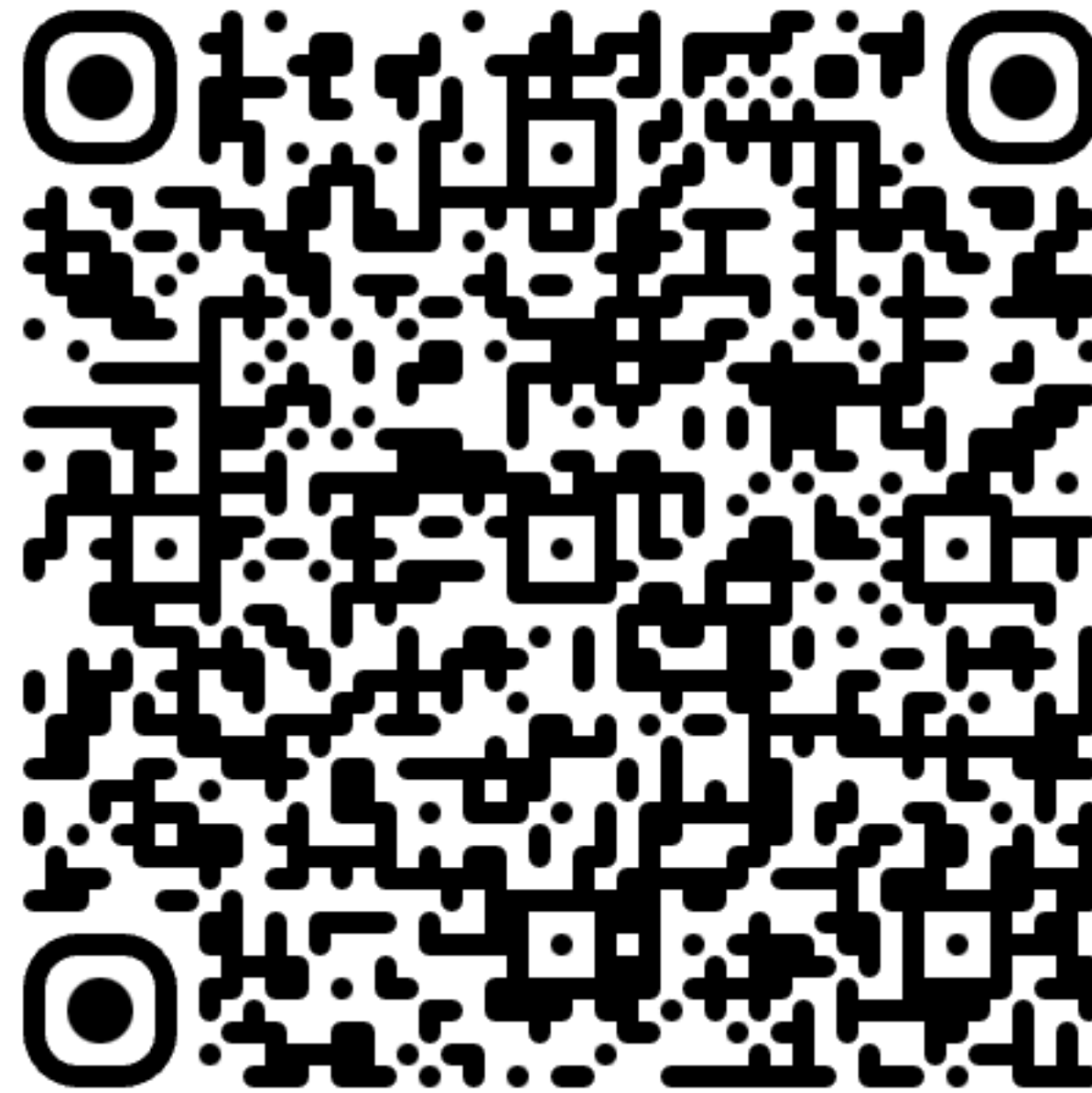


Coding for Economists

Advanced Session 2

Jian Cao
2 May 2025

Module Files



[Google Drive Folder](#)

Outline

Outline

- Neural Networks

Outline

- Neural Networks
- Use LSTM for Time Series Analysis

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- Neural Networks
- Use LSTM for Time Series Analysis
- Use GNN for Network Analysis

Neural Networks

Neural Networks

- Machine learning methods that mimic how **neurons** work.

Neural Networks

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- Good at picking up rules/patterns that **cannot be manually programmed**.

Neural Networks

- Machine learning methods that mimic how **neurons** work.
- Good at picking up rules/patterns that **cannot be manually programmed**.
- Only bounded by **data** and **computing power**.

Example: Number Recognition

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1	2	3
4	5	6
7	8	9
10	11	12

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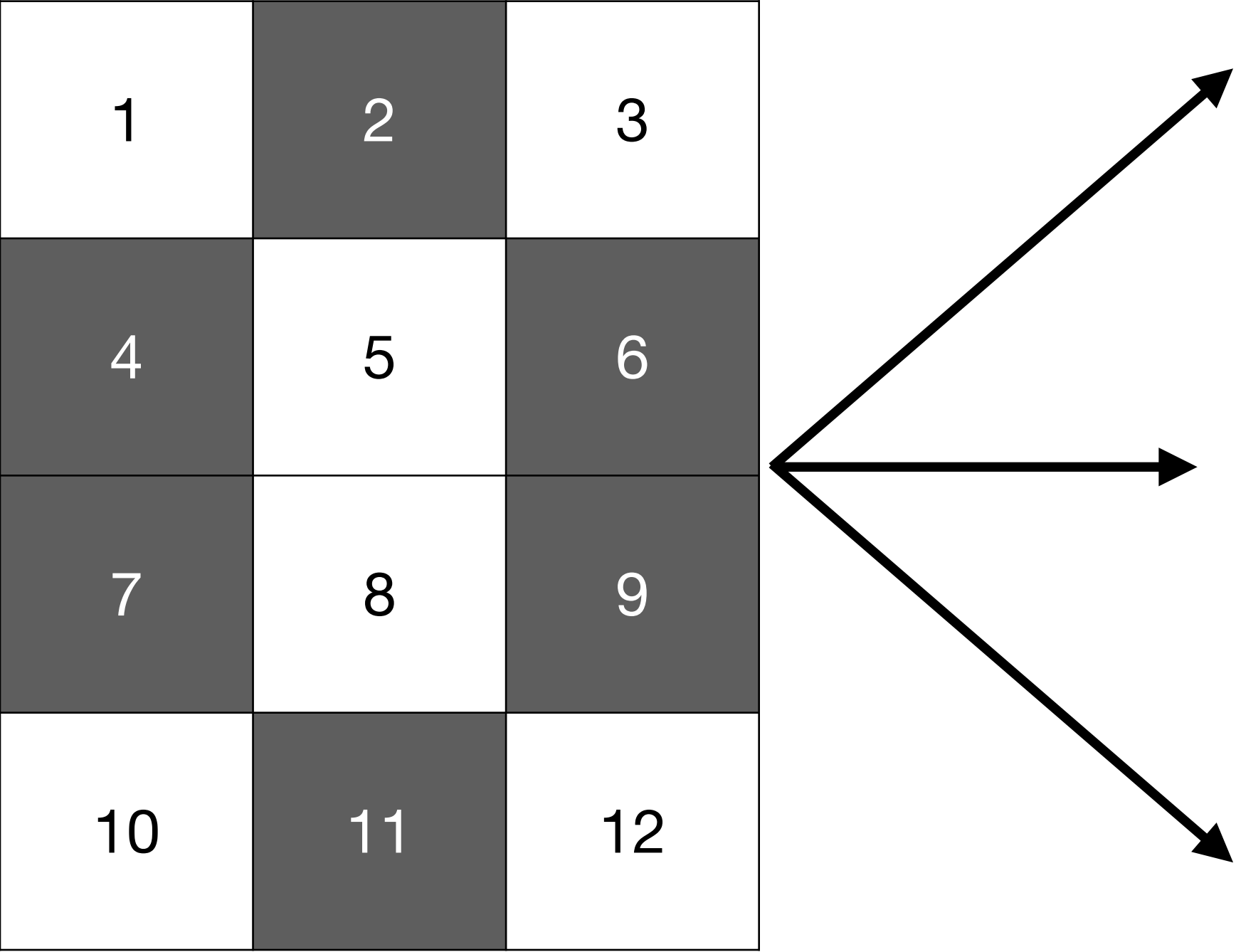
1	2	3
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Example: Number Recognition

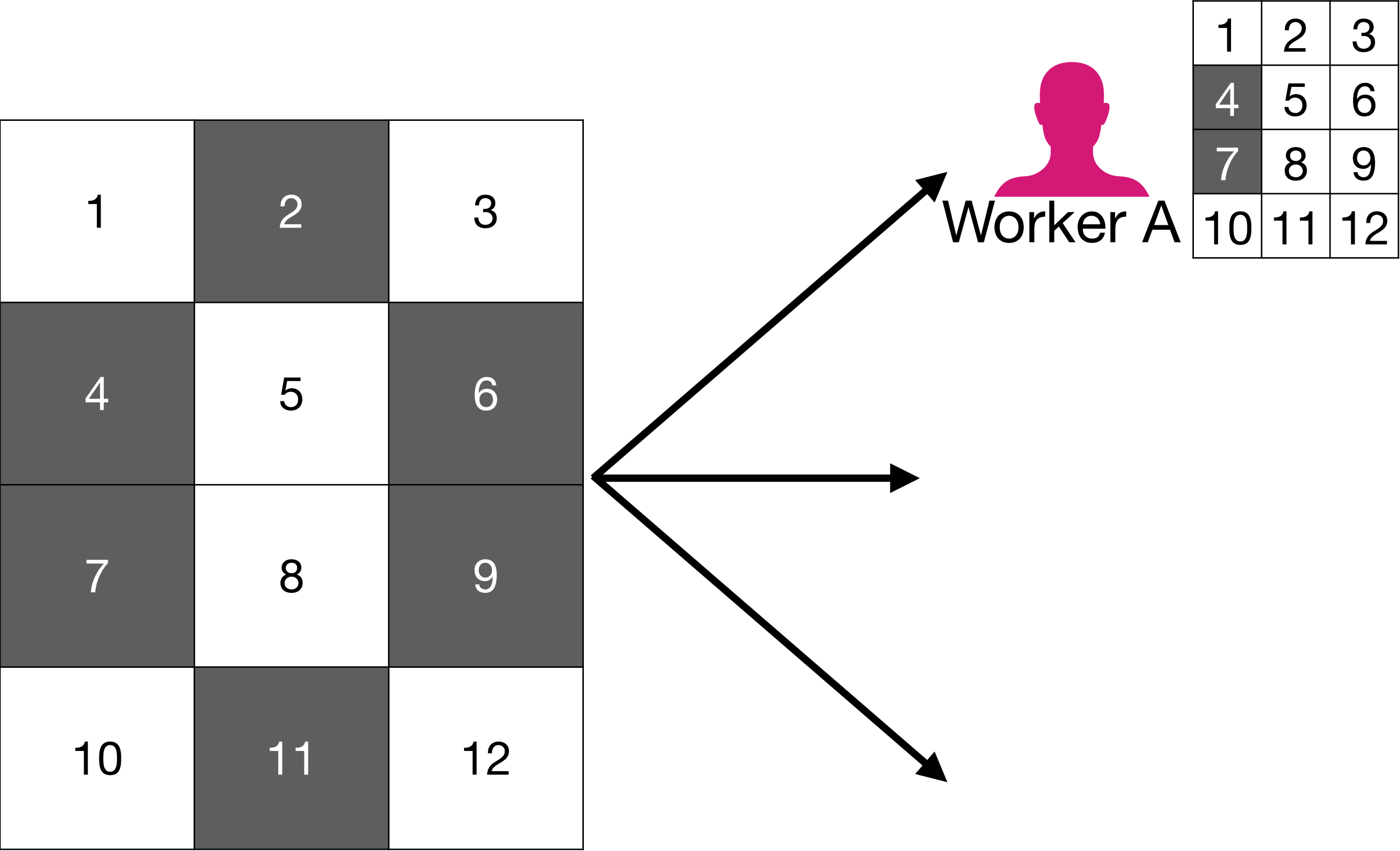
Example: Number Recognition

1	2	3
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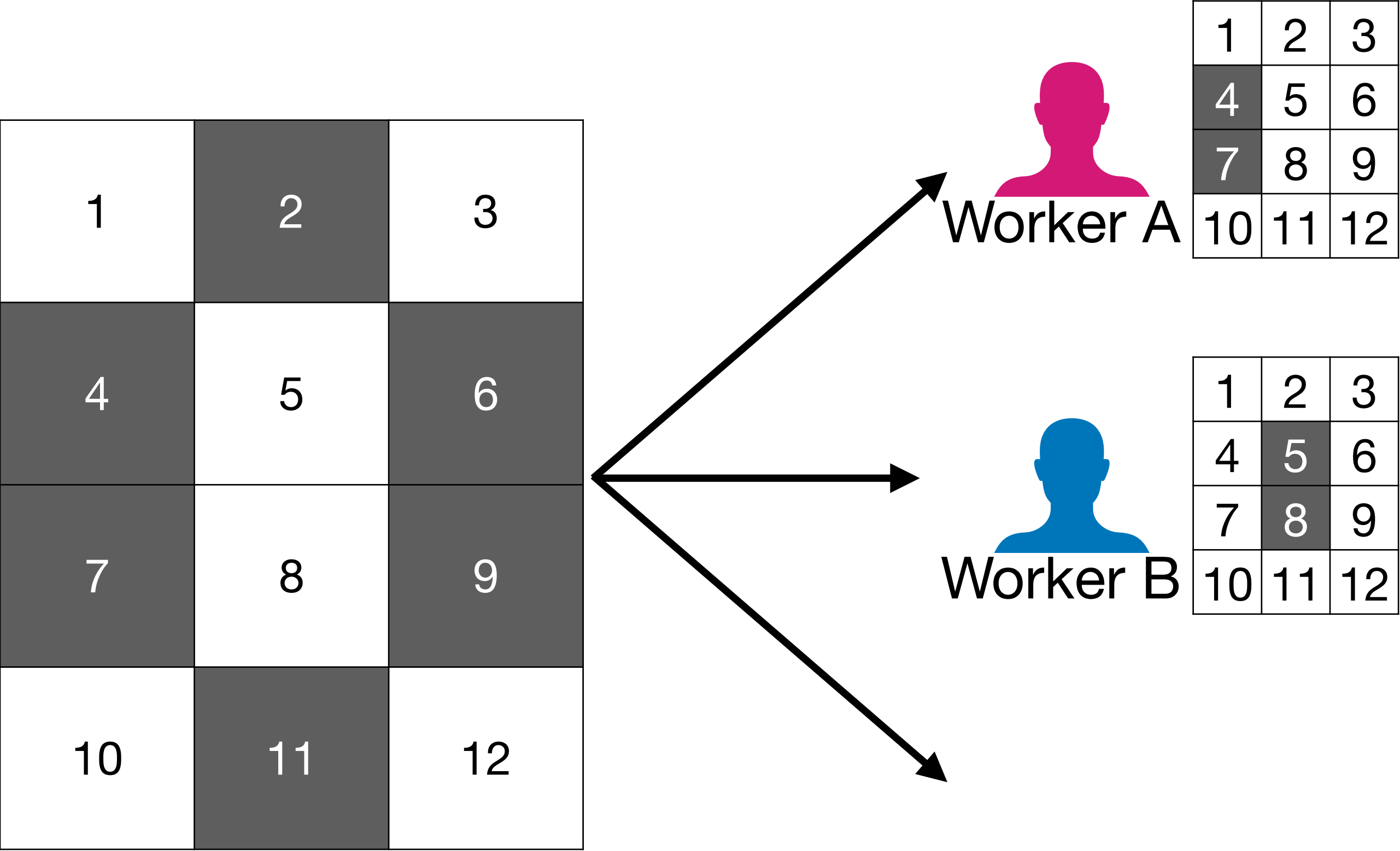
Example: Number Recognition



