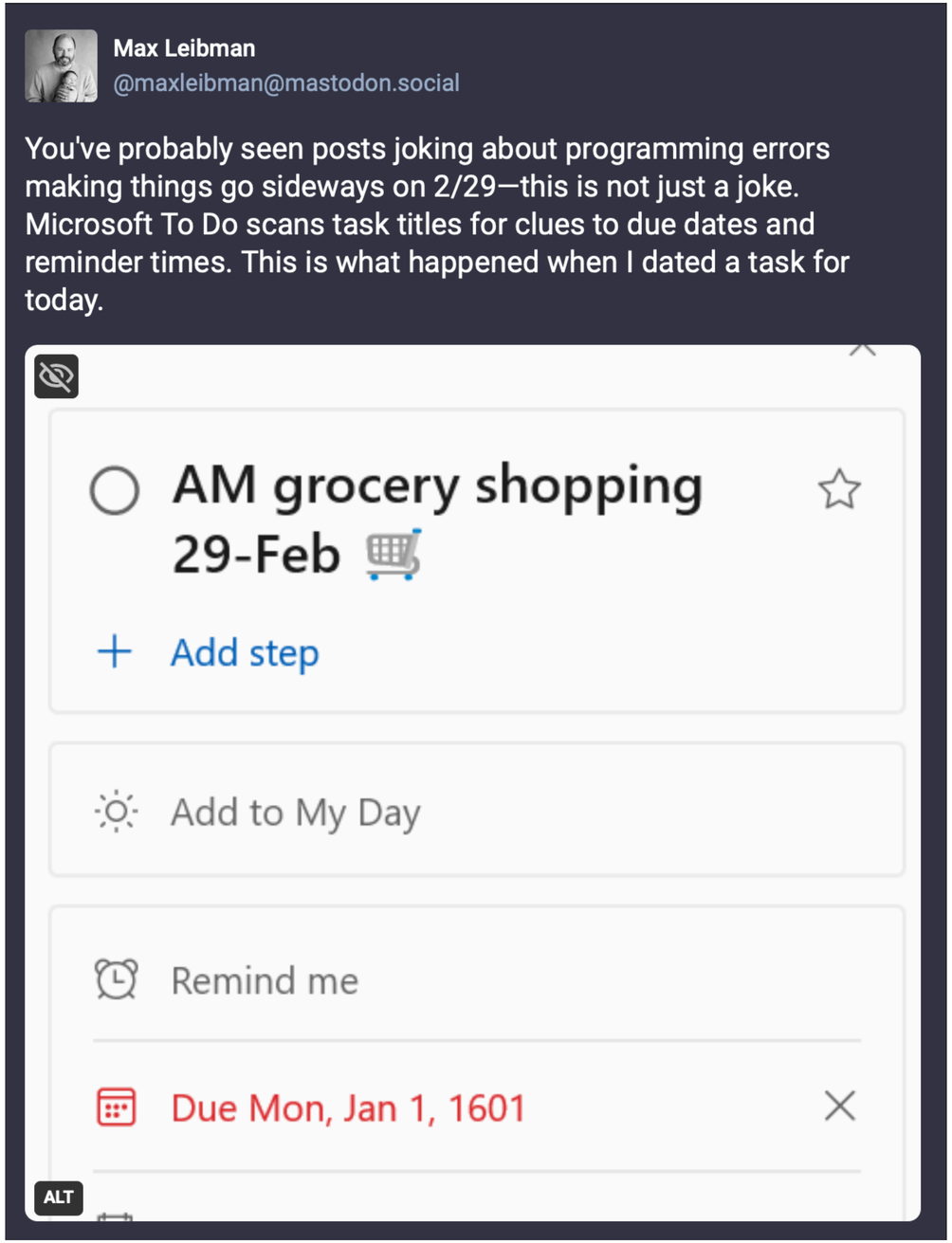
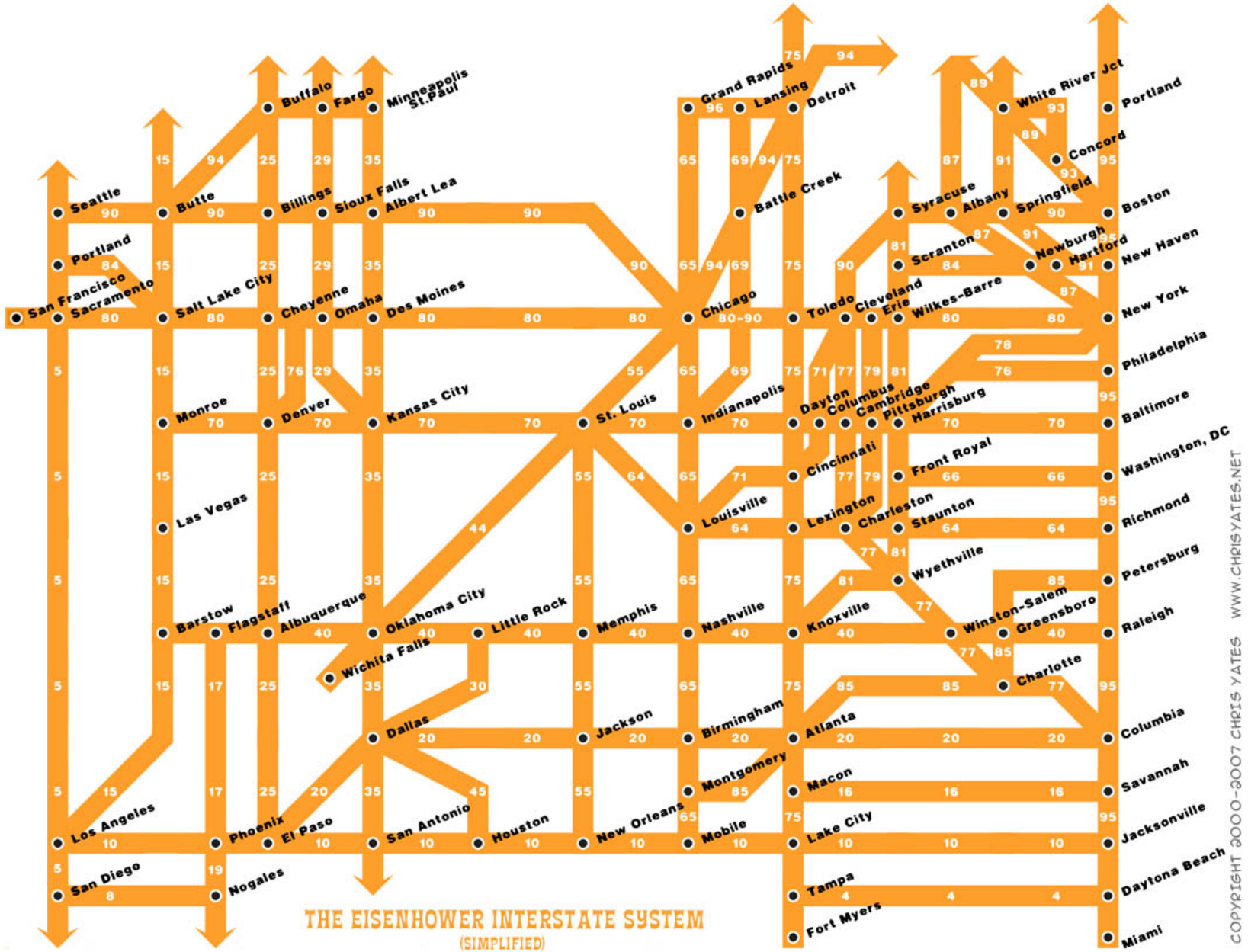
CMPU 101 § 53 · Computer Science I

