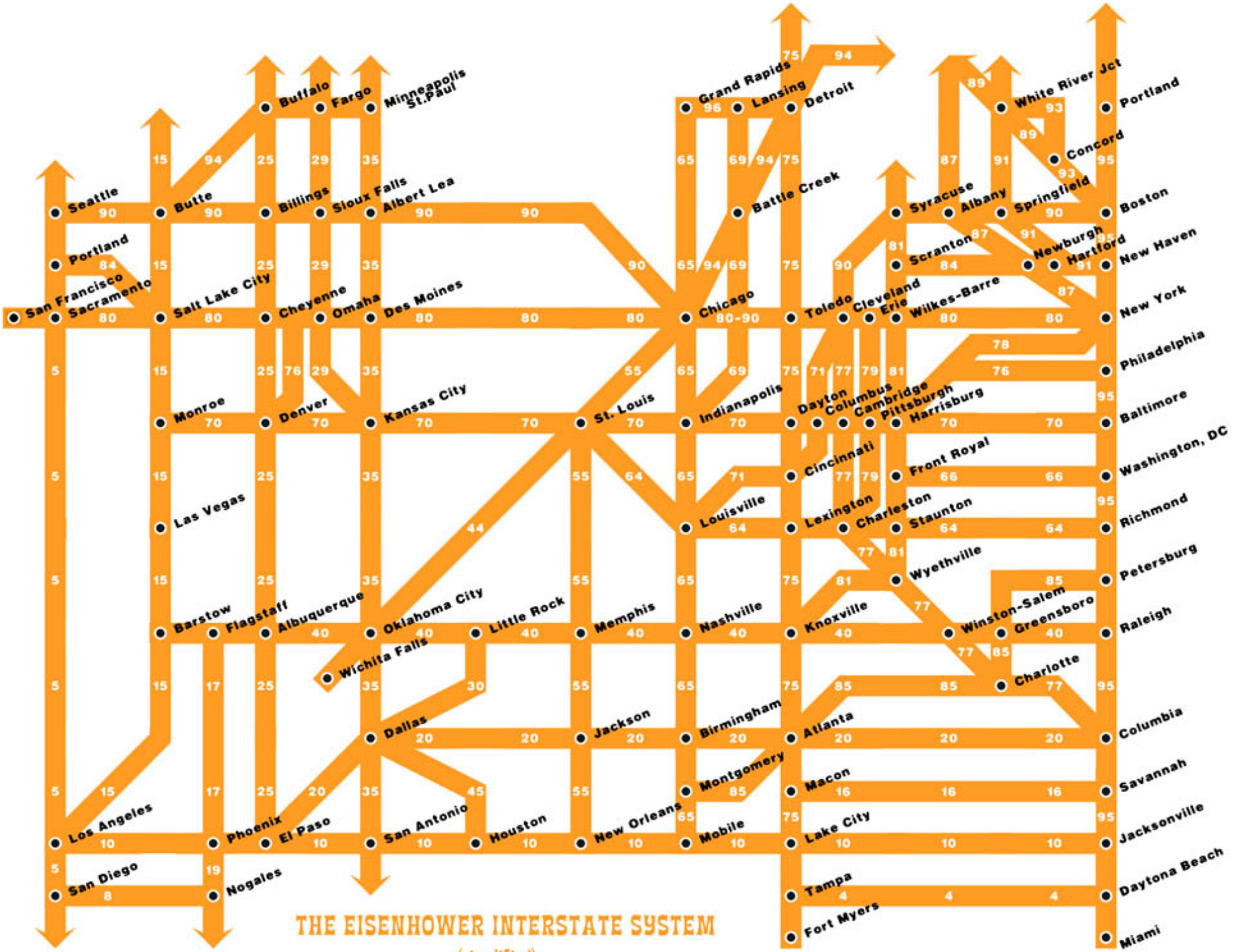
Synonyms


Hostile
Slick
Icy
Chilly
Direct
Nifty
Cool
Abrupt
Sharp
Composed

Chemical Bonds

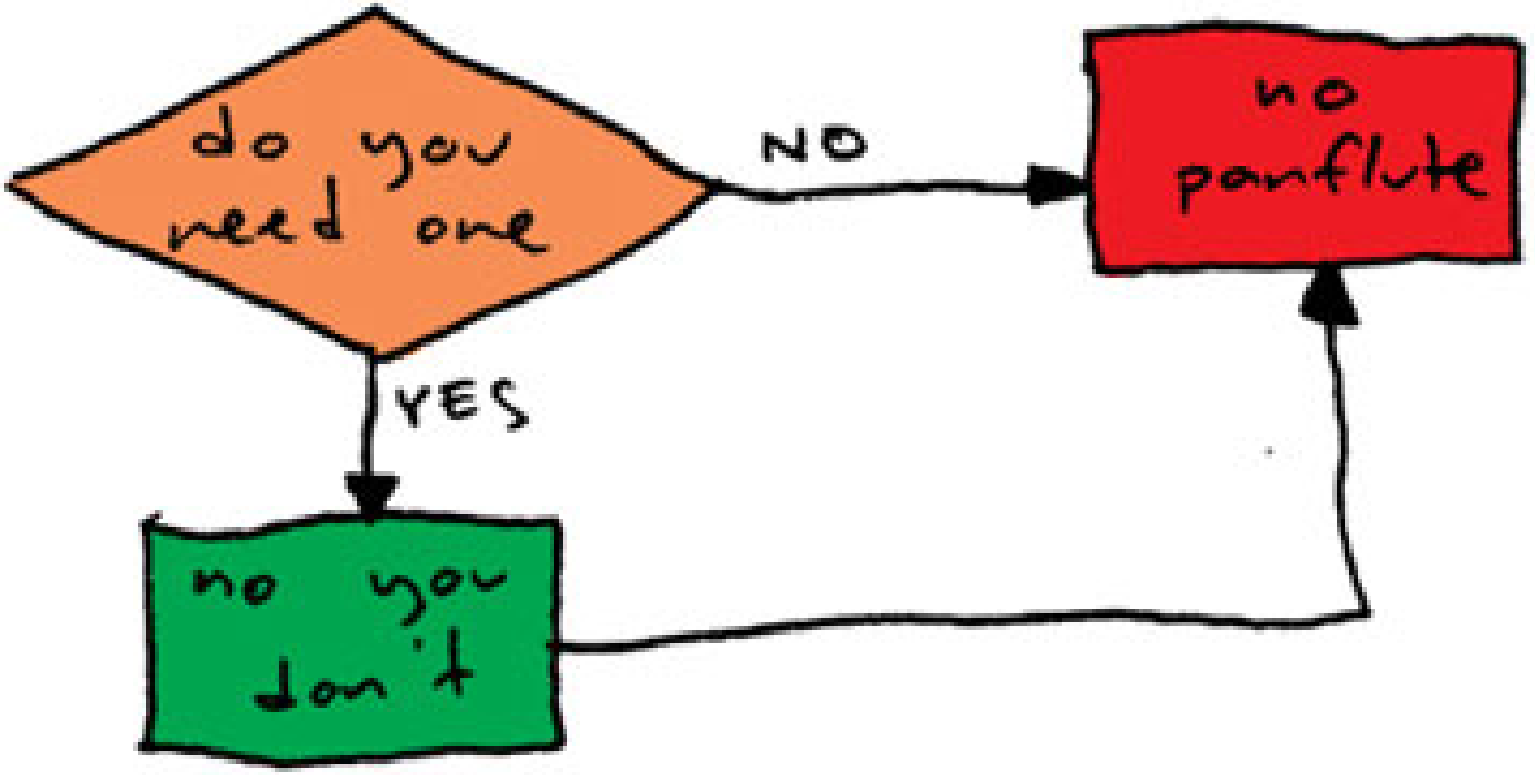


http://4.bp.blogspot.com/-xCtBJ8lKHqA/Tjm0BONWBRI/AAAAAAAAAK4/-mHrbAUOHHg/s1600/Ethanol2.gif



http://strangemaps.files.wordpress.com/2007/02/fullinterstatemap-web.jpg

PANFLUTE FLOWCHART



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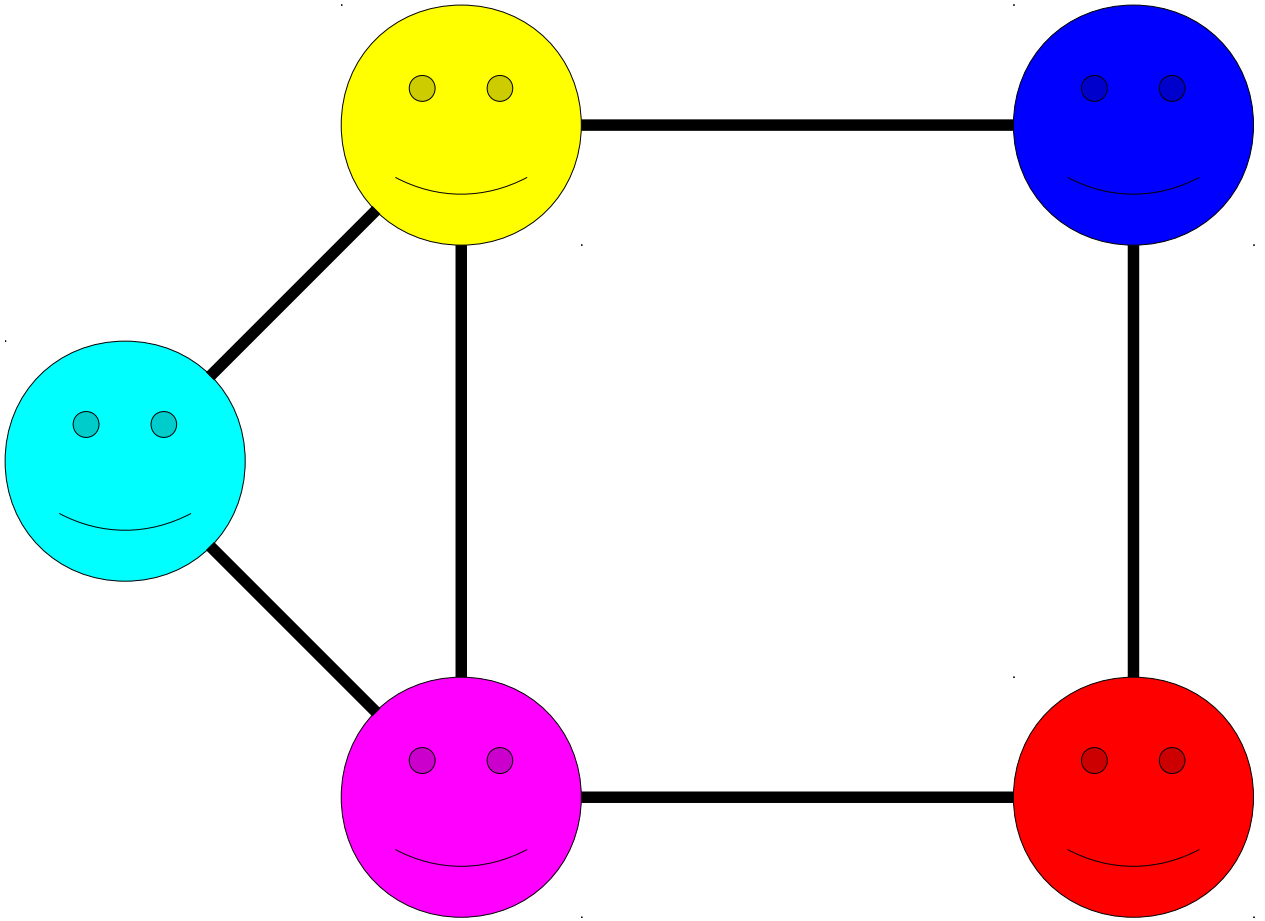

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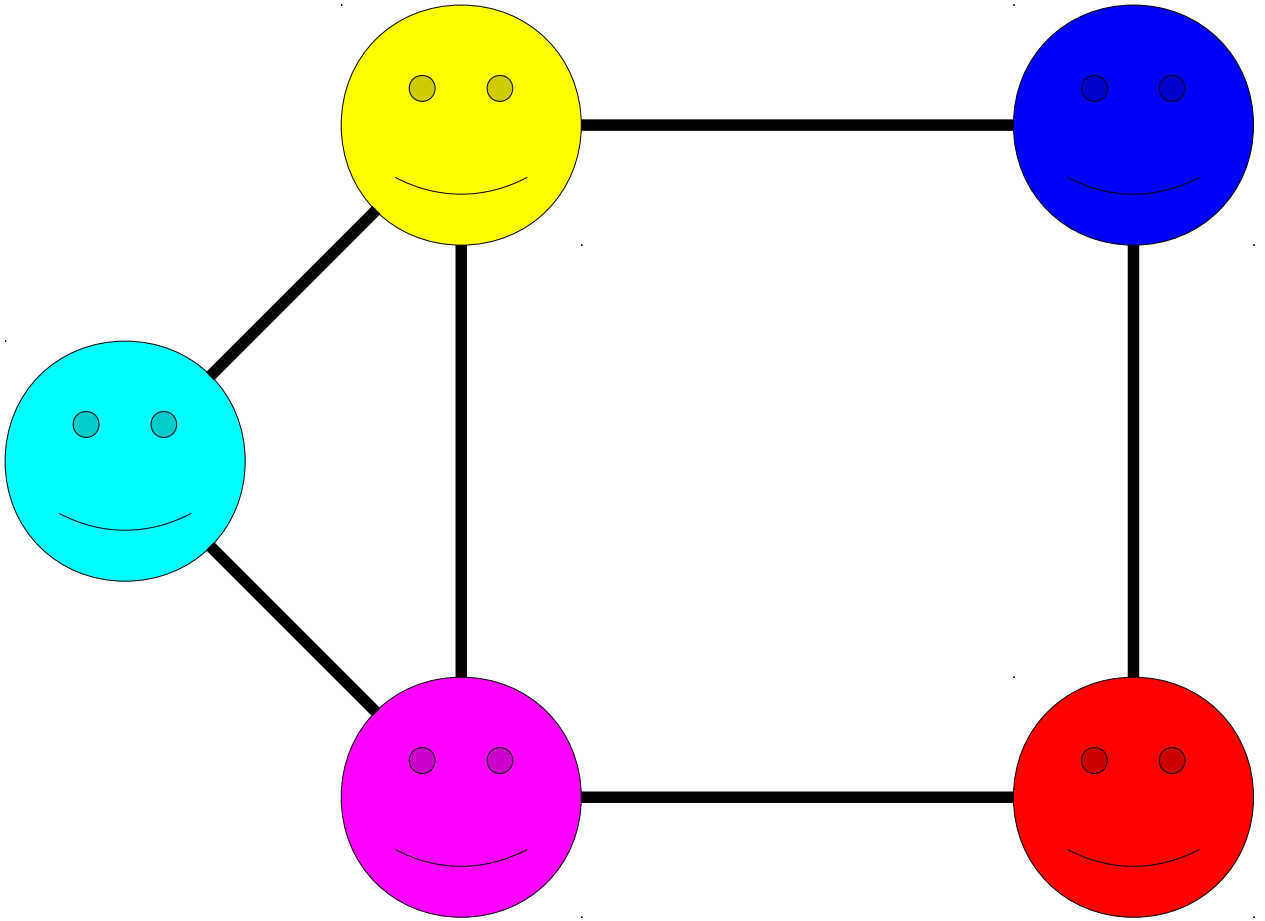

A graph consists of a set of **nodes** connected by **edges**.

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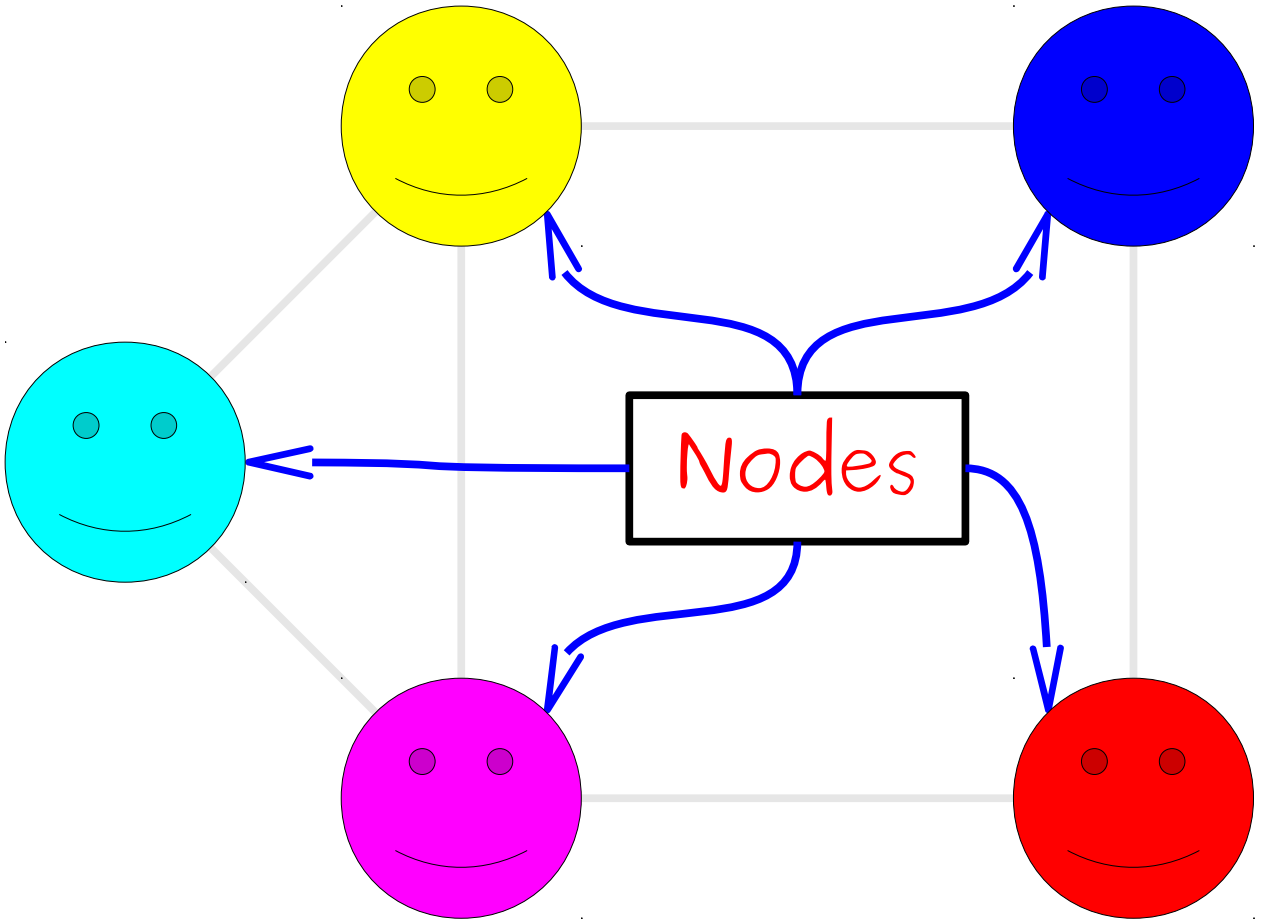

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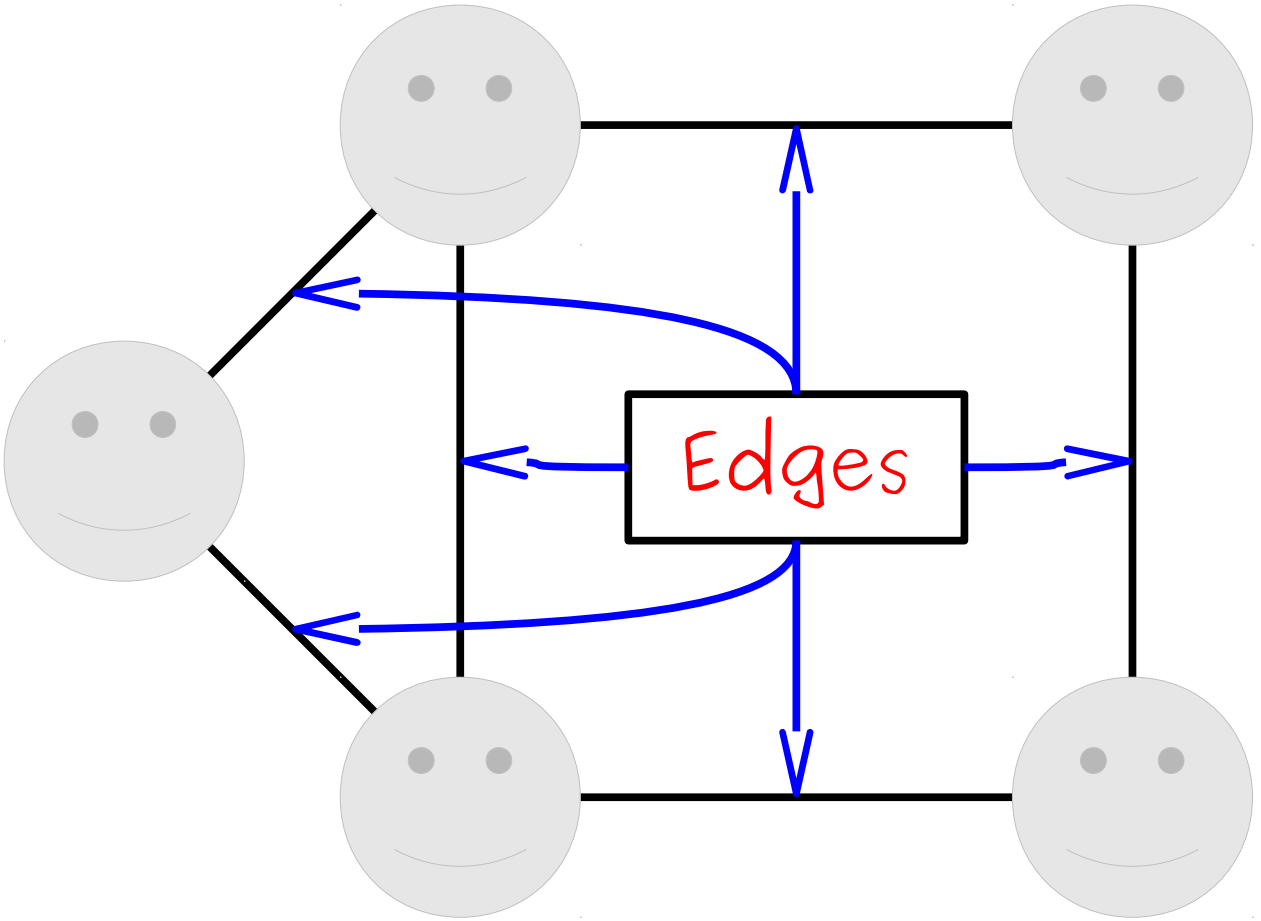

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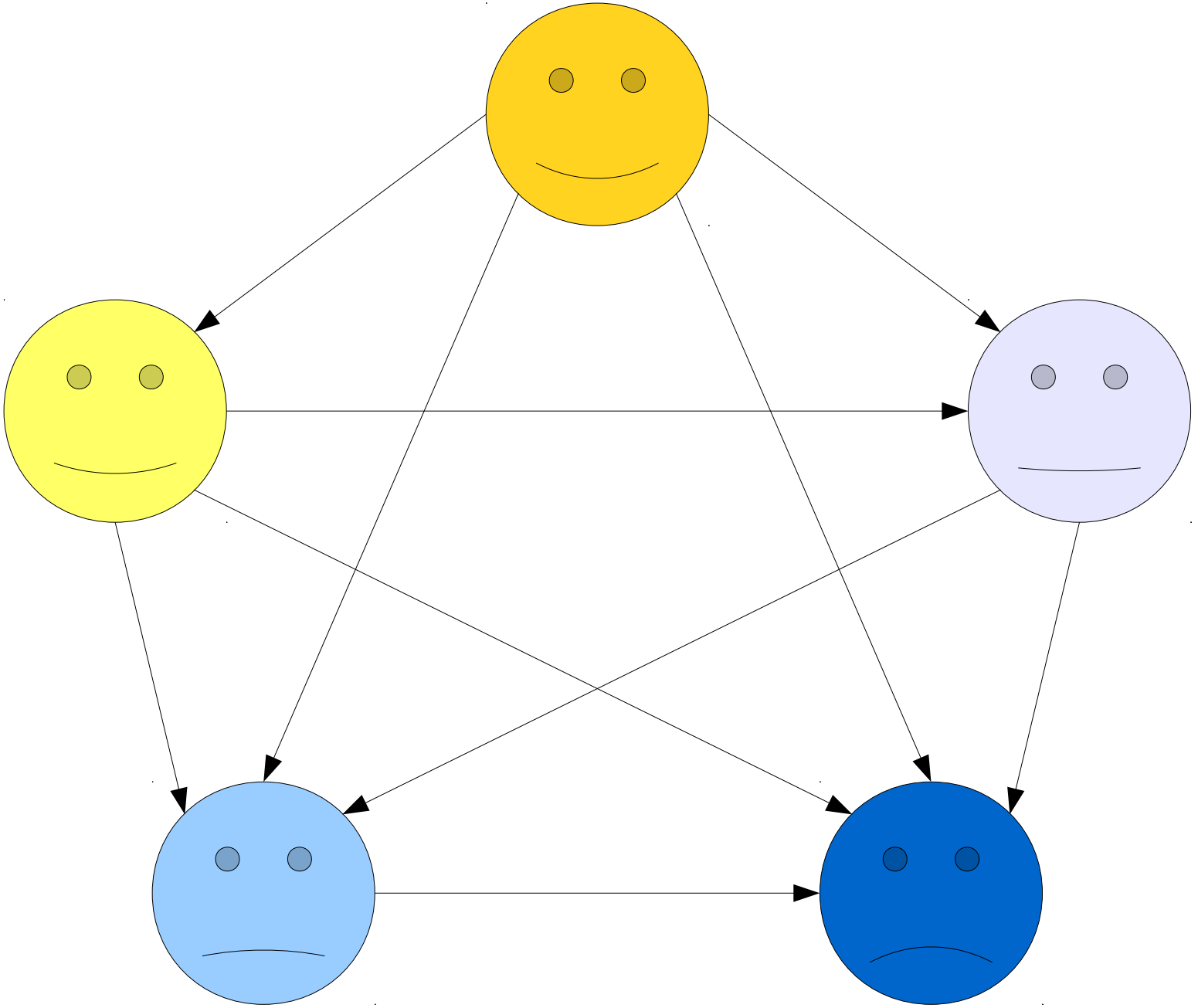
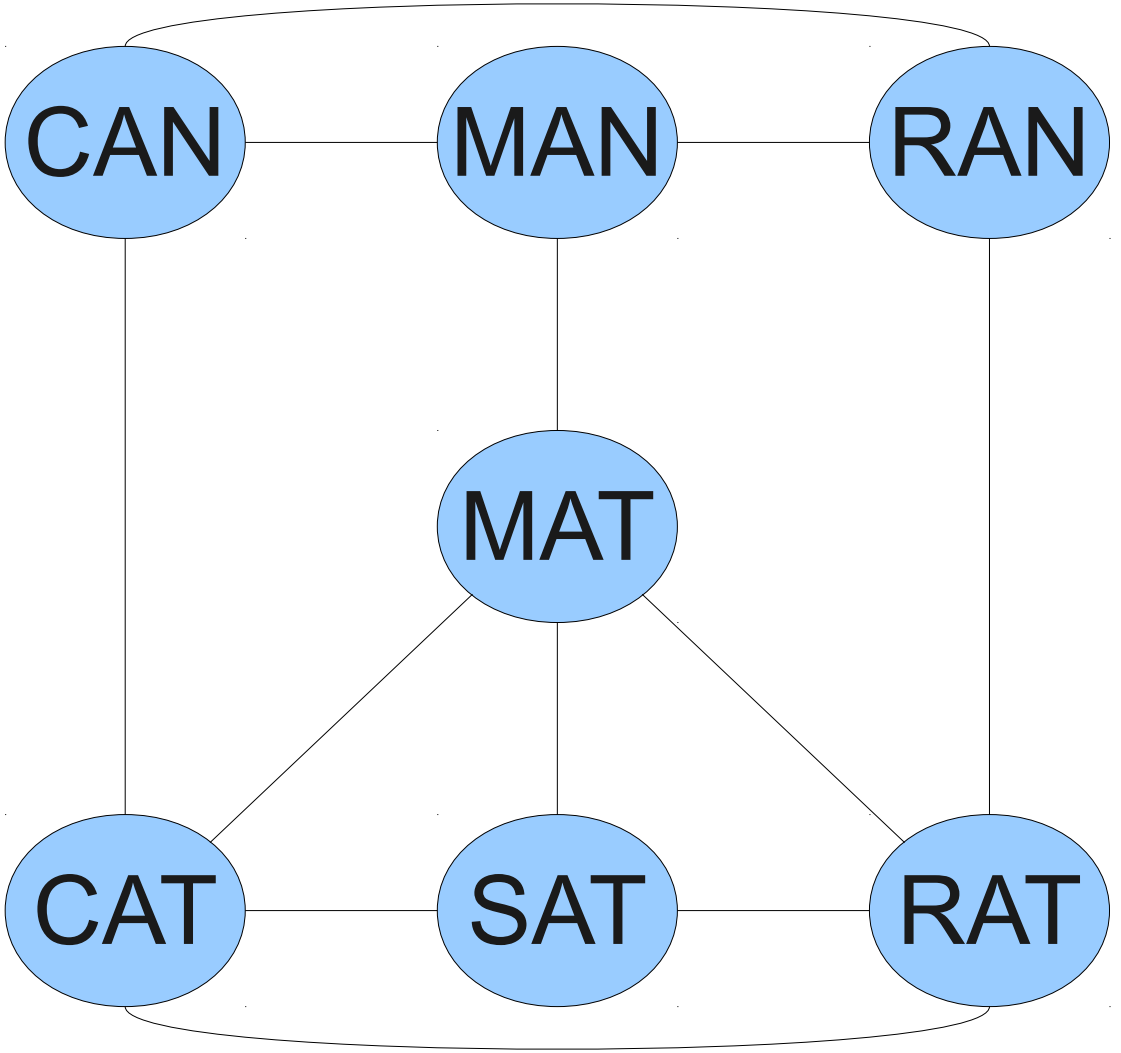
Some graphs are **directed**.



Some graphs are **undirected**.