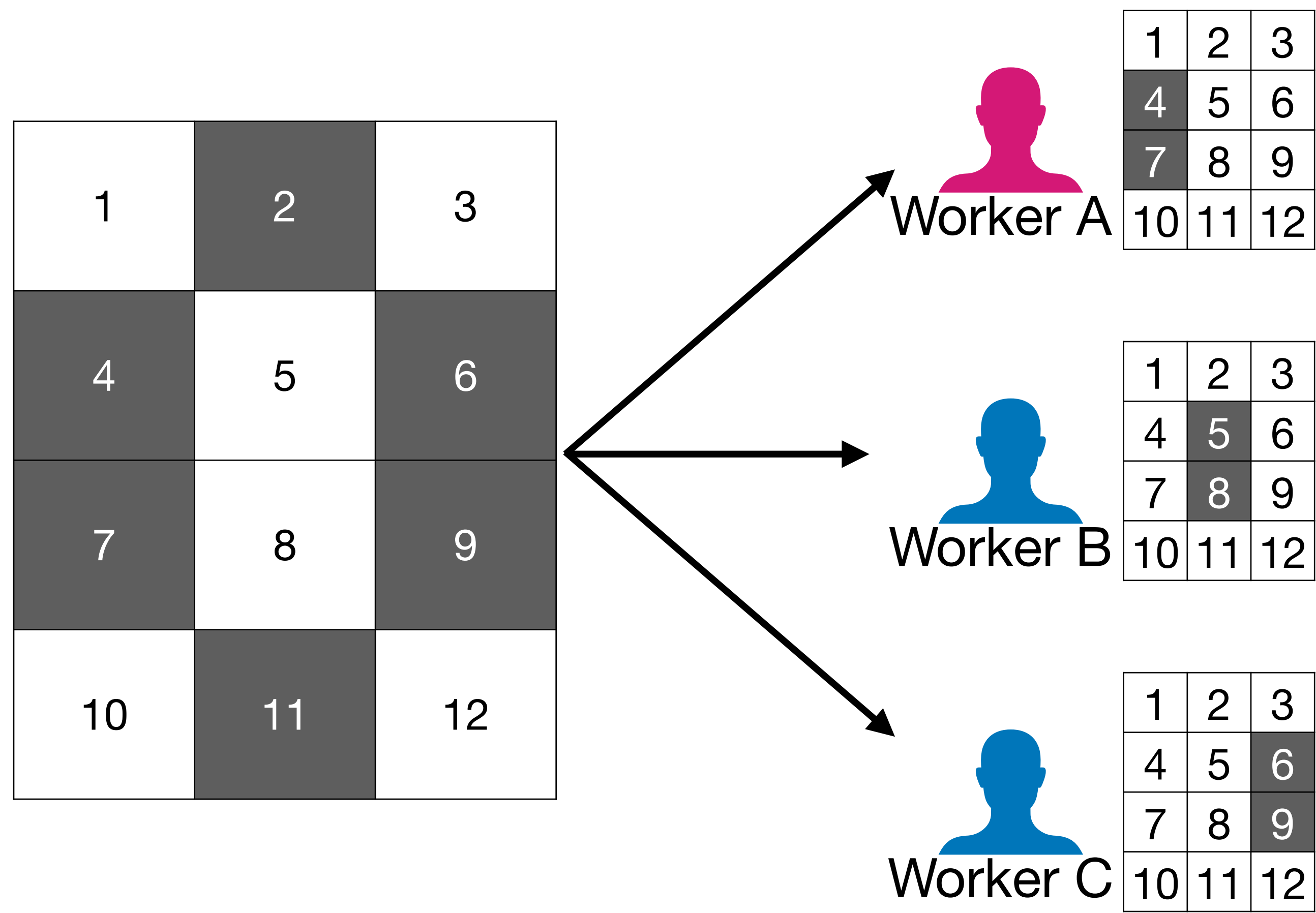
Example: Number Recognition



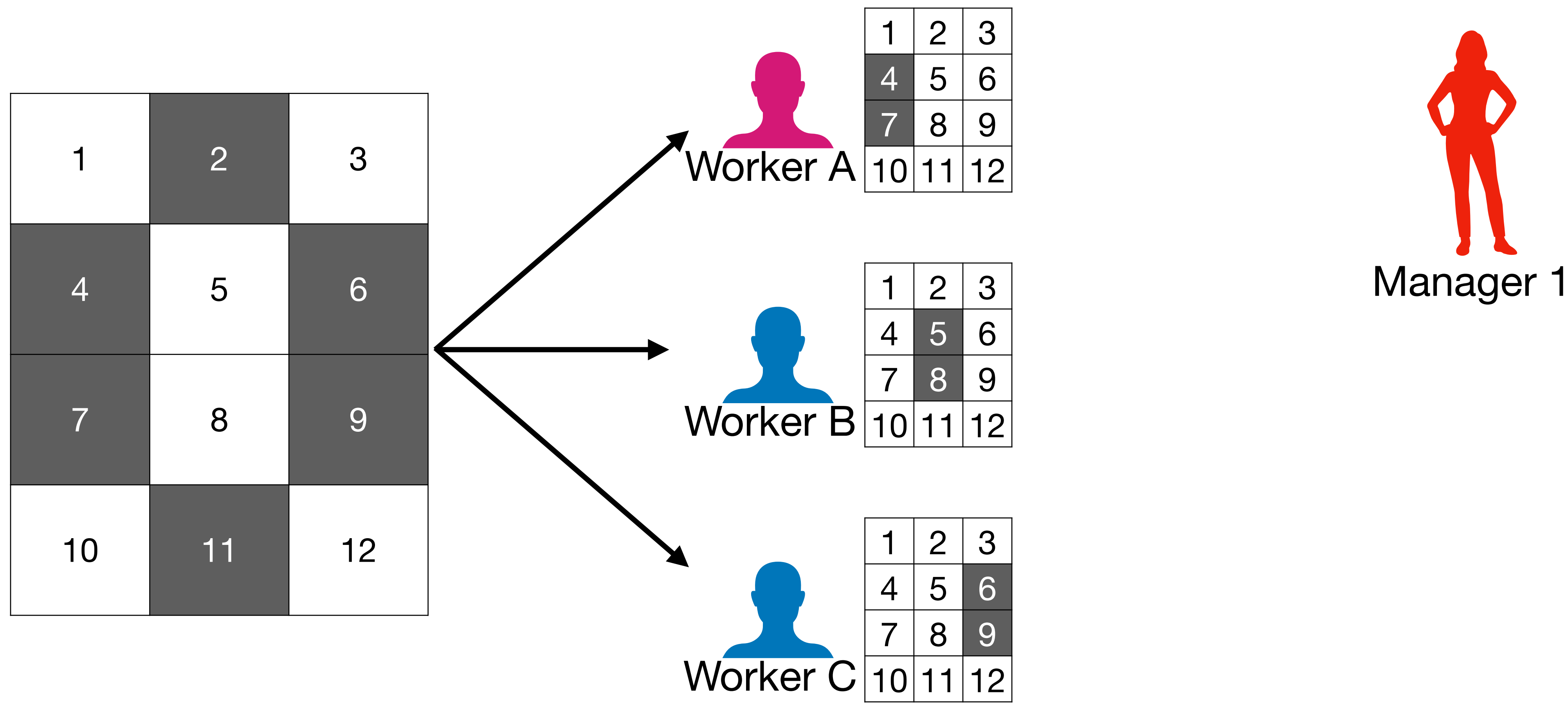
Example: Number Recognition



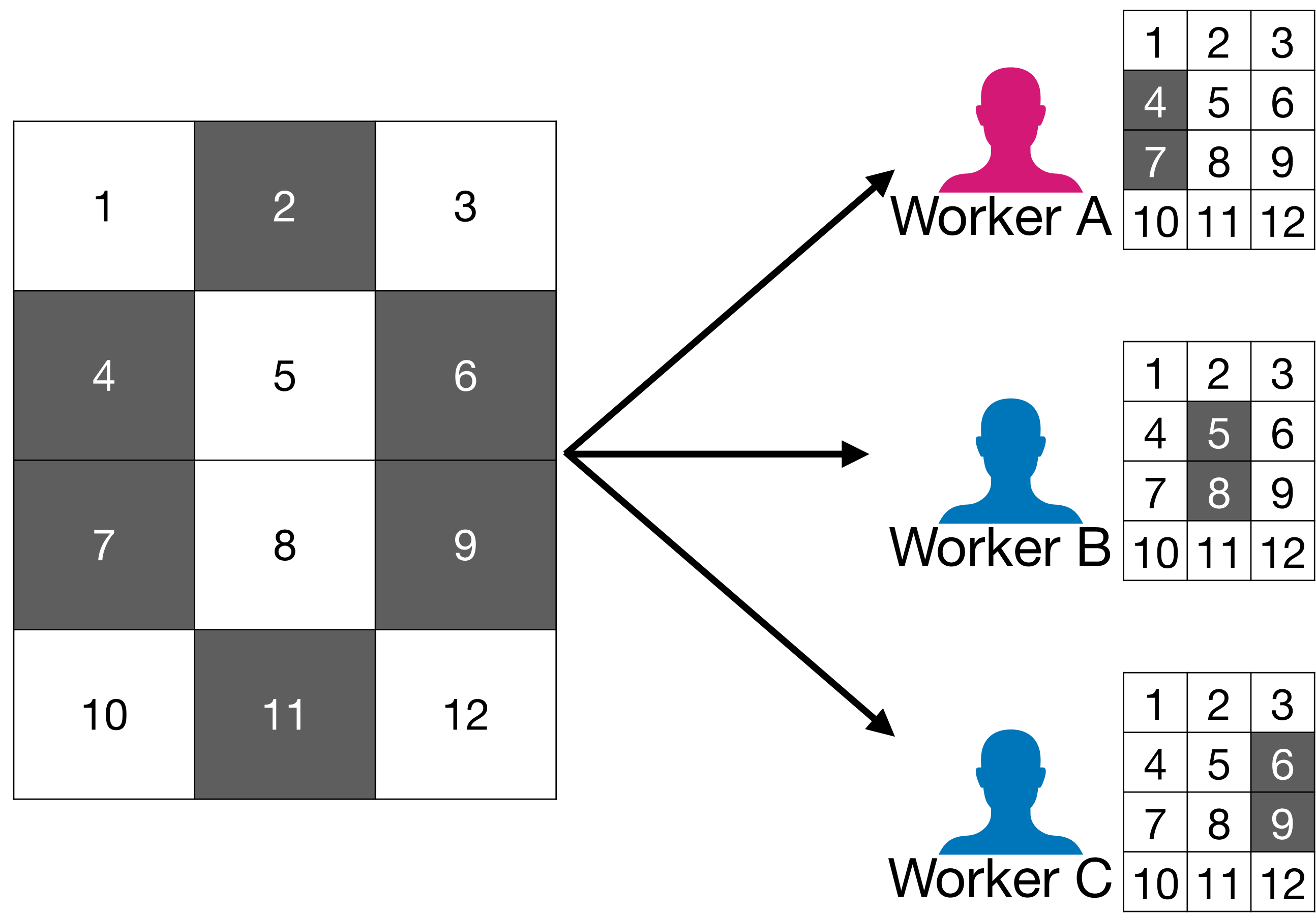
Example: Number Recognition



Example: Number Recognition

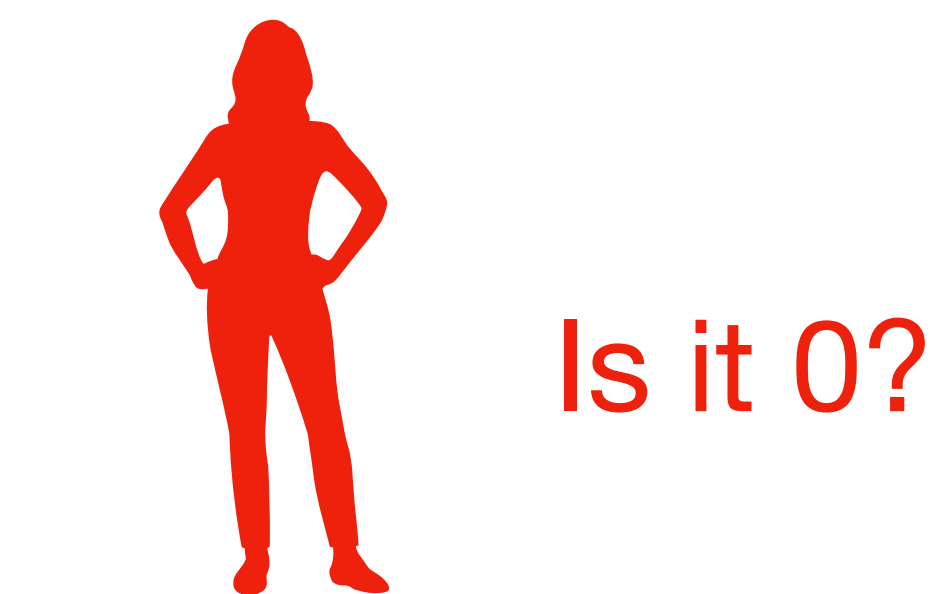
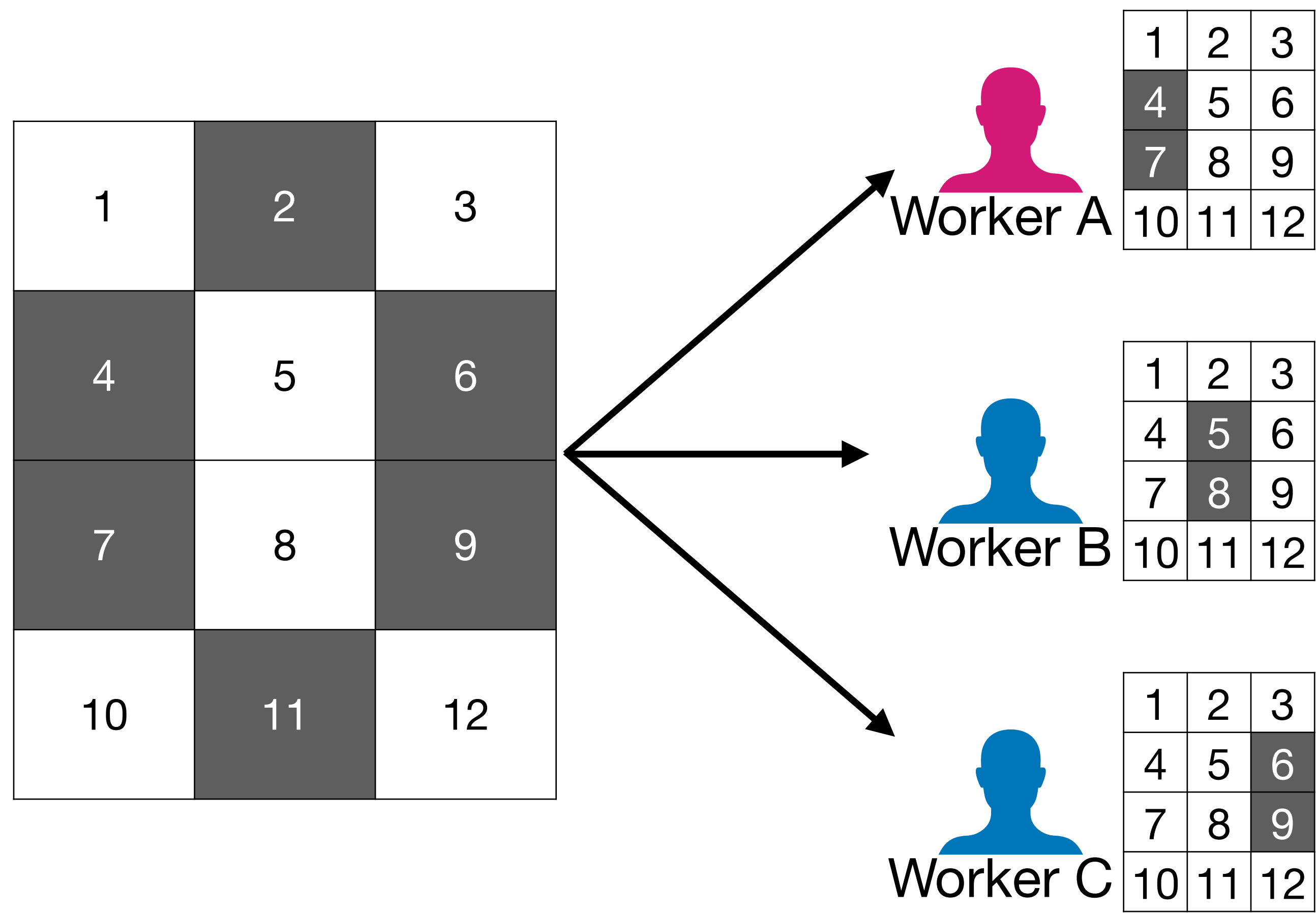


Example: Number Recognition

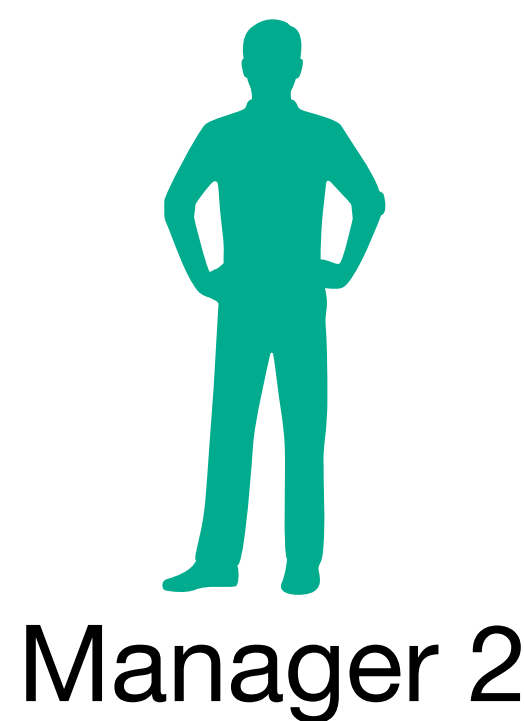



Manager 1
Is it 0?