Graphs and Simulation

29 February 2024



This is why we write tests.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THE EISENHOWER INTERSTATE SYSTEM
(SIMPLIFIED)
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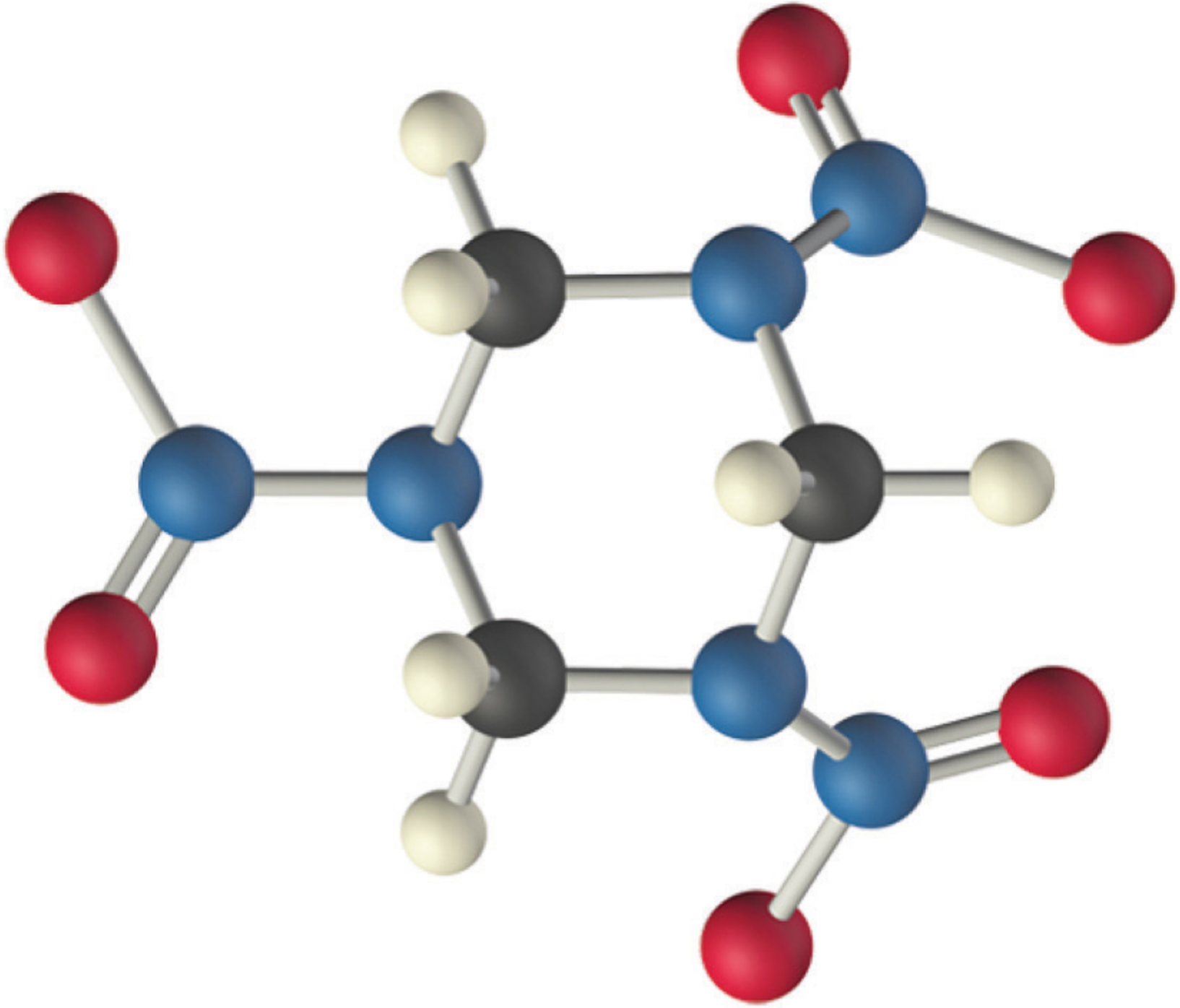
Highways