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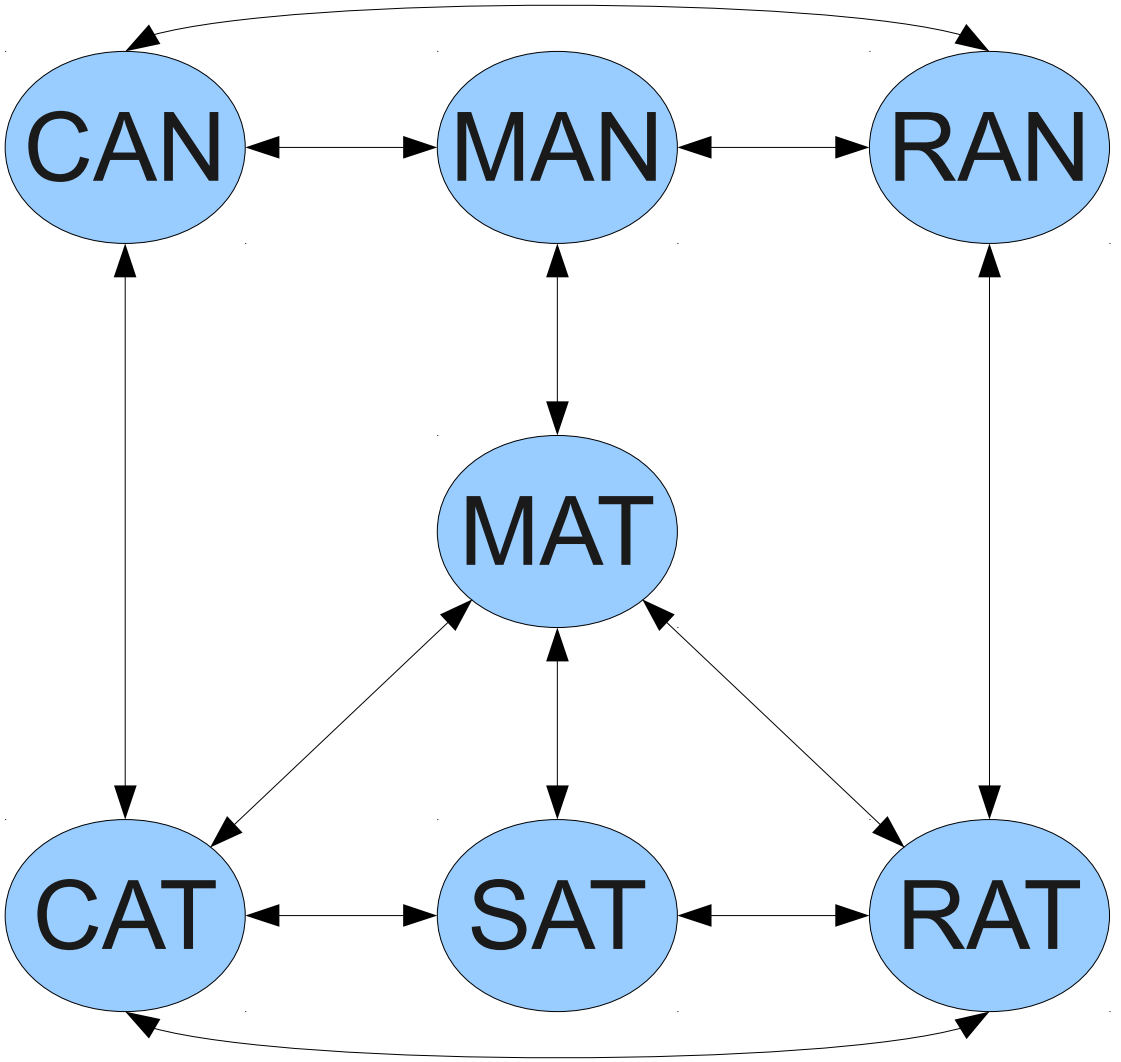
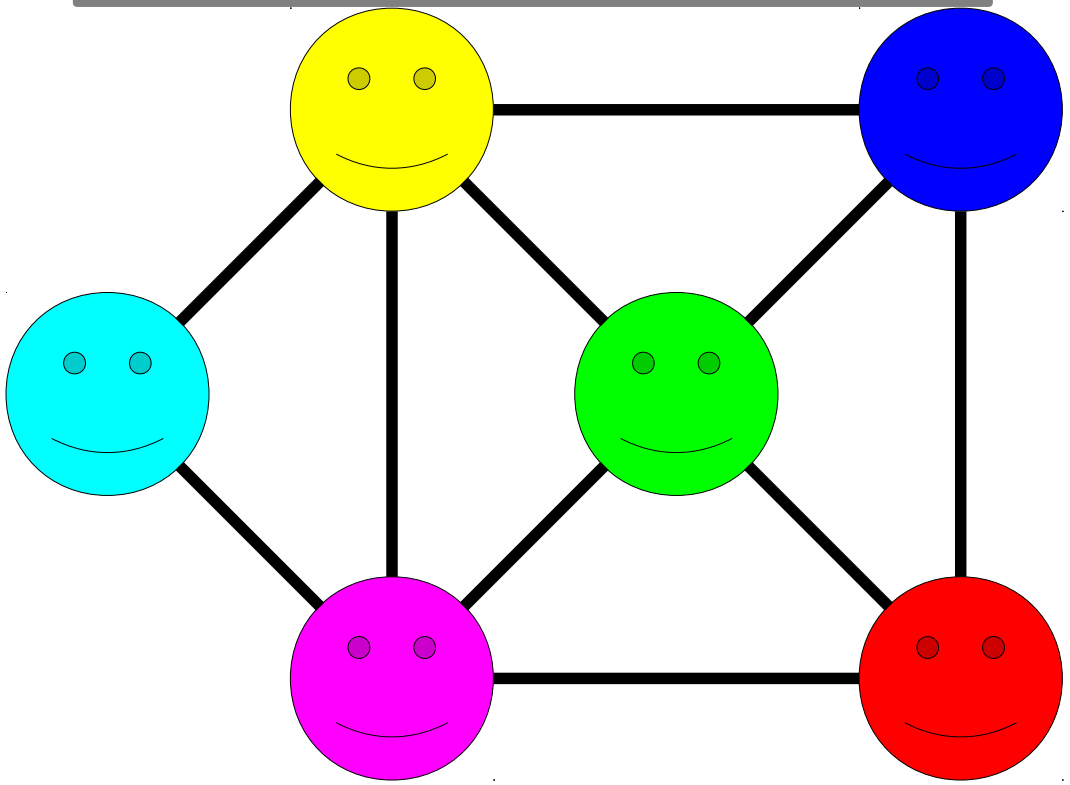


You can think of them as directed graphs with edges both ways.

How can we represent graphs in Java?

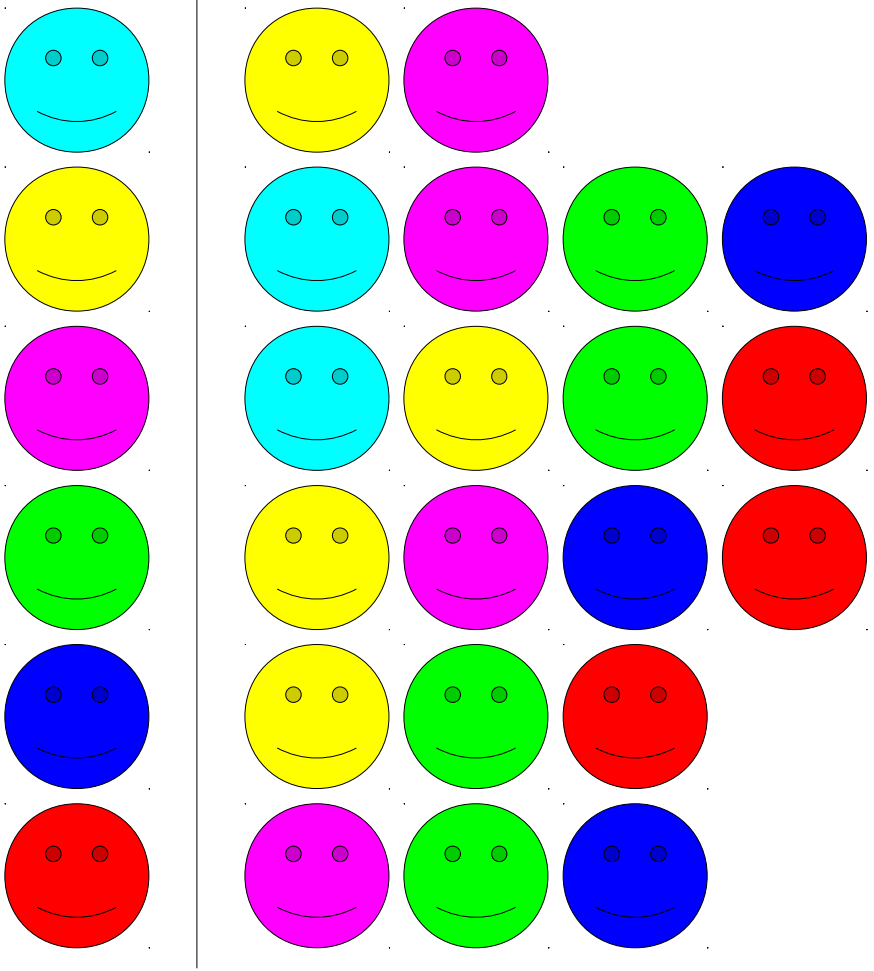
Representing Graphs

We can represent a graph as a map from nodes to the list of nodes each node is connected to.



`HashMap<`***Node***`, ArrayList<`***Node***`>>`

Node	`ArrayList<`***Node***`>`
Node	**Connected To**



The Wikipedia Graph

- Wikipedia (and the web in general) is a graph!
- Each page is a node.
- There is an edge from one page to another if the first page links to the second.

Time Out for Announcements!

CS Casual Dinner

- CS Casual Dinner for Women Studying Computer Science: this **Wednesday, February 26** at **6PM** in **Gates 519**!
- RSVP through the email link sent out last night.
- Keith will be holding shortened office hours on Wednesday (4:30PM – 6:00PM).

Assignment 5

- Assignment 5 out, due Friday at 3:15PM.
- **Recommendation:** Try to get Steganography and Tone Matrix completed by Wednesday and start on Histogram Equalization.
- Have questions?
  - Stop by the LaIR!
  - Ask on QuestionHut!
  - Email your section leader!
  - Stop by Keith's or Vikas's office hours!

Alternate Exam Times

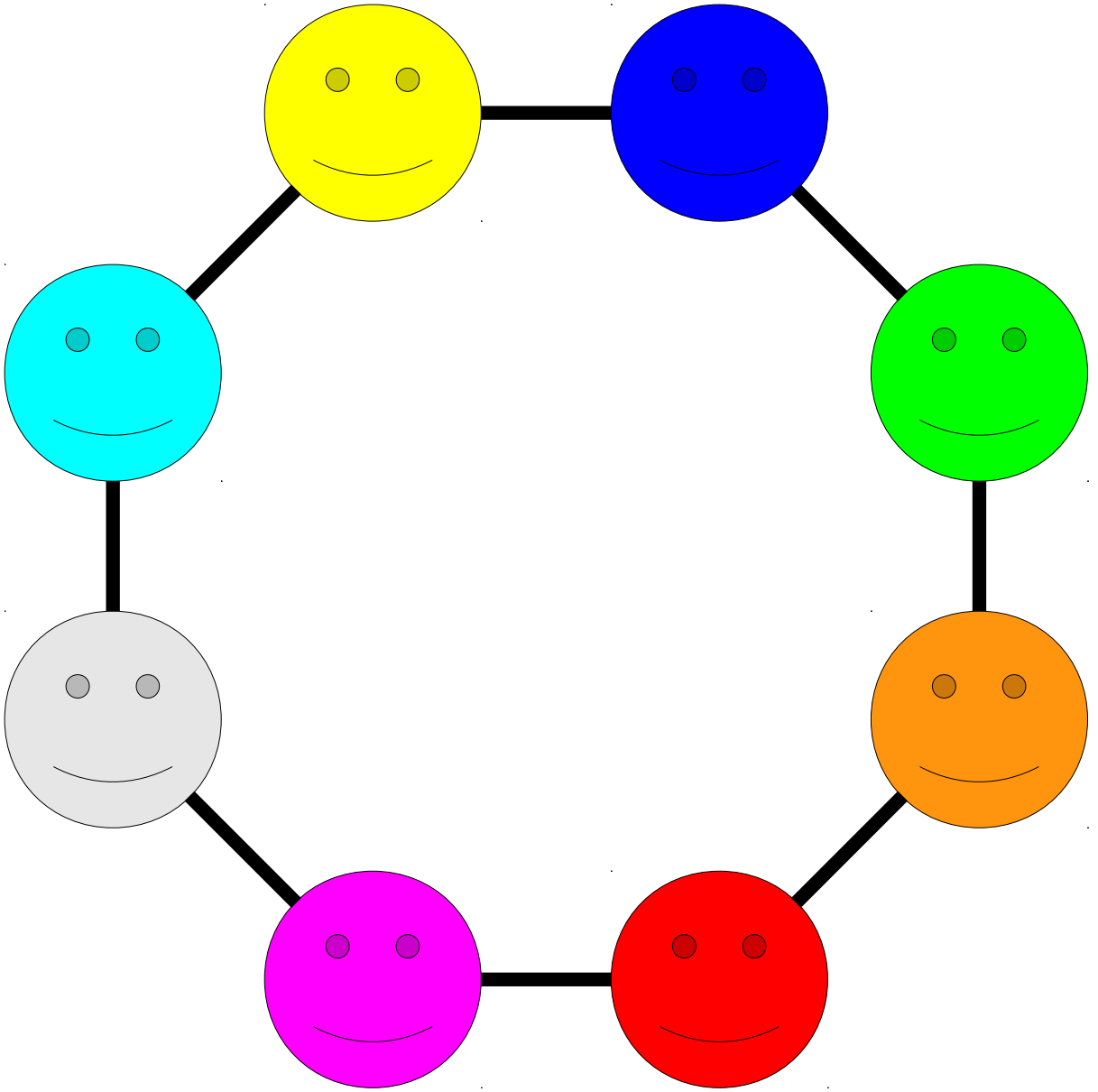
- Second midterm is **Wednesday, March 5** from 7PM – 10PM.
- Need to take the exam at an alternate time? Fill out the alternate exam time request form by Wednesday at 3:15PM.
  - For logistical reasons, no alternate exam requests will be considered after this time.

Back to CS106A!

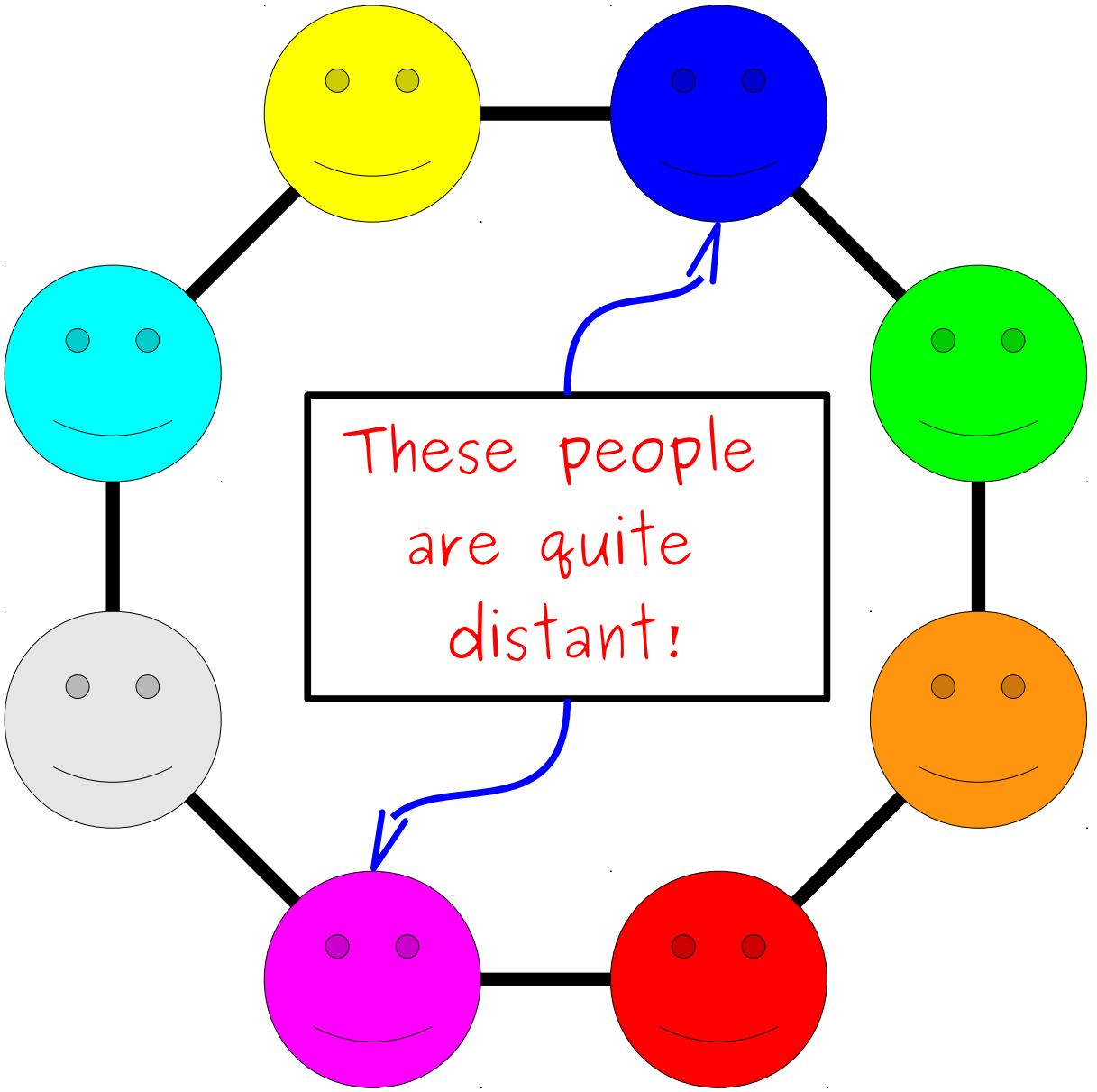
Network Analysis

- We can analyze how nodes in a graph are connected to learn more about the graph.
- How connected are the nodes in the graph?
- How important is each node in the graph?

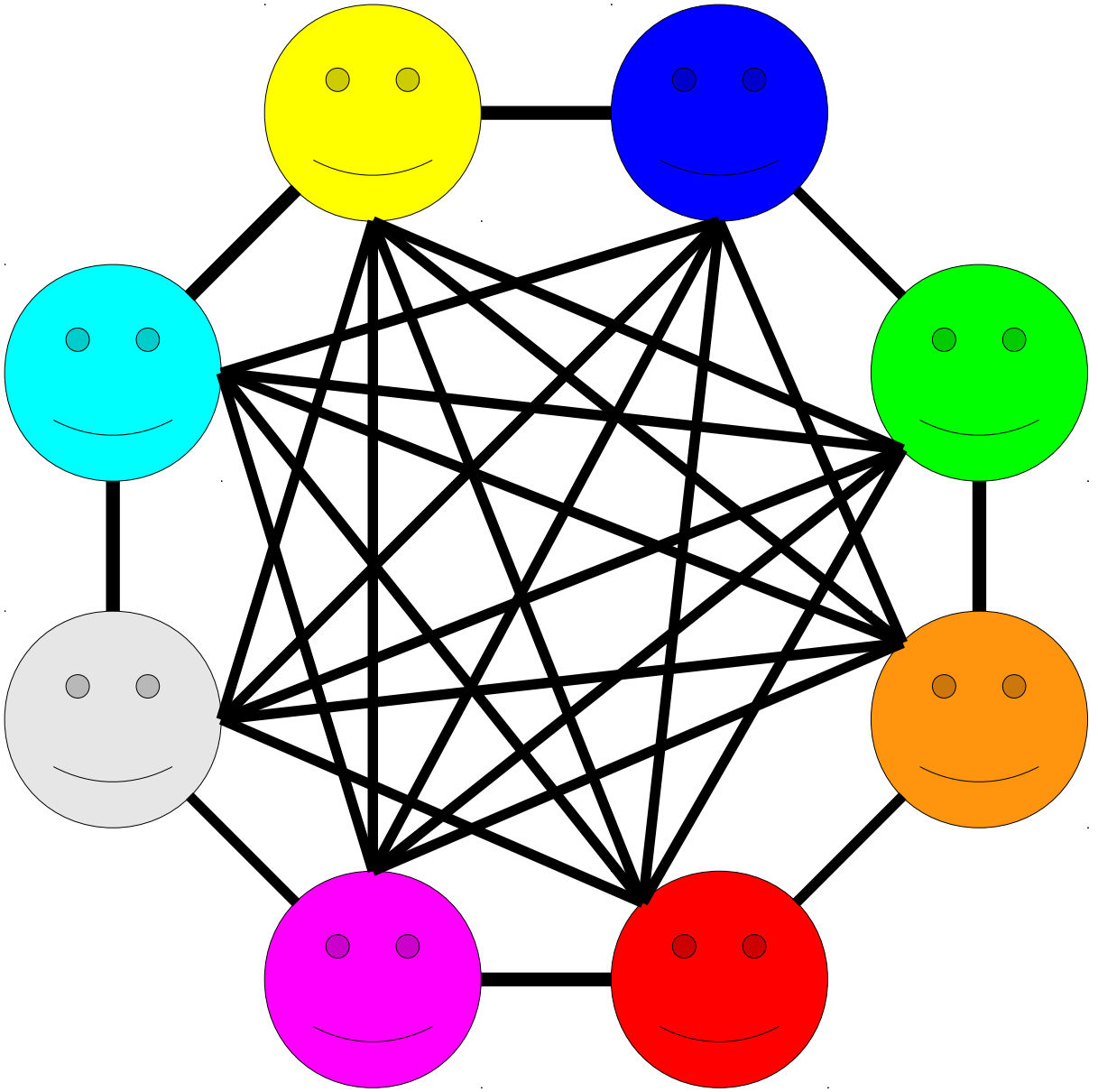
Connectivity



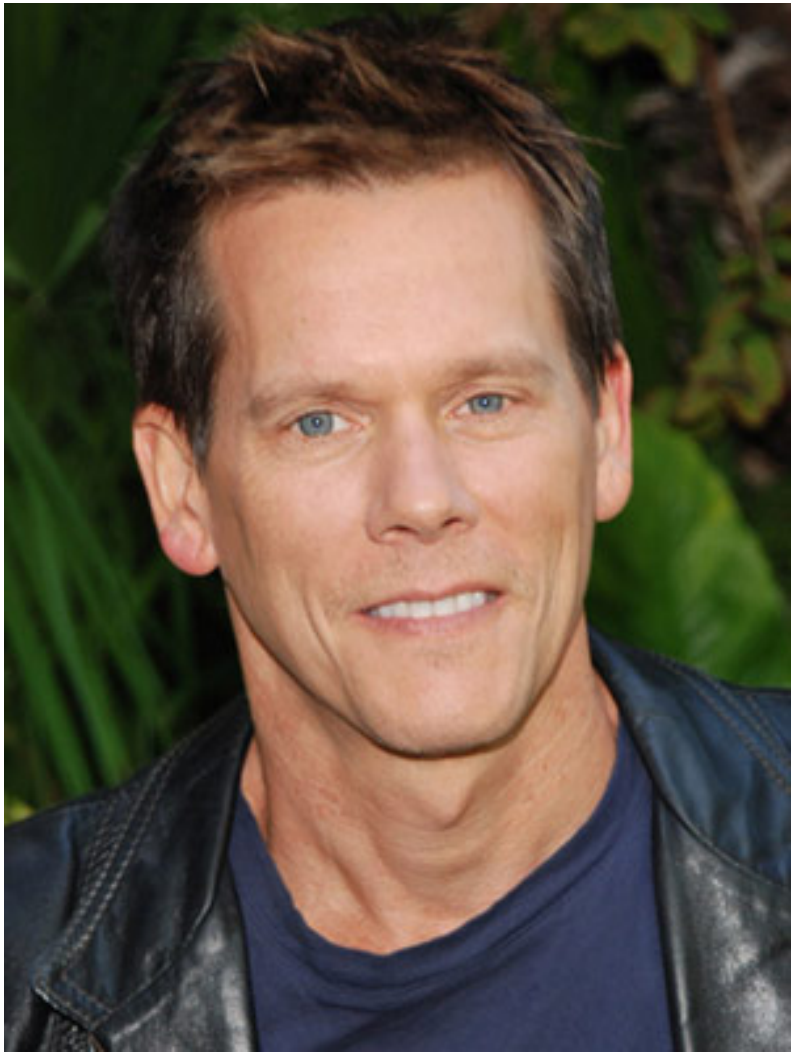
Connectivity



Connectivity



Network Connectivity



- All actors and actresses have a **Bacon number** describing how removed they are from Kevin Bacon.
- Fewer than 1% of all actors and actresses have a Bacon number greater than six.

Image: http://3.bp.blogspot.com/_s59ARuFLHSs/TD-BqVrYtNI/AAAAAAAACx8/5-Ultw06u0s/s1600/Kevinbacon.jpg

Finding Important Nodes

- Suppose that we want to have the computer find “important” articles on Wikipedia.
- We just have the link structure, not the text of the page, the number of edits, the length of the article, etc.
- How might we do this?

Link Analysis

- To find important Wikipedia pages, let's look at the links between pages.
- We'll make two assumptions:
  - The more important an article is, the more pages will link to it.
  - The more important an article is, the more that its links matter.
- **An article is important if other important articles link to it.**

Link Analysis

- **An article is important if other important articles link to it.**

Link Analysis

To find ... let's
look a...

We'll n...

The r... more
page...

The r... more
that ...

- **An article is important if other important articles link to it.**

The Random Surfer Model

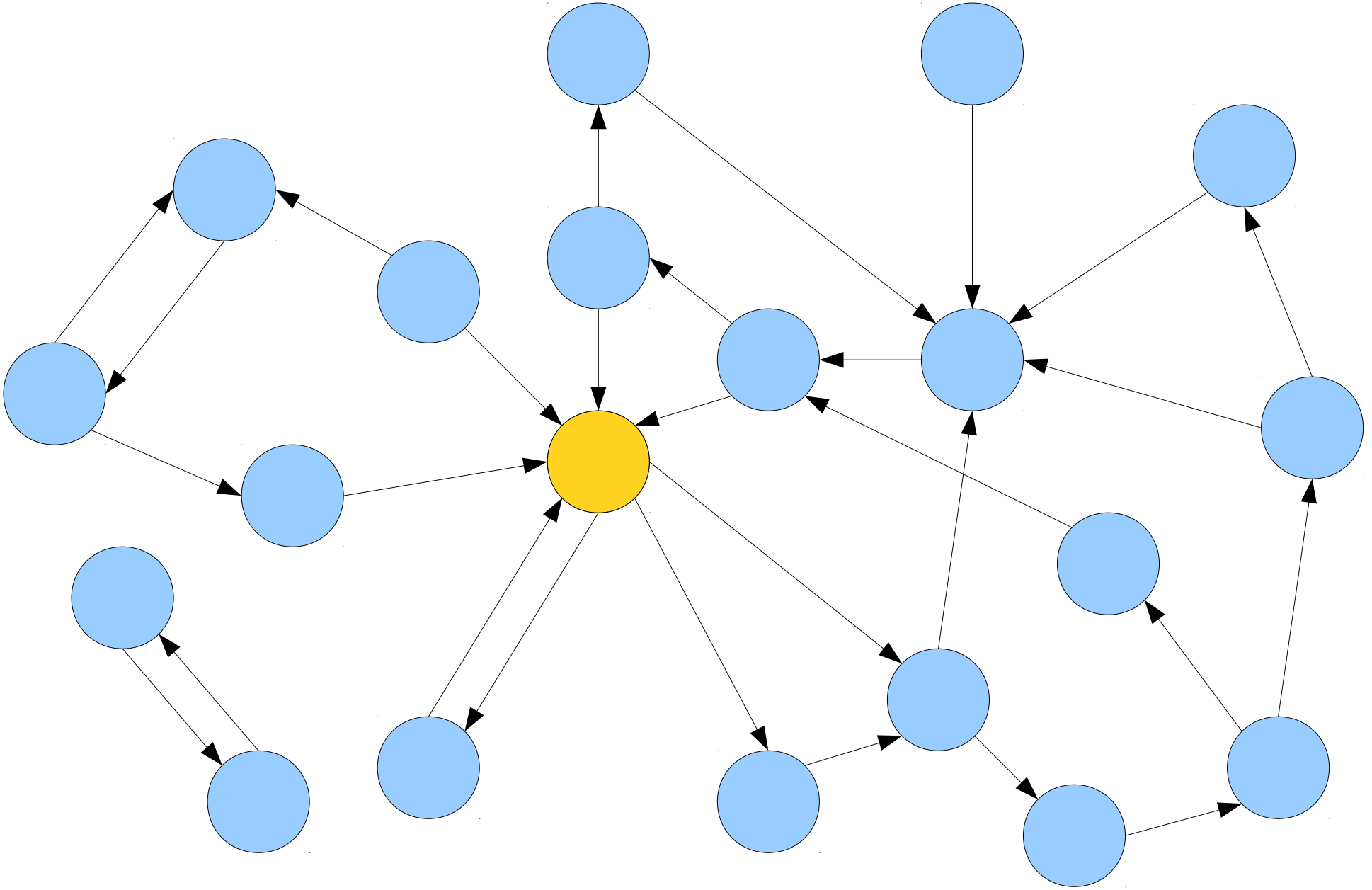
http://farm1.static.flickr.com/192/492079742_30a94de366.jpg

(seriously though)

The Random Surfer Model

- Think about the behavior of a Wikipedia reader who randomly surfs Wikipedia.
- Visits some initial page at random.
- From there, the user either
  - Clicks a random link on the page to some other article, or
  - hits the “random page” link to visit a totally random page.