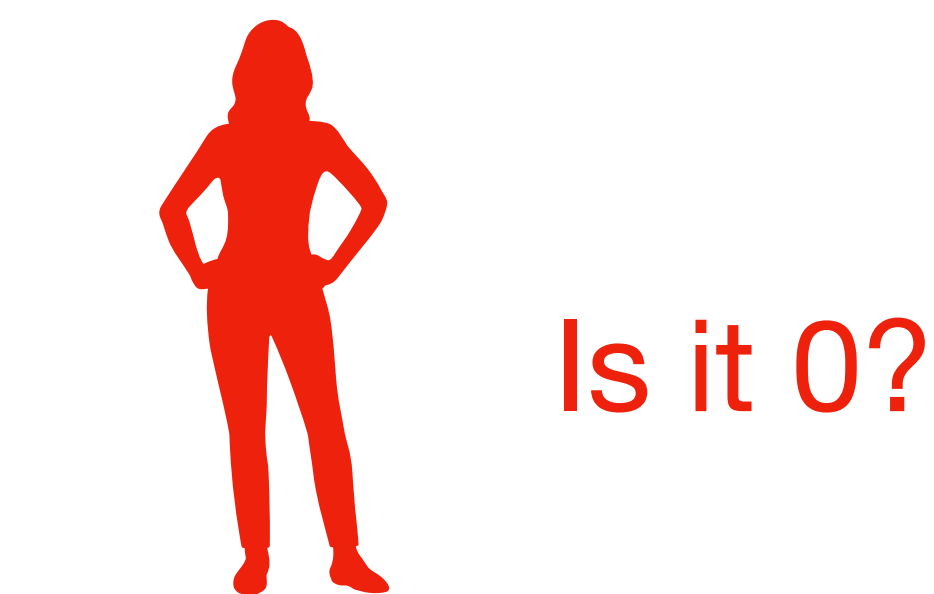
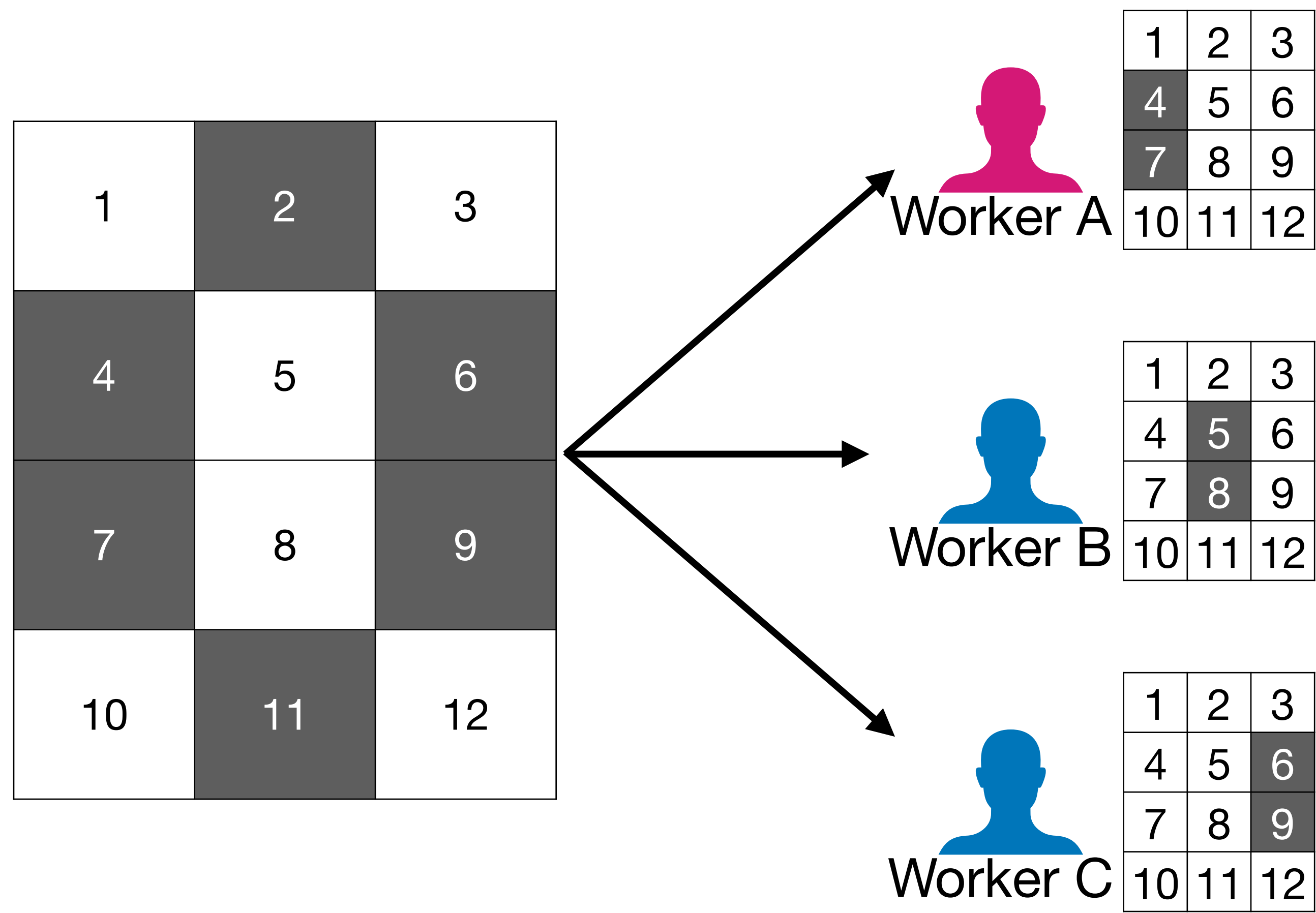
Example: Number Recognition



Manager 1



Example: Number Recognition

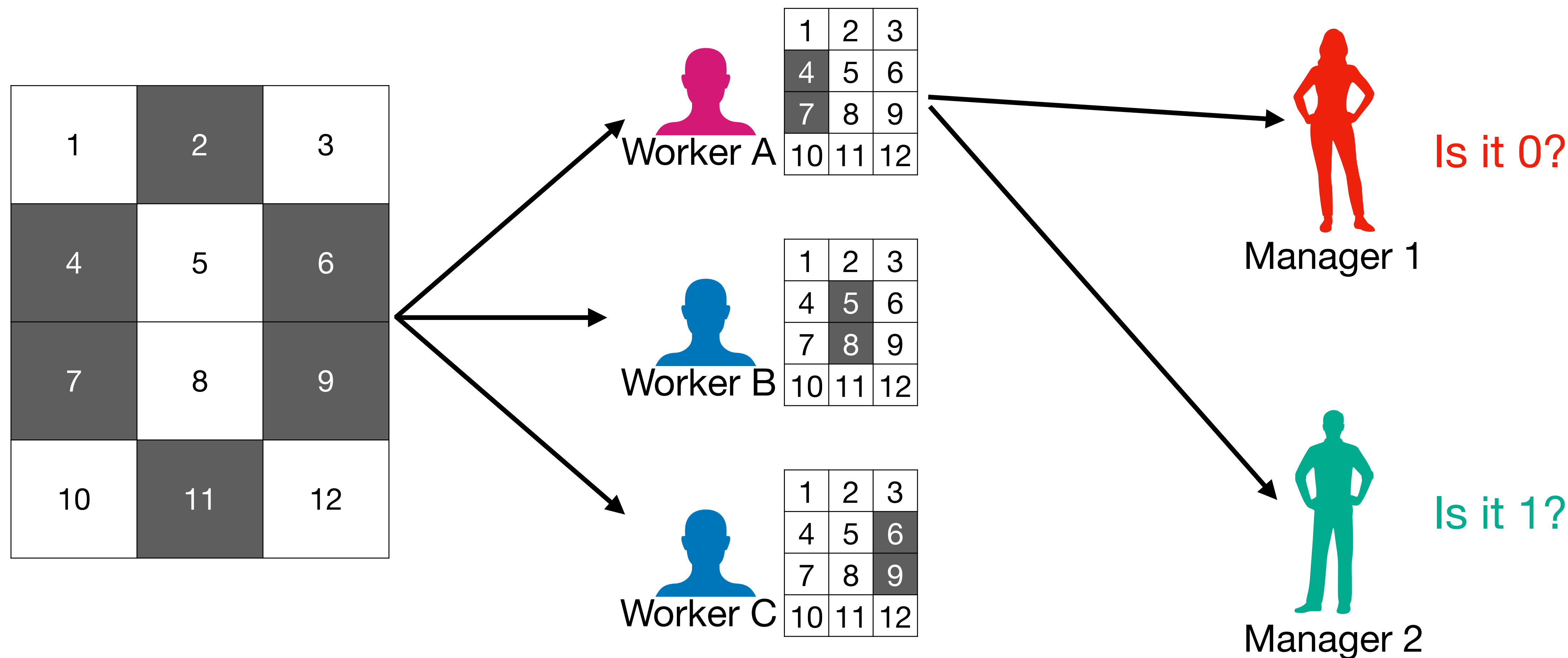


Is it 0?

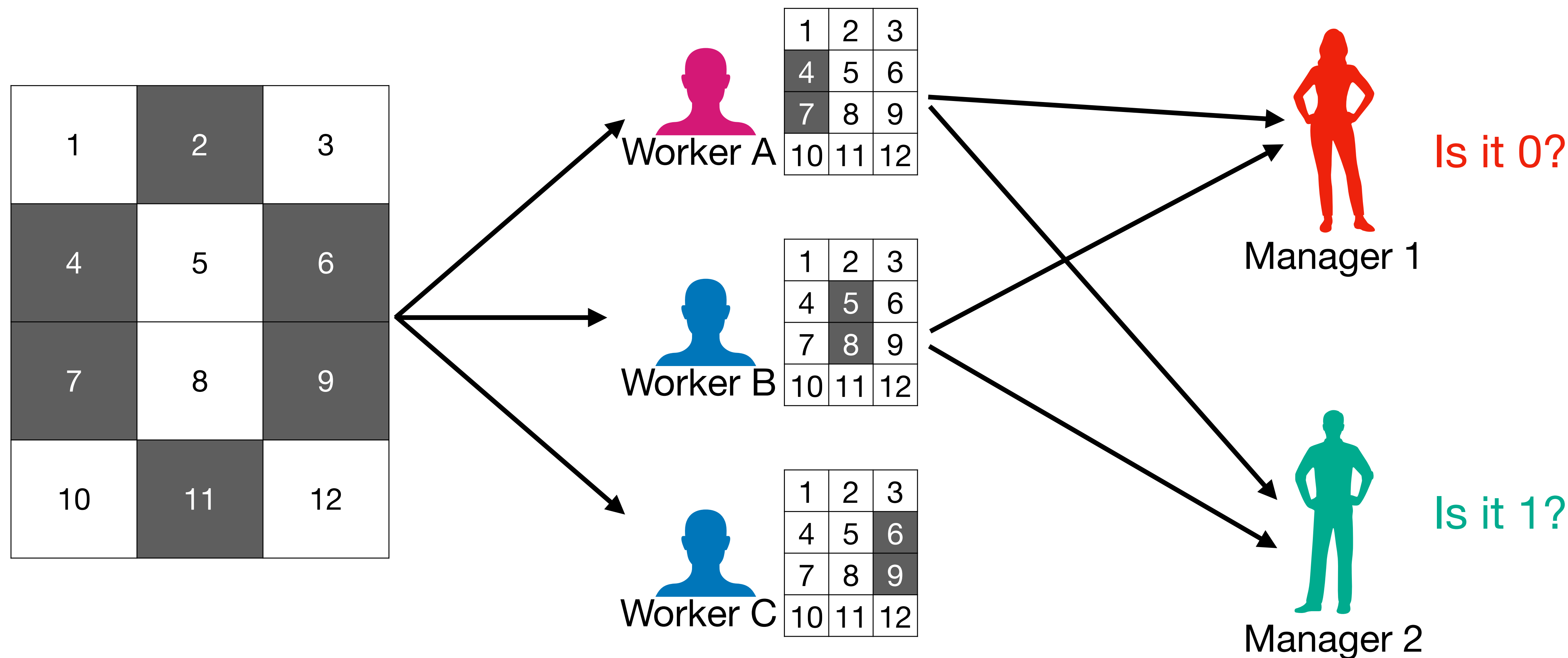


Is it 1?