Chemical bonds

Dystopian proxies for friendship

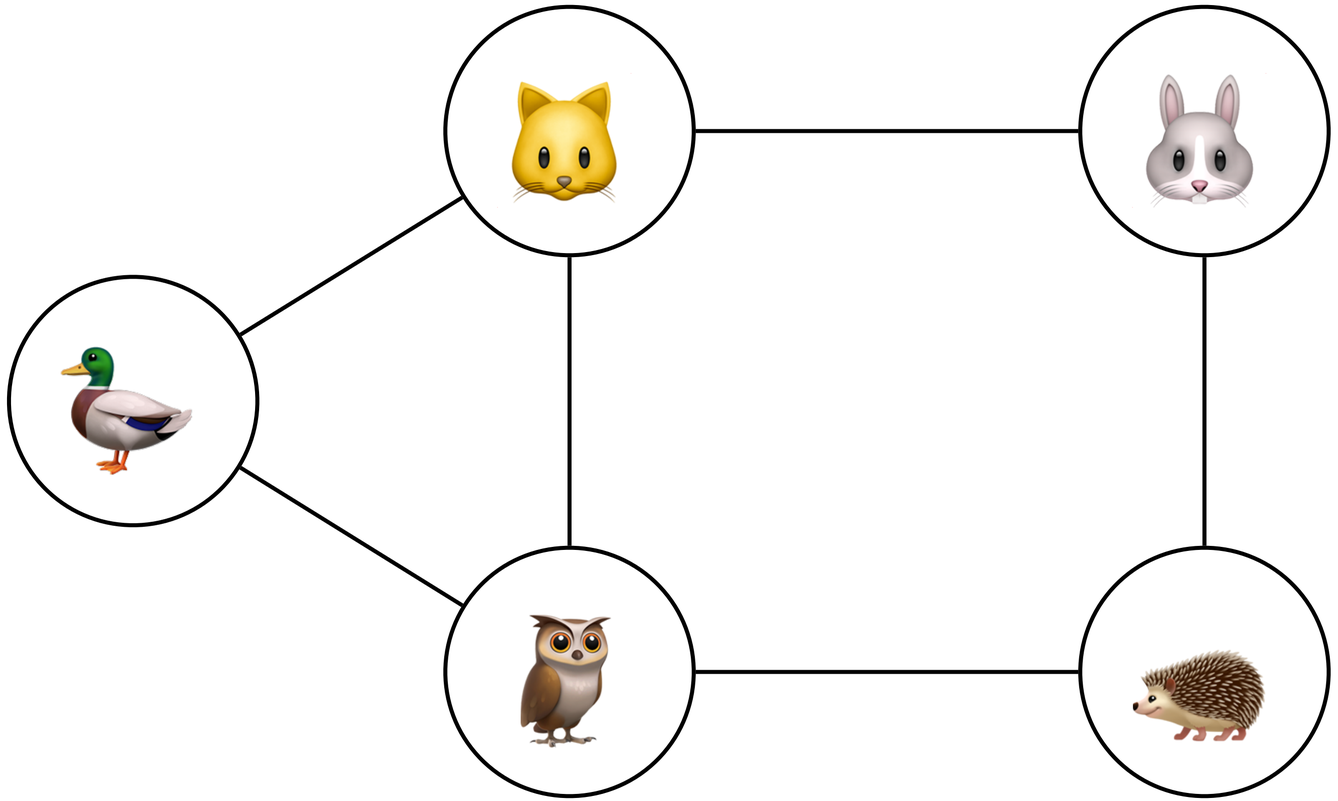
Each of these structures consists of

a collection of objects and

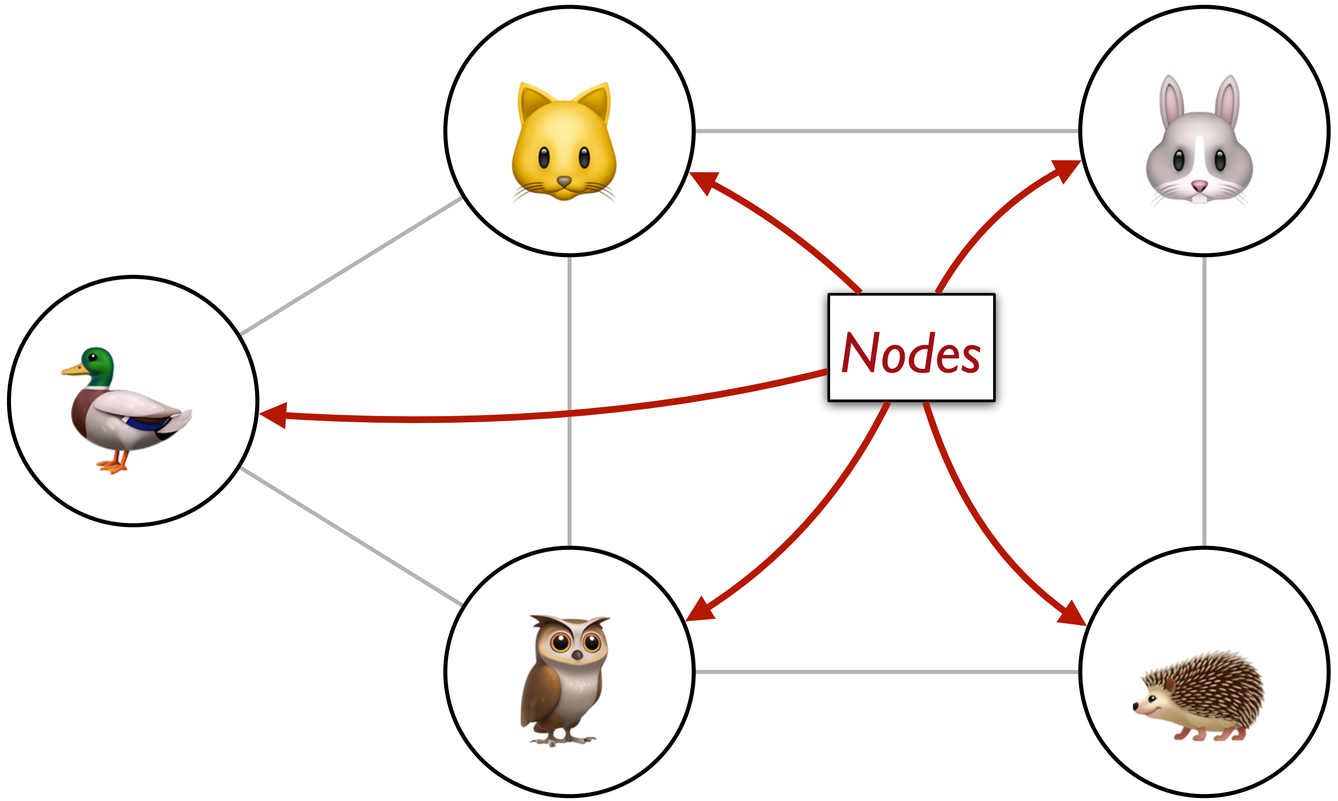
links between those objects.