The Random Surfer Model



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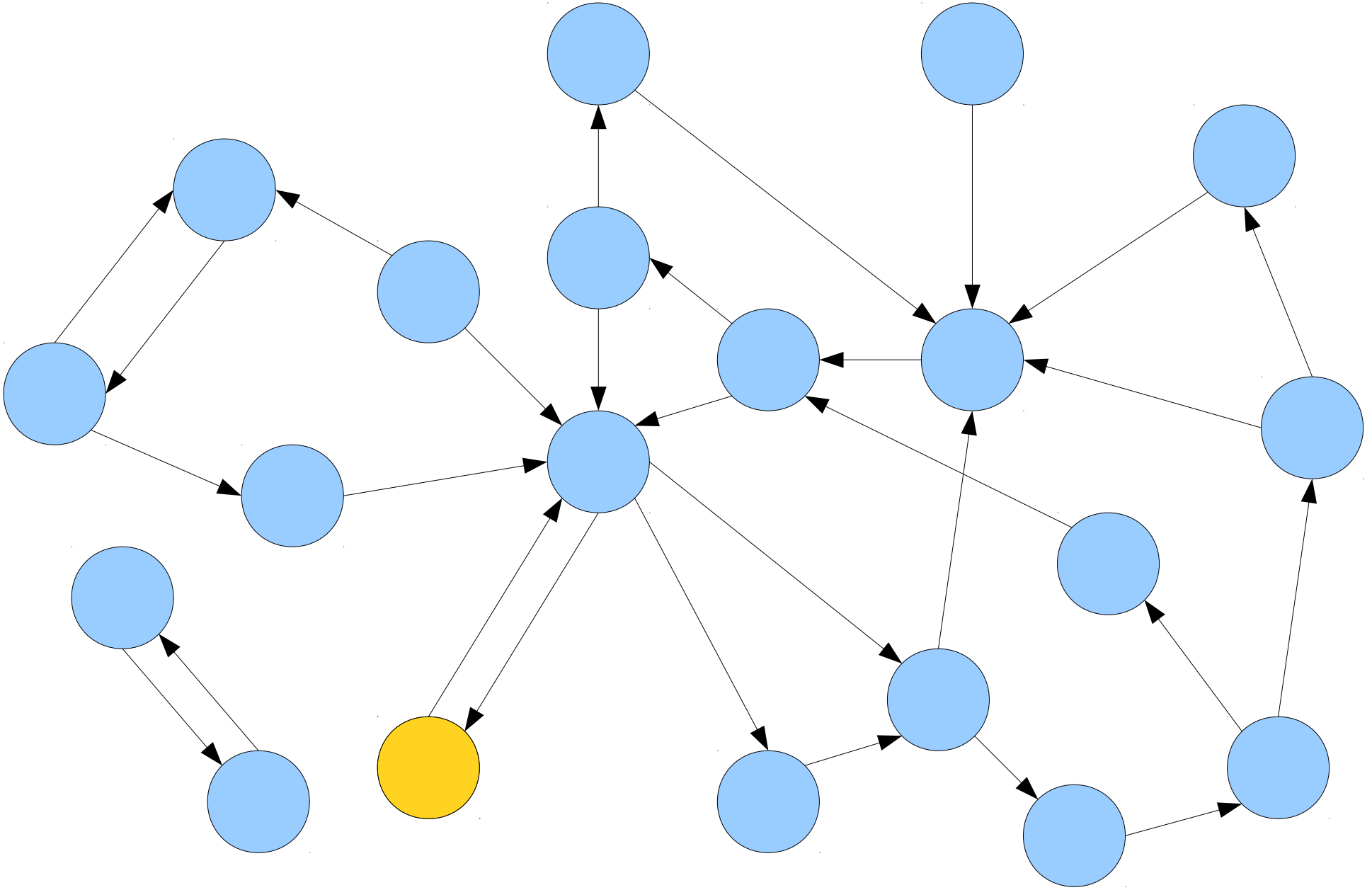

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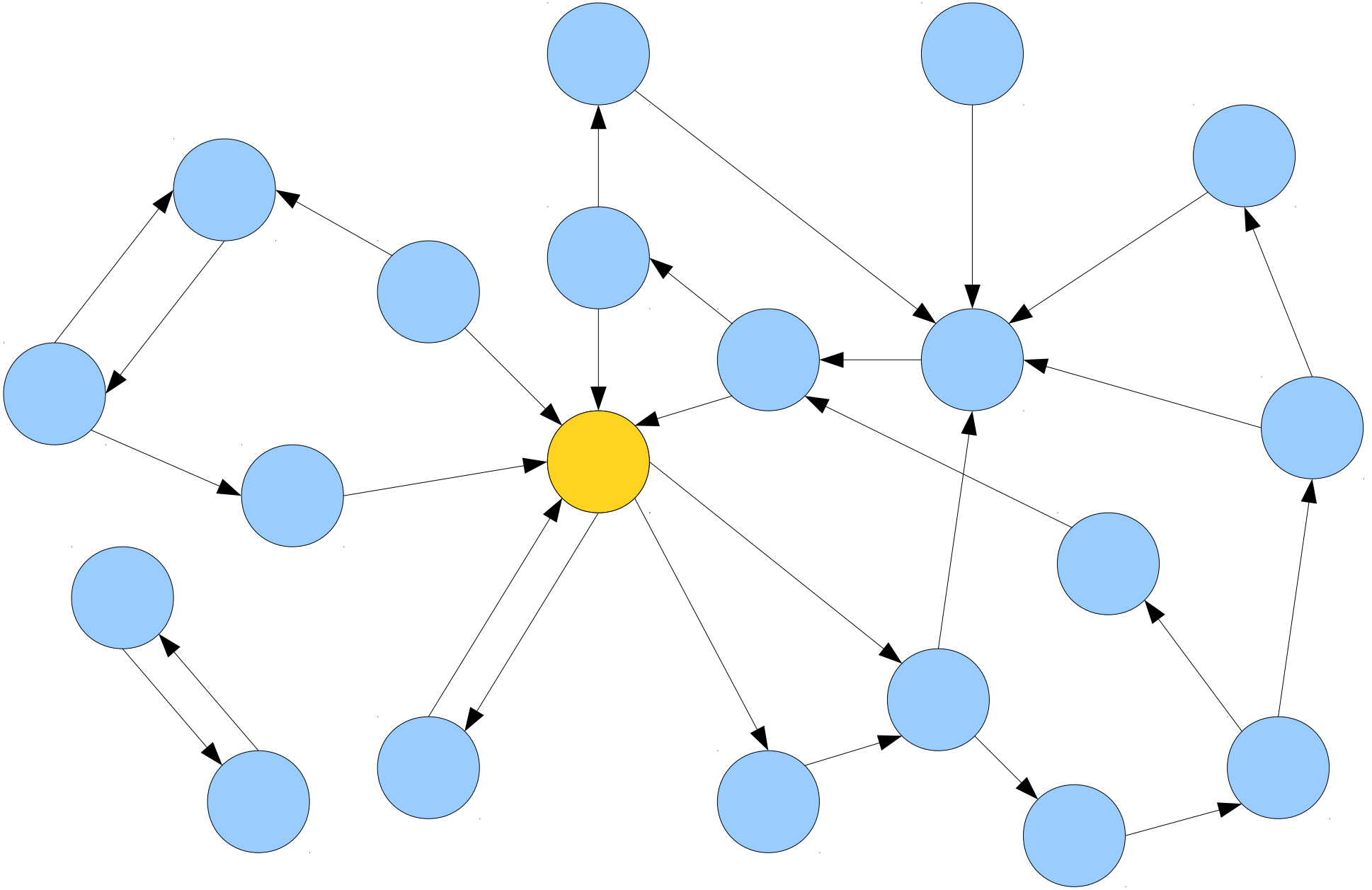

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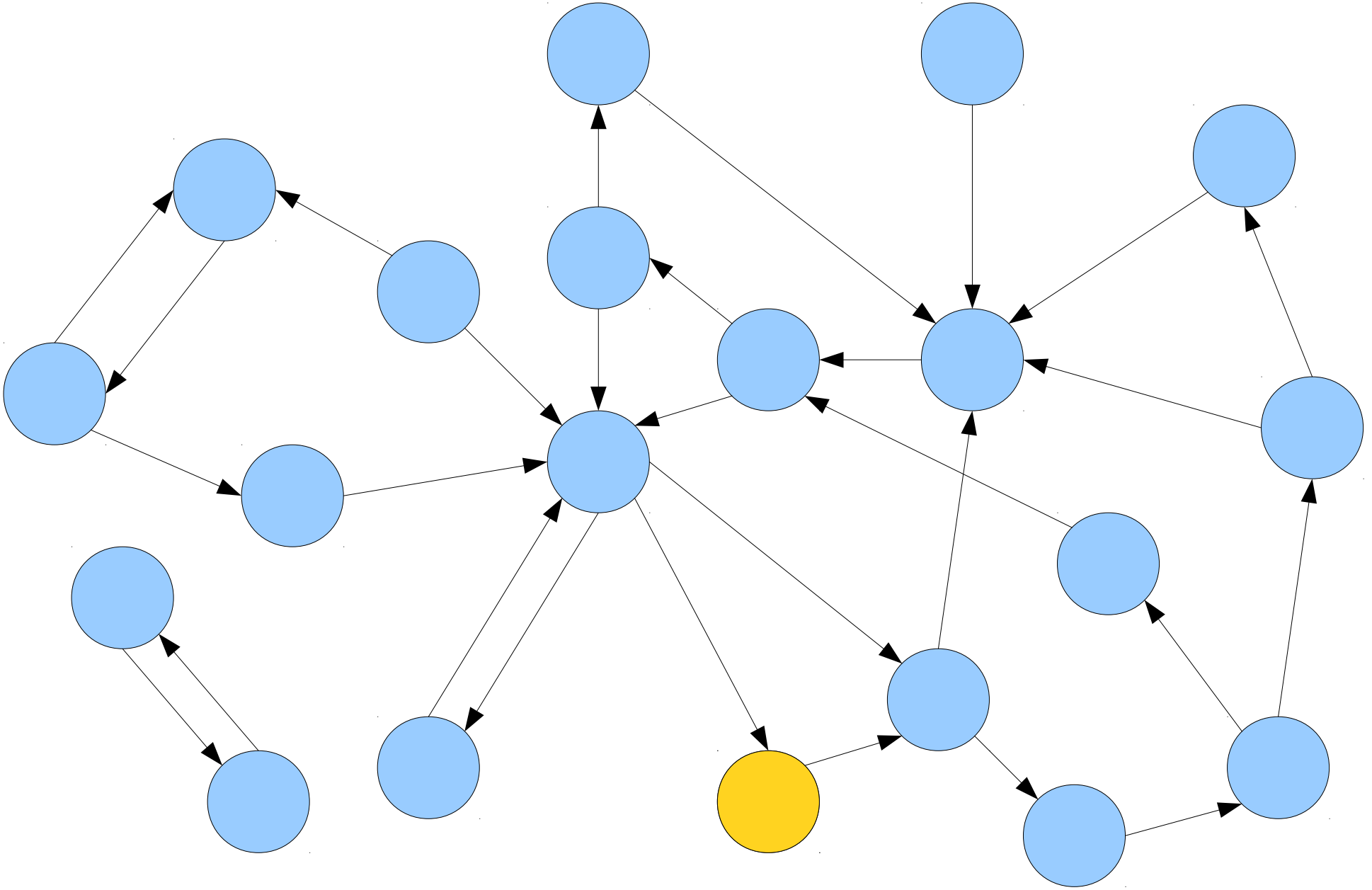

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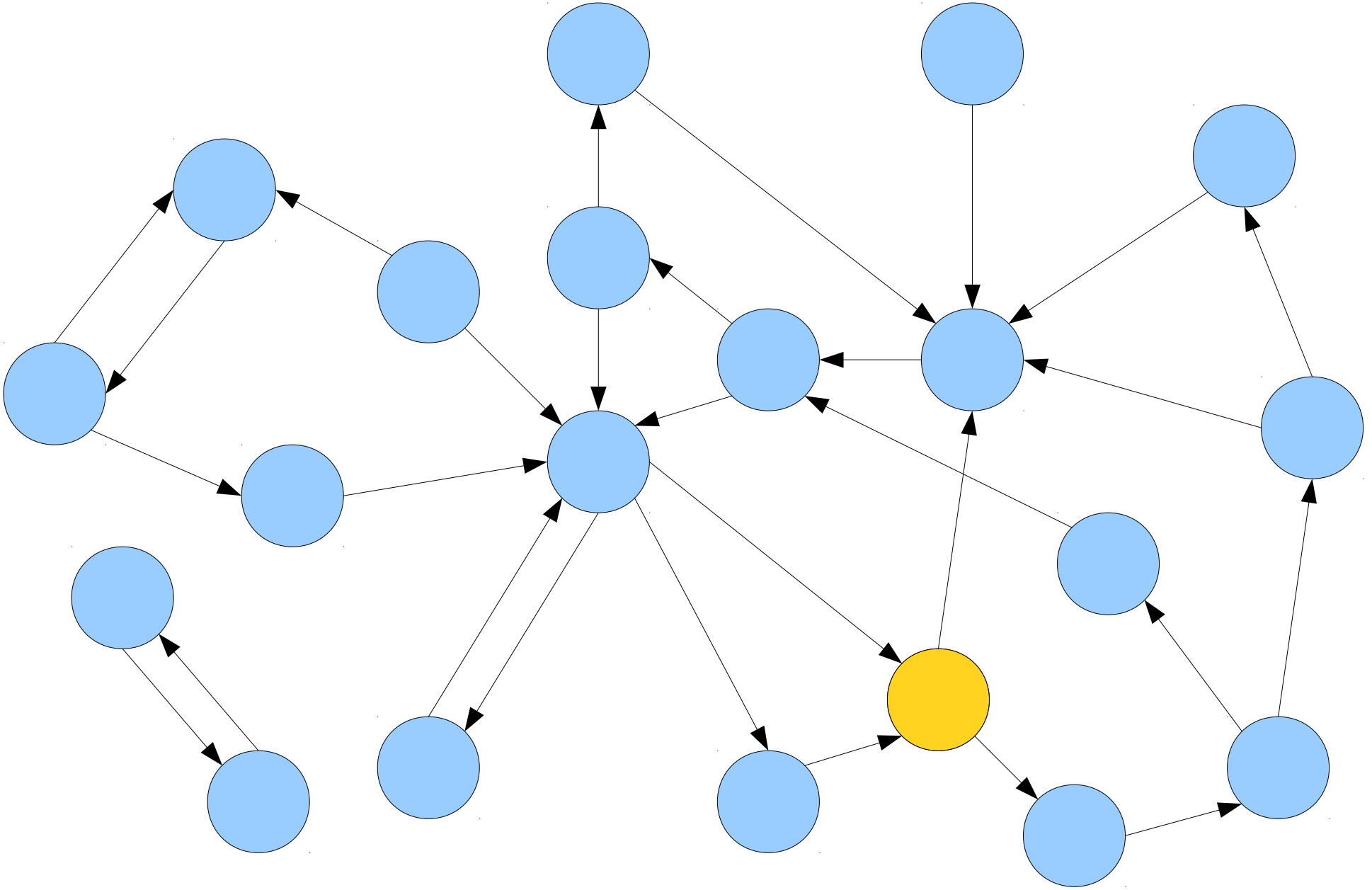

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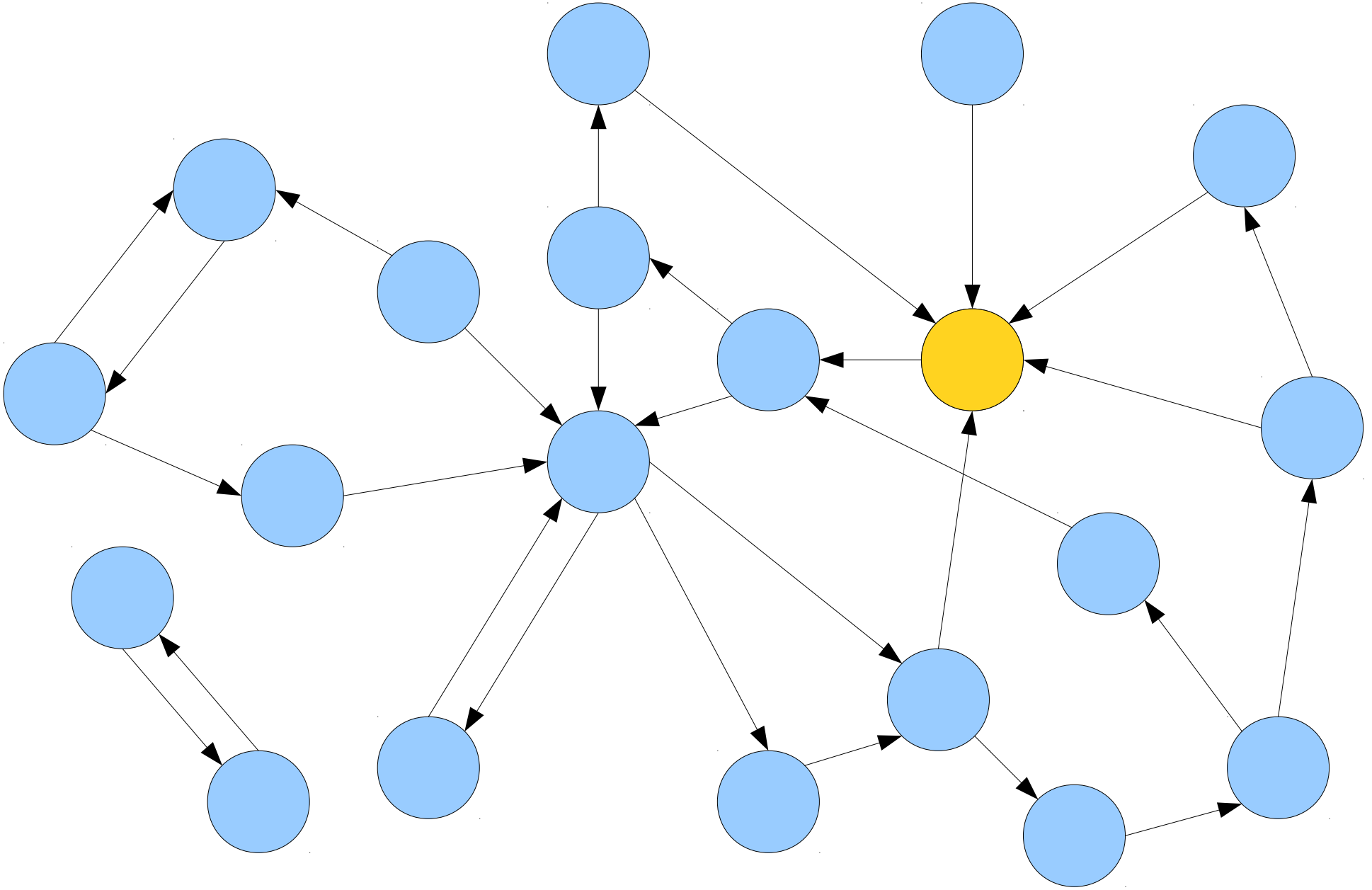

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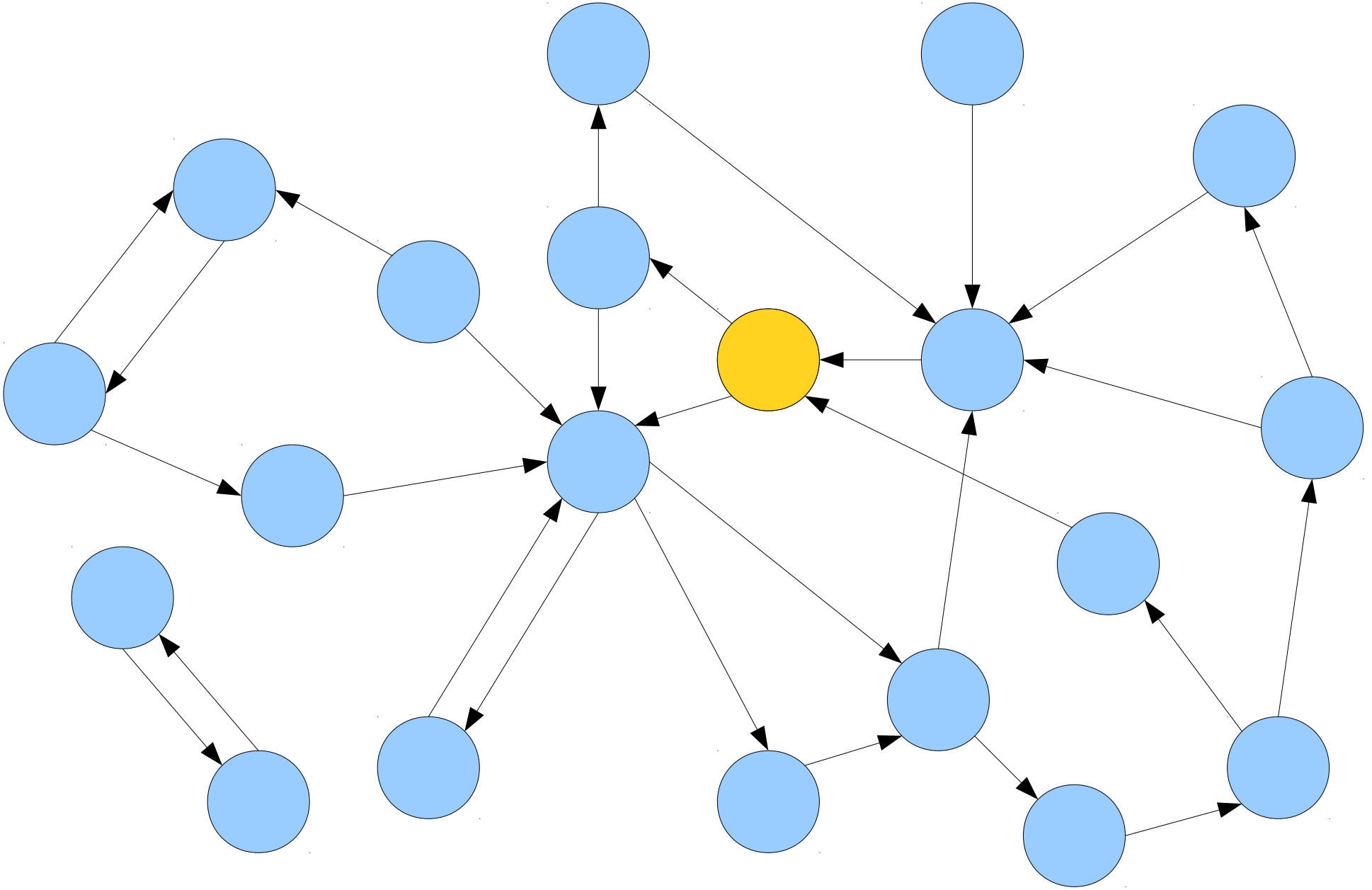

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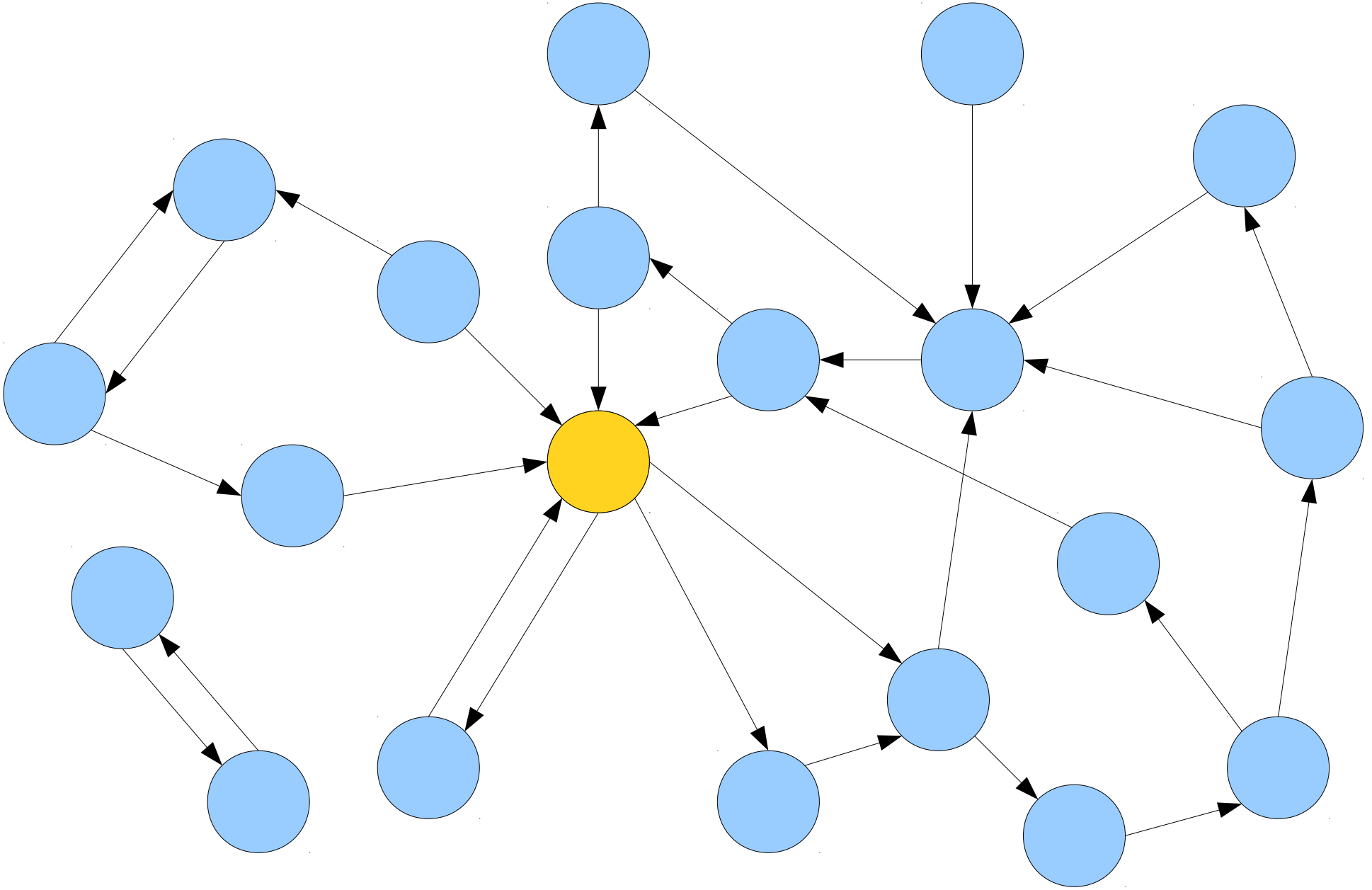

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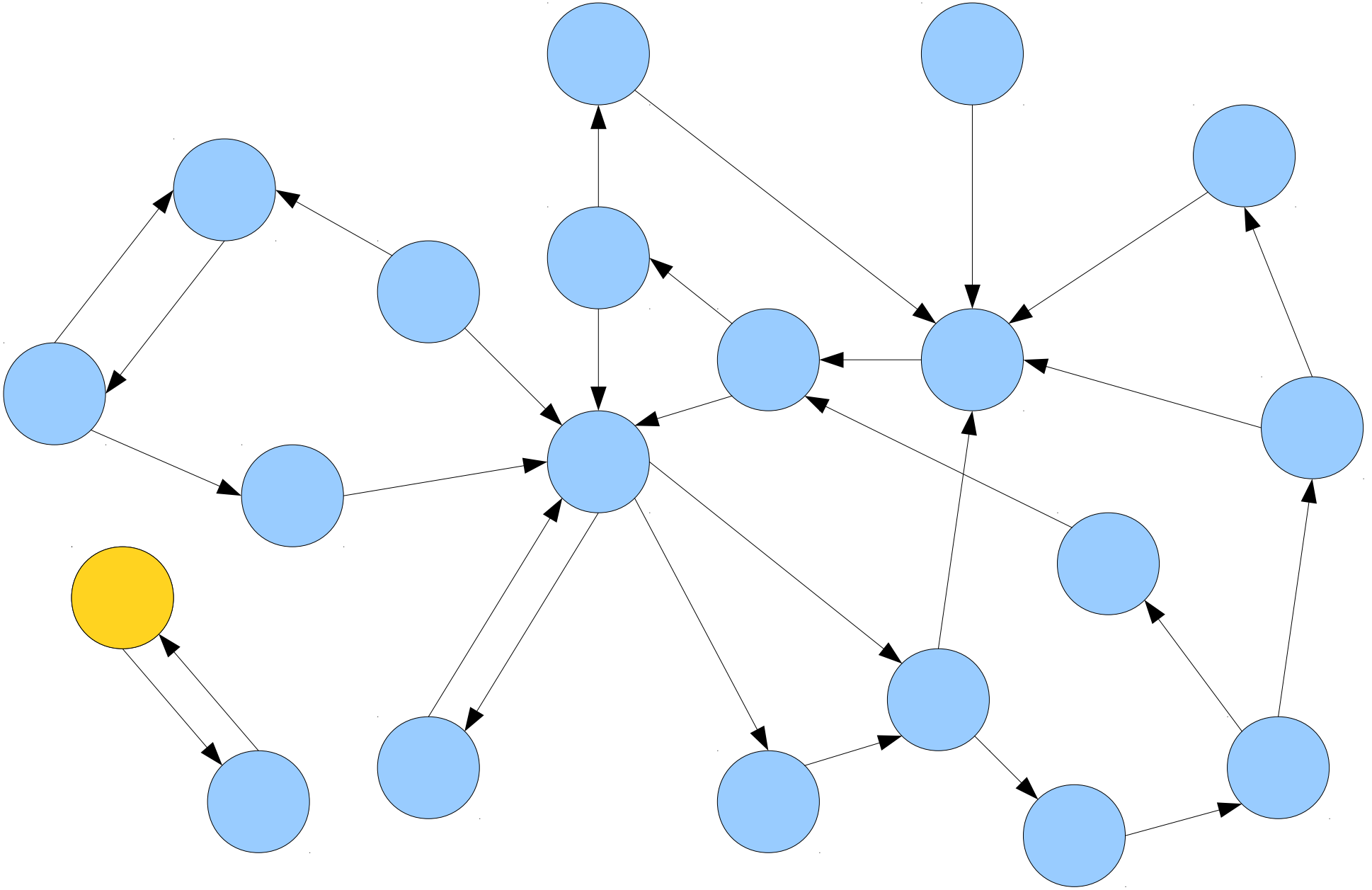