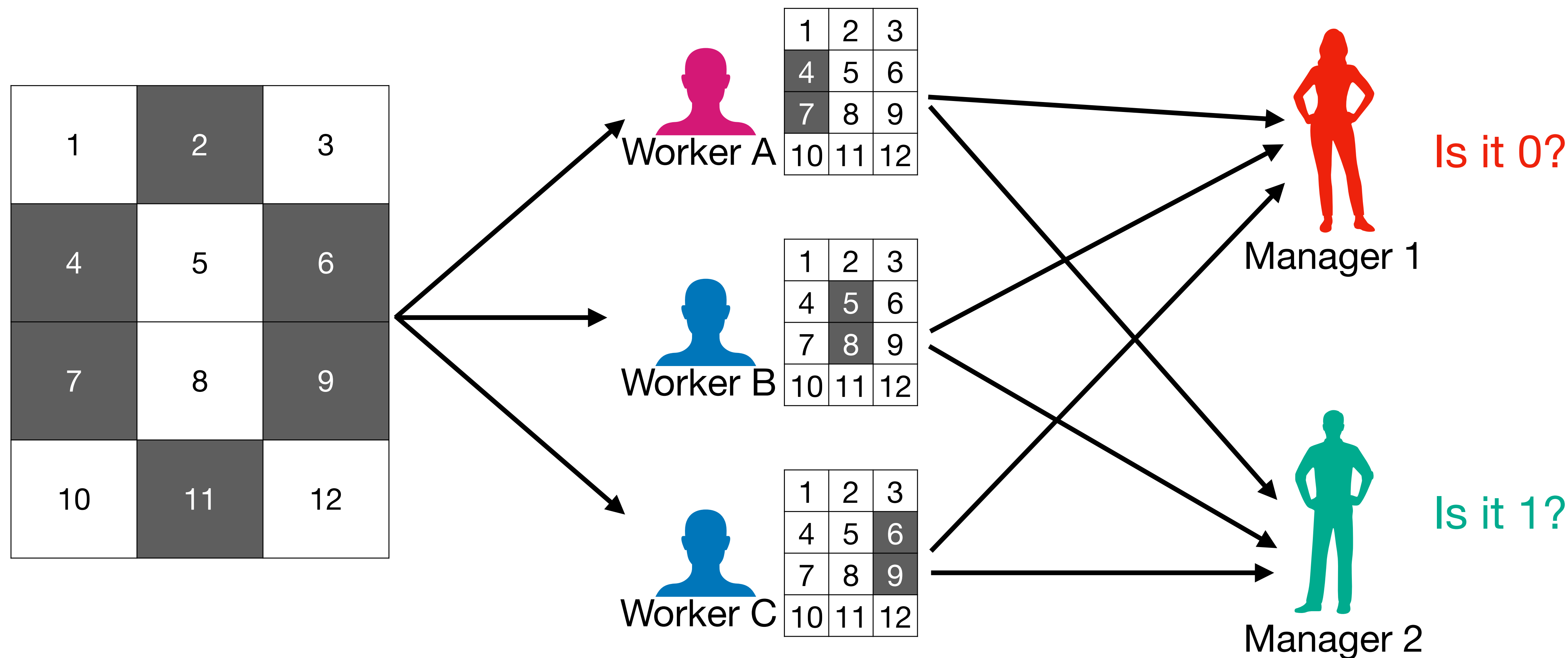
Example: Number Recognition



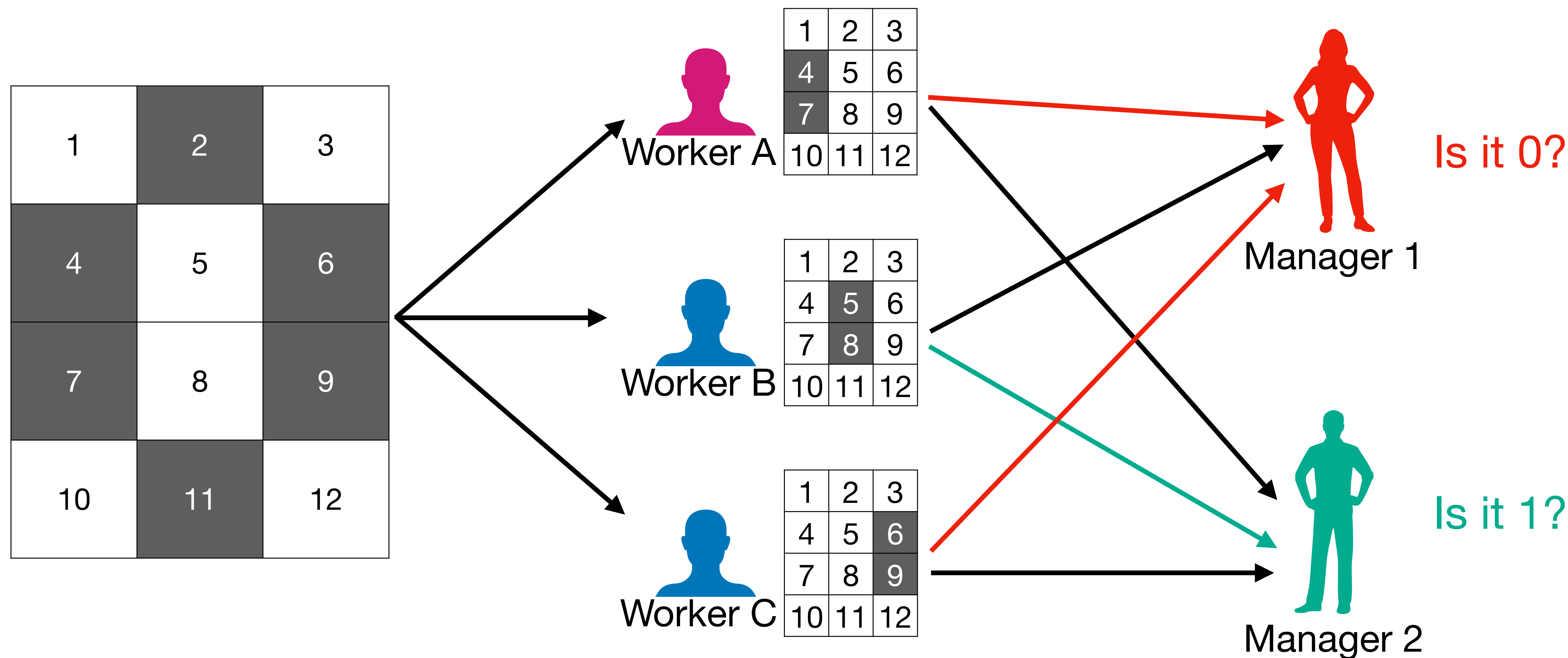
Example: Number Recognition



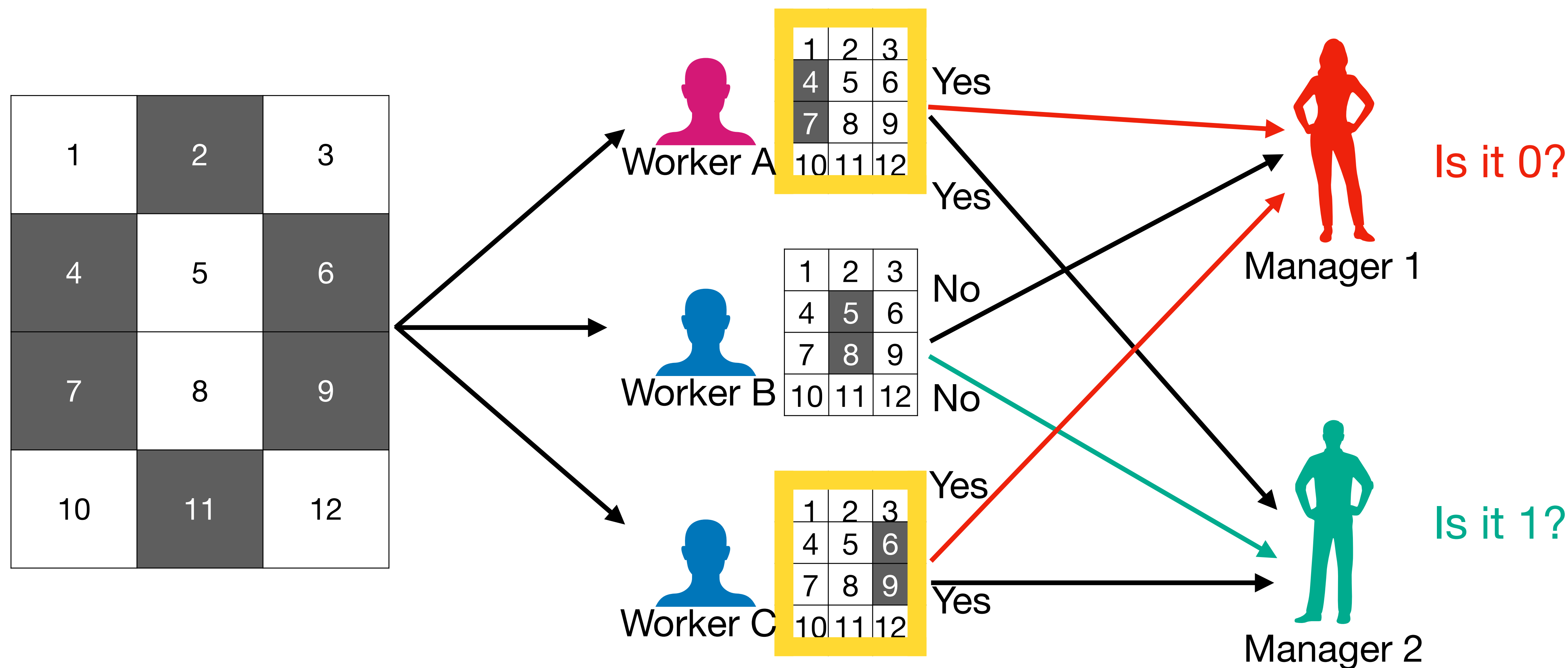
Example: Number Recognition



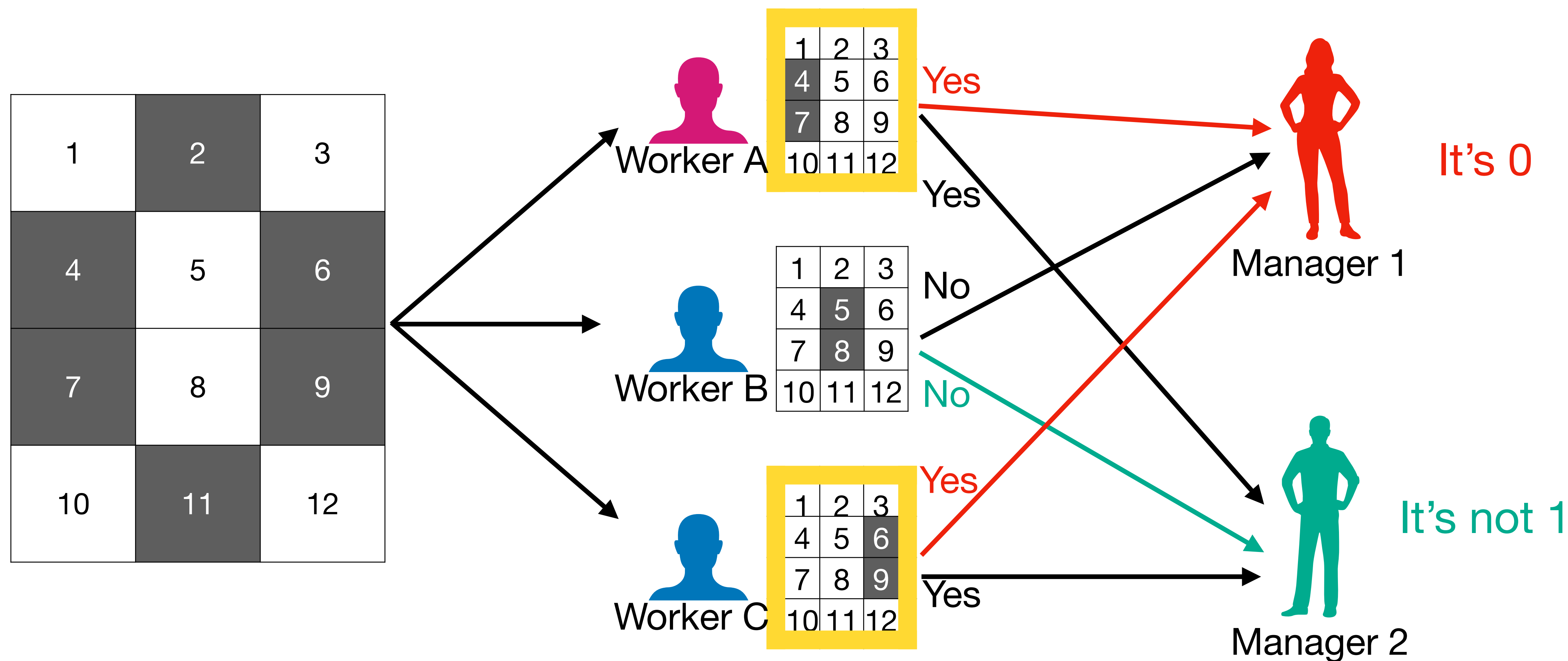
Example: Number Recognition



Example: Number Recognition

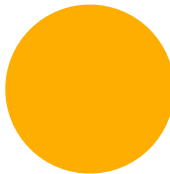
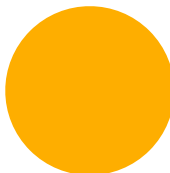
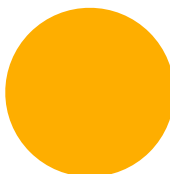