We'd like to find a general framework for describing these objects and their properties.

A *graph* is a mathematical structure for representing relationships between entities.



A graph consists of a set of *nodes* (or *vertices*) connected by *edges* (or *arcs*).



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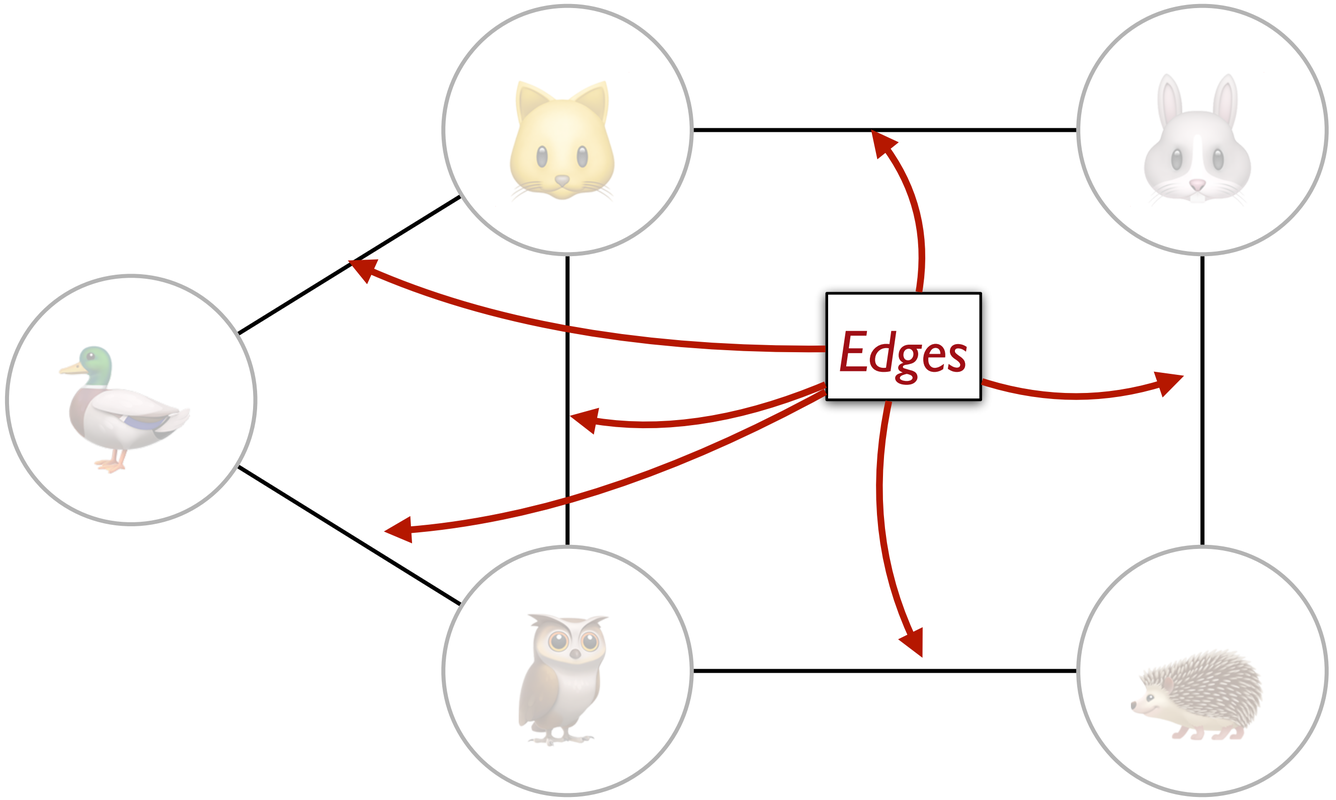
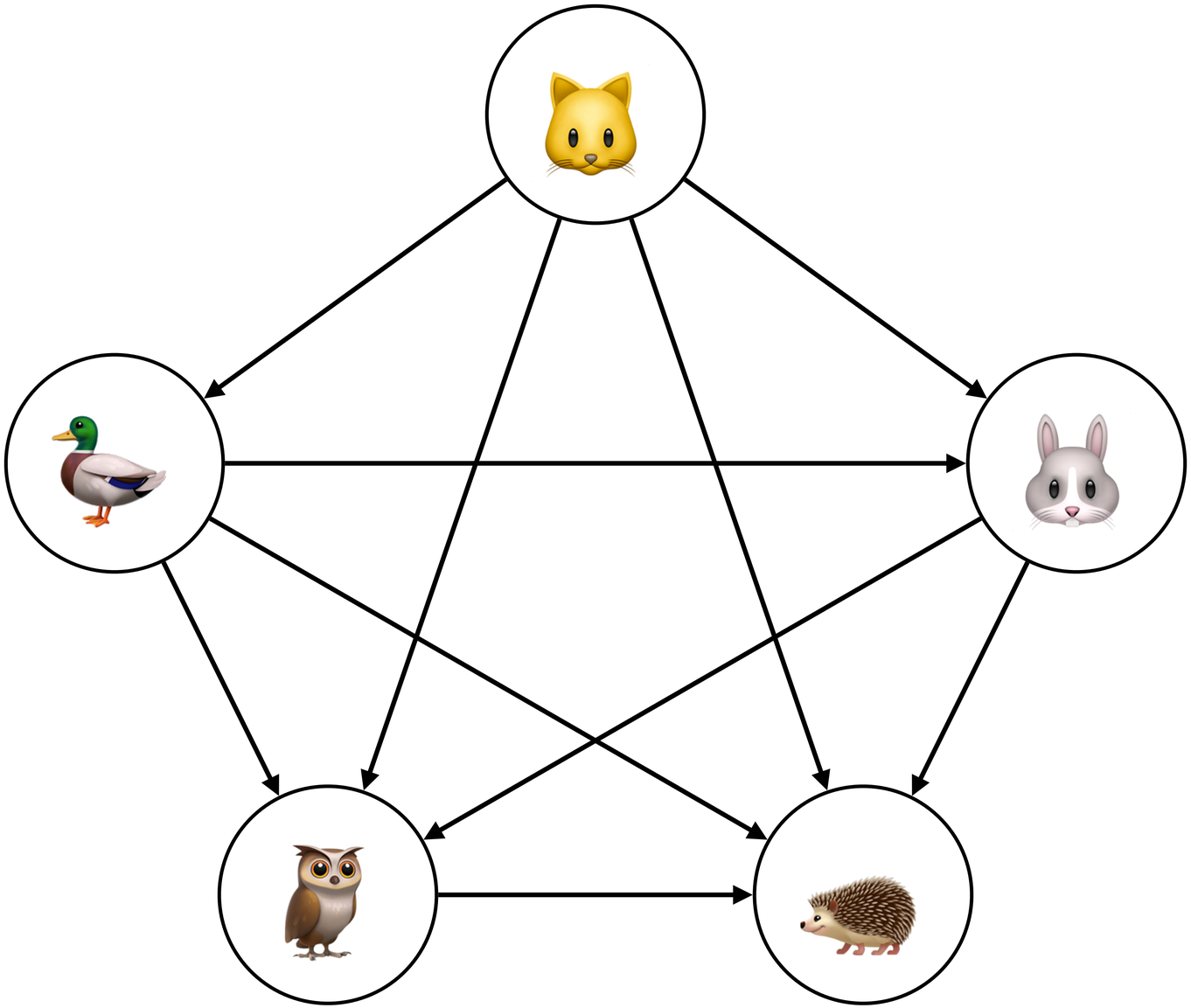
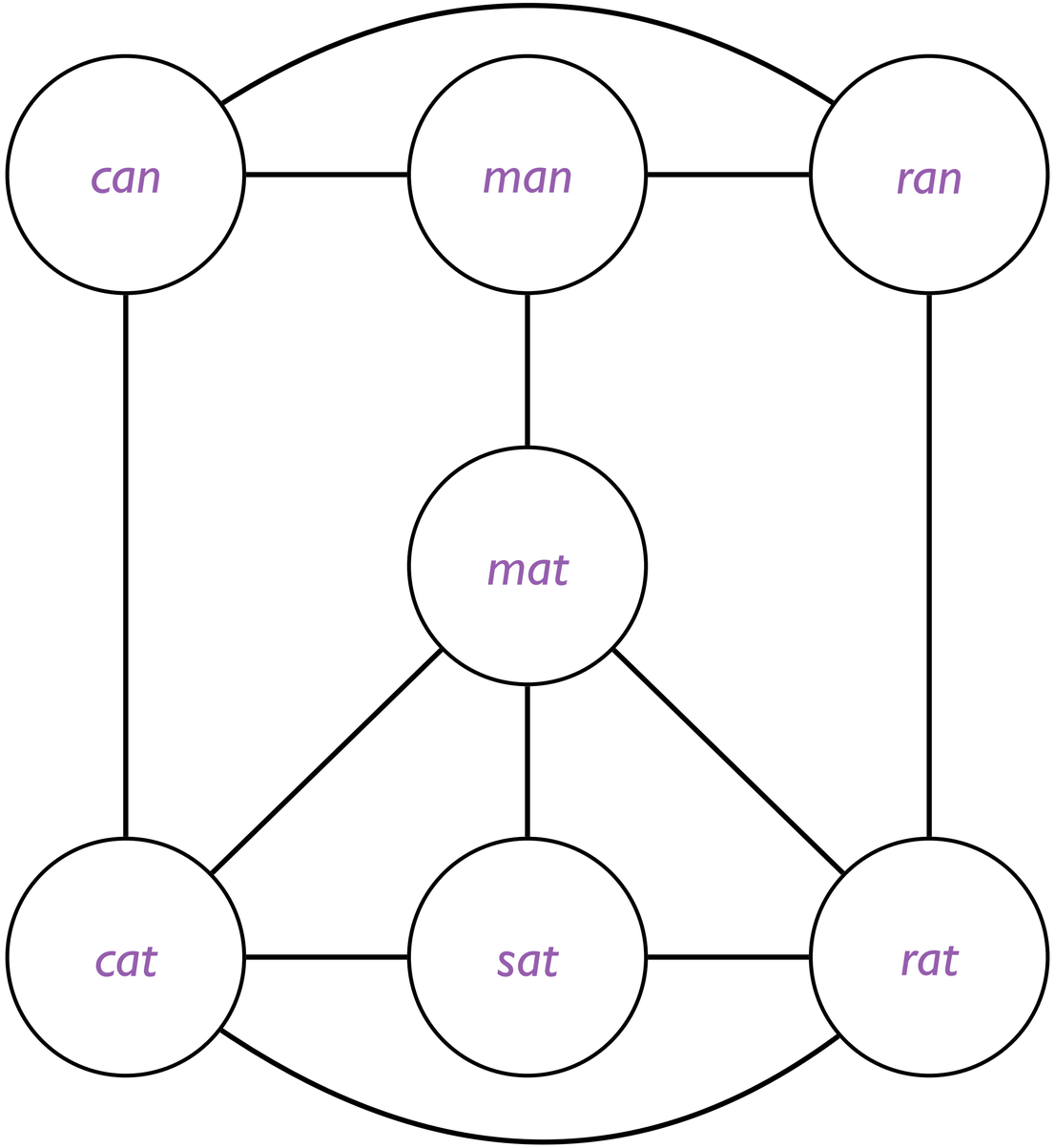