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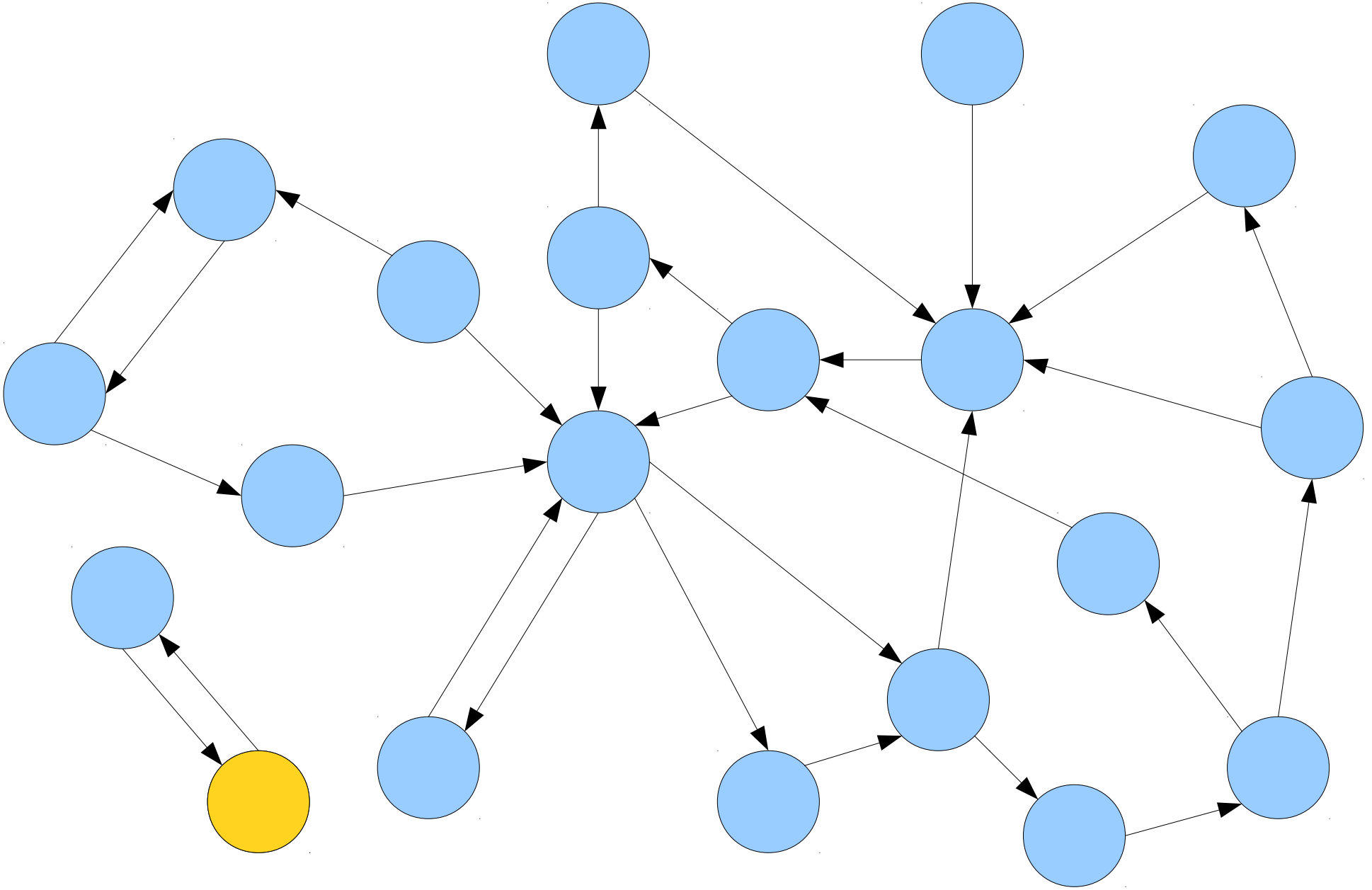

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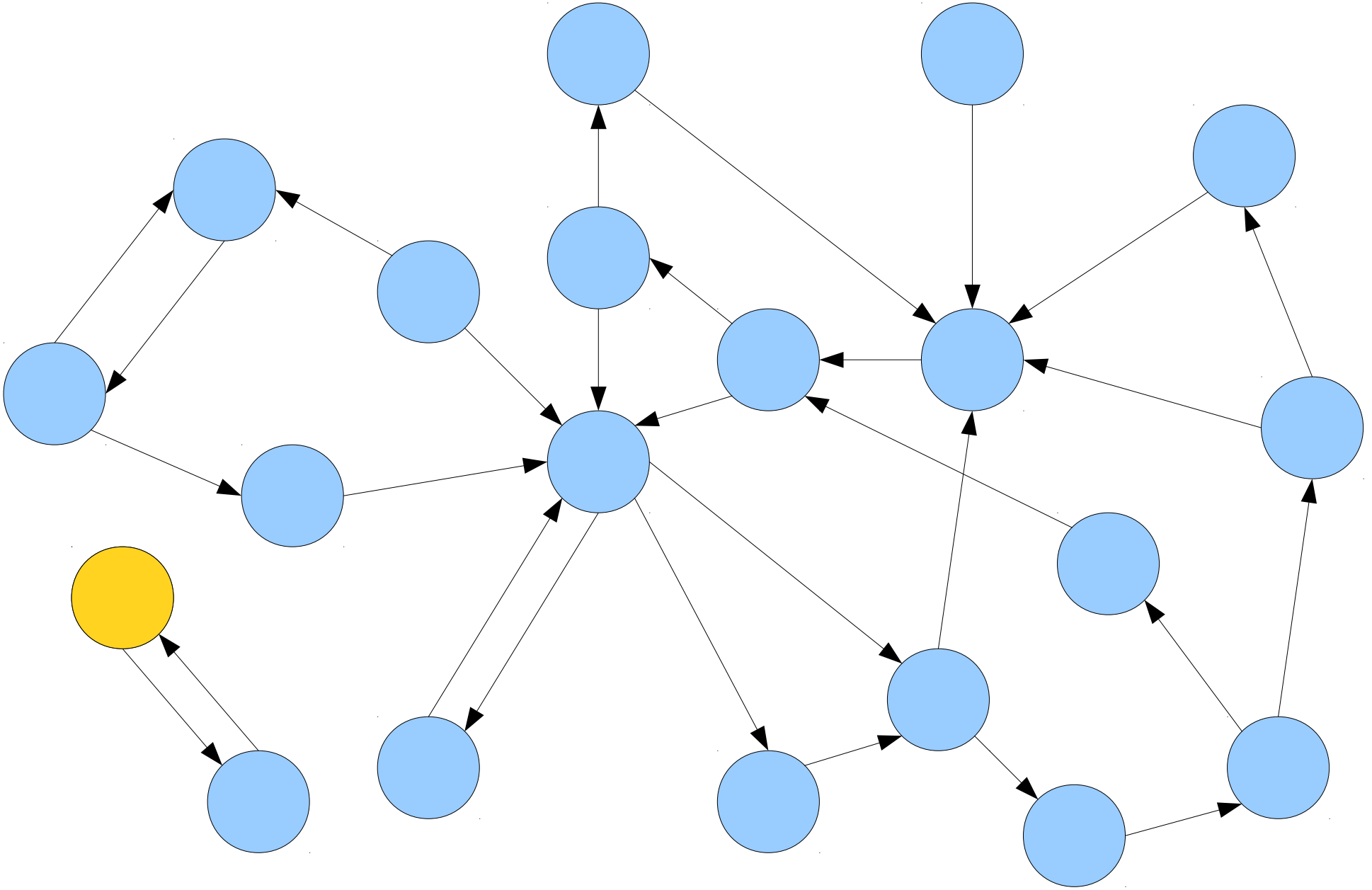

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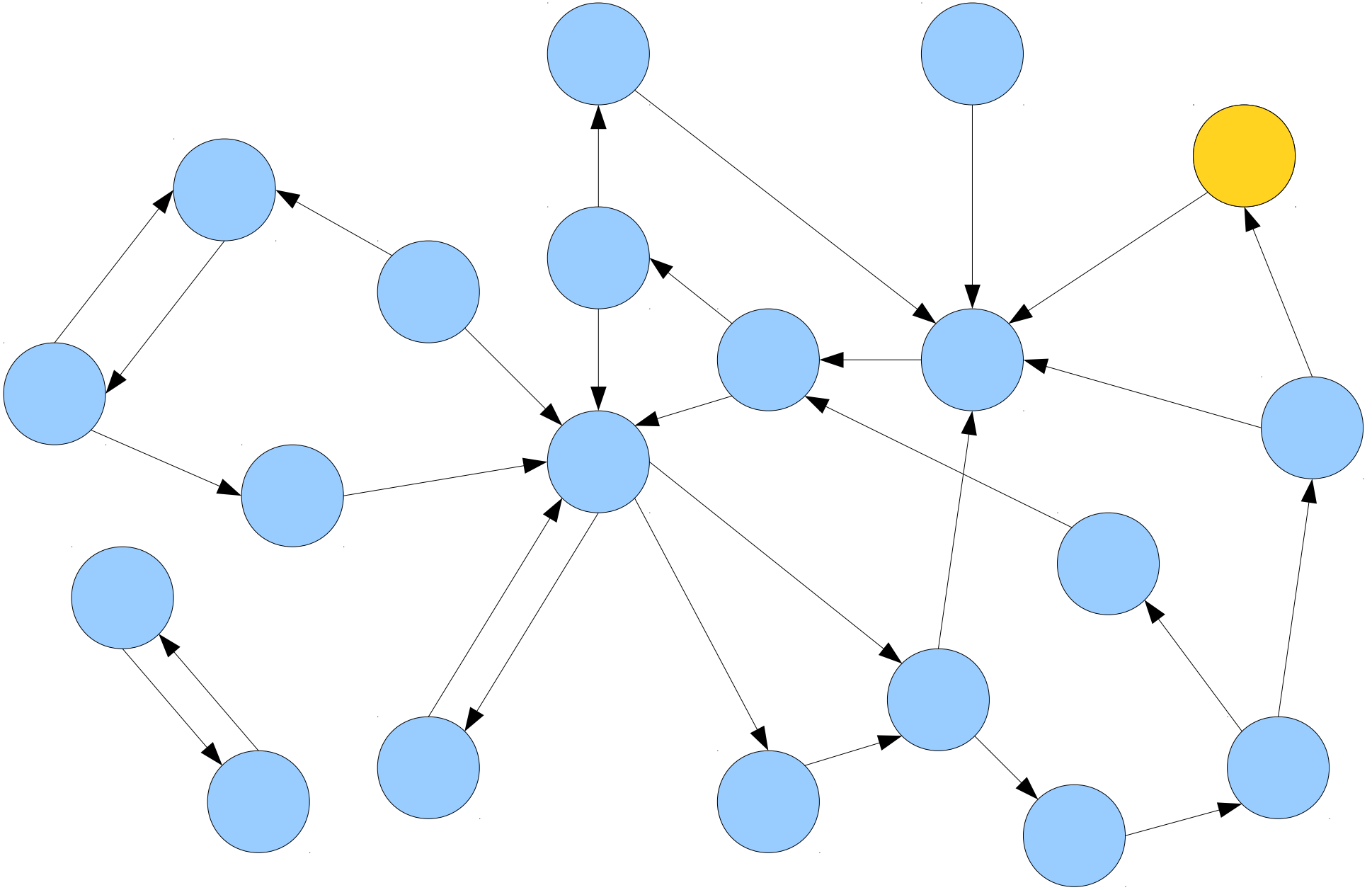

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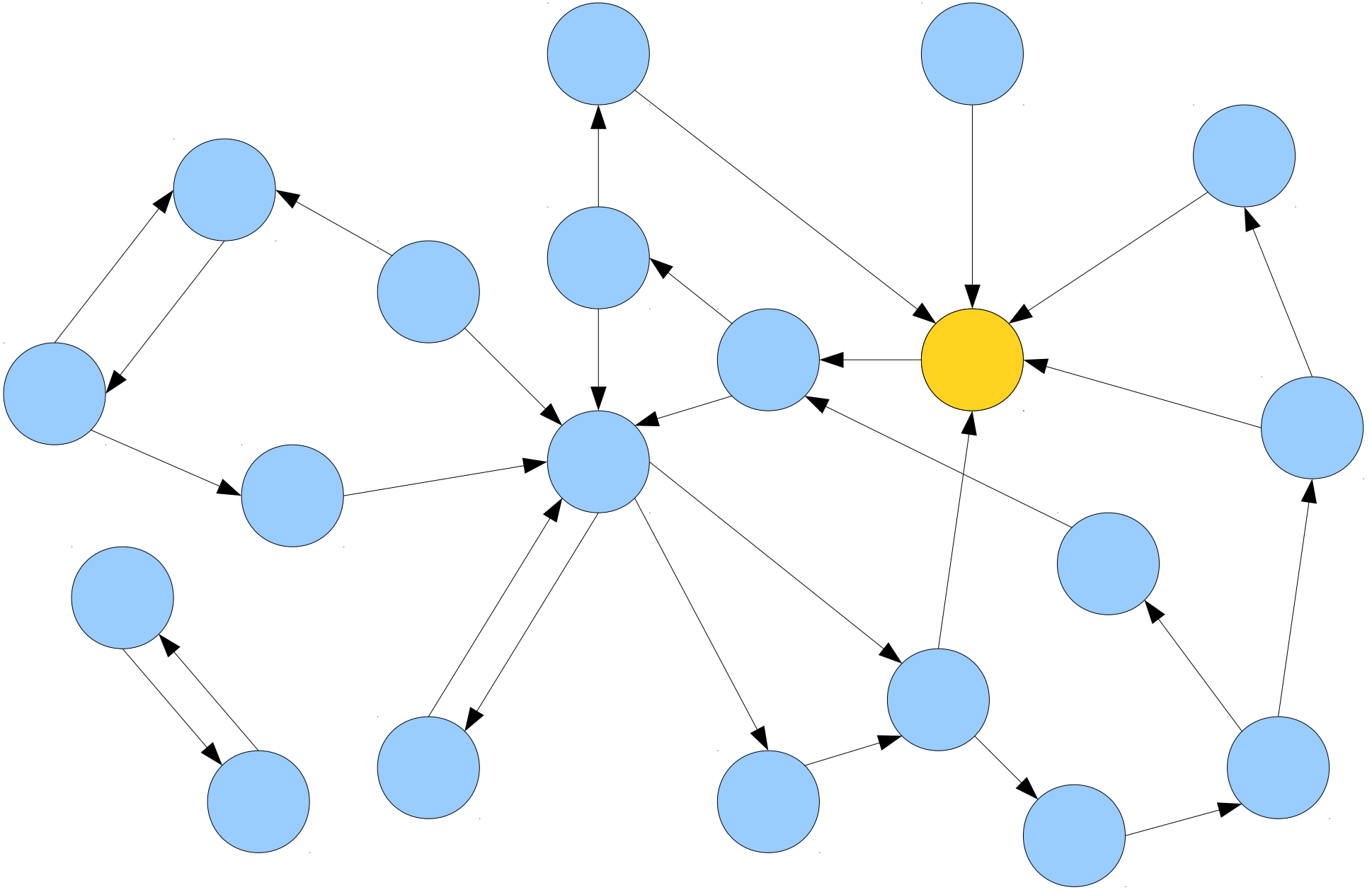

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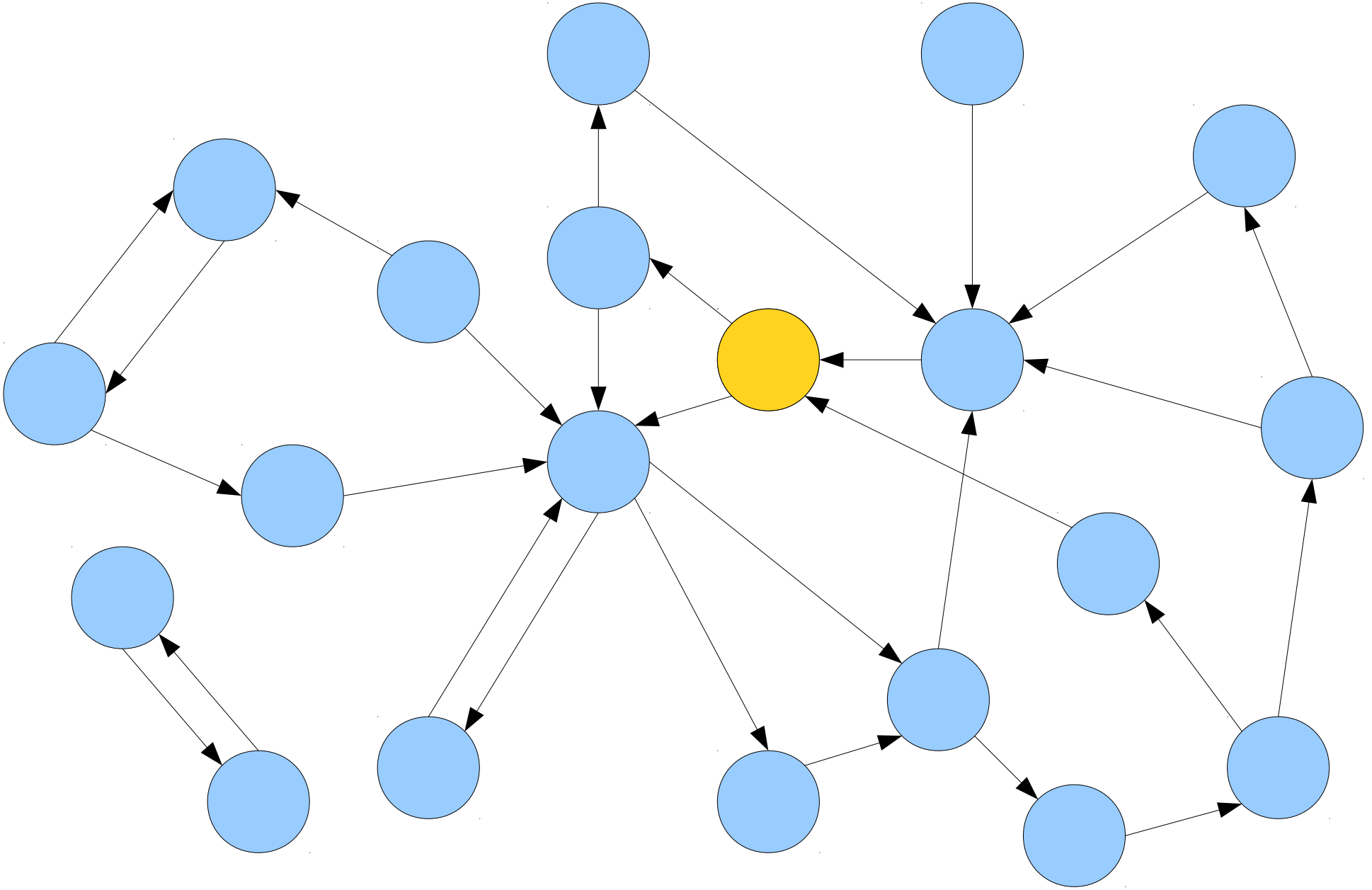

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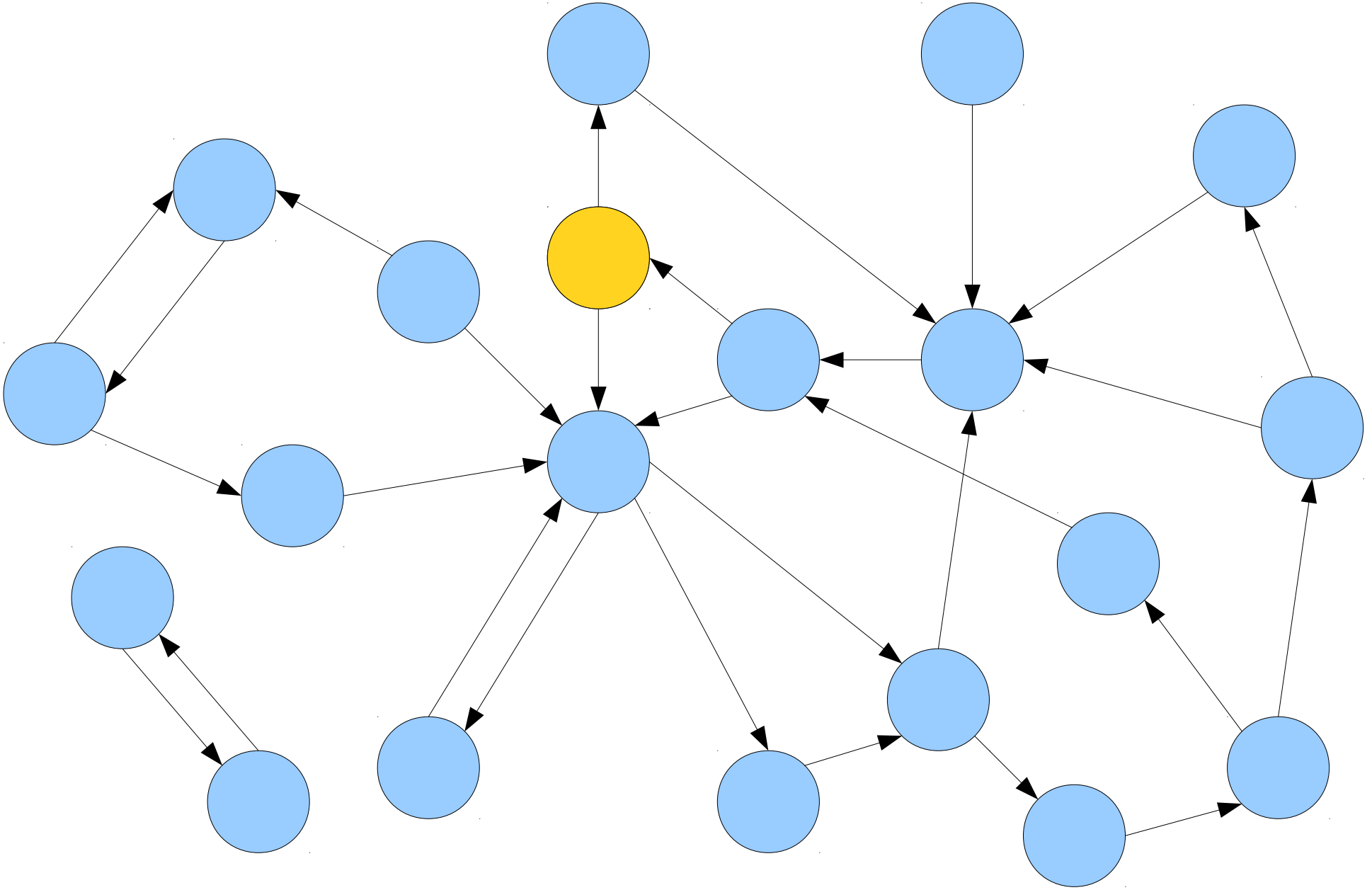

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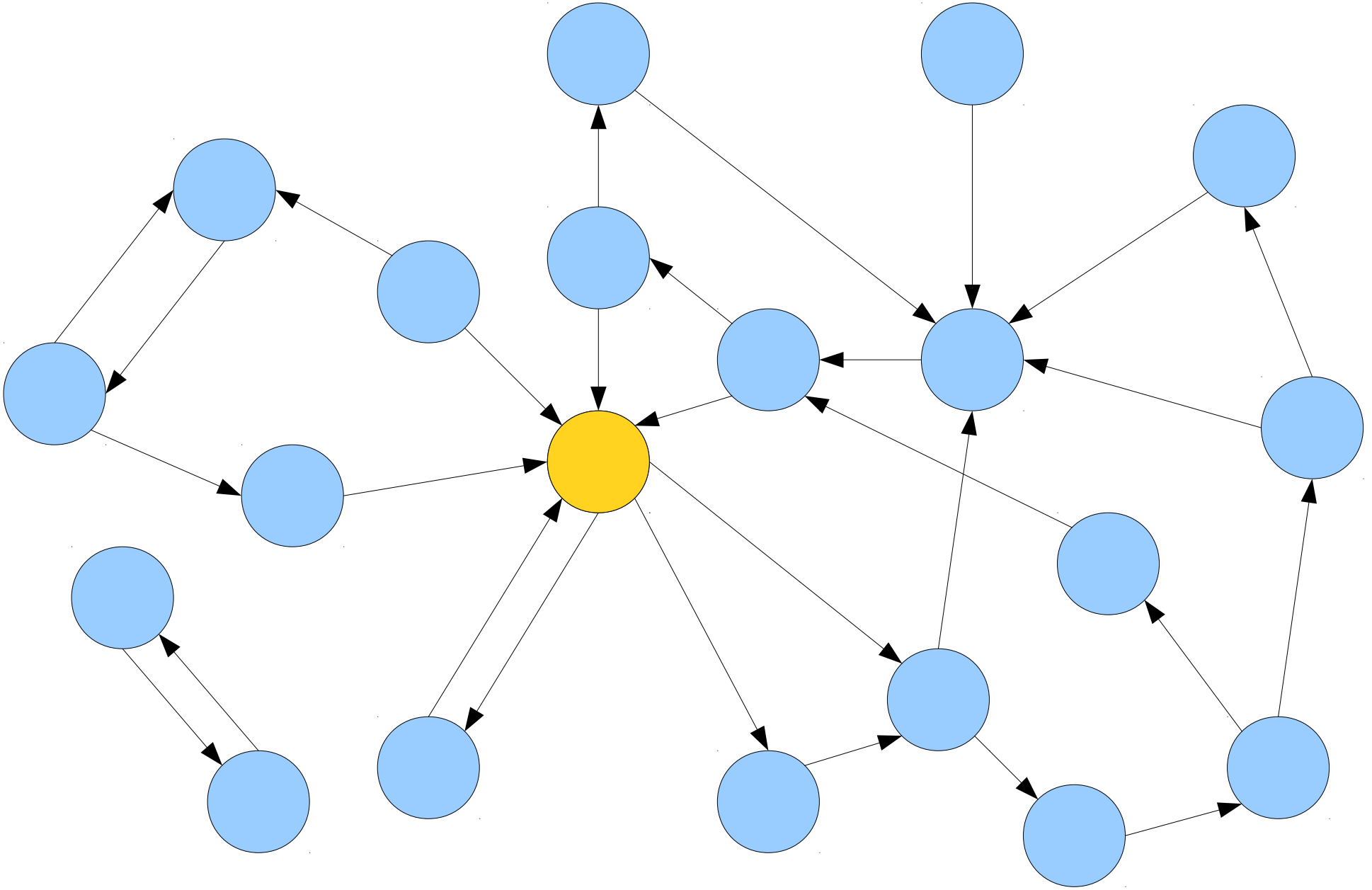

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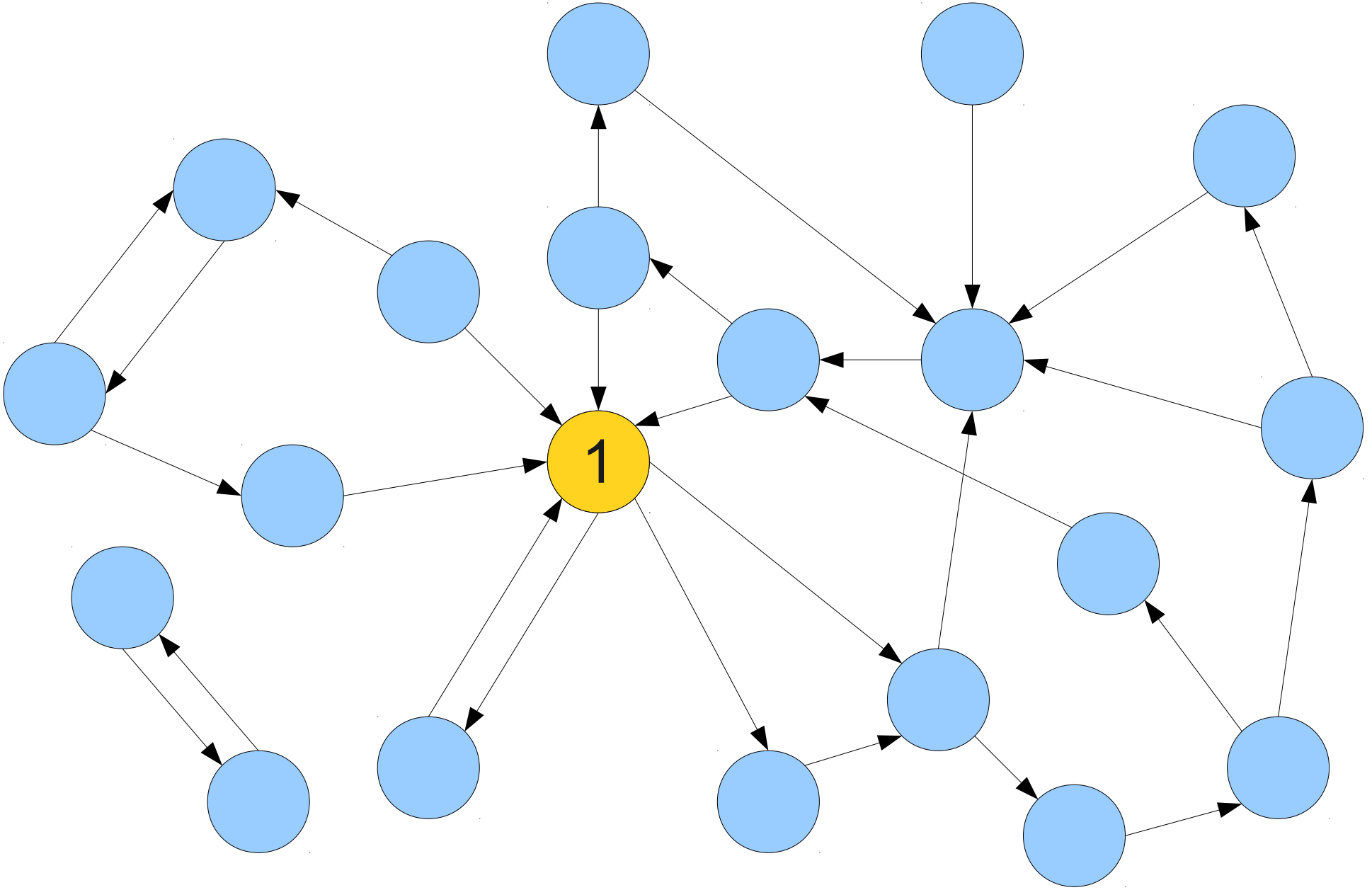