Example: Number Recognition



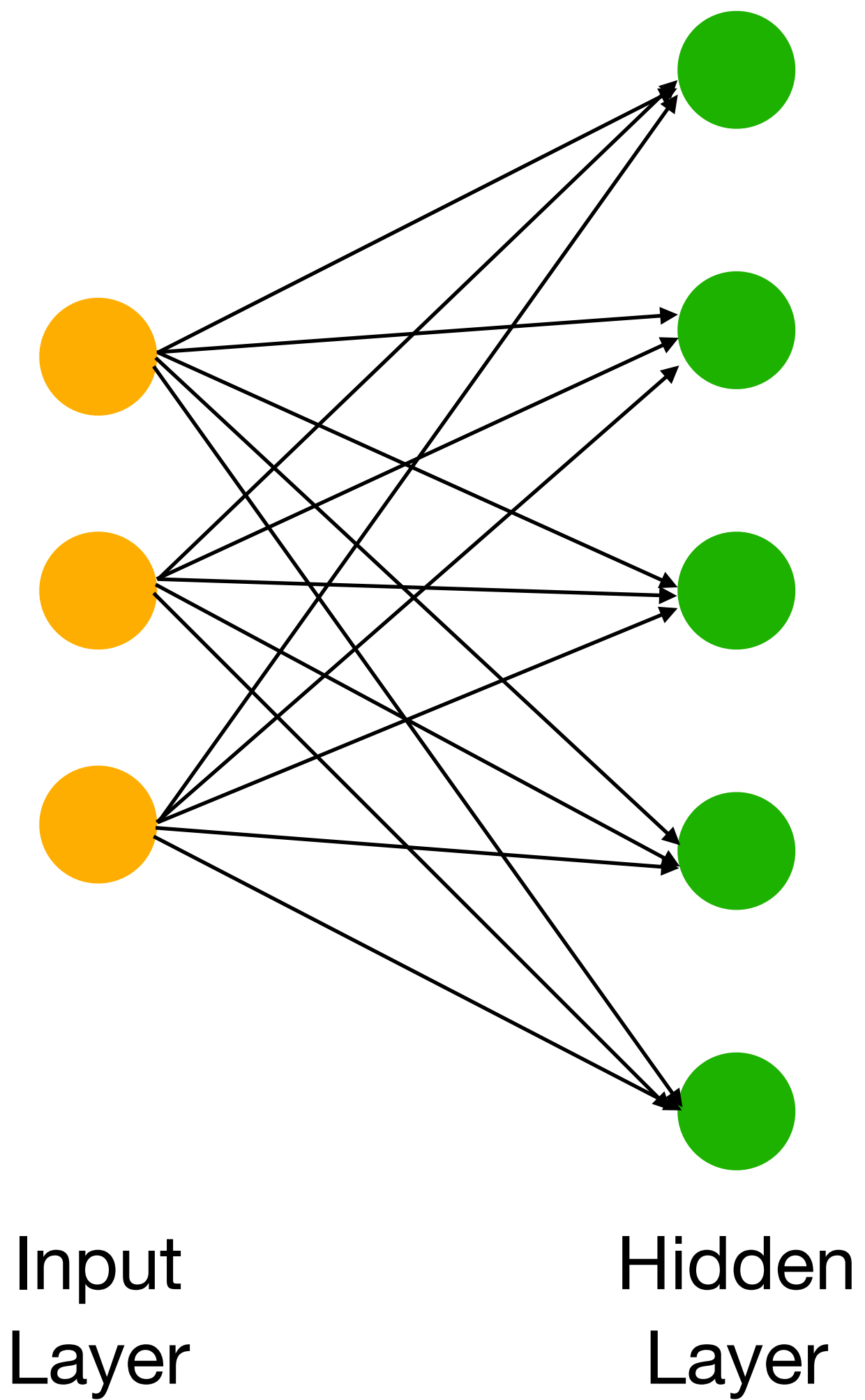
Neural Network

Neural Network

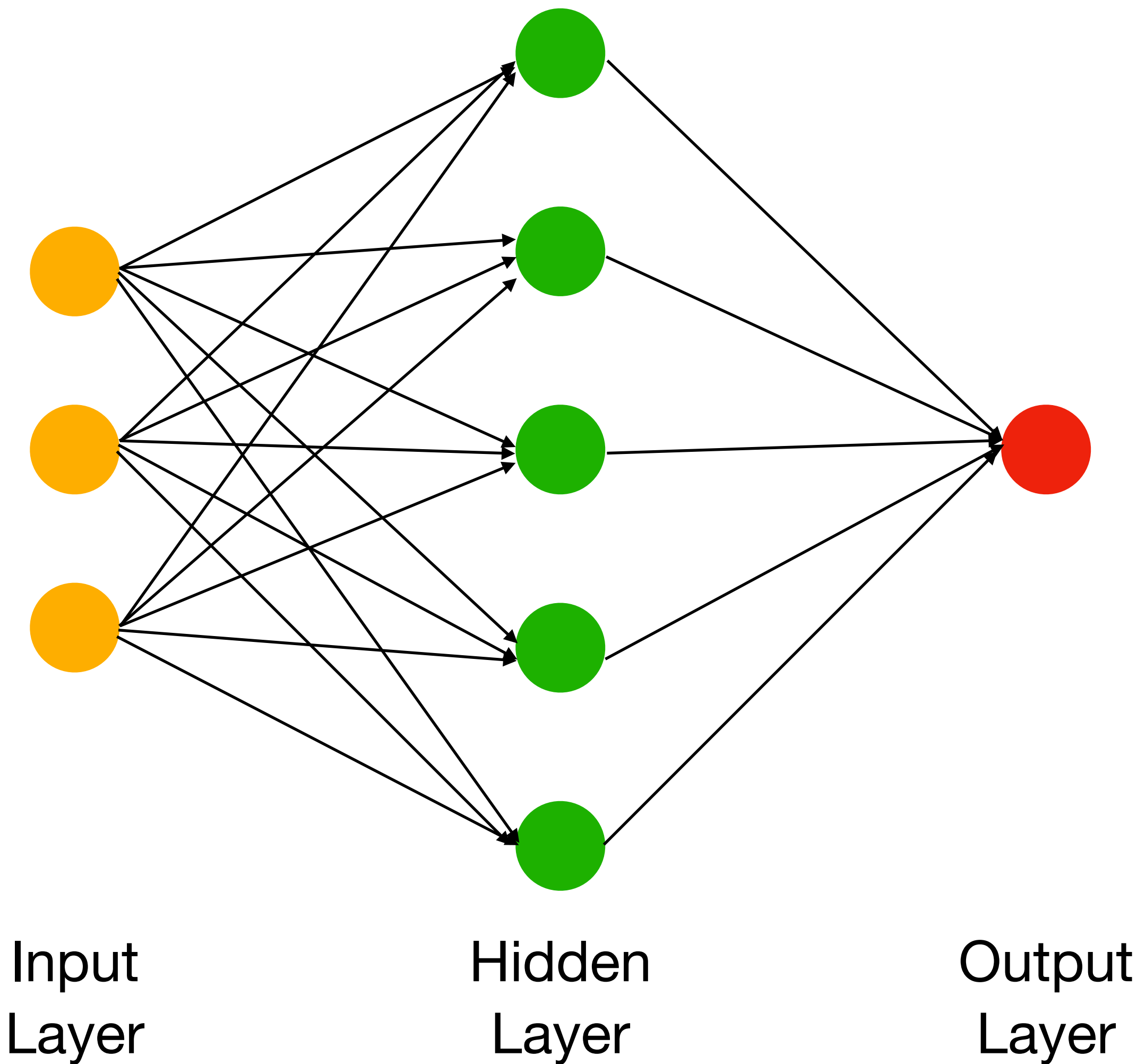


Input
Layer

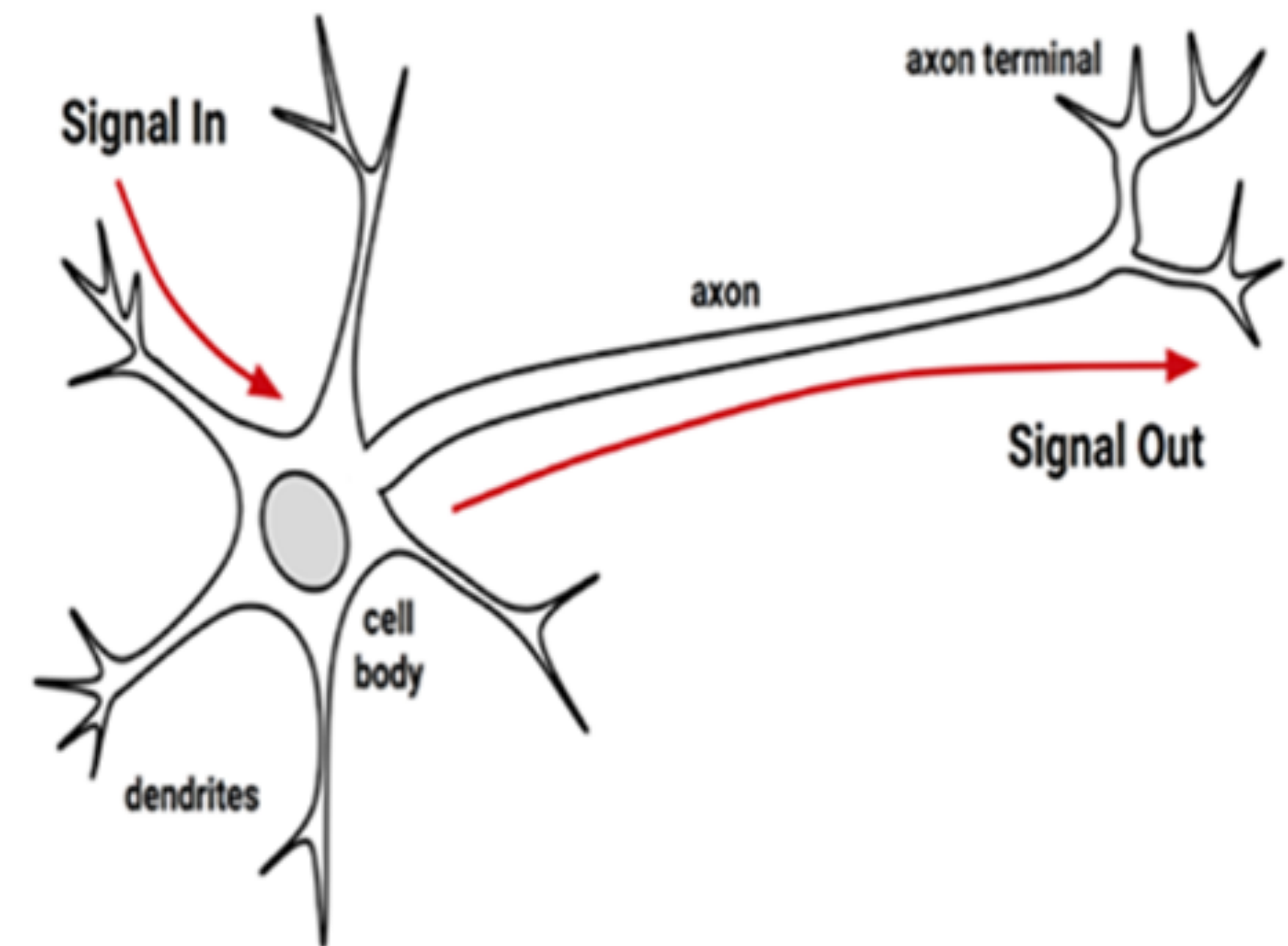
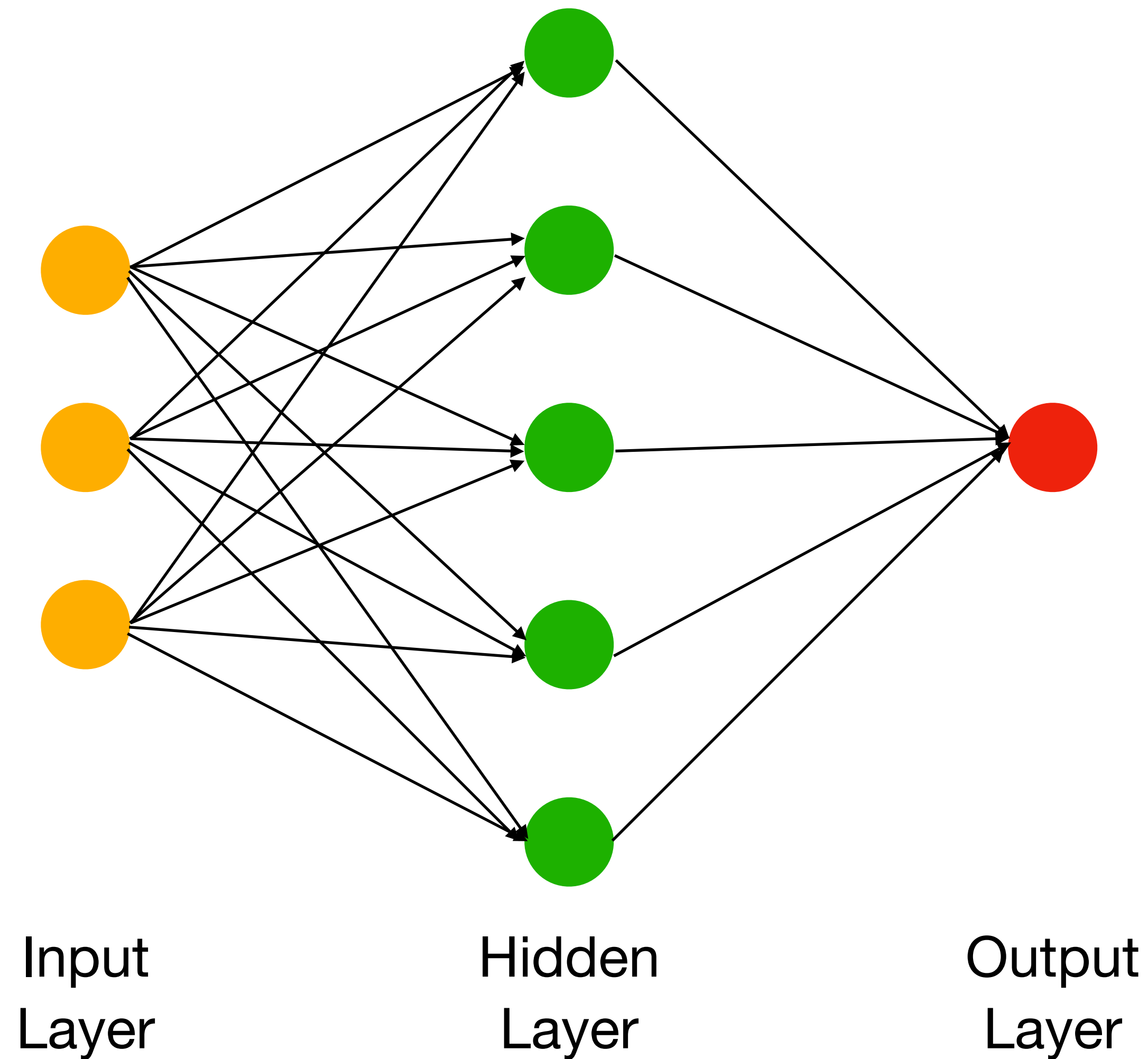
Neural Network



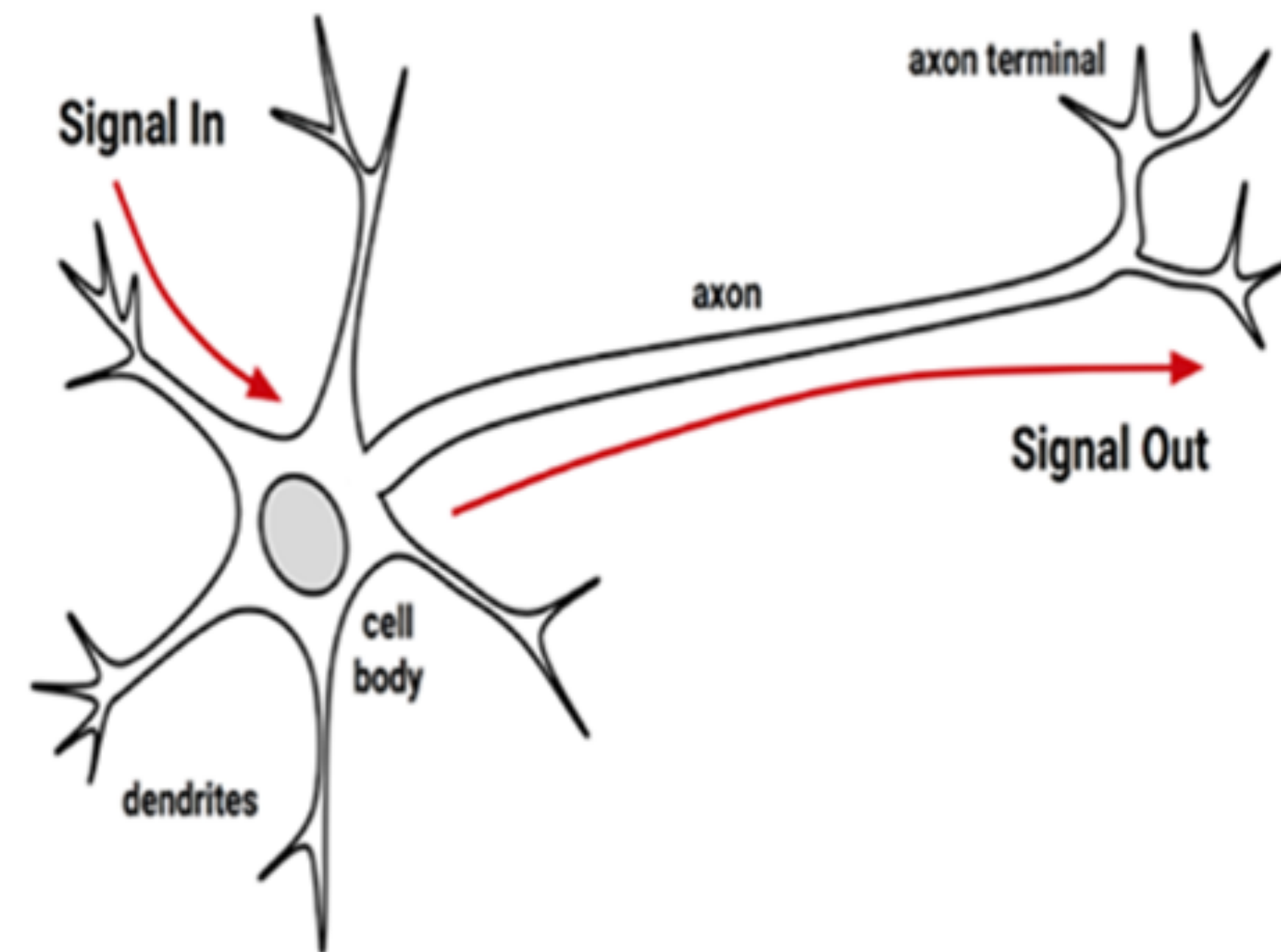
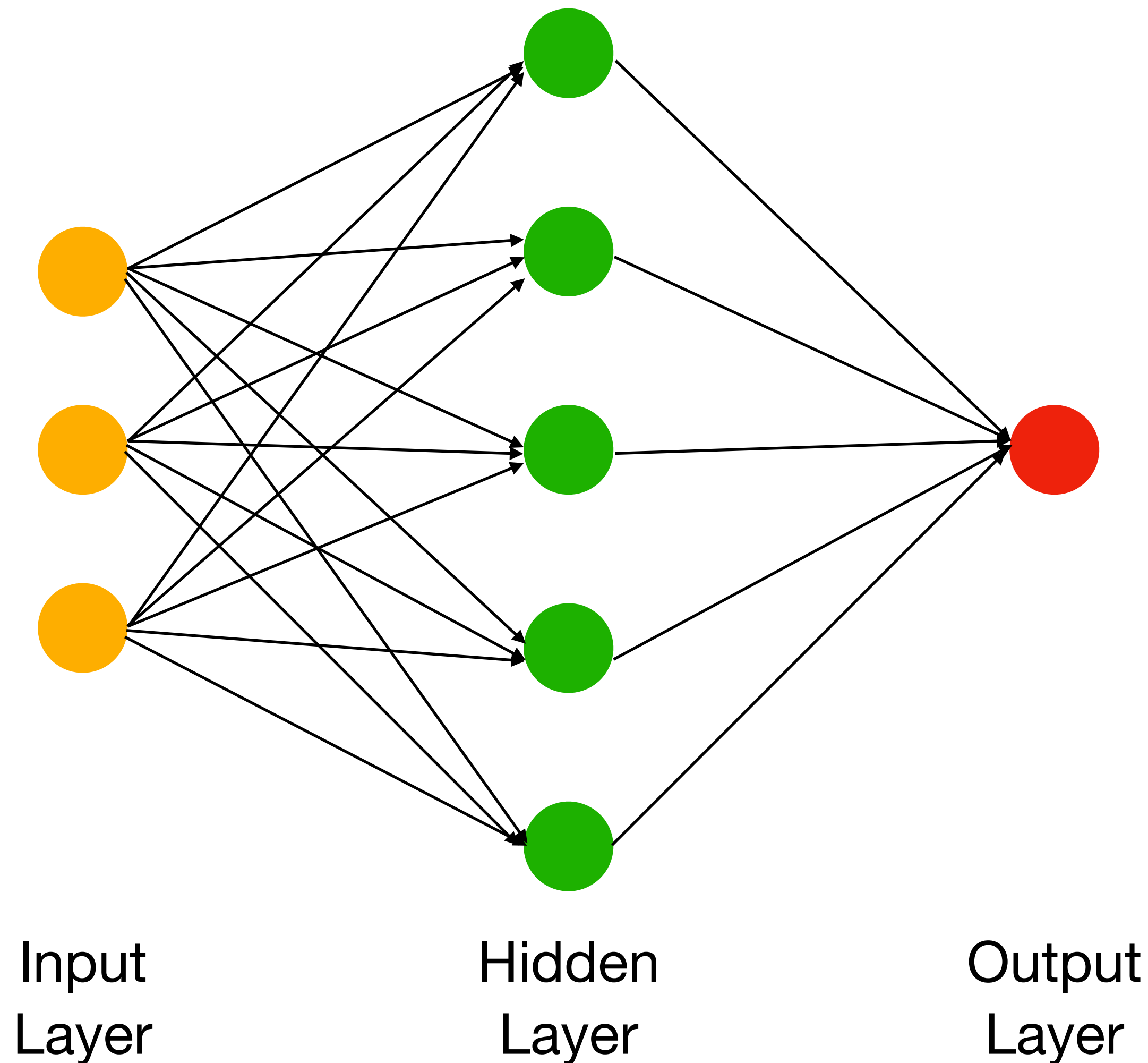
Neural Network



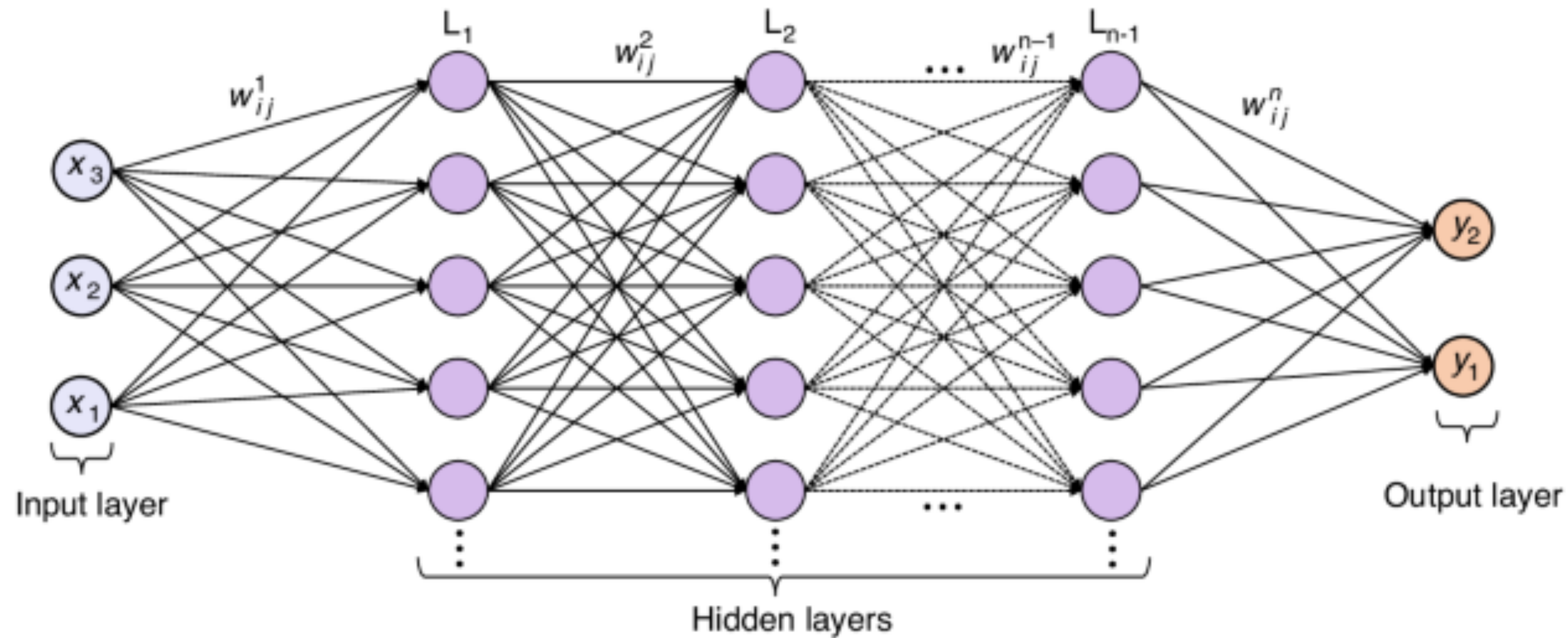
Neural Network



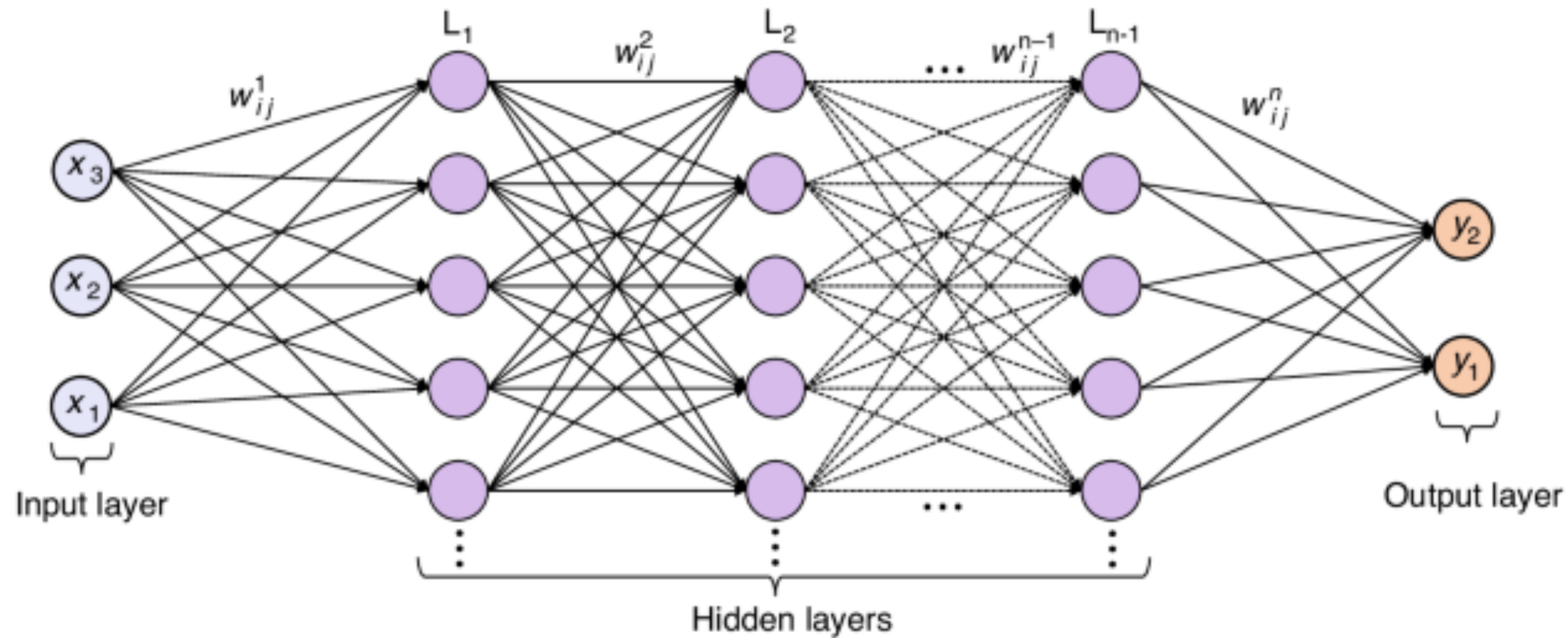
Neural Network



Fully Connected Network (MLP)