A graph consists of a set of *nodes* (or *vertices*) connected by *edges* (or *arcs*).

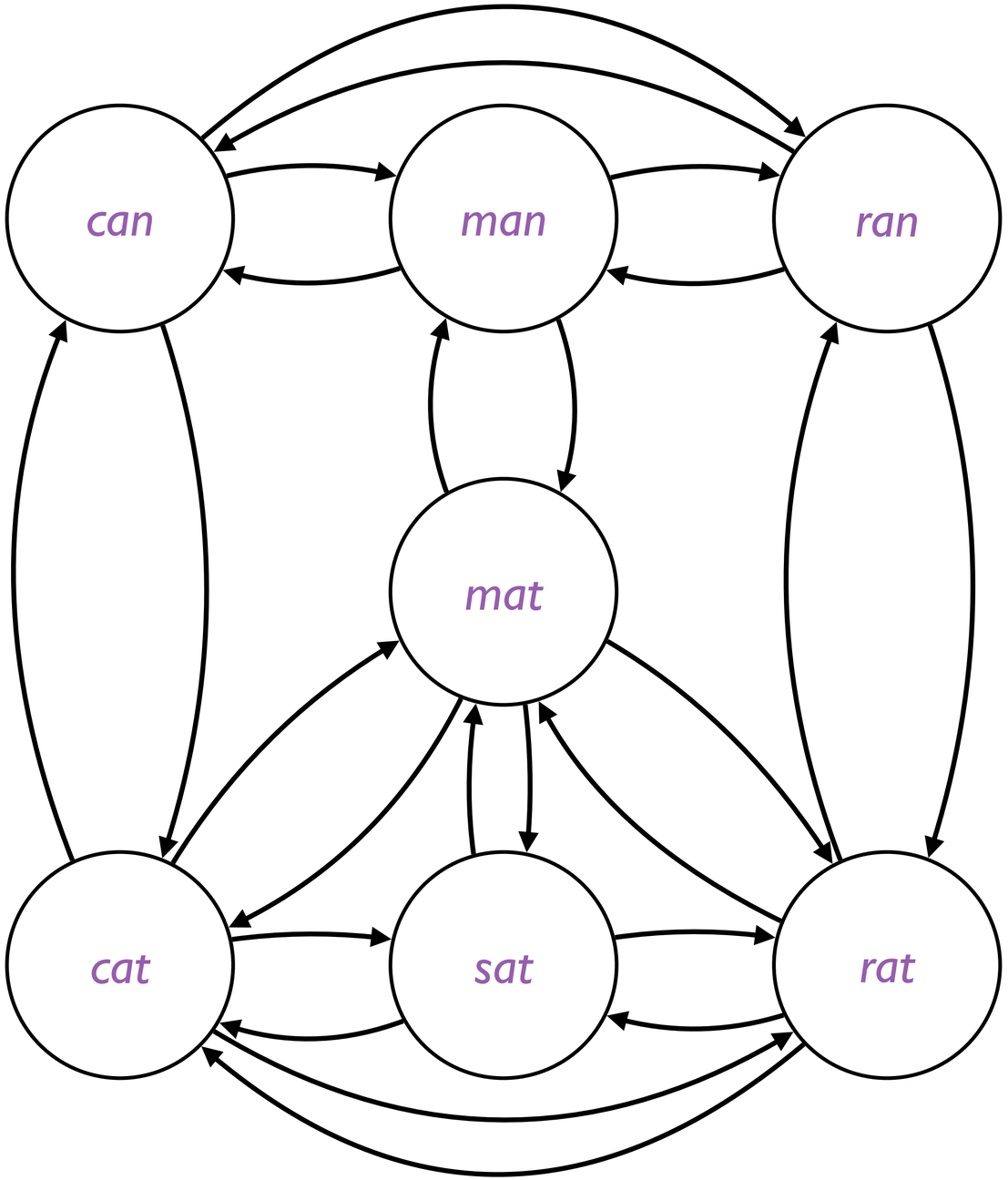


Some graphs are *directed*.