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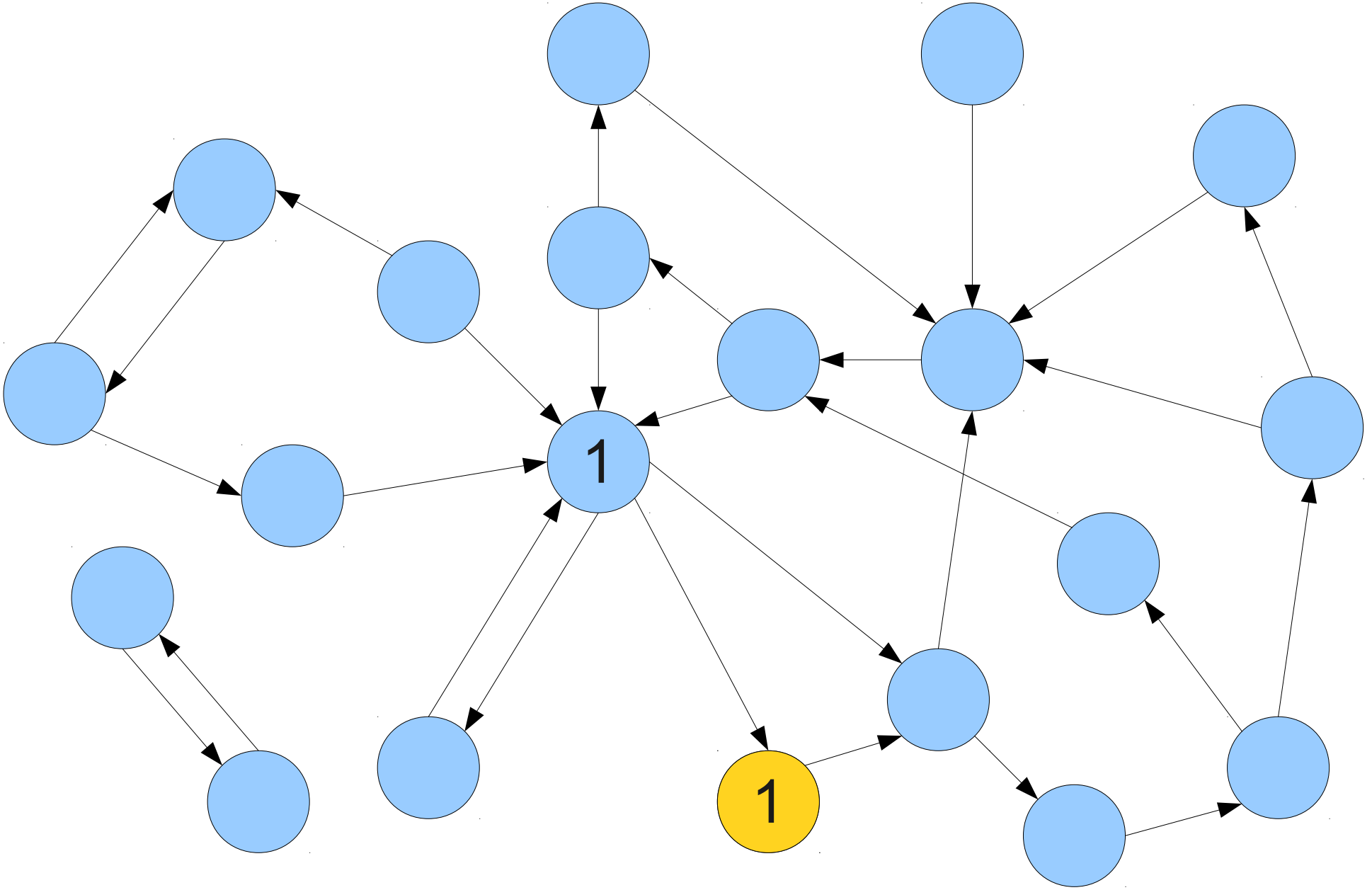

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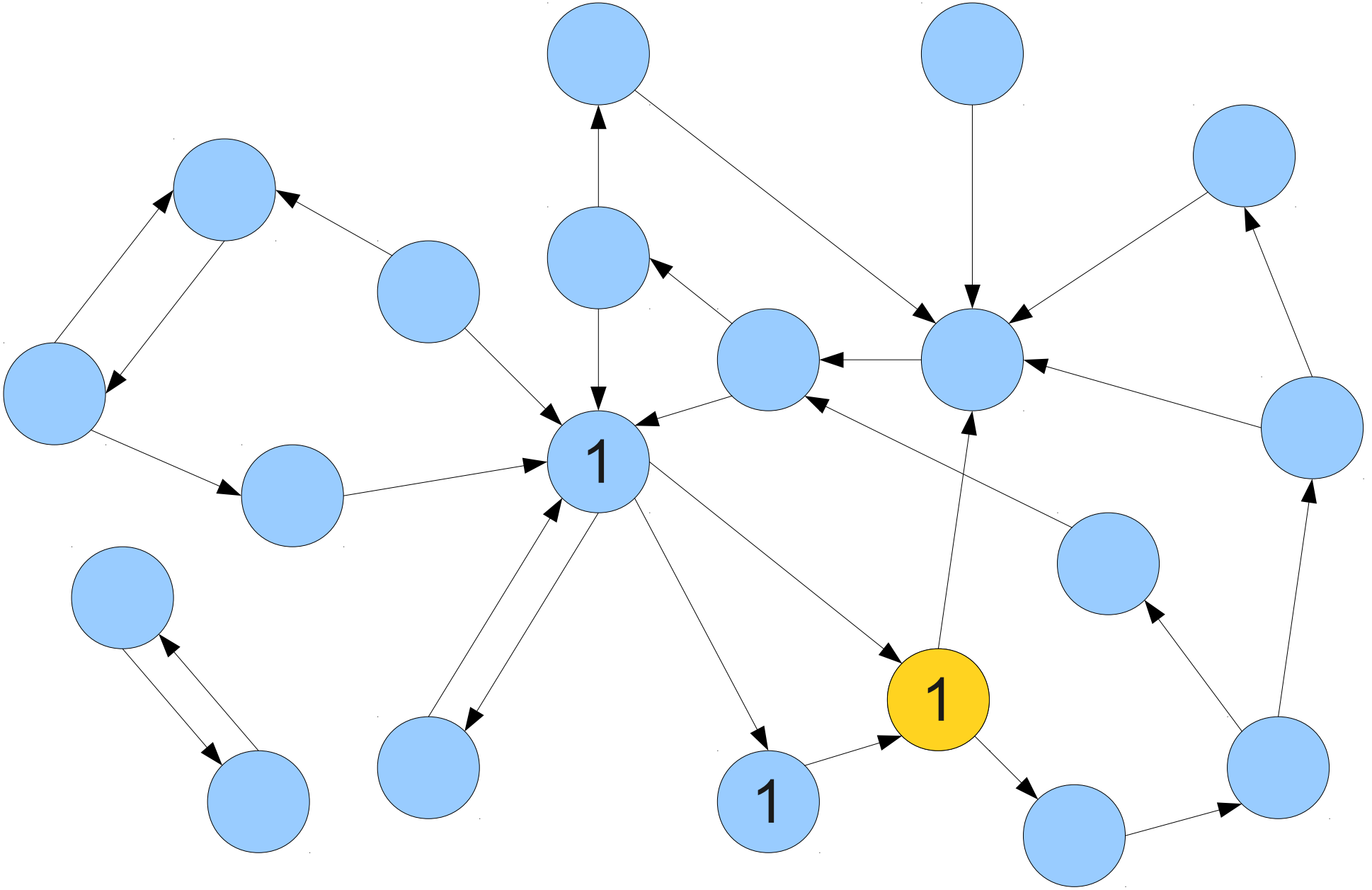

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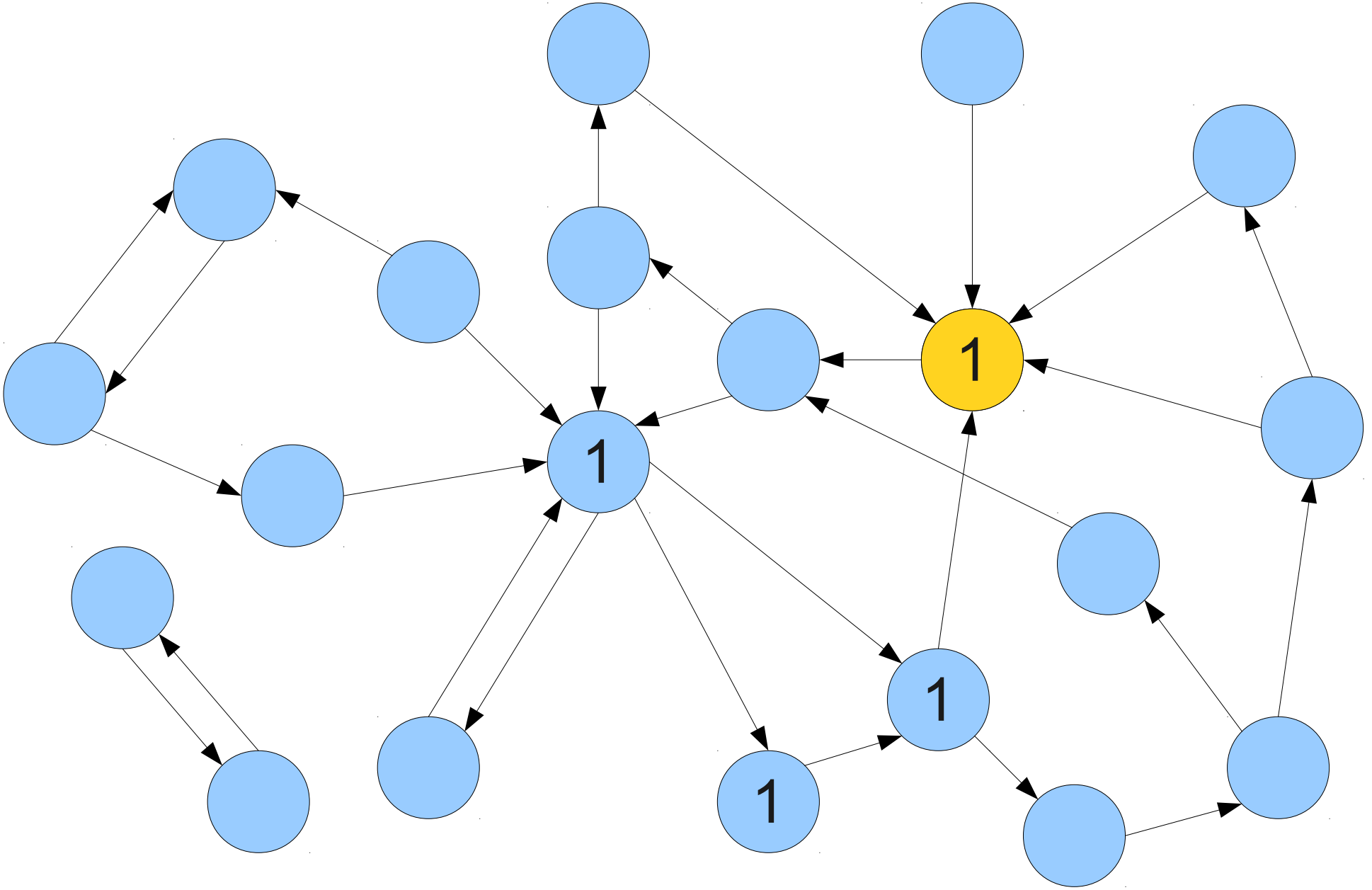

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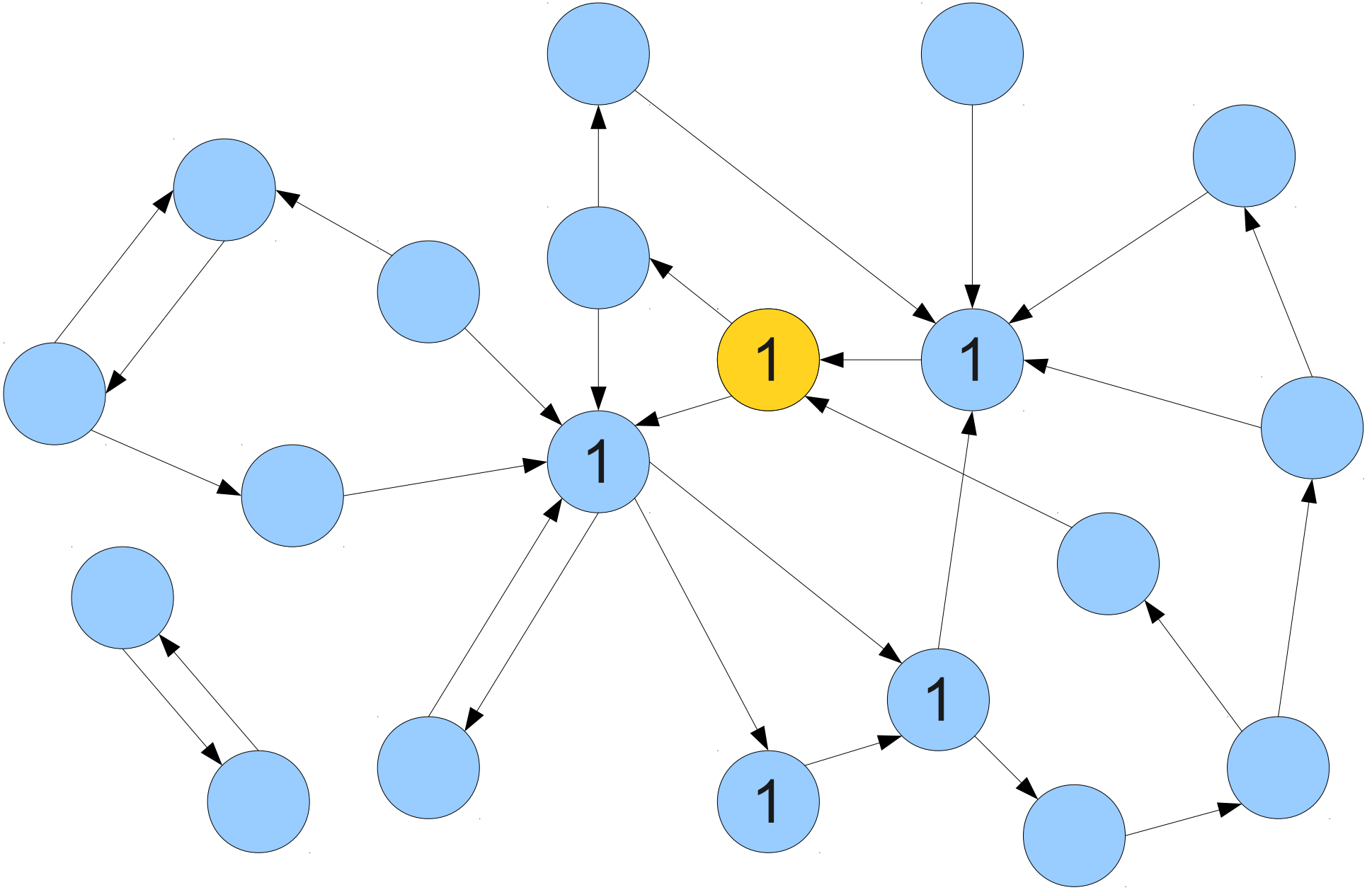

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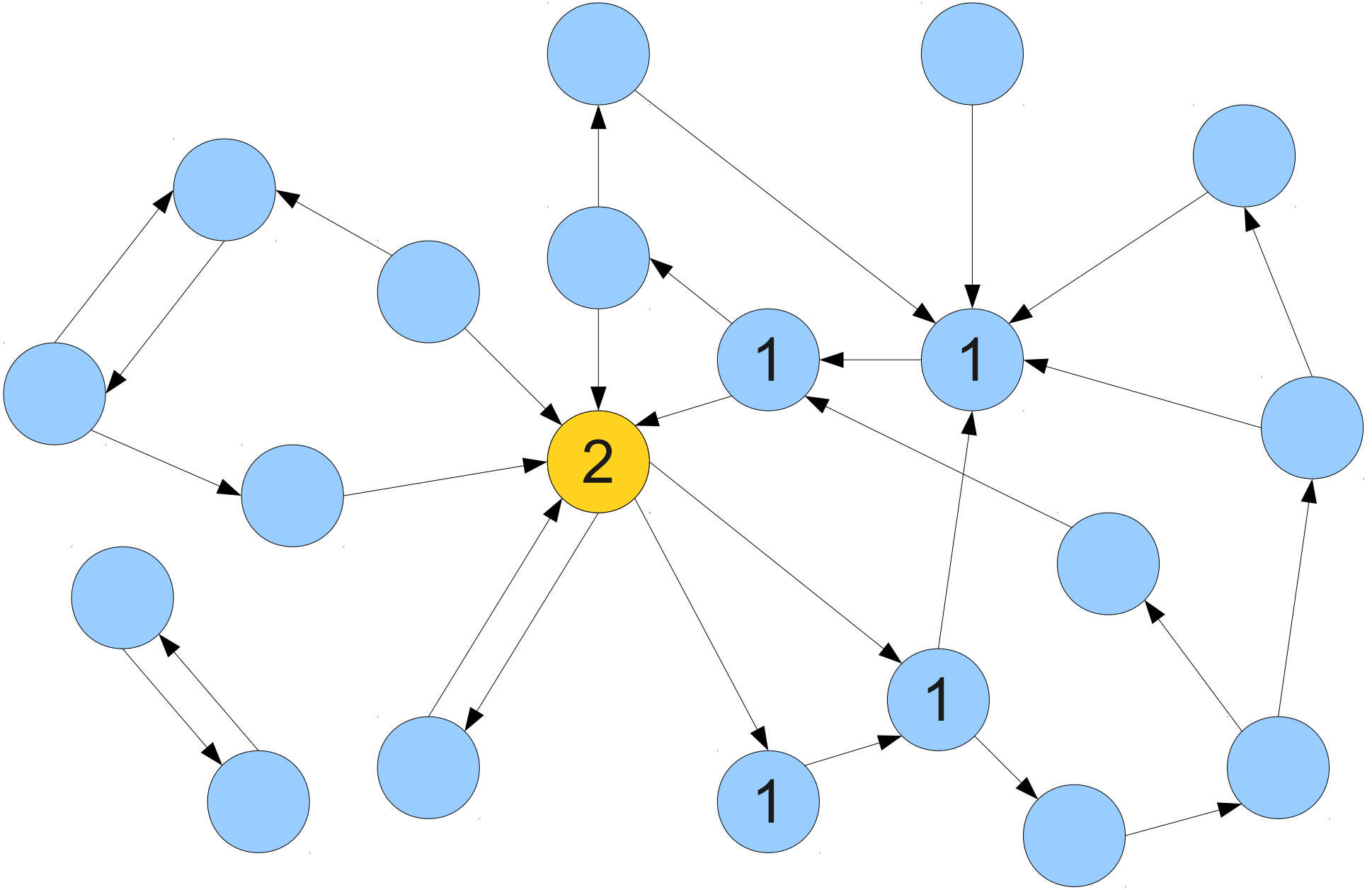

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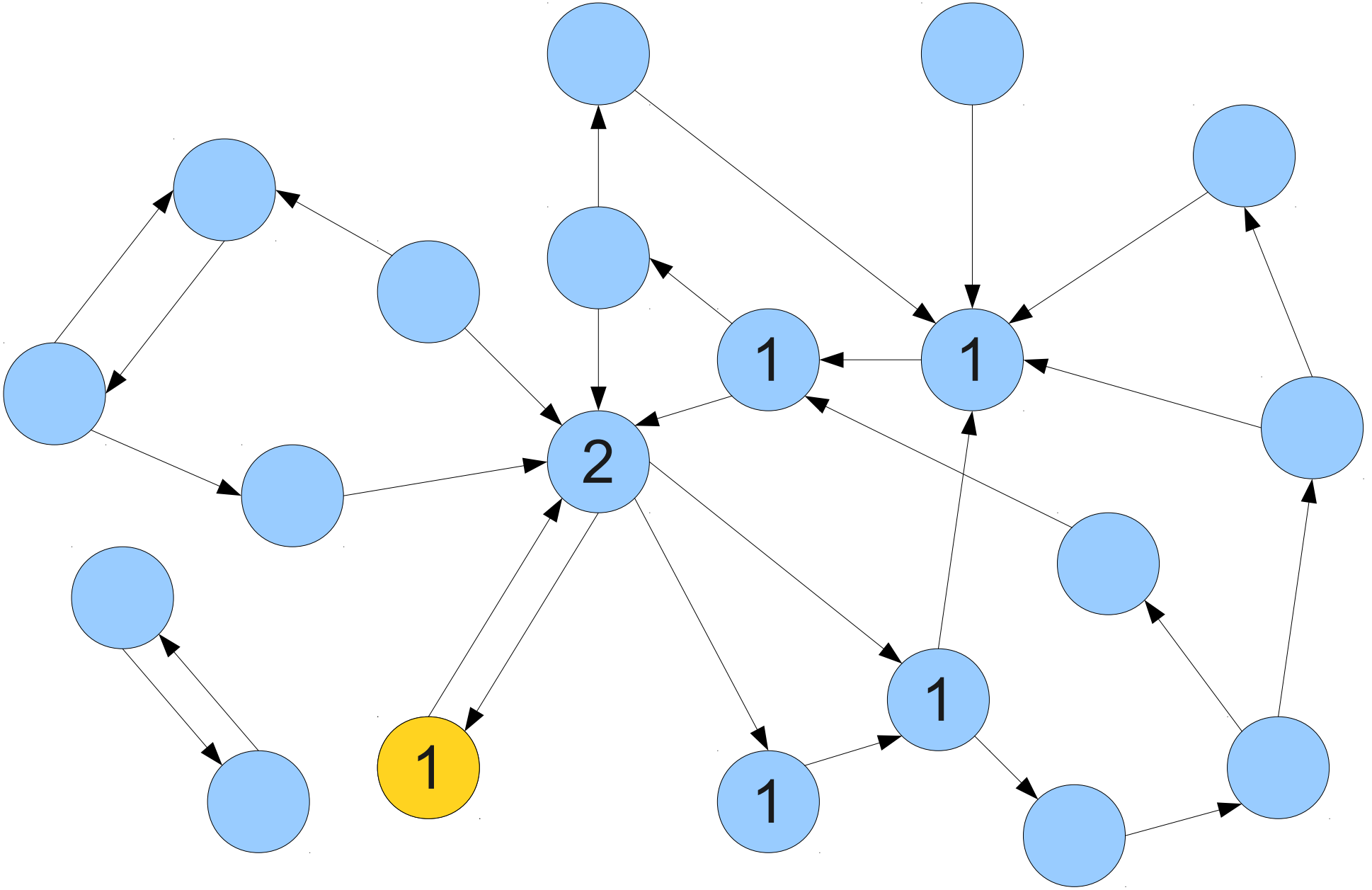

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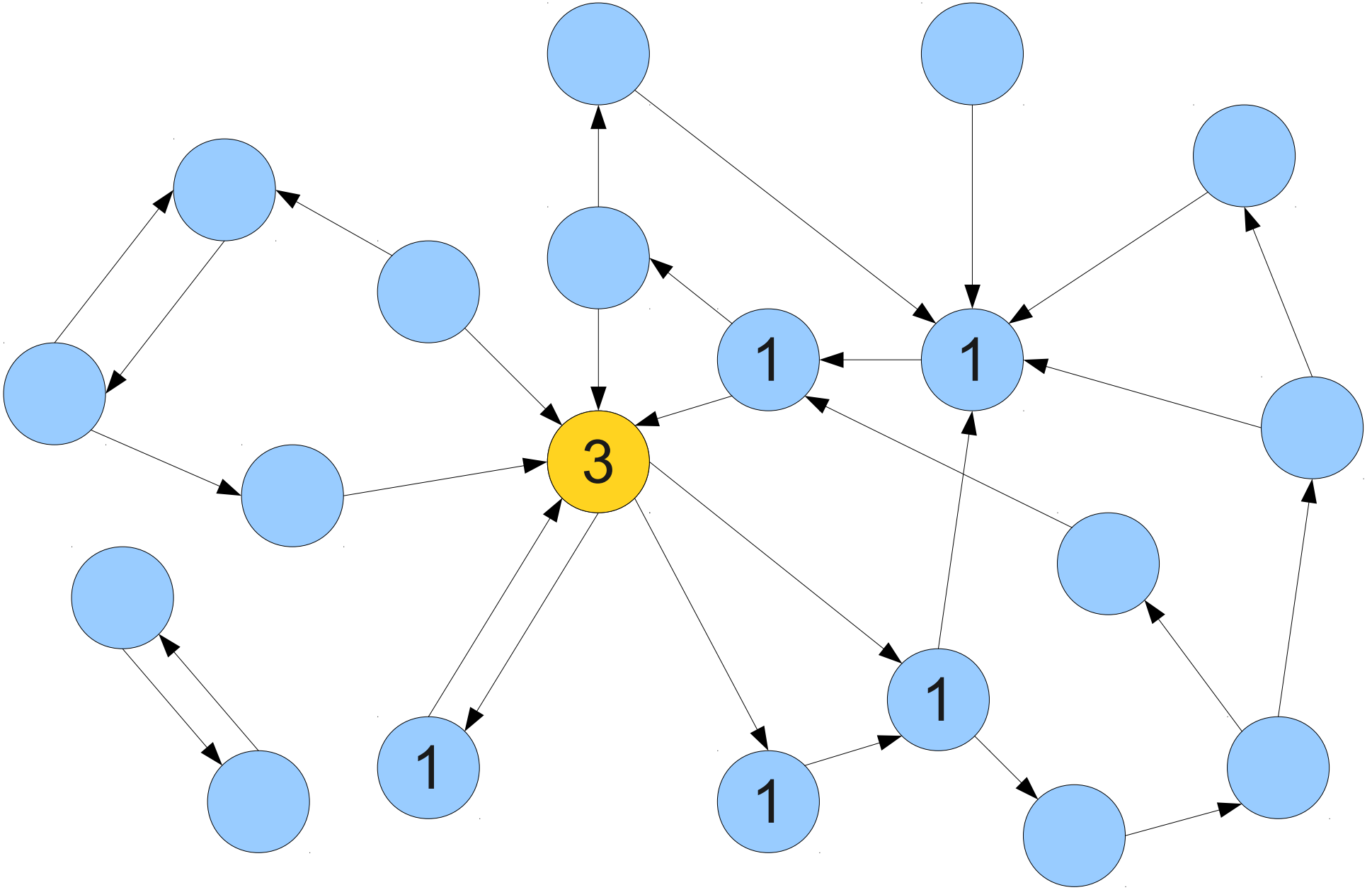

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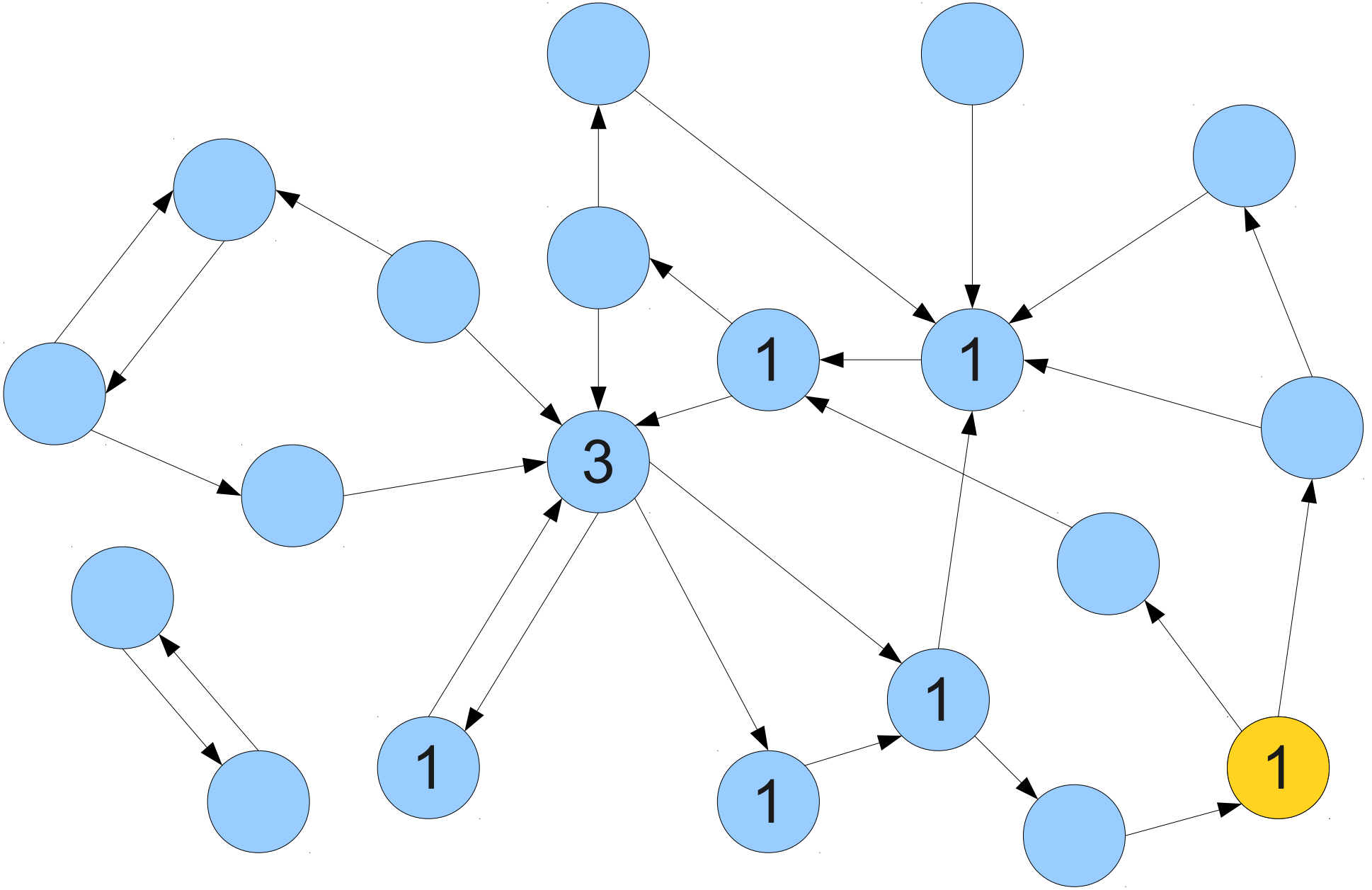