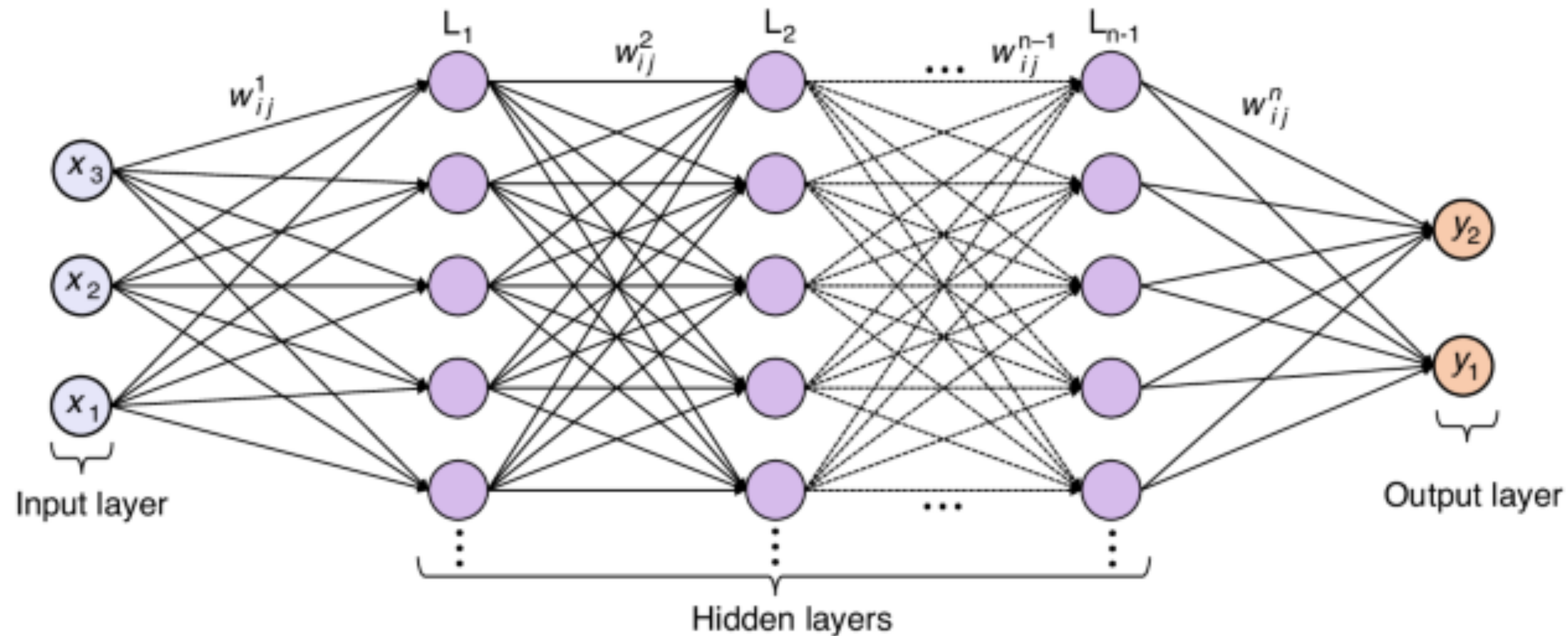


Fully Connected Network (MLP)



- Widely used in general-purpose classification & regression

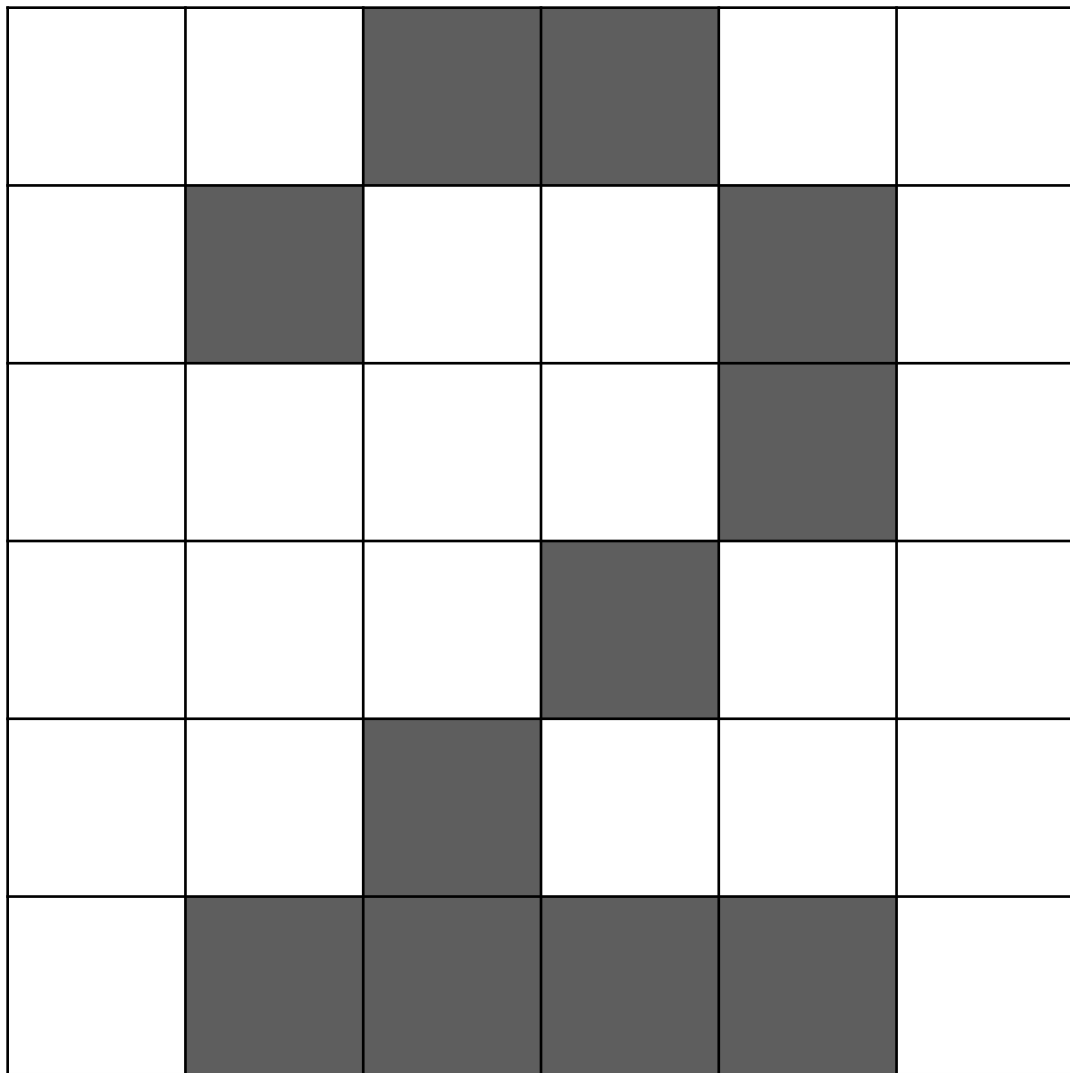
Fully Connected Network (MLP)



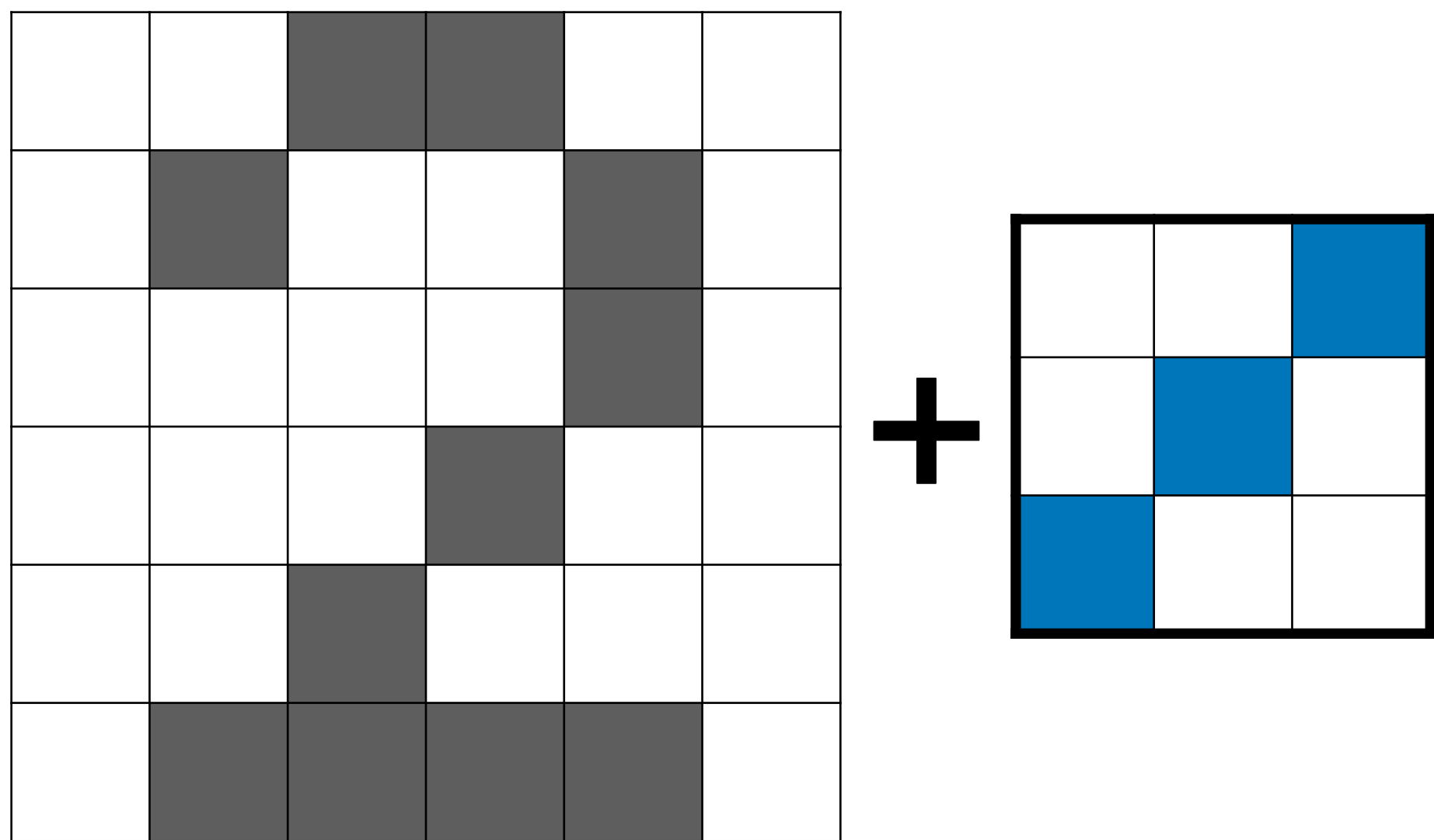
- Widely used in general-purpose classification & regression
- e.g. anomaly detection, stock value forecasting, house-price estimation

Convolutional NN (CNN)

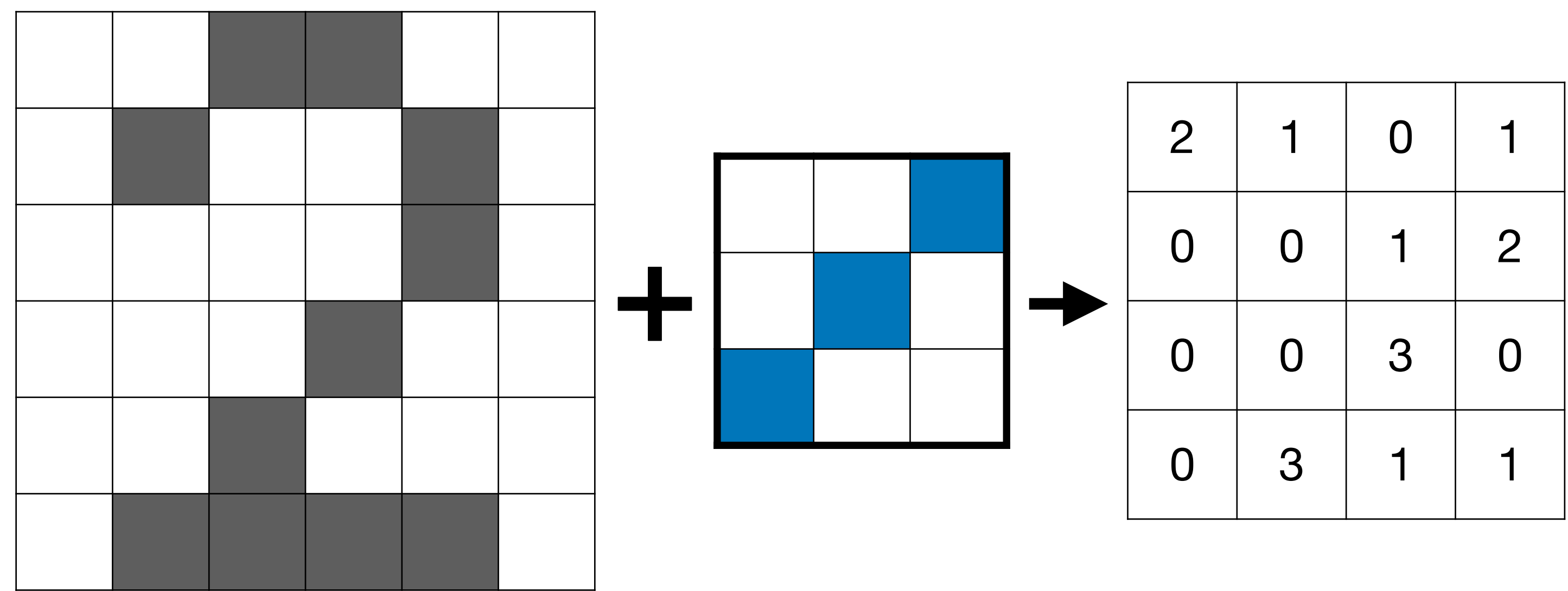
Convolutional NN (CNN)



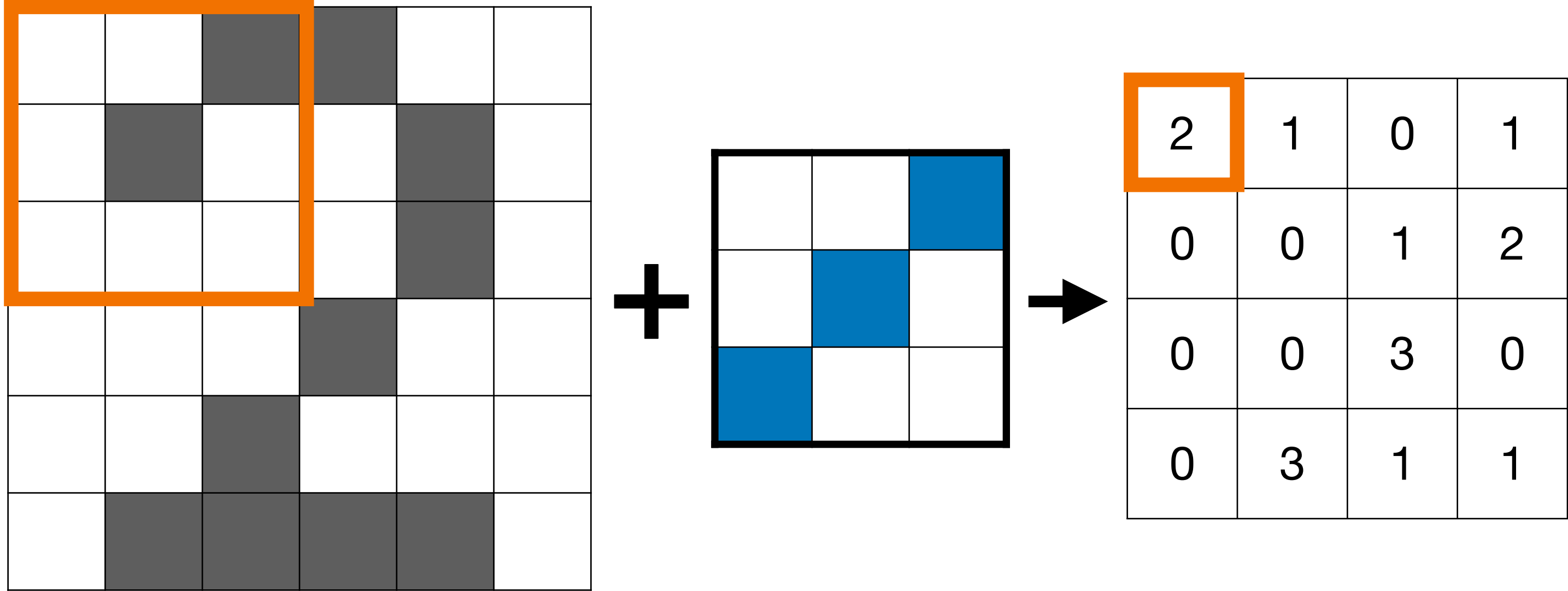
Convolutional NN (CNN)