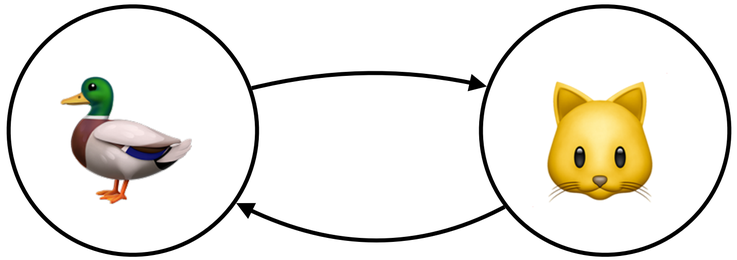
Some graphs are *undirected*.

Every undirected graph can also be represented as a directed graph, albeit with twice the edges.

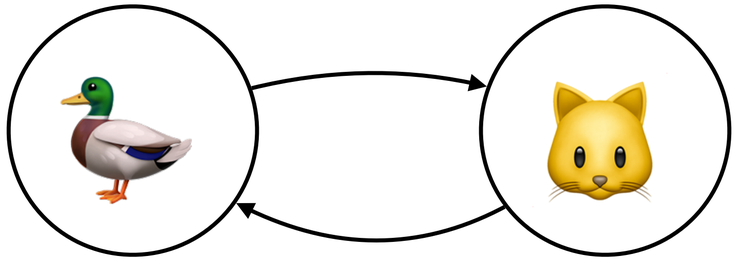

can
man
ran
mat
cat
sat
rat

How can we represent a graph?

```
data Graph:
  | vertex(name :: String, neighbors :: List<Graph>)
end
```



```
data Graph:
  | vertex(name :: String, neighbors :: List<Graph>)
end
```



```
vertex("🦆",
  [list:
    vertex("🐱",
      [list:
        vertex("🦆",
          ...
```

This breaks horribly if there are cycles in the graph.

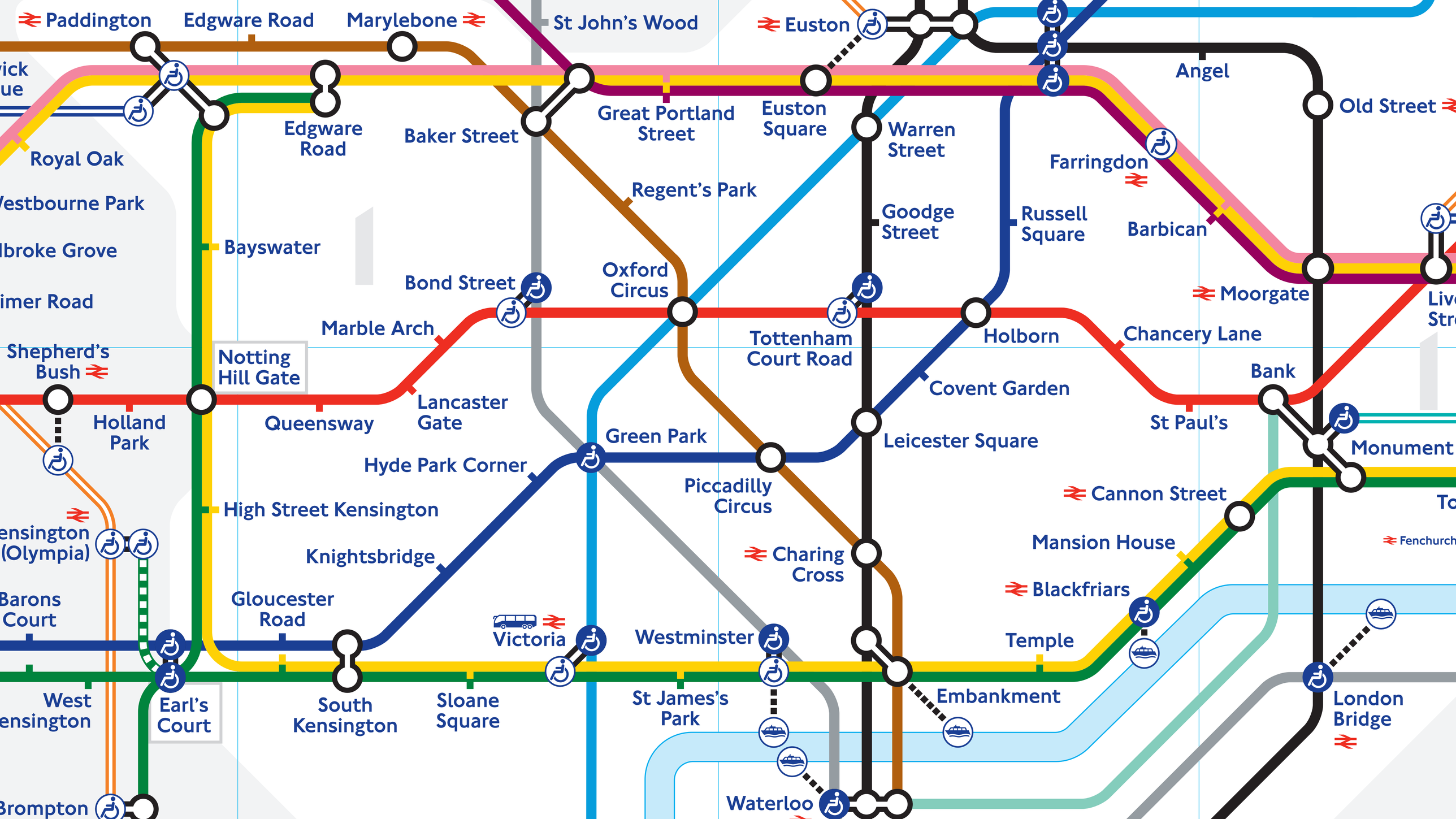
Better plan:

```
data Vertex:
  | vertex(name :: String, neighbors :: List<String>)
end
```

Now a graph is a `List<Vertex>`.