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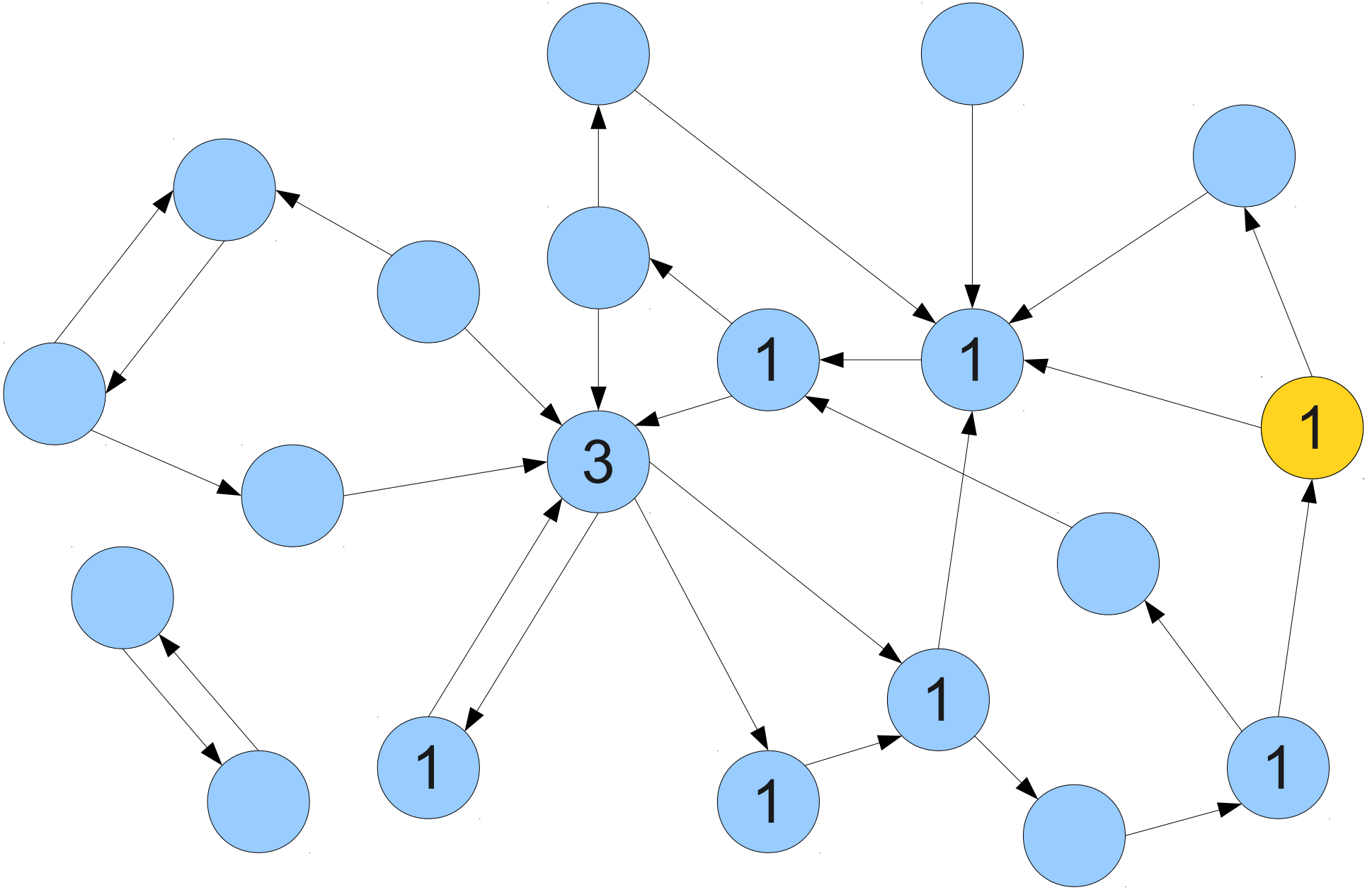

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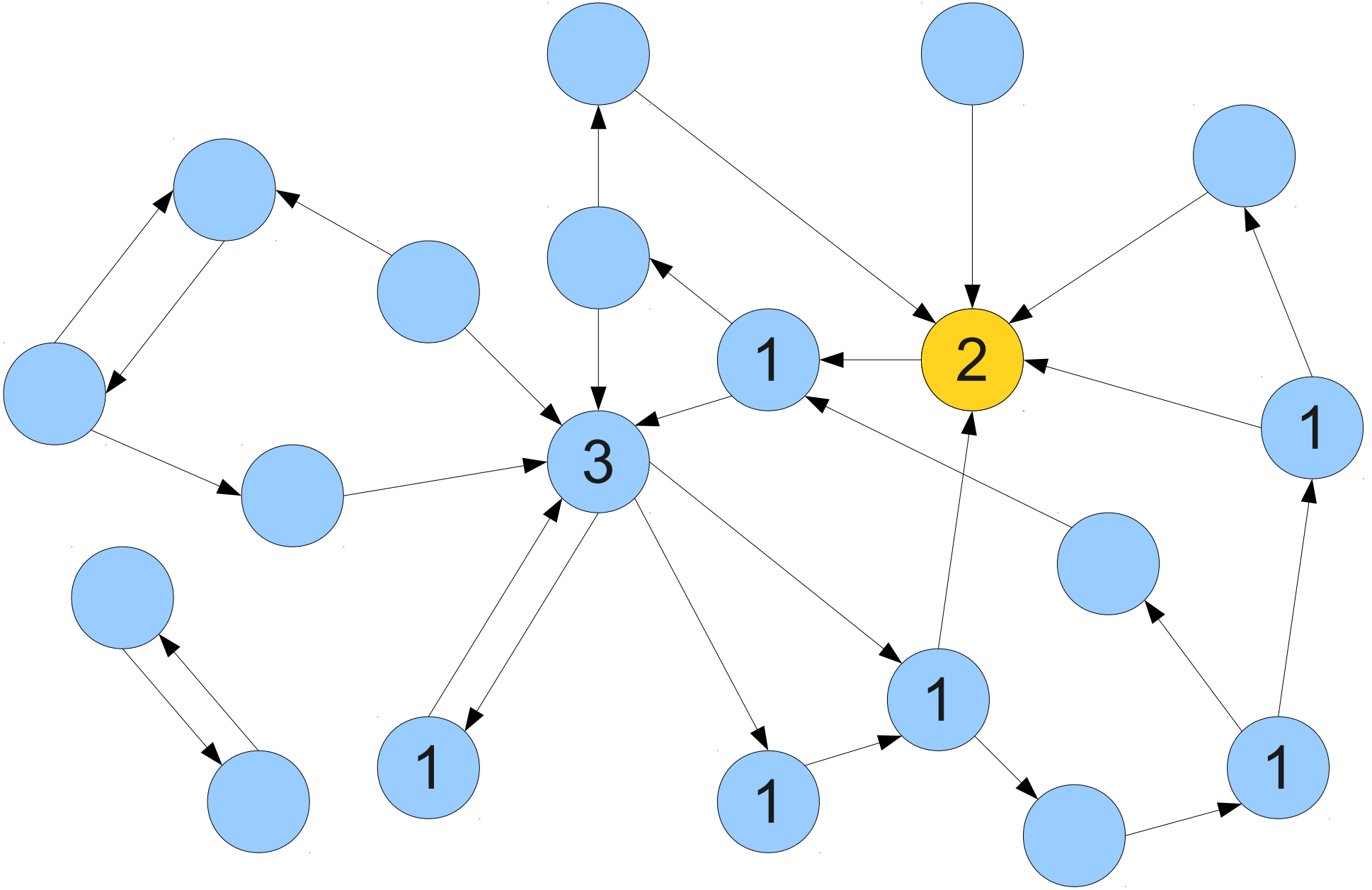

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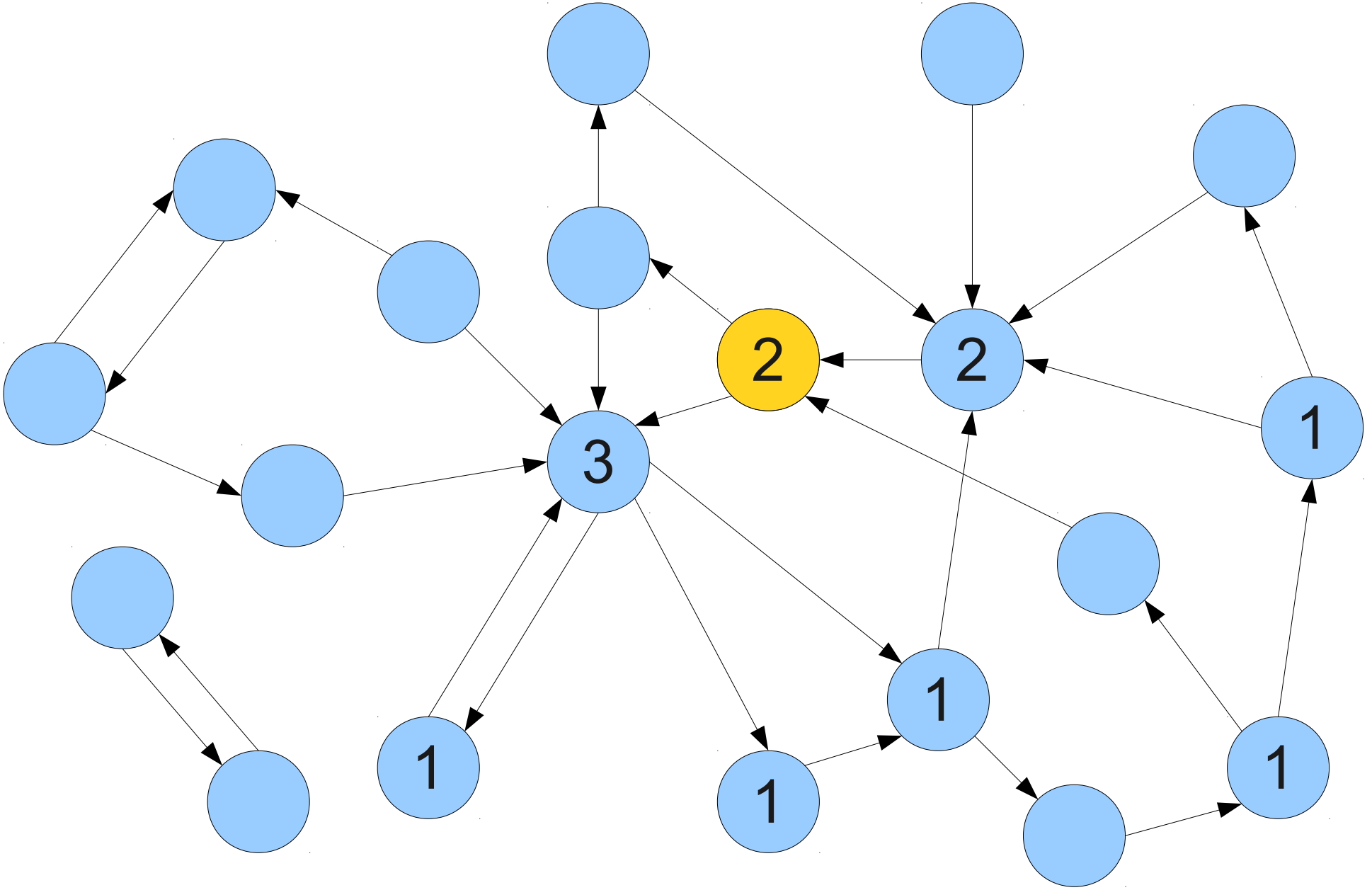

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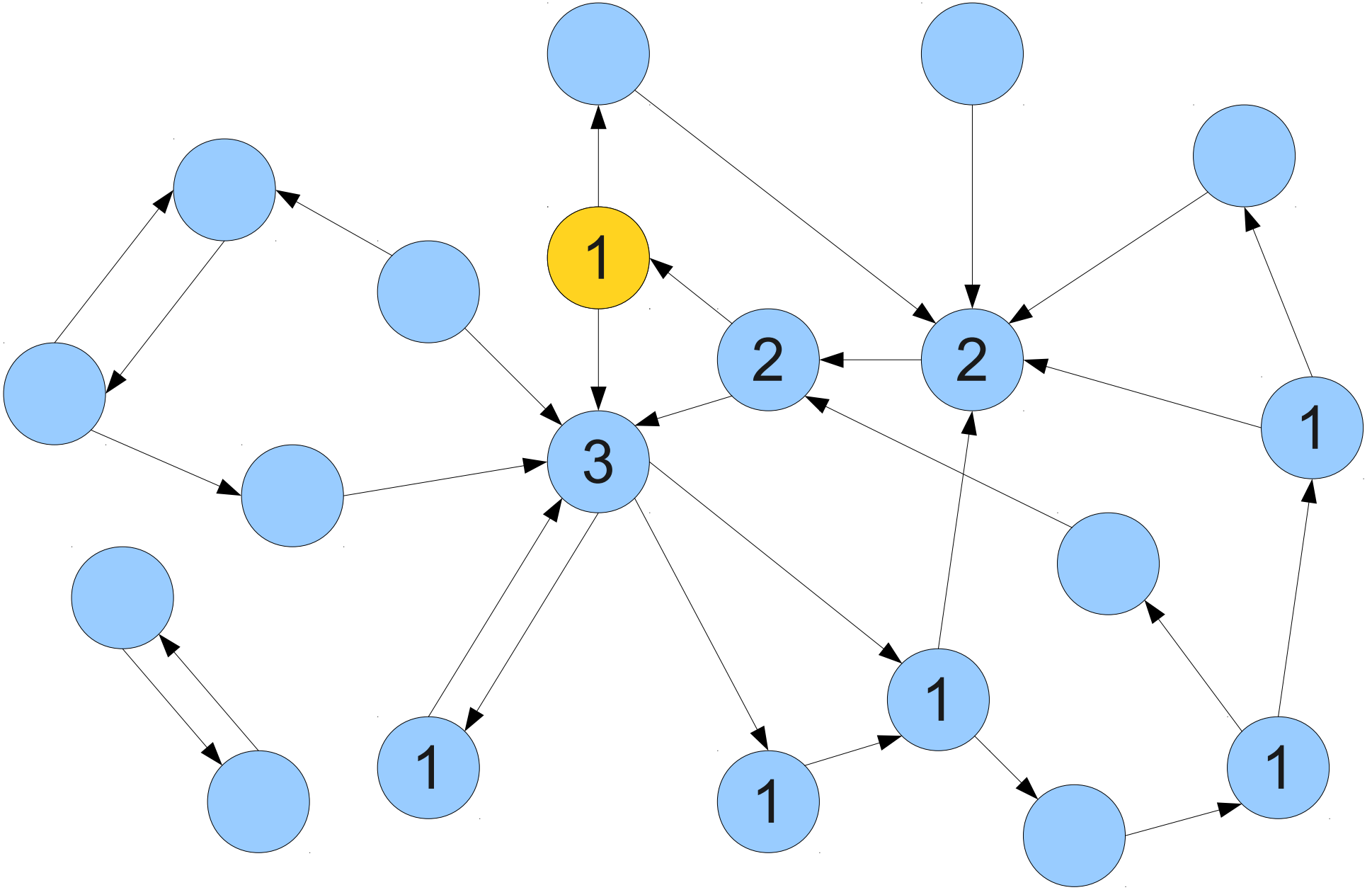

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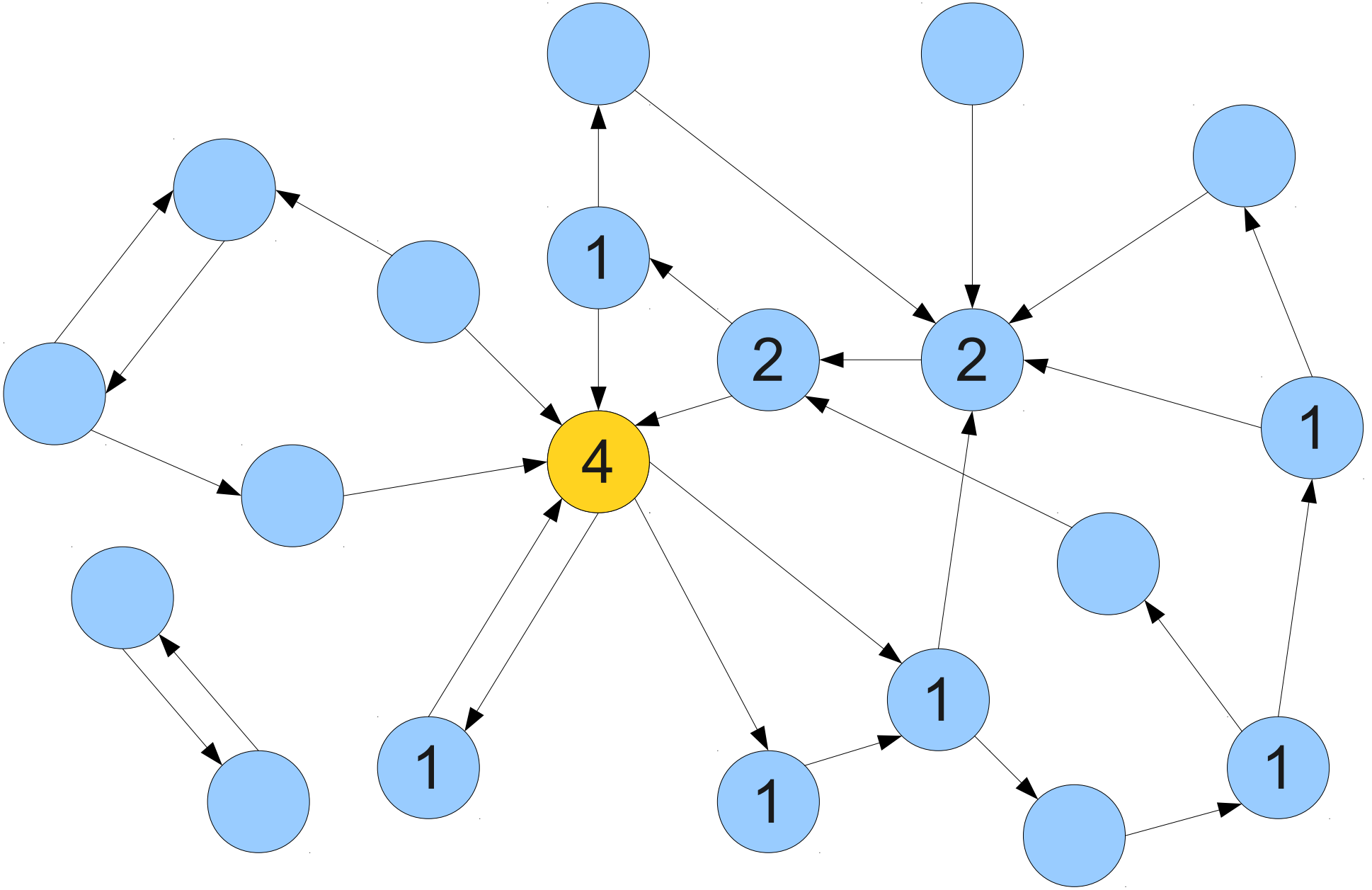

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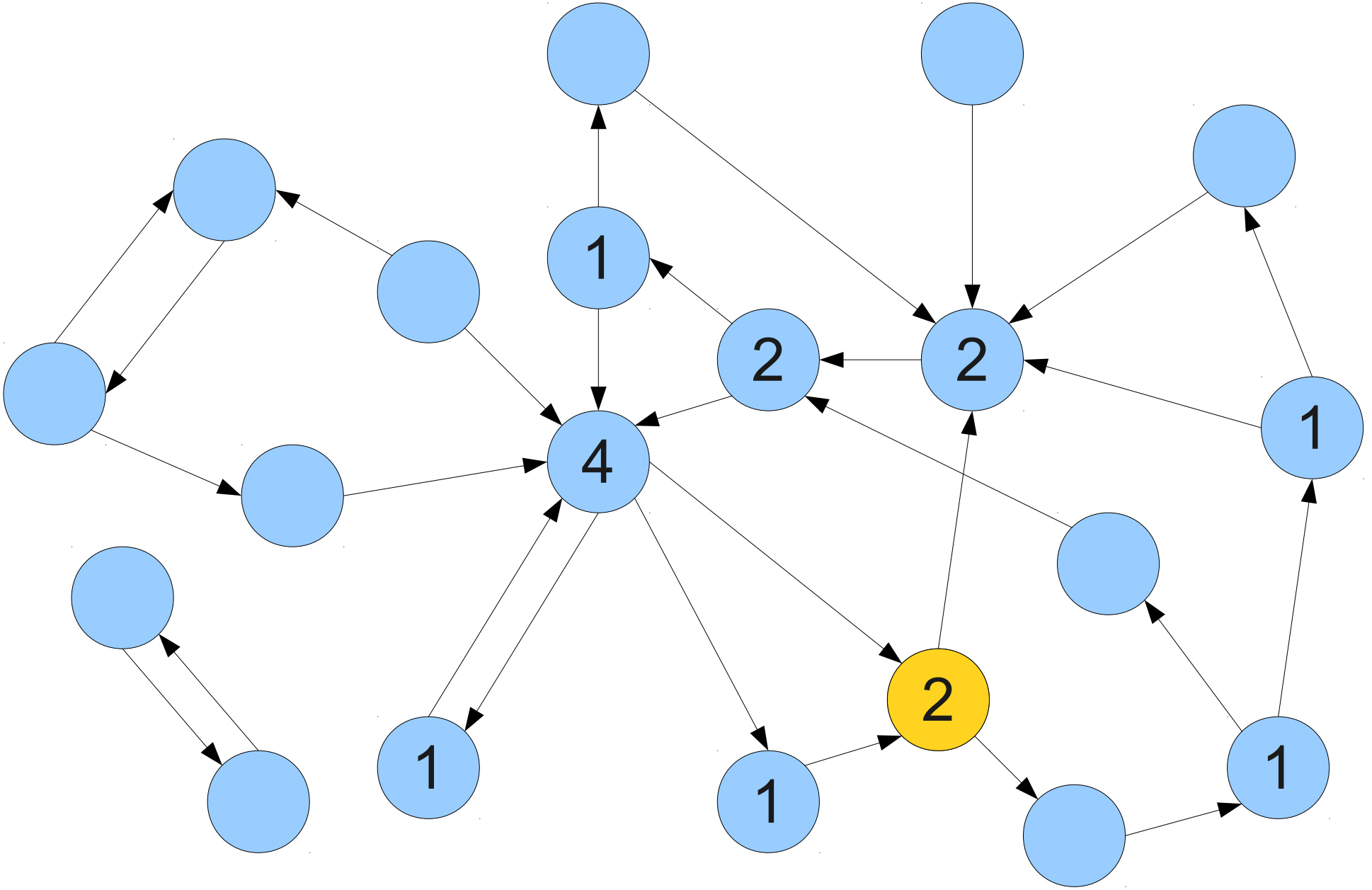

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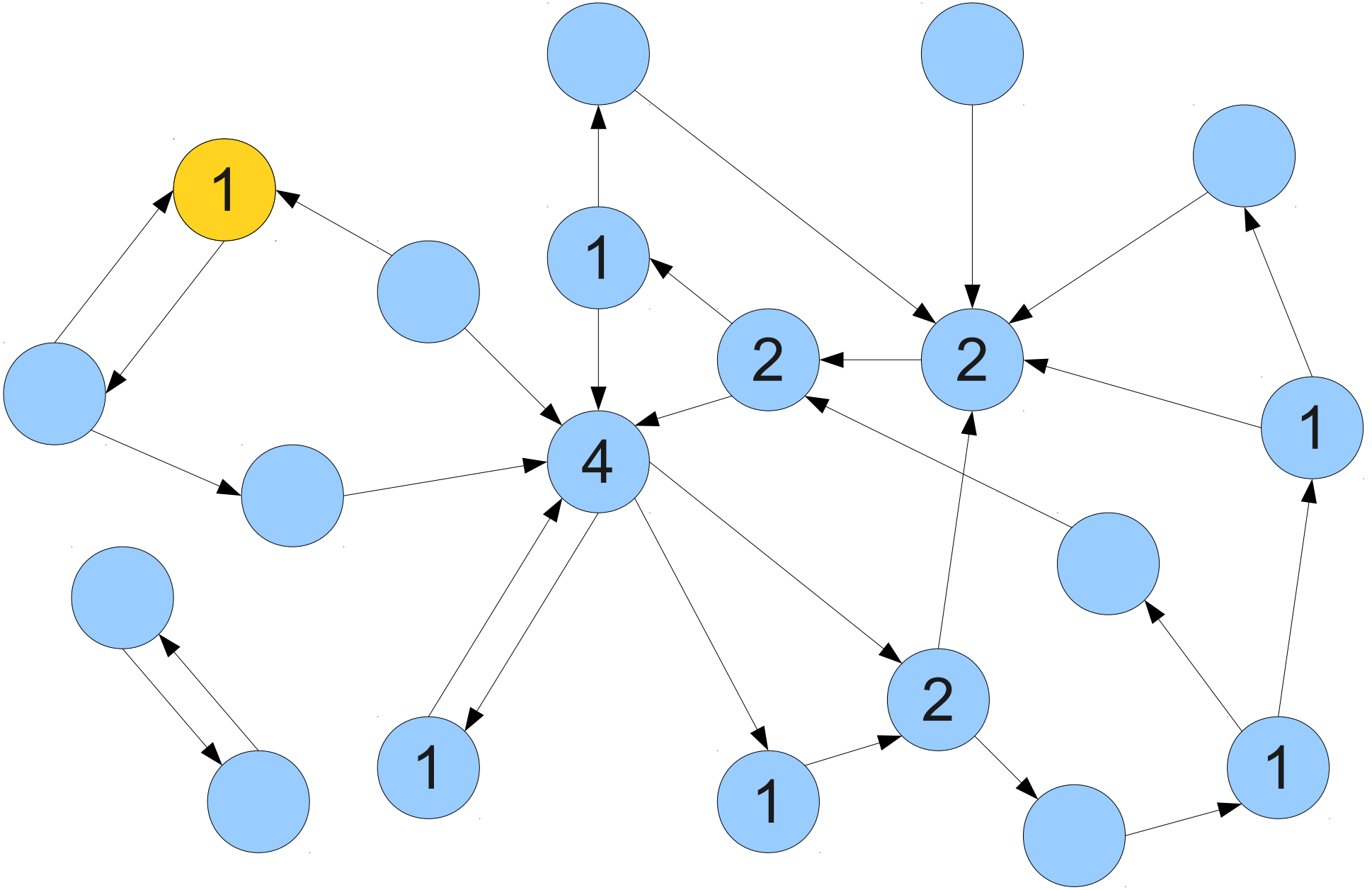

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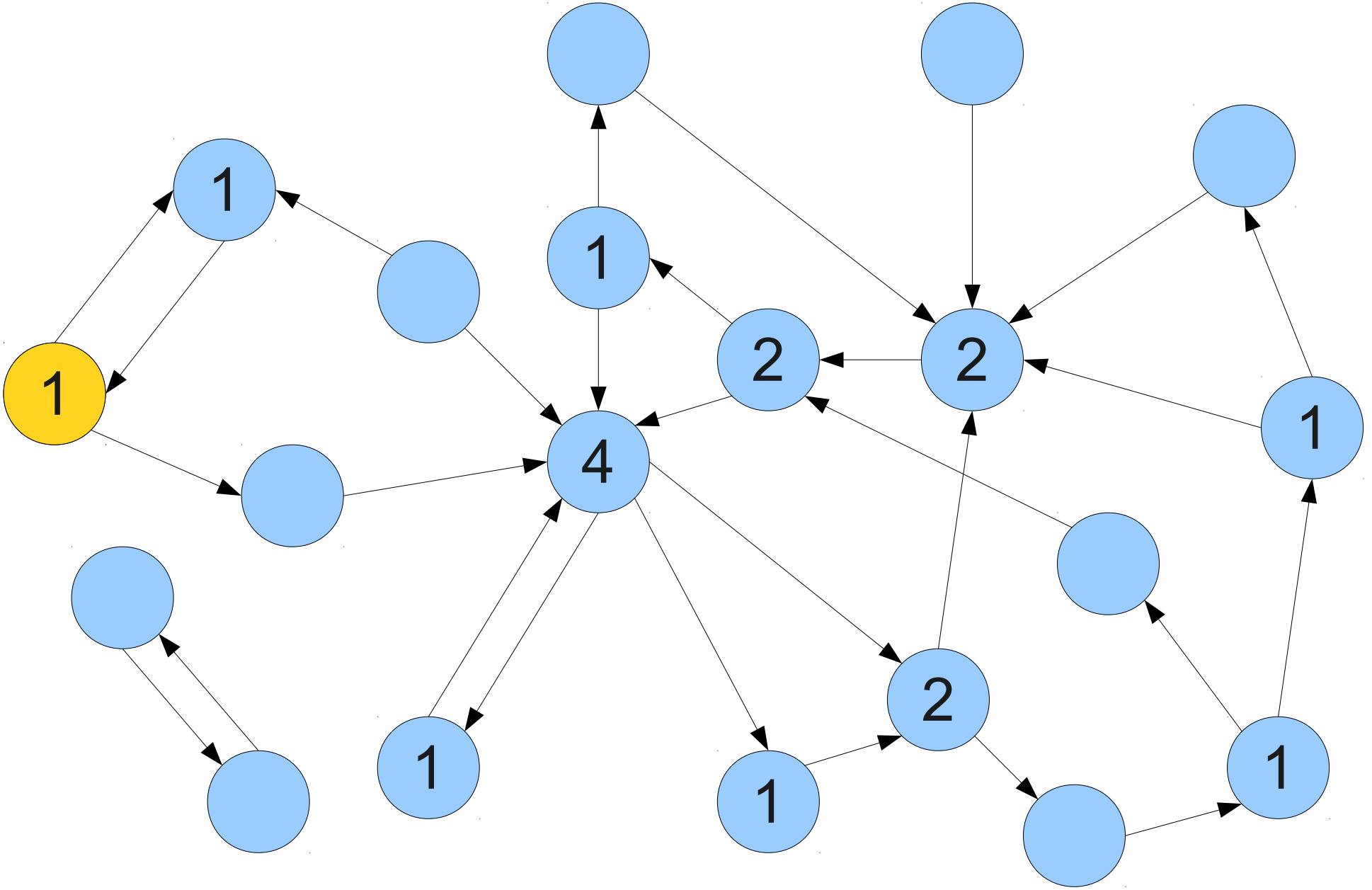