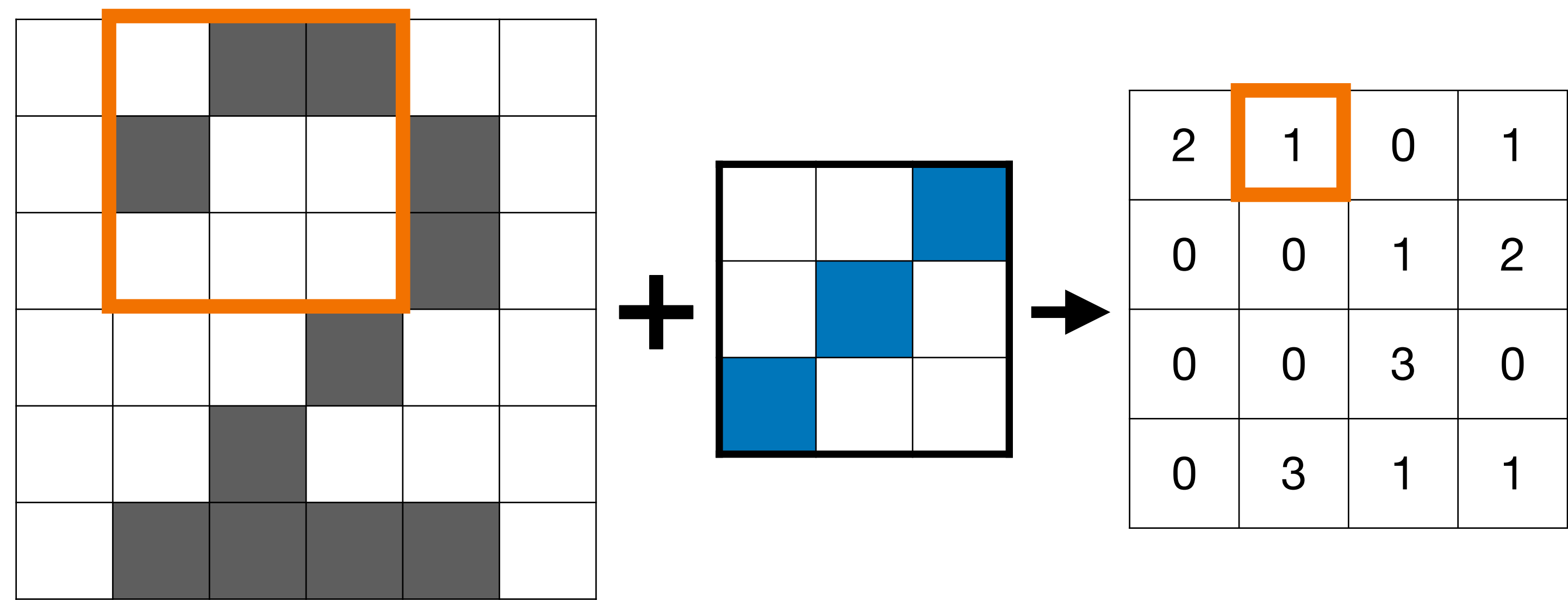
Convolutional NN (CNN)



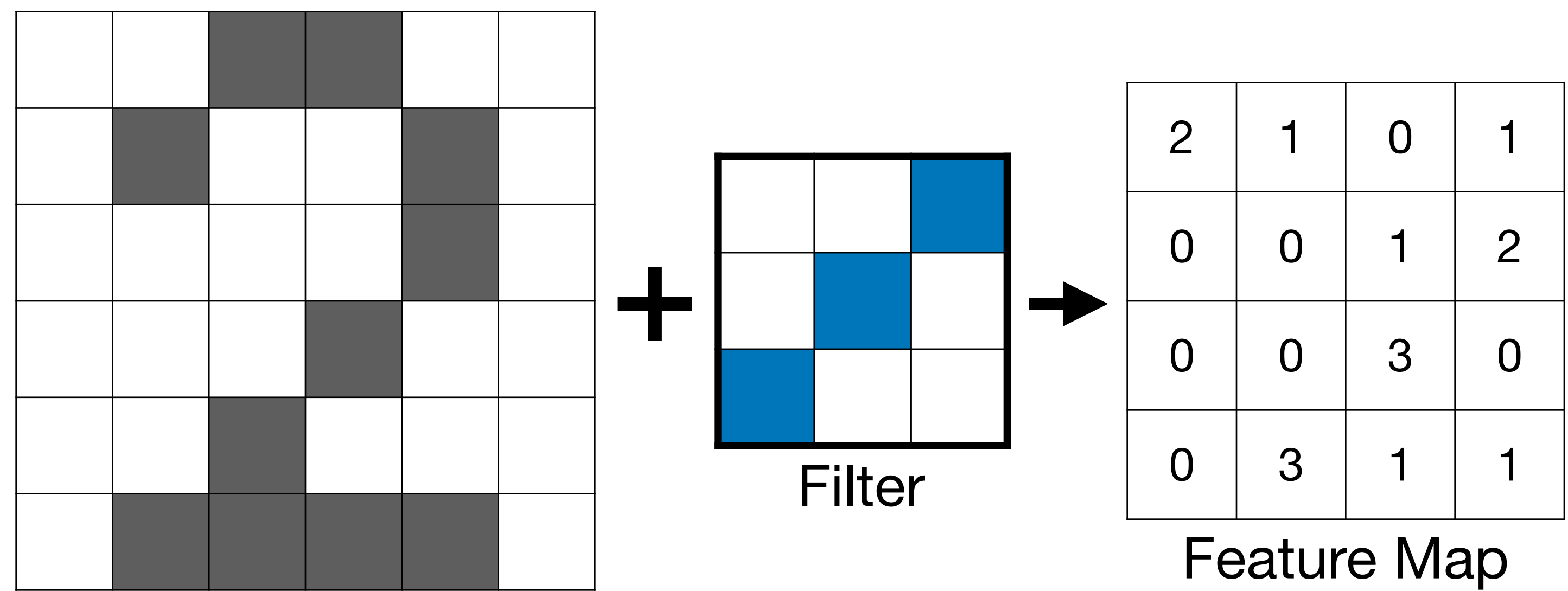
Convolutional NN (CNN)



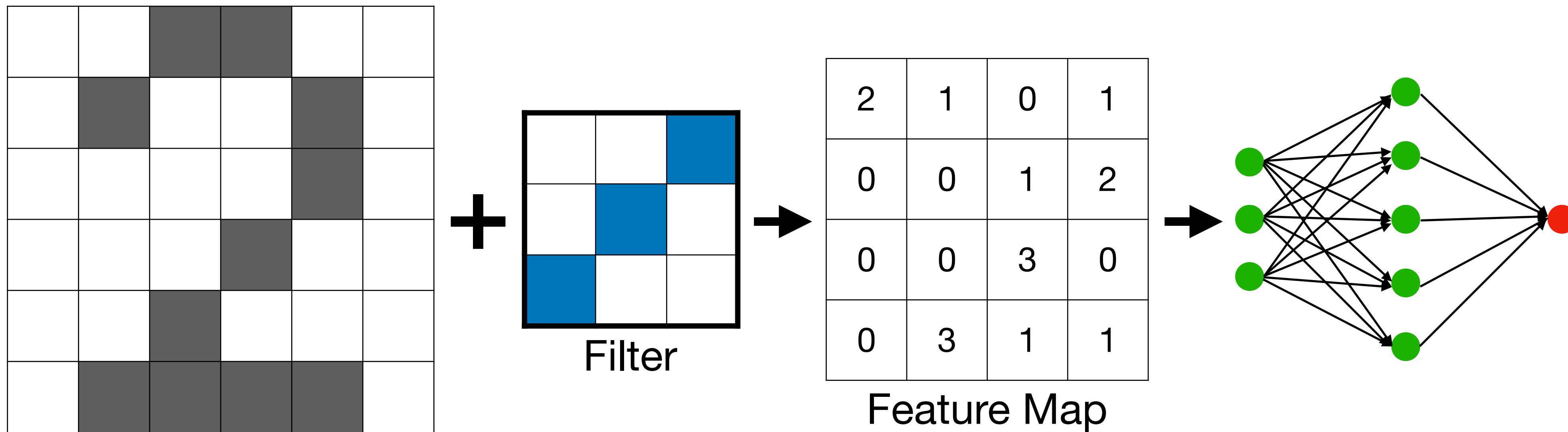
Convolutional NN (CNN)



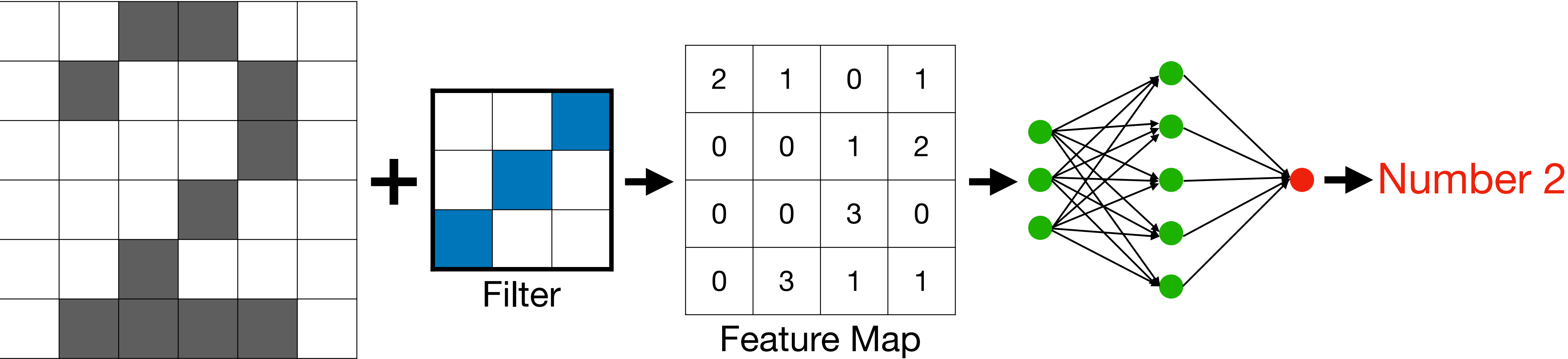
Convolutional NN (CNN)



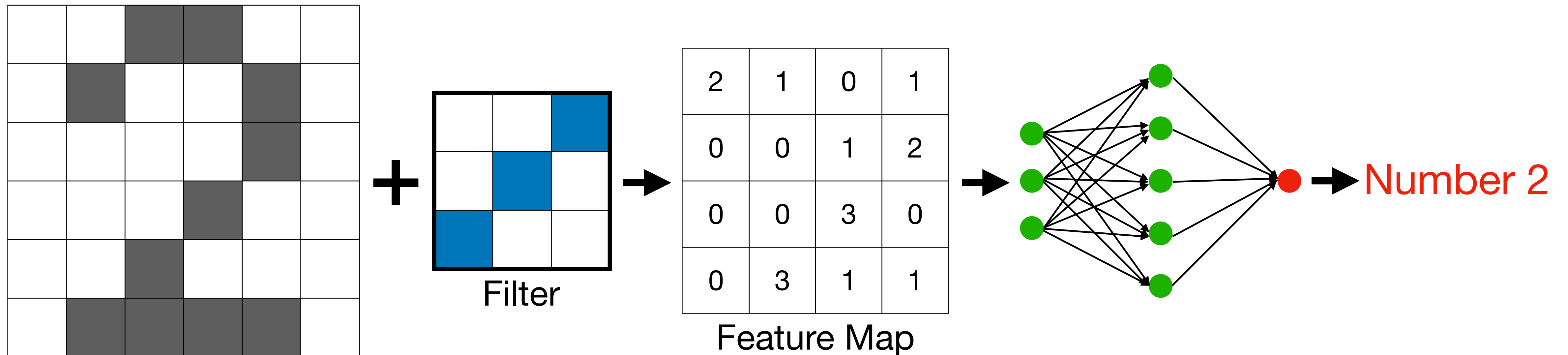
Convolutional NN (CNN)



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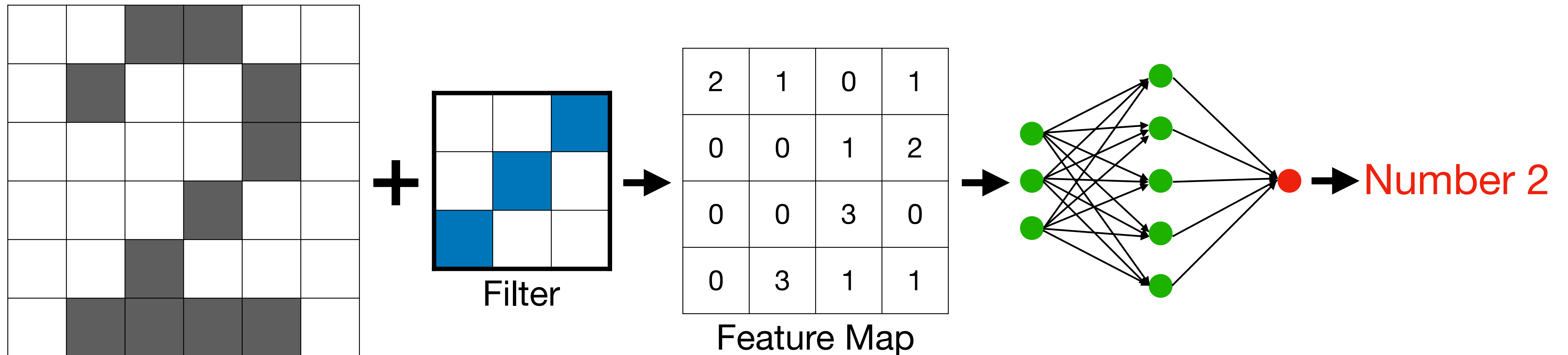


Convolutional NN (CNN)



- Ideal for well-structured spatial correlation

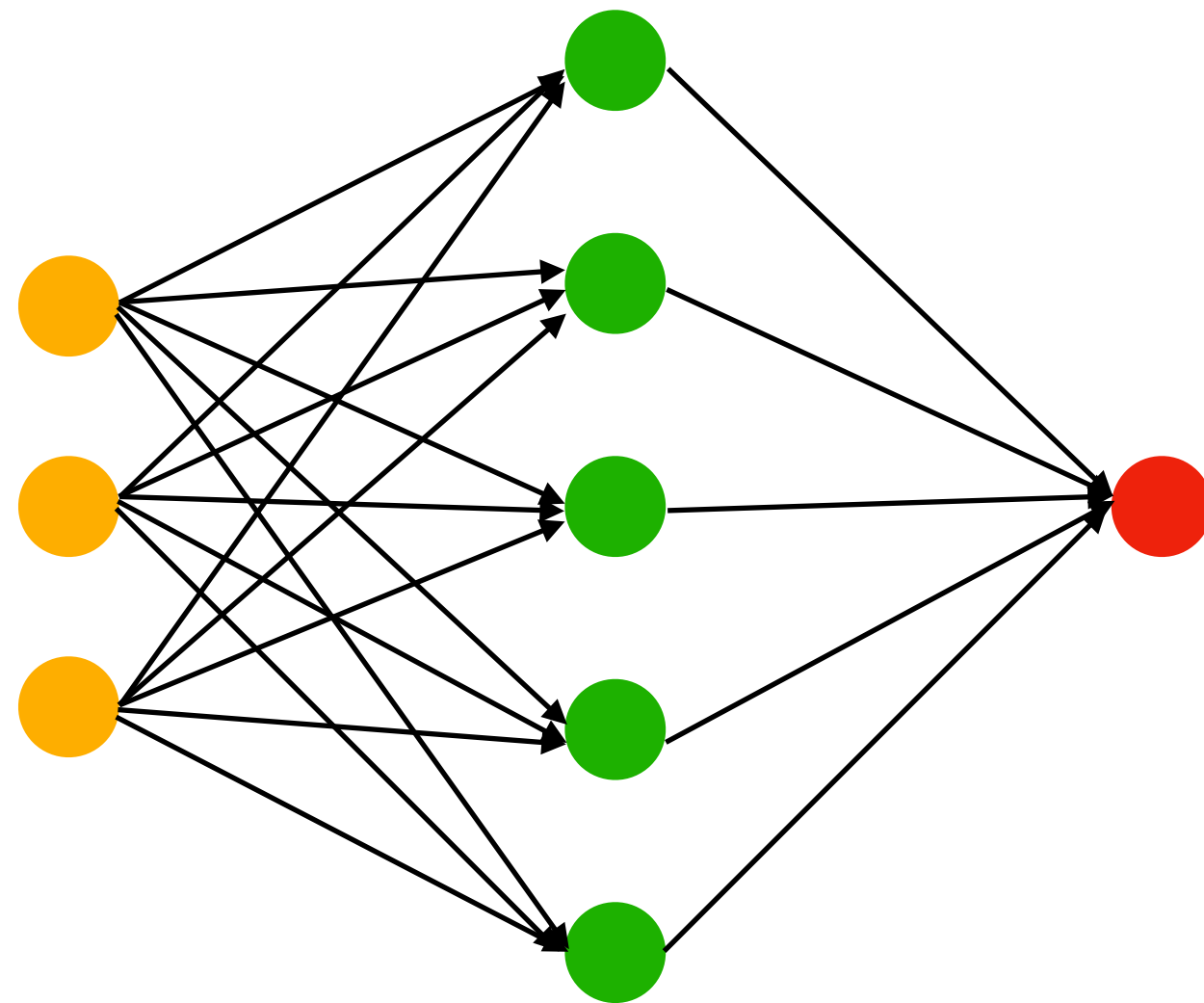
Convolutional NN (CNN)