This is called an “adjacency list” representation.

Example: London Underground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Royal Oak
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Baker Street
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Warren Street
Farringdon
Regent's Park
Goodge Street
Russell Square
Barbican
Bayswater
Bond Street
Oxford Circus
Moorgate
Marble Arch
Tottenham Court Road
Holborn
Chancery Lane
Shepherd's Bush
Notting Hill Gate
Bank
Holland Park
Queensway
Lancaster Gate
Covent Garden
St Paul's
Green Park
Leicester Square
Monument
Hyde Park Corner
Piccadilly Circus
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High Street Kensington
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Charing Cross
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Temple
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Earl's Court
South Kensington
Sloane Square
St James's Park
Embankment
London Bridge
Waterloo


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Brompton


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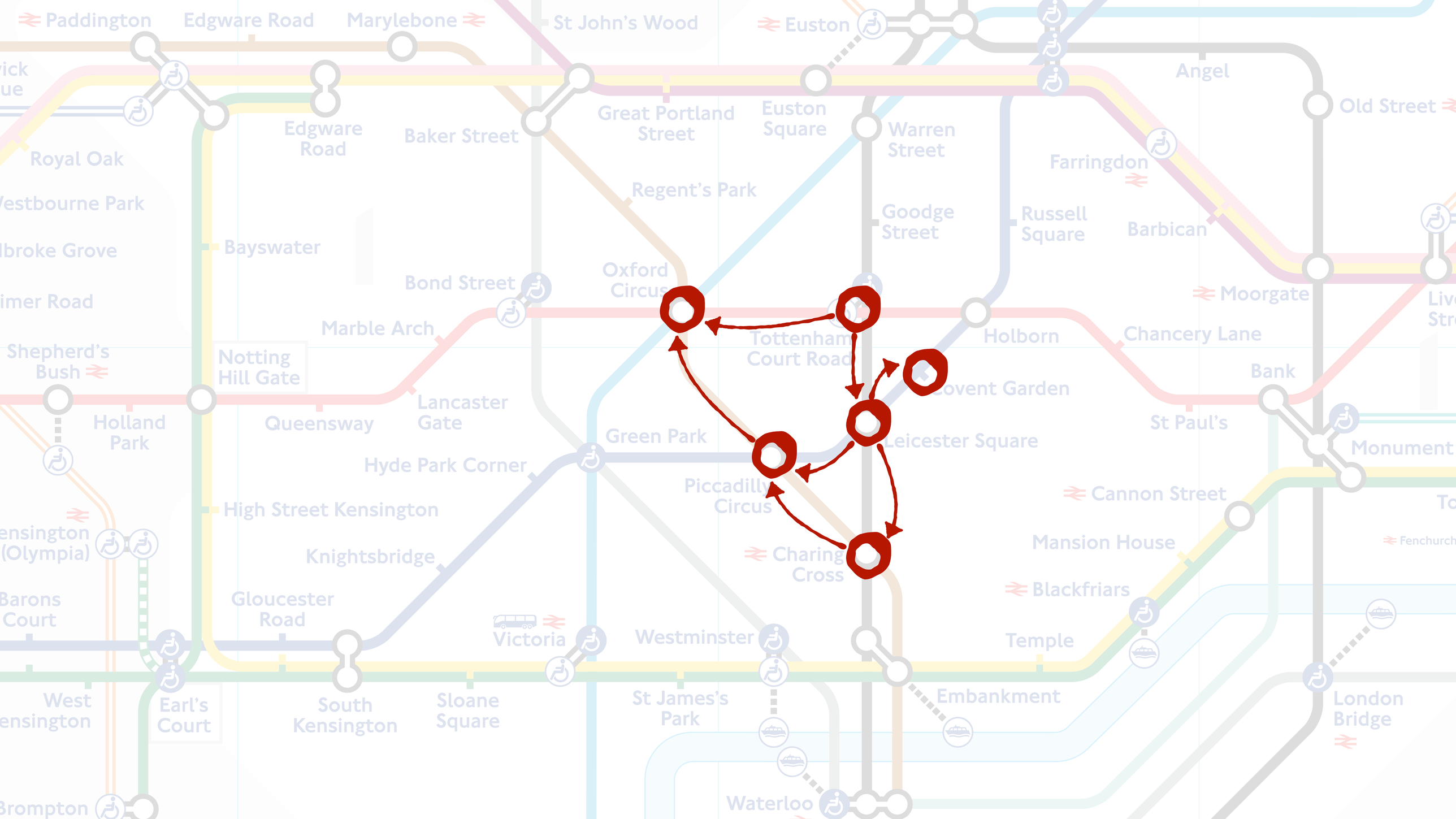
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This isn't a complete model. We could keep adding directional edges – and, in fact, all of the stations that are connected would eventually have edges going both ways.

Exercise

Let's use a reactor to simulate a traveller riding the subway, following the connections in the graph.

Exercise

Let's use a reactor to simulate a traveller riding the subway, following the connections in the graph.

Starter code:

`tinyurl.com/101-2024-02-29-starter`

Code:

tinyurl.com/101-2024-02-29

Challenge exercise

Update the simulation to allow any number of travellers at the same time.

Code:

tinyurl.com/101-2024-02-29-rush-hour

Acknowledgments

This lecture incorporates material from:

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Laney Strange, Northeastern University