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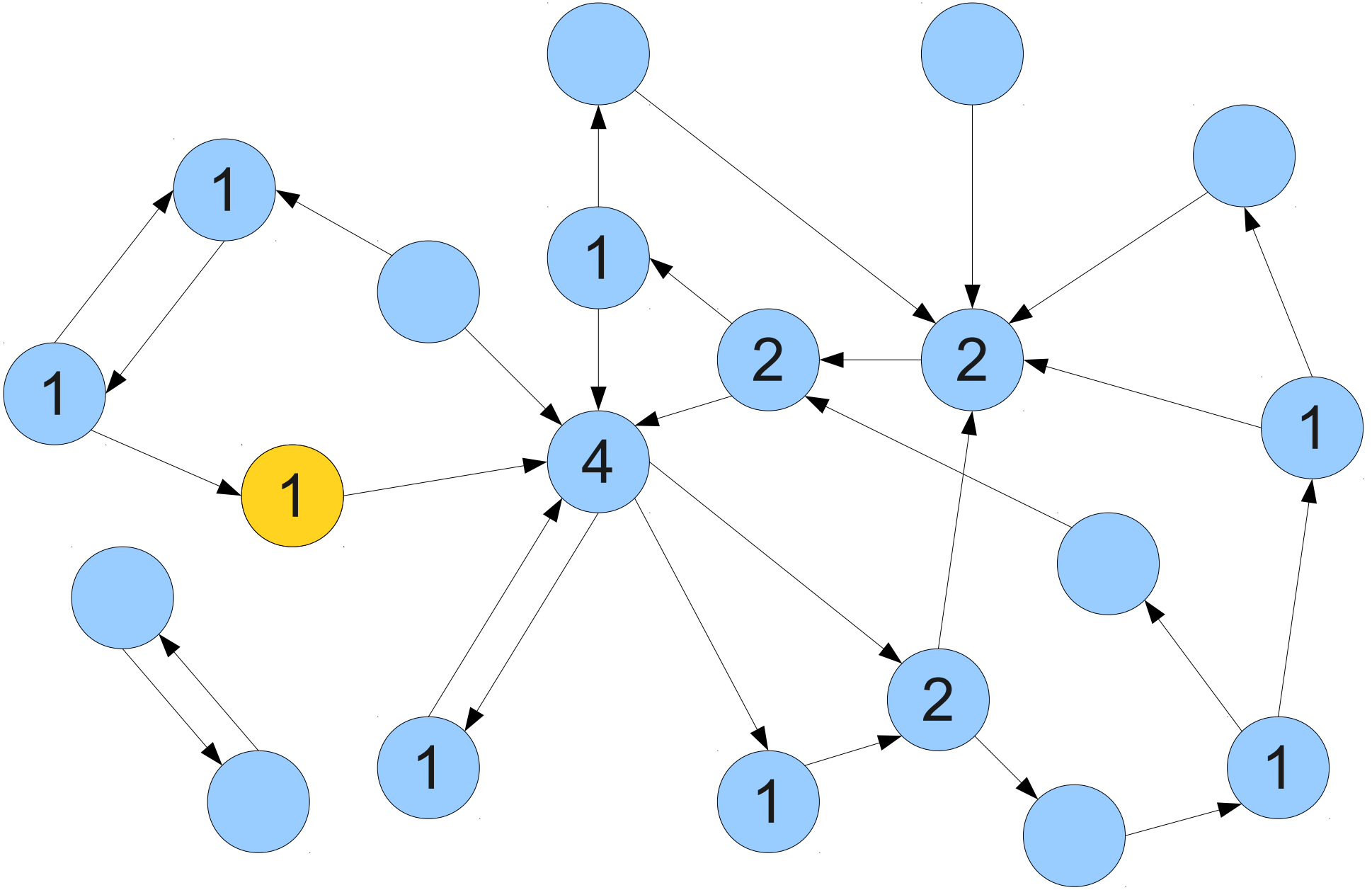
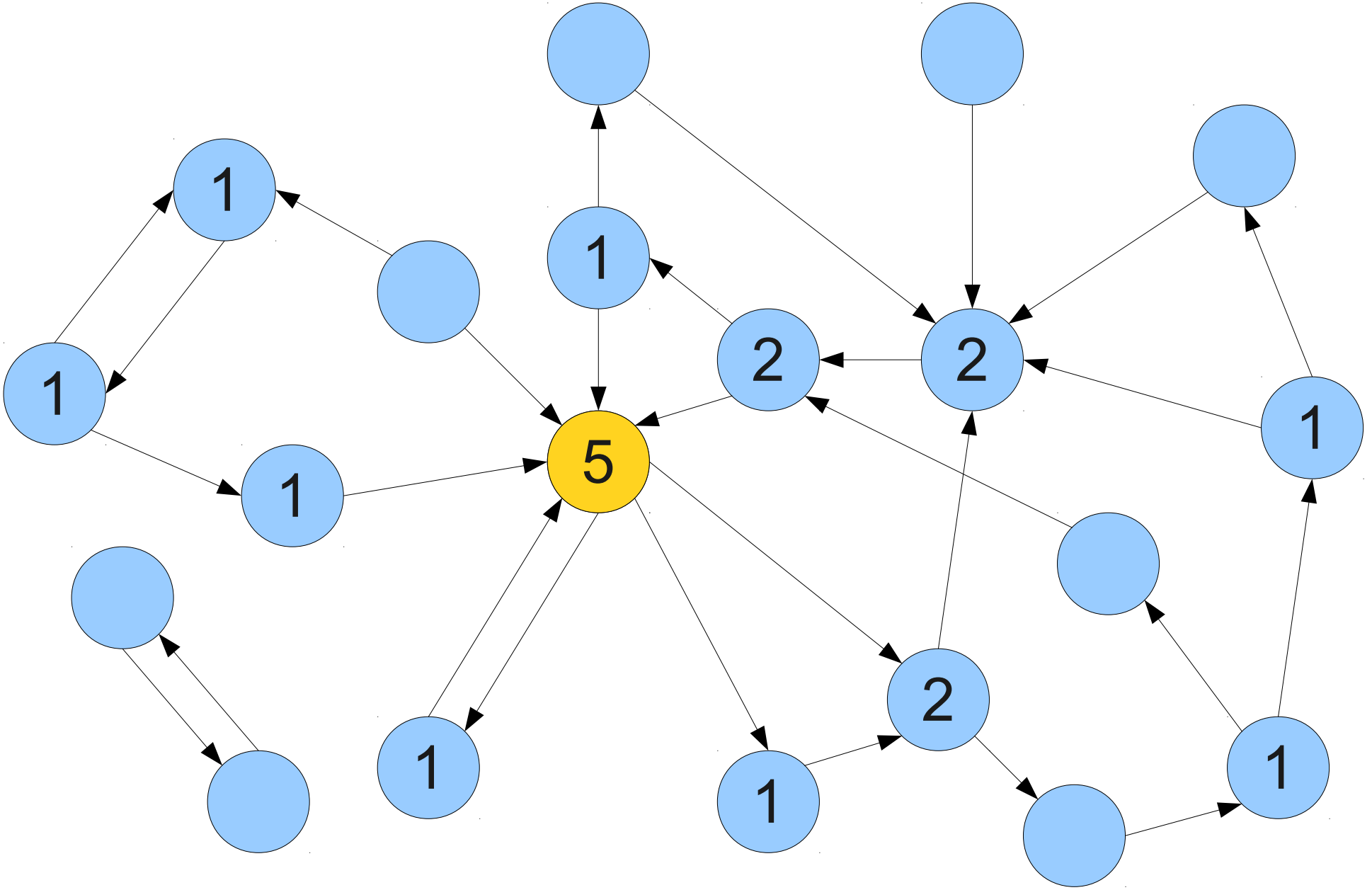


The Random Surfer Model



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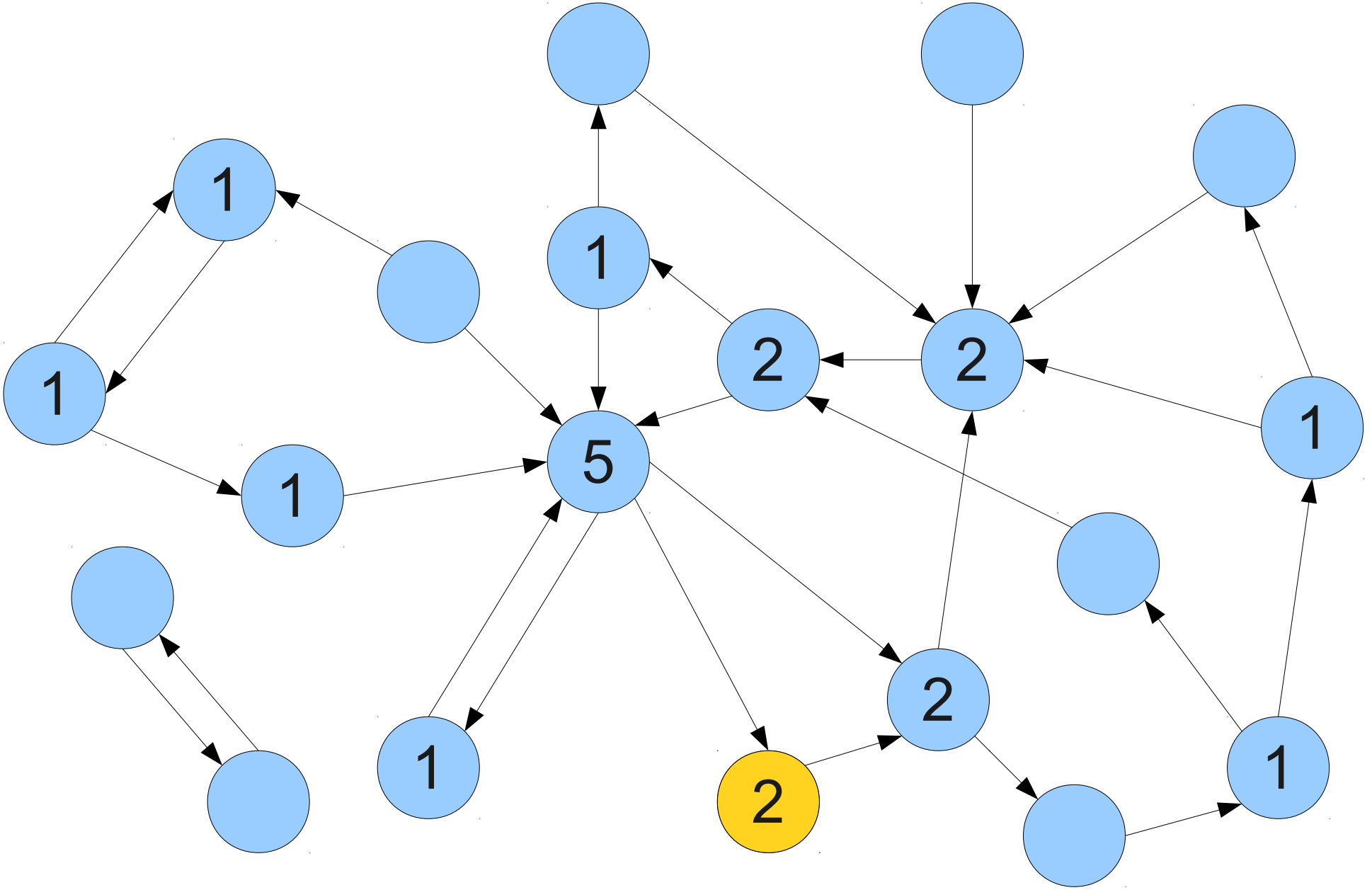

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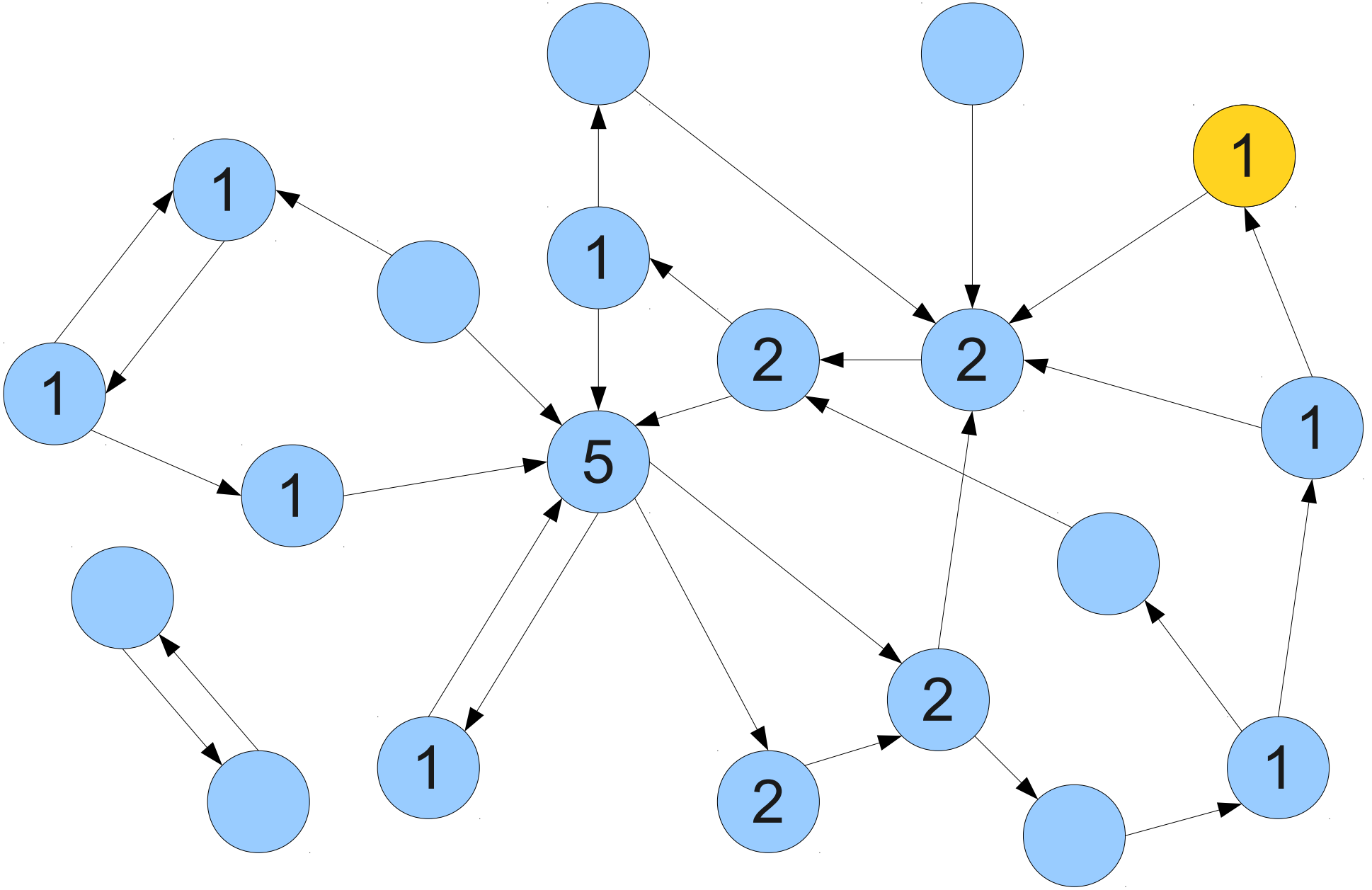

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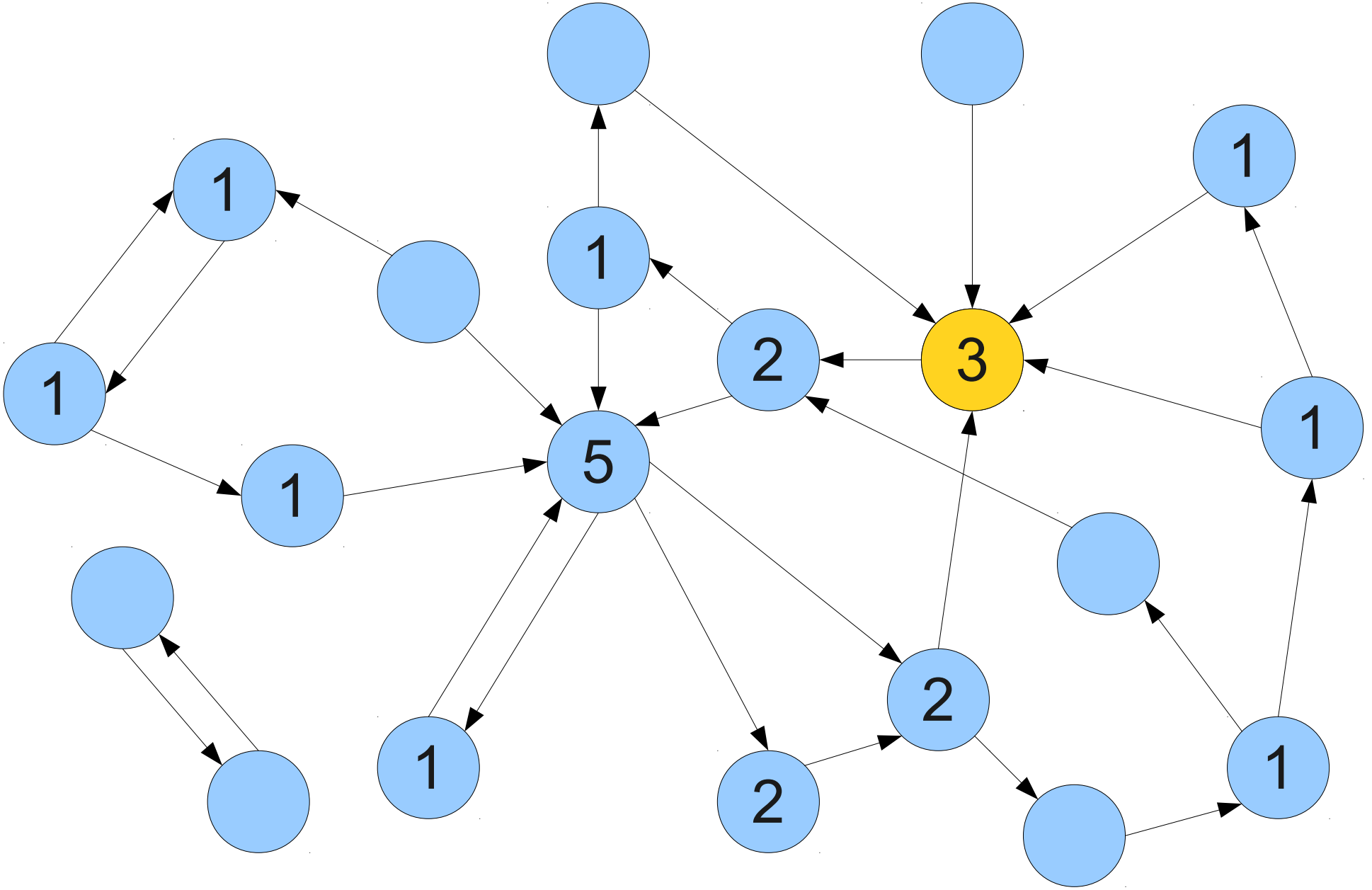

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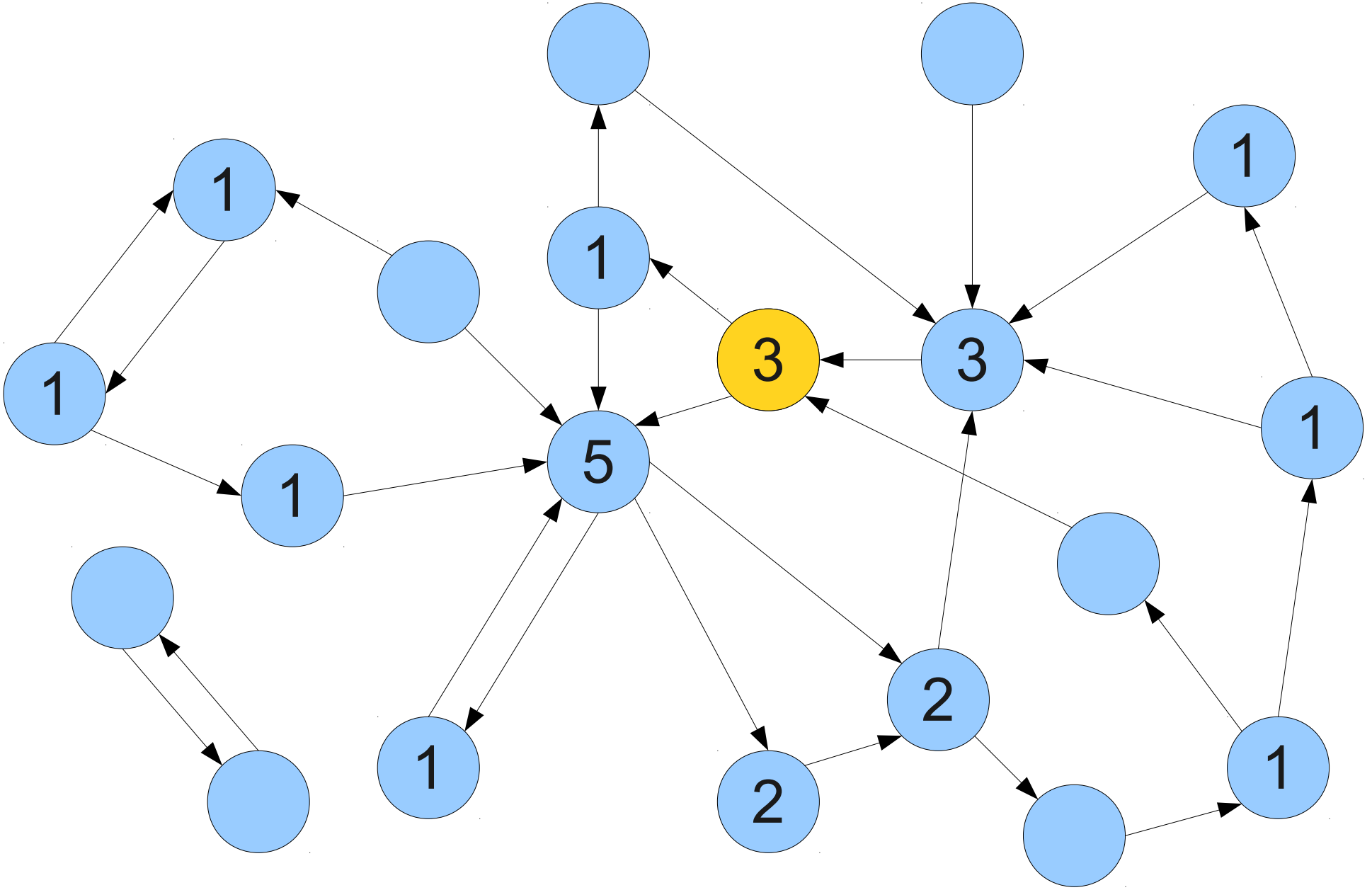

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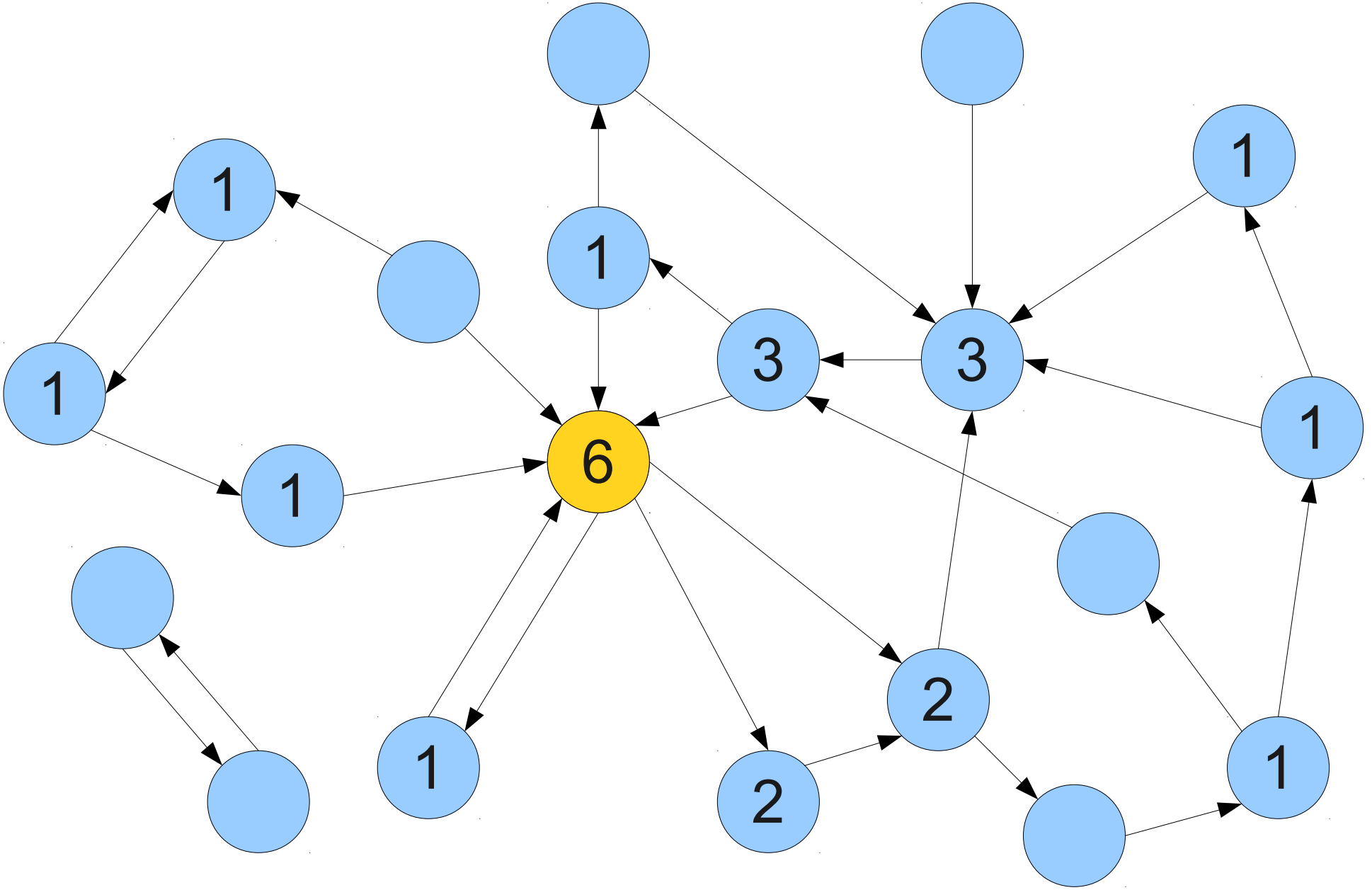

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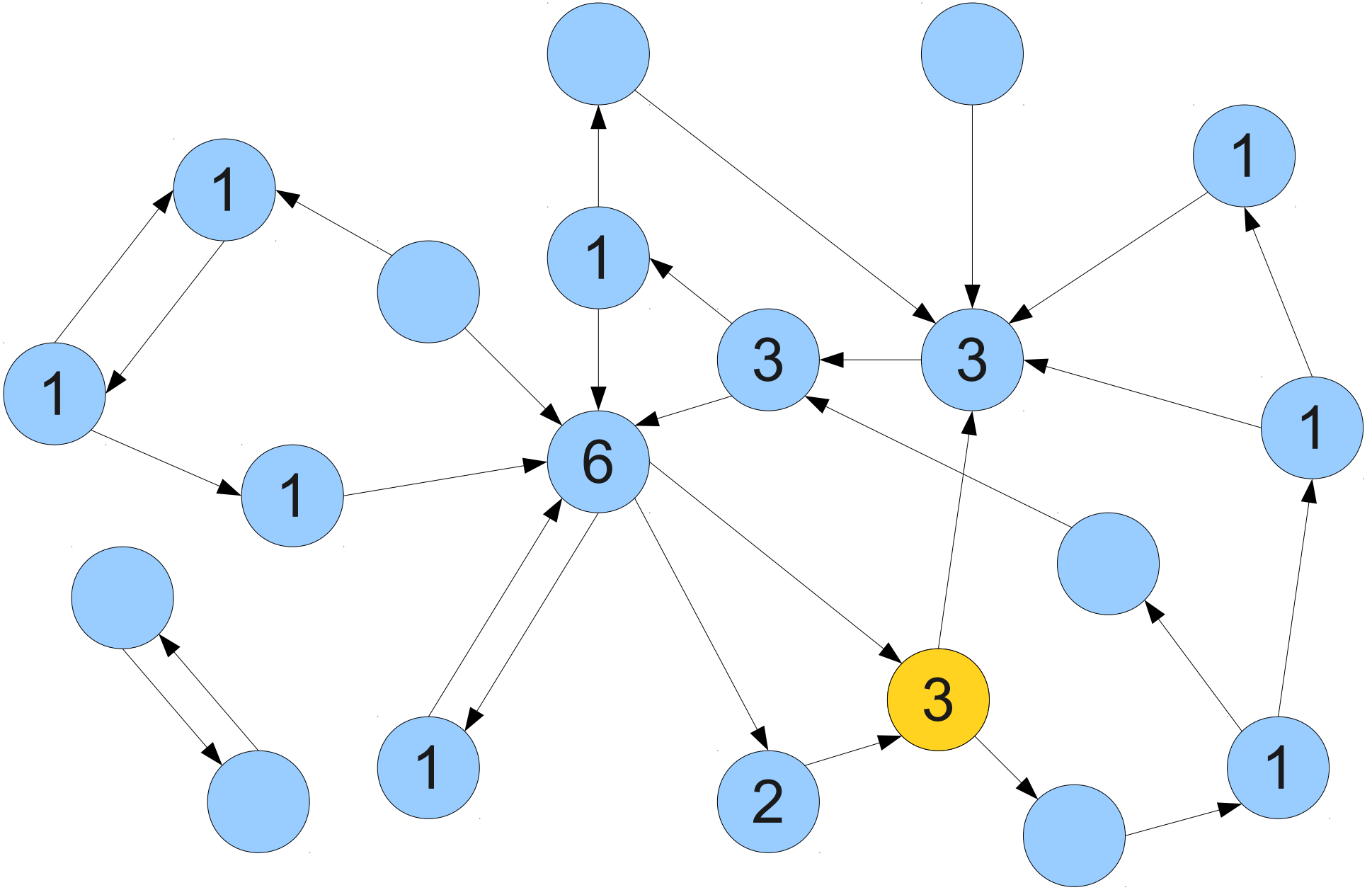