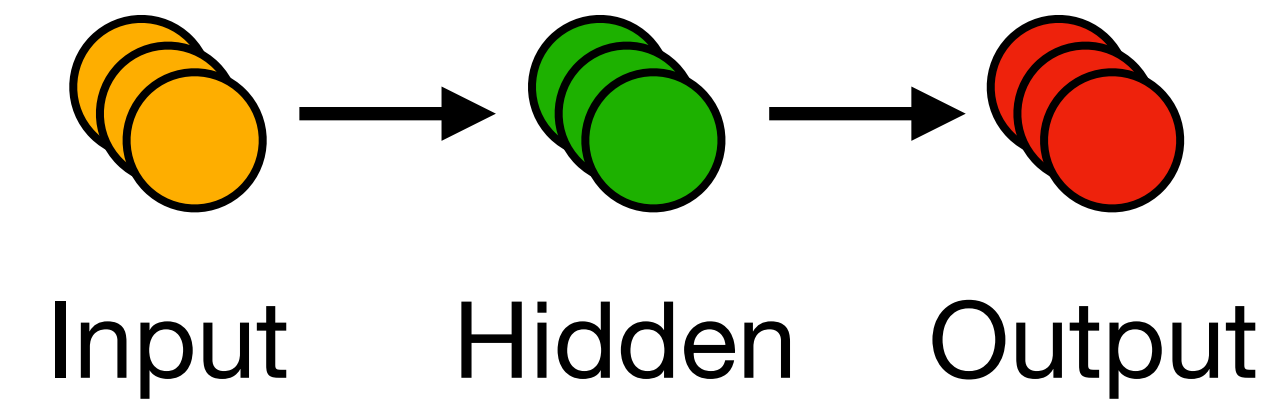
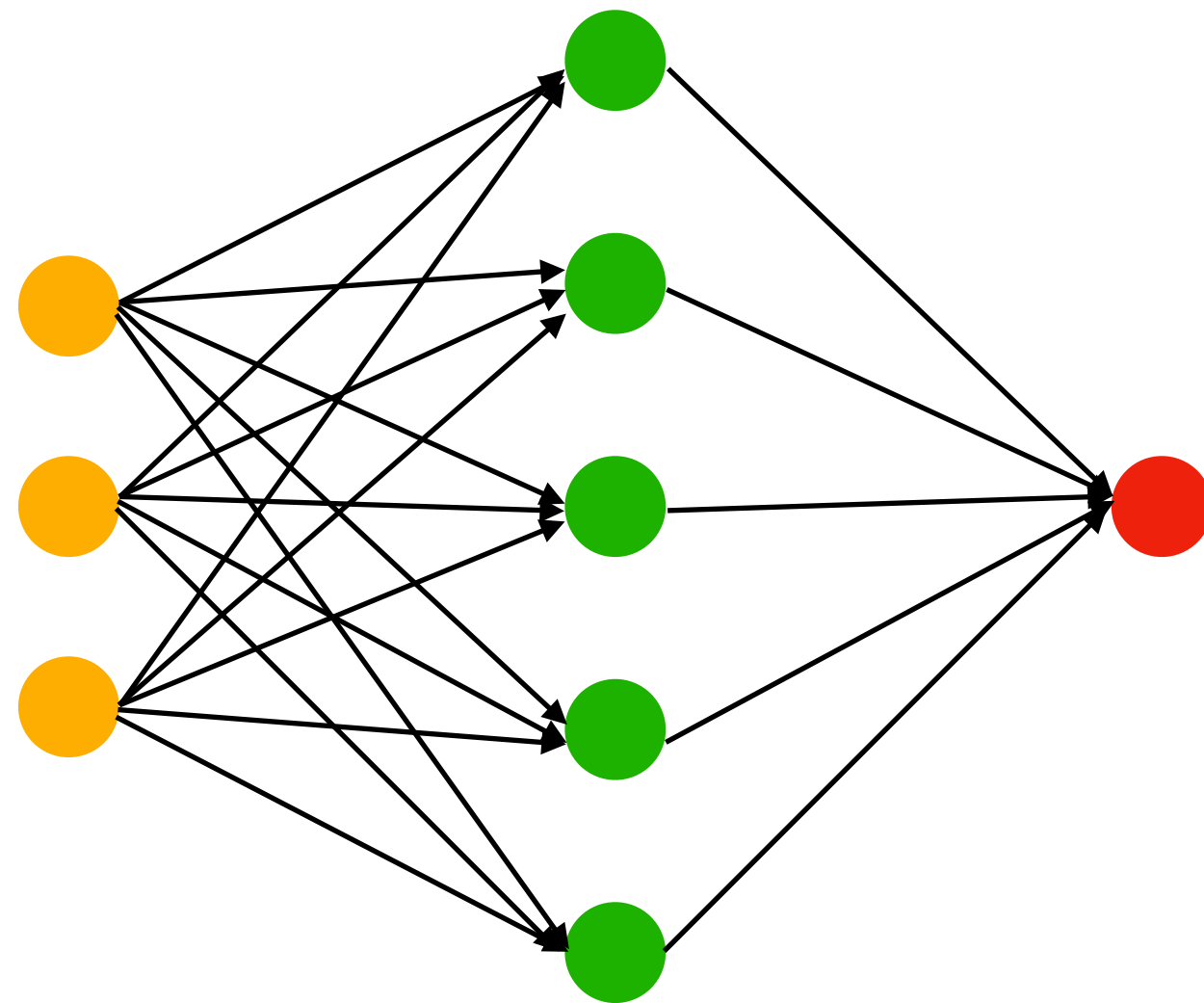
- Ideal for well-structured spatial correlation
- e.g. images, video frames, 2D/3D grids

Recurrent NN (RNN)

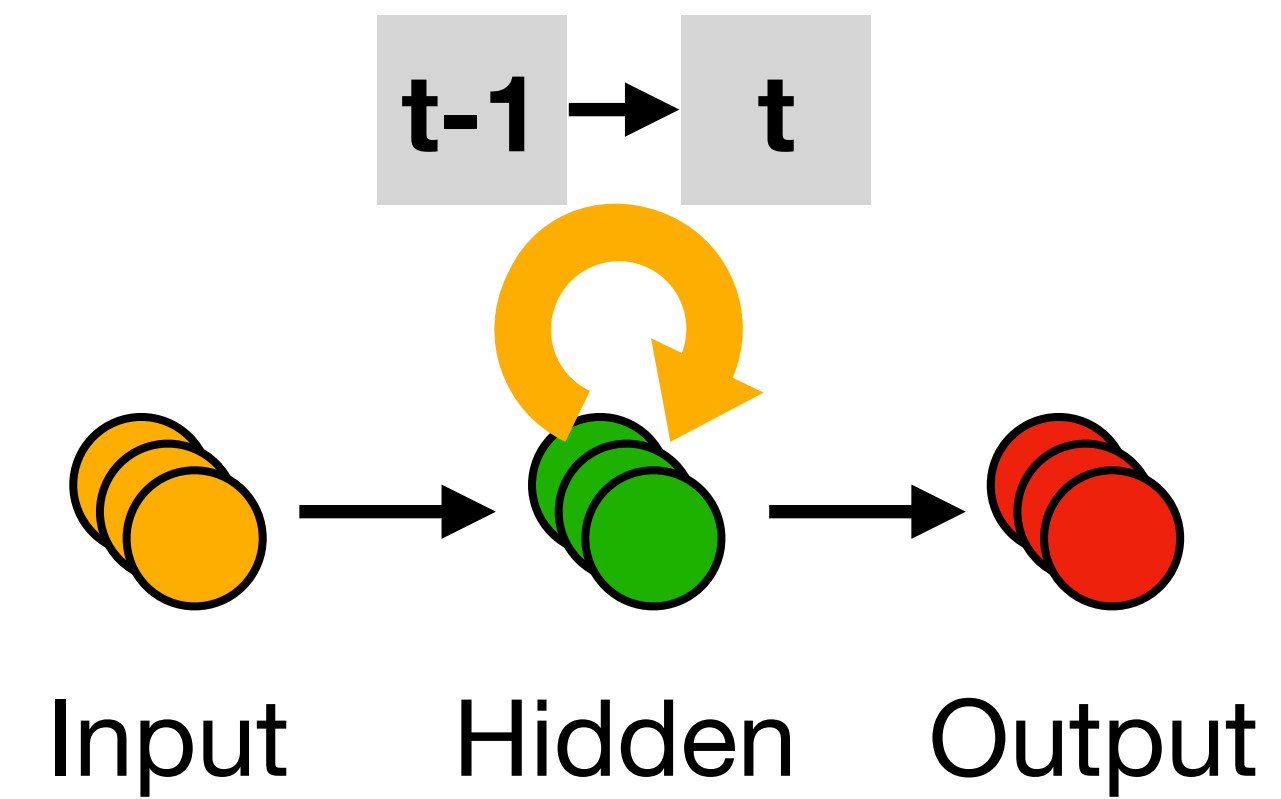
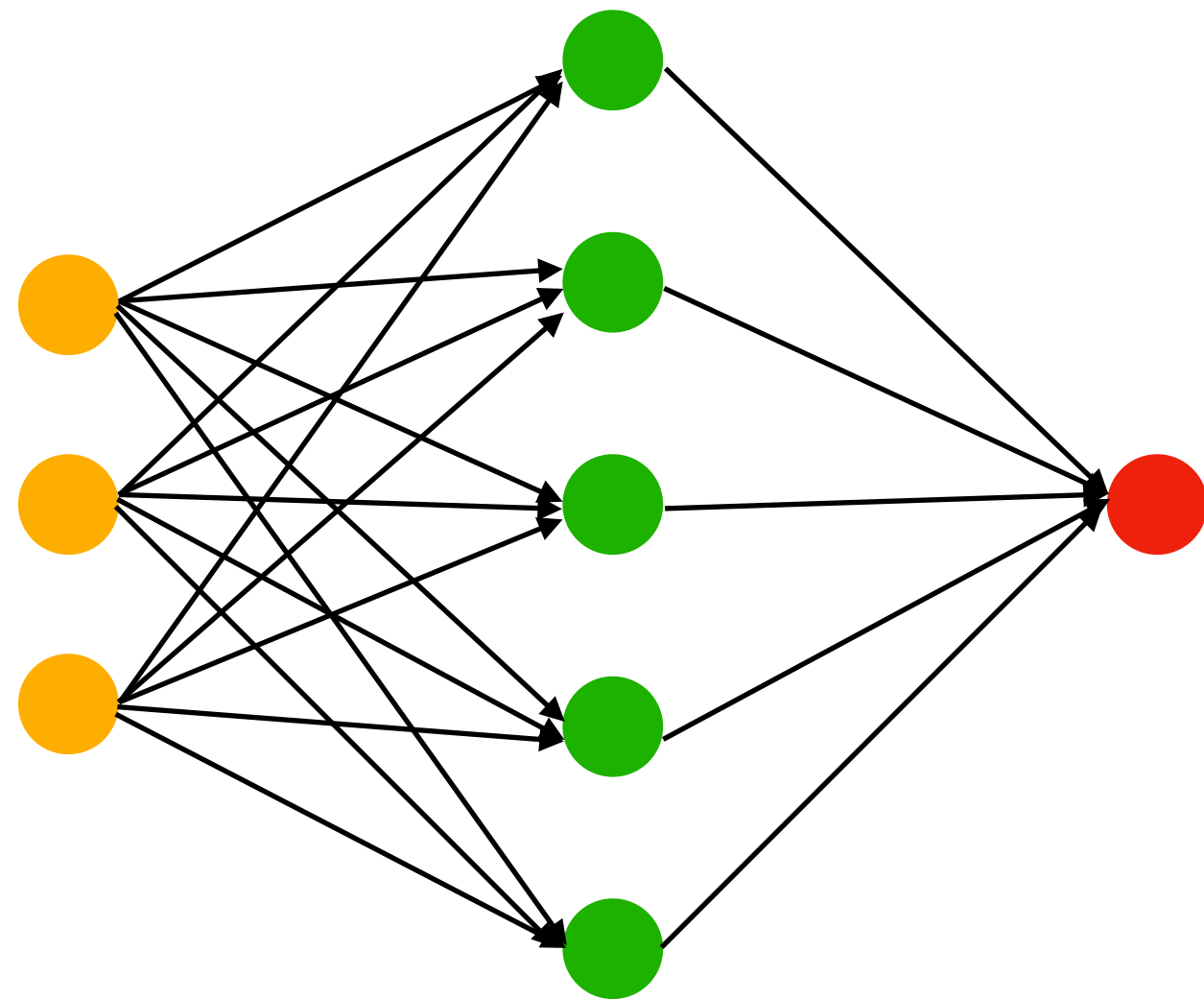
Recurrent NN (RNN)



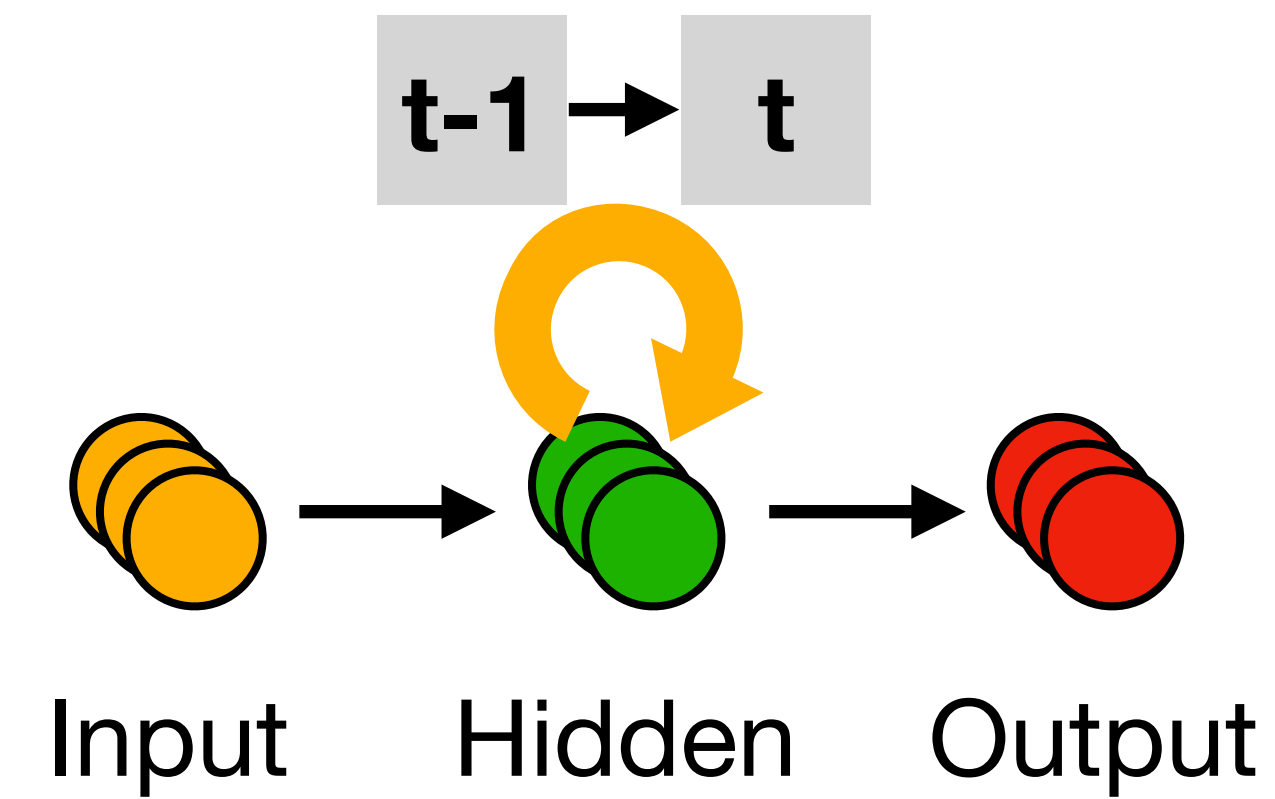