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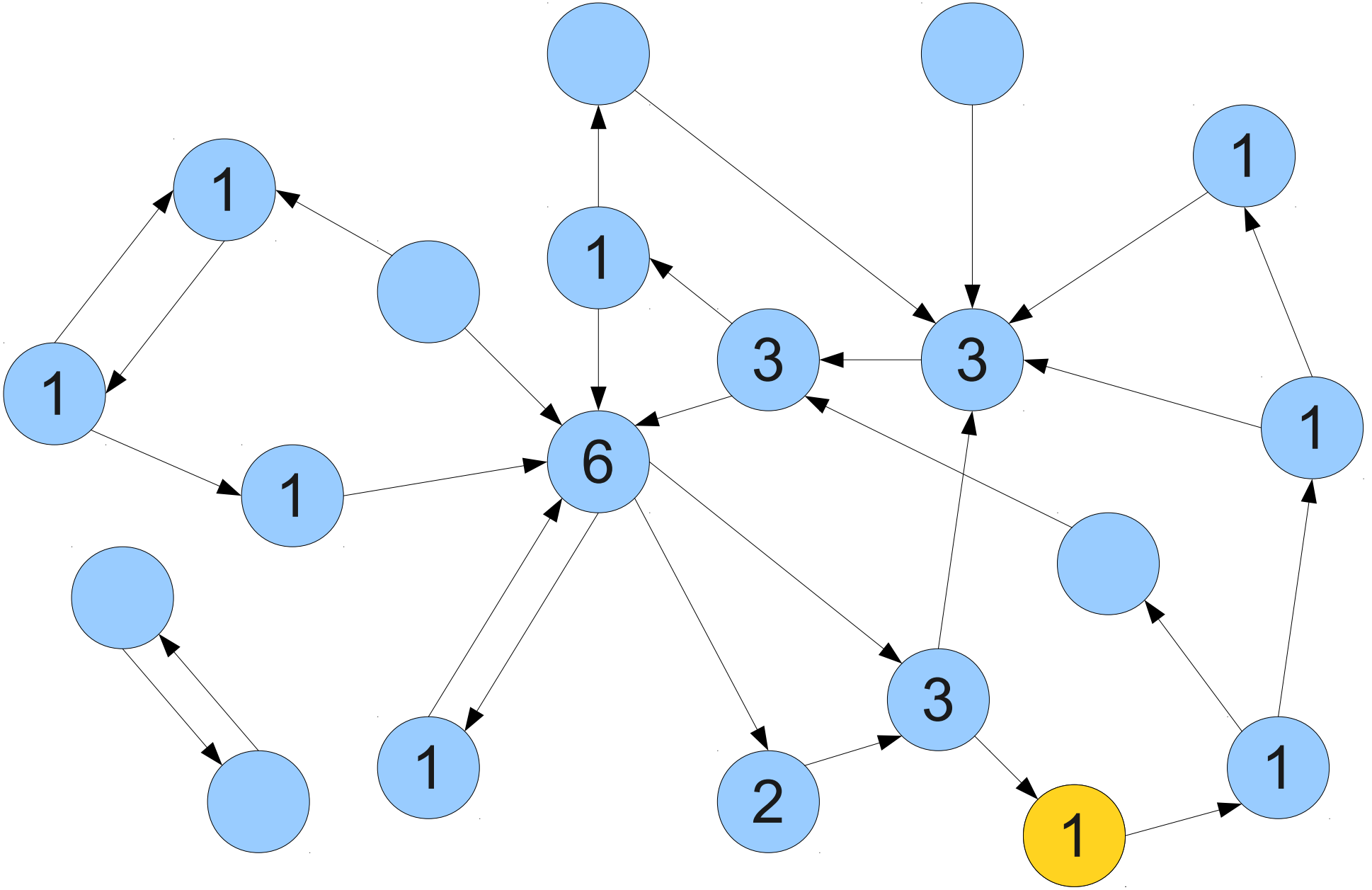

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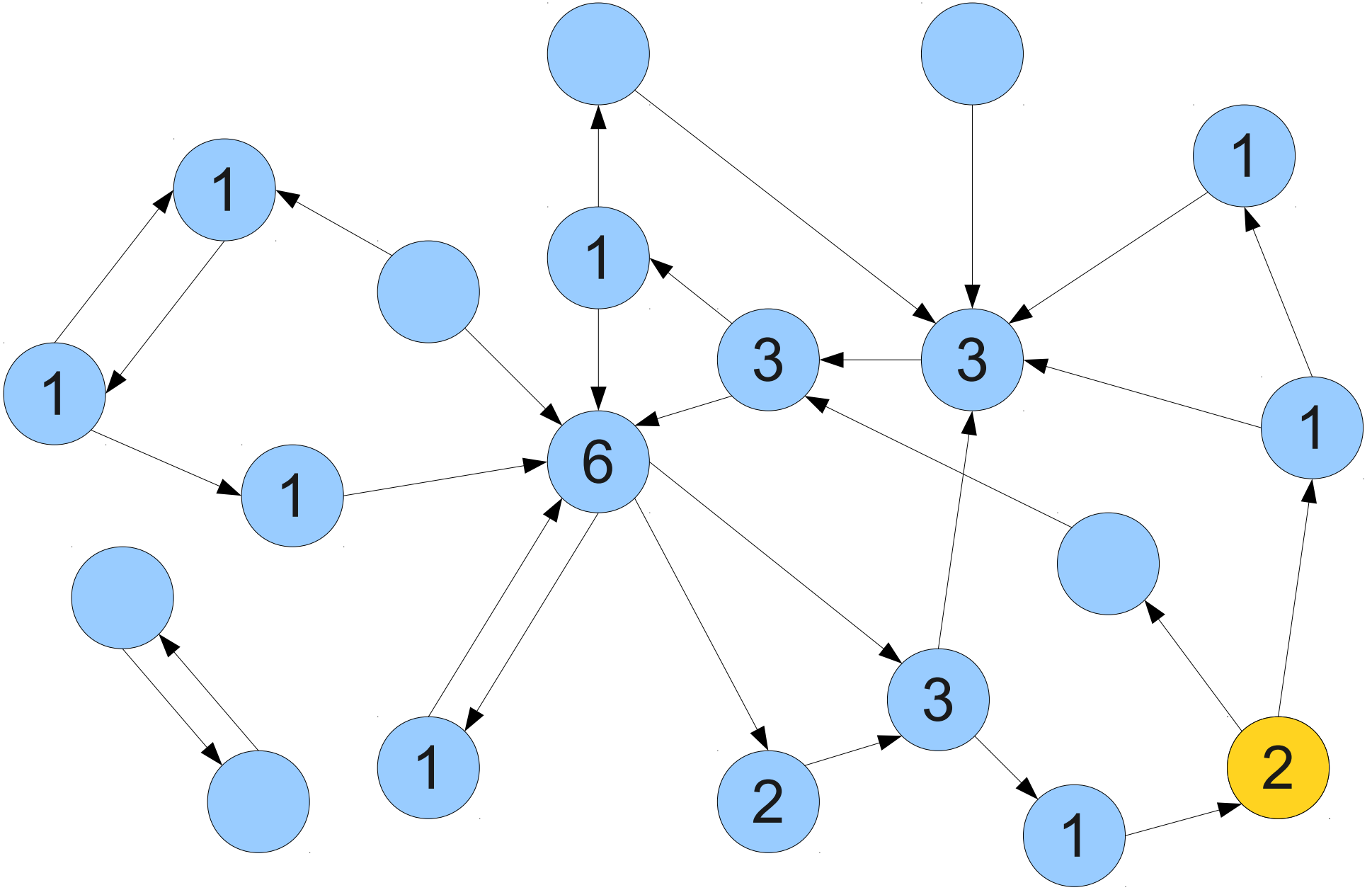

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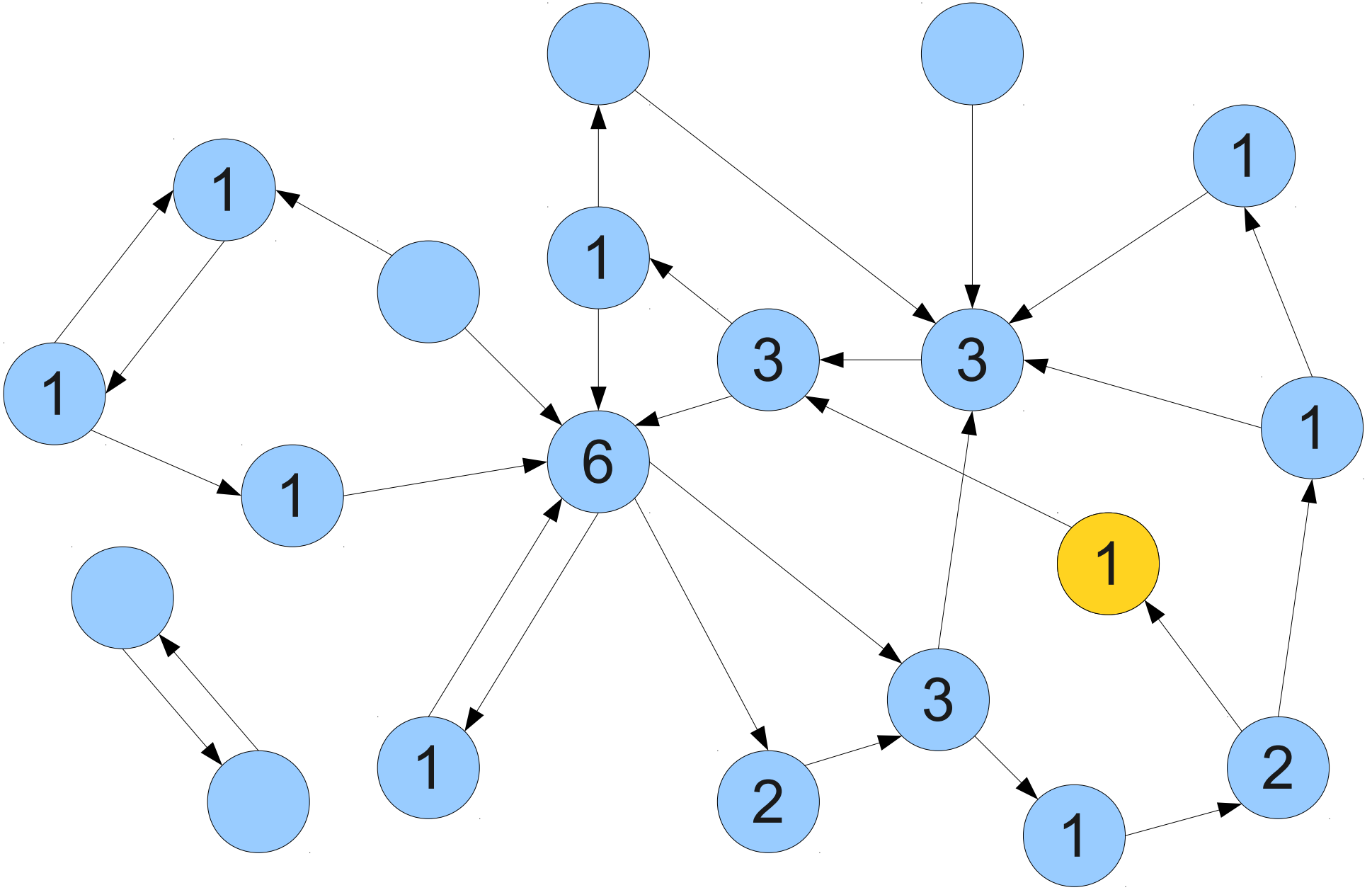

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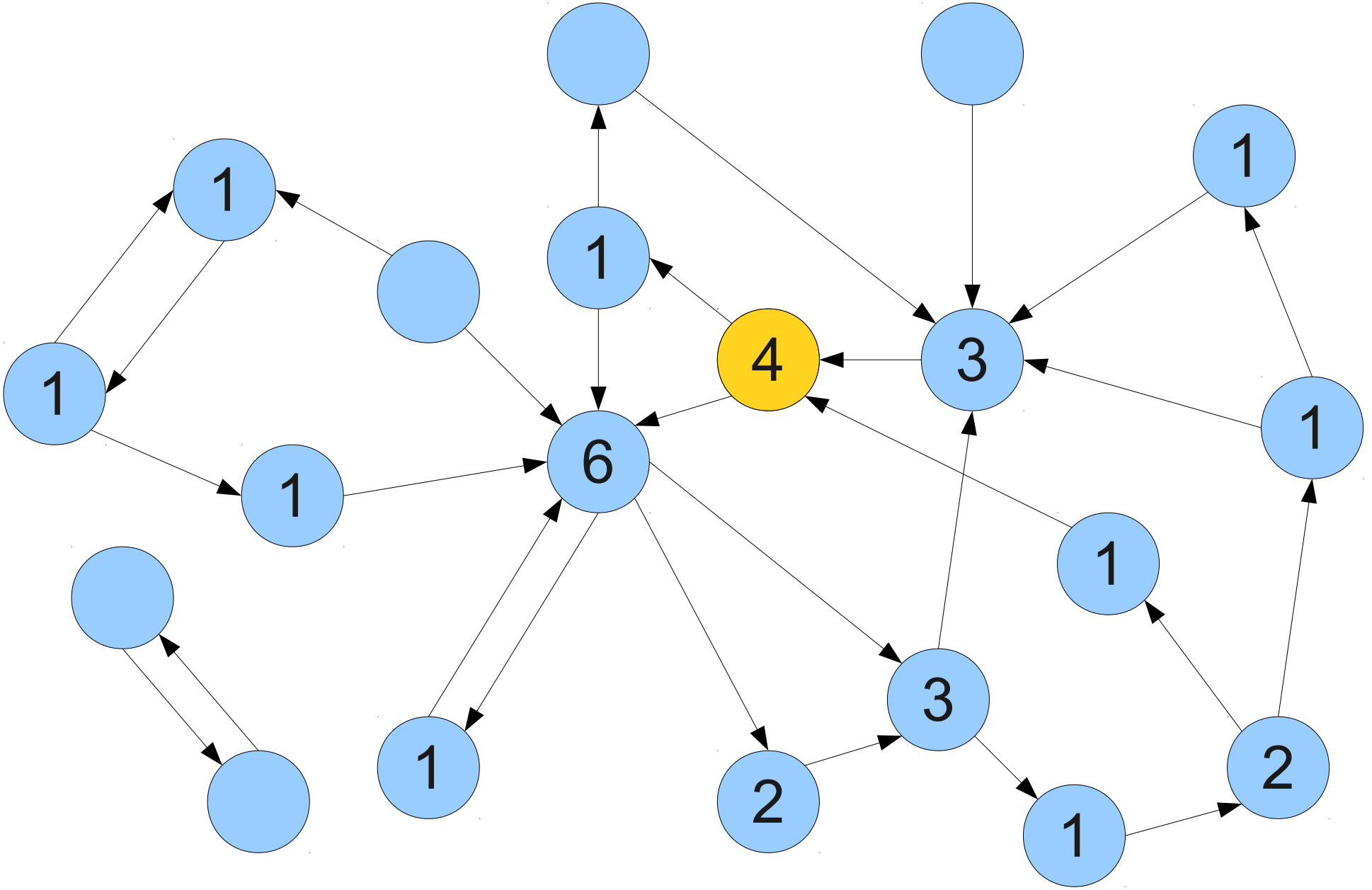

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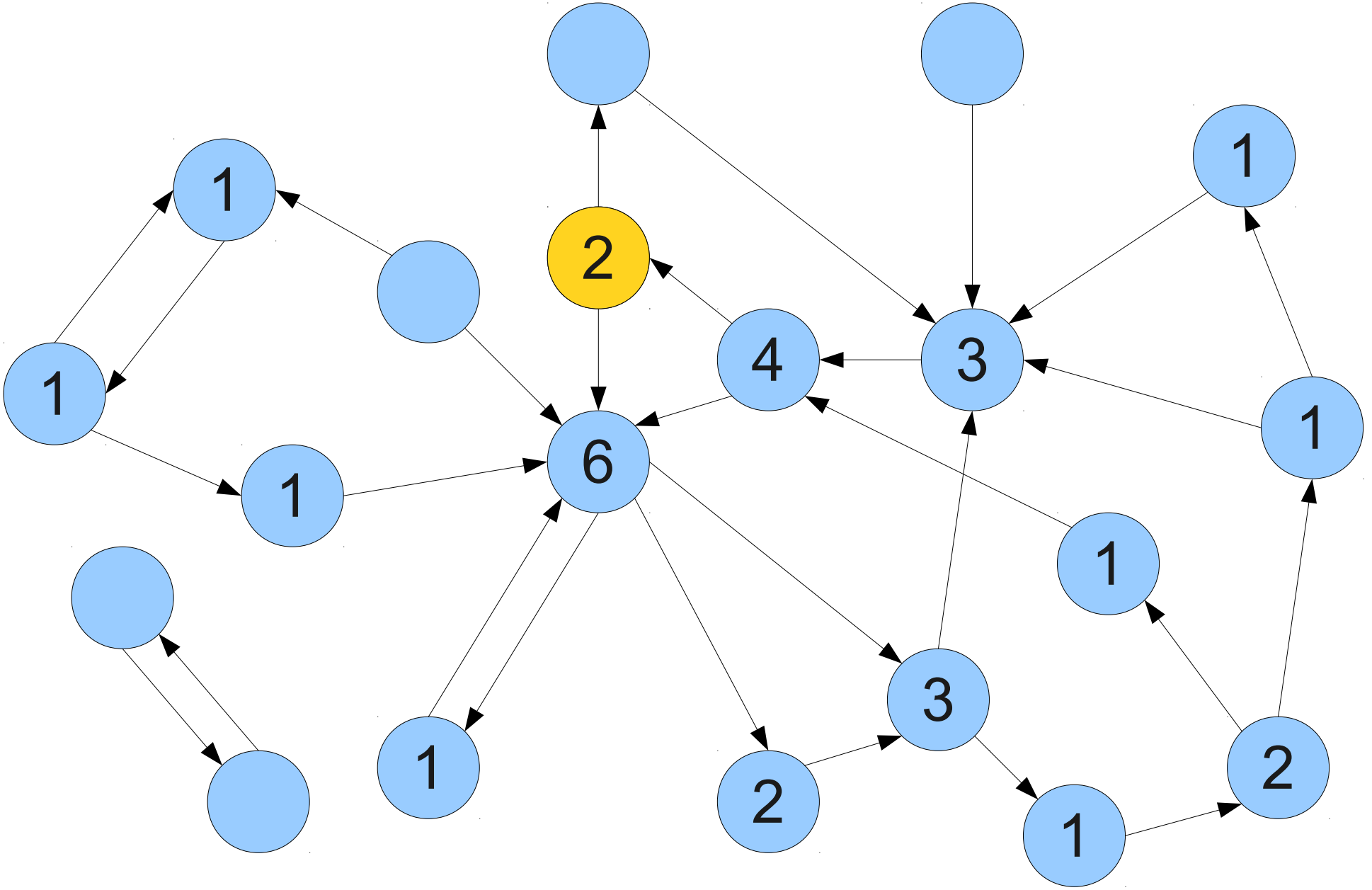

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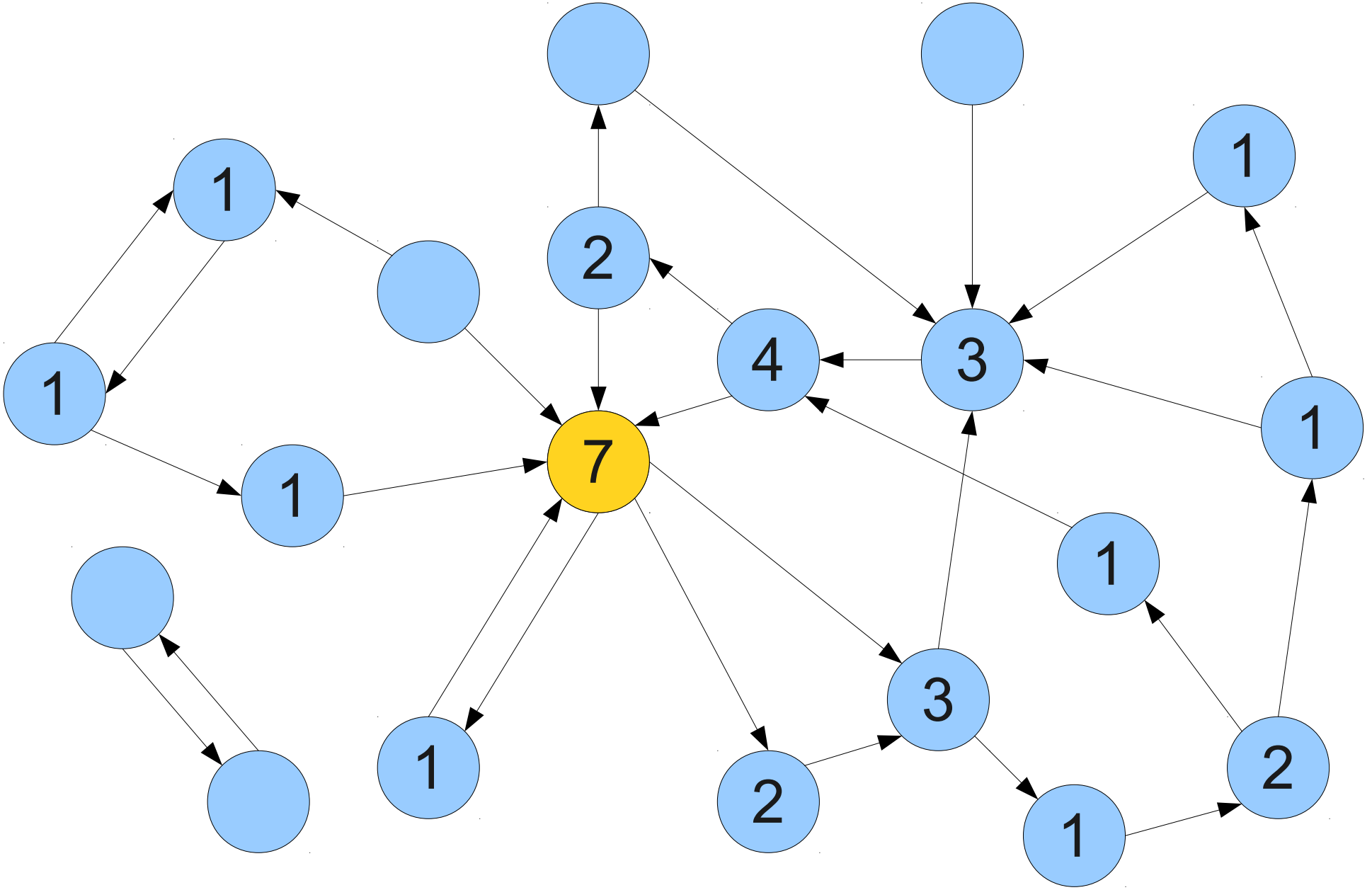

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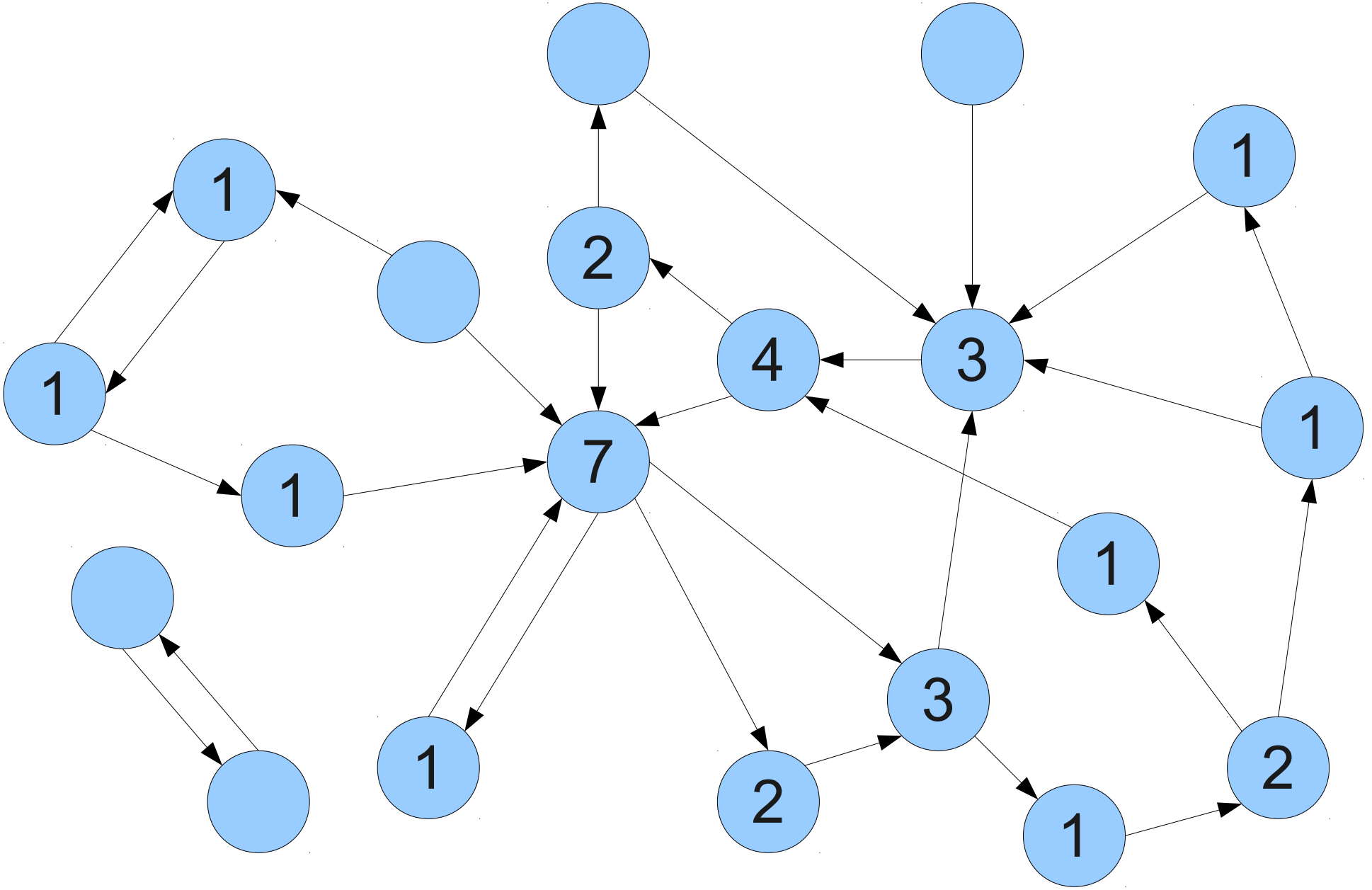

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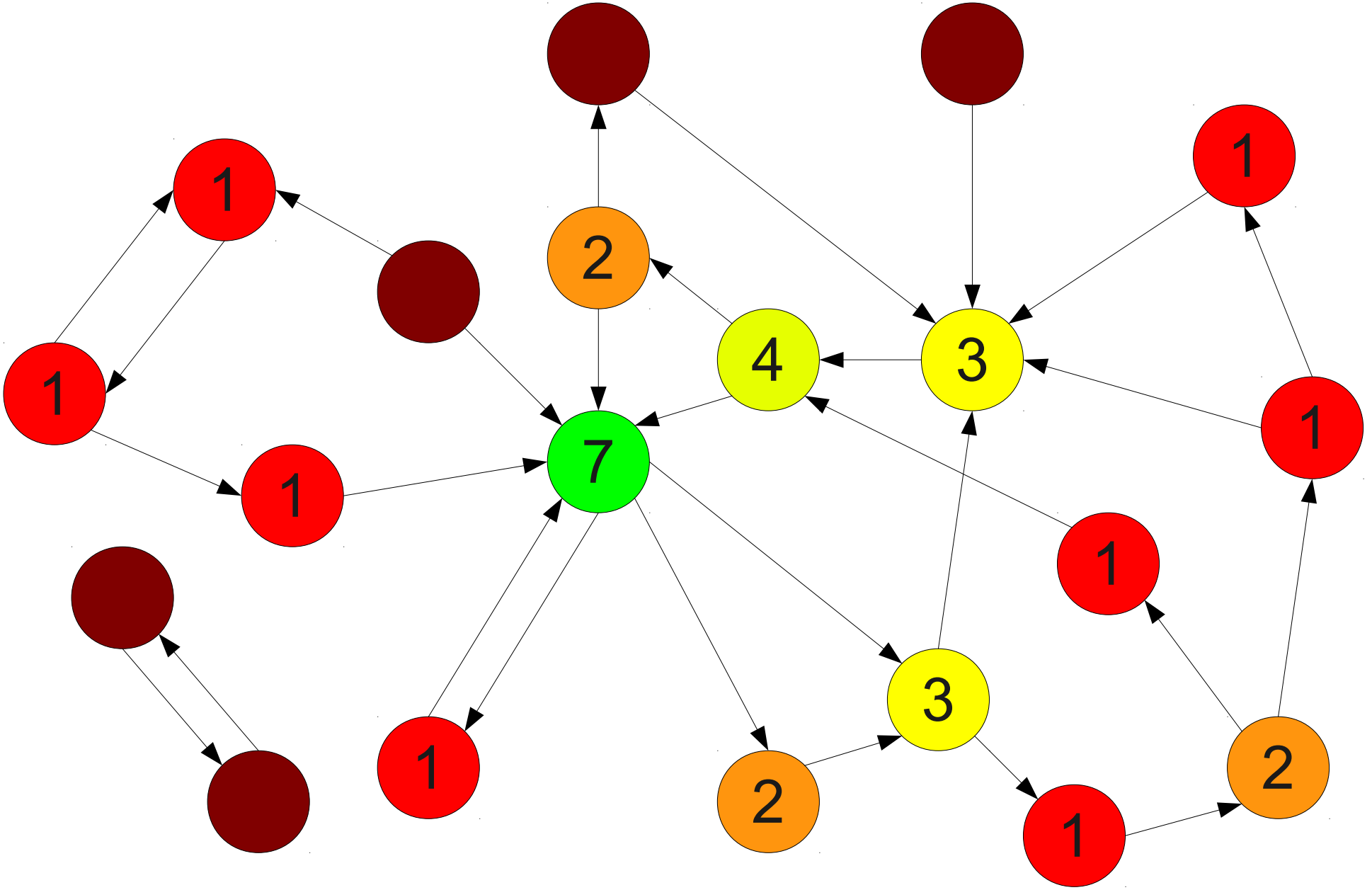

Ranking Articles with the RSM

- Randomly walk through the graph.
- At each step, either
  - Jump to a totally random article, or
  - Follow a random link.
- Record how many times each article was visited.
- The most-visited articles are, in some sense, the most important.

Other Applications of the RSM

- Ecosystem Stability:
  - Each node represents a species.
  - Edges represent one species that eats another.
  - High-value species are those that are important to the stability of the ecosystem.
- Learn more:
  - **http://news.bbc.co.uk/2/hi/8238462.stm**

Who invented this?

[Our approach] can be thought of as a model of user behavior. We assume there is a "random surfer" who is given a web page at random and keeps clicking on links, never hitting "back" but eventually gets bored and starts on another random page.

[Our approach] can be thought of as a model of user behavior. We assume there is a "random surfer" who is given a web page at random and keeps clicking on links, never hitting "back" but eventually gets bored and starts on another random page. The probability that the random surfer visits a page is its **PageRank**.

The Anatomy of a Large-Scale Hypertextual Web Search Engine

Sergey Brin and Lawrence Page
Computer Science Department,
Stanford University, Stanford, CA 94305, USA
sergey@cs.stanford.edu and page@cs.stanford.edu

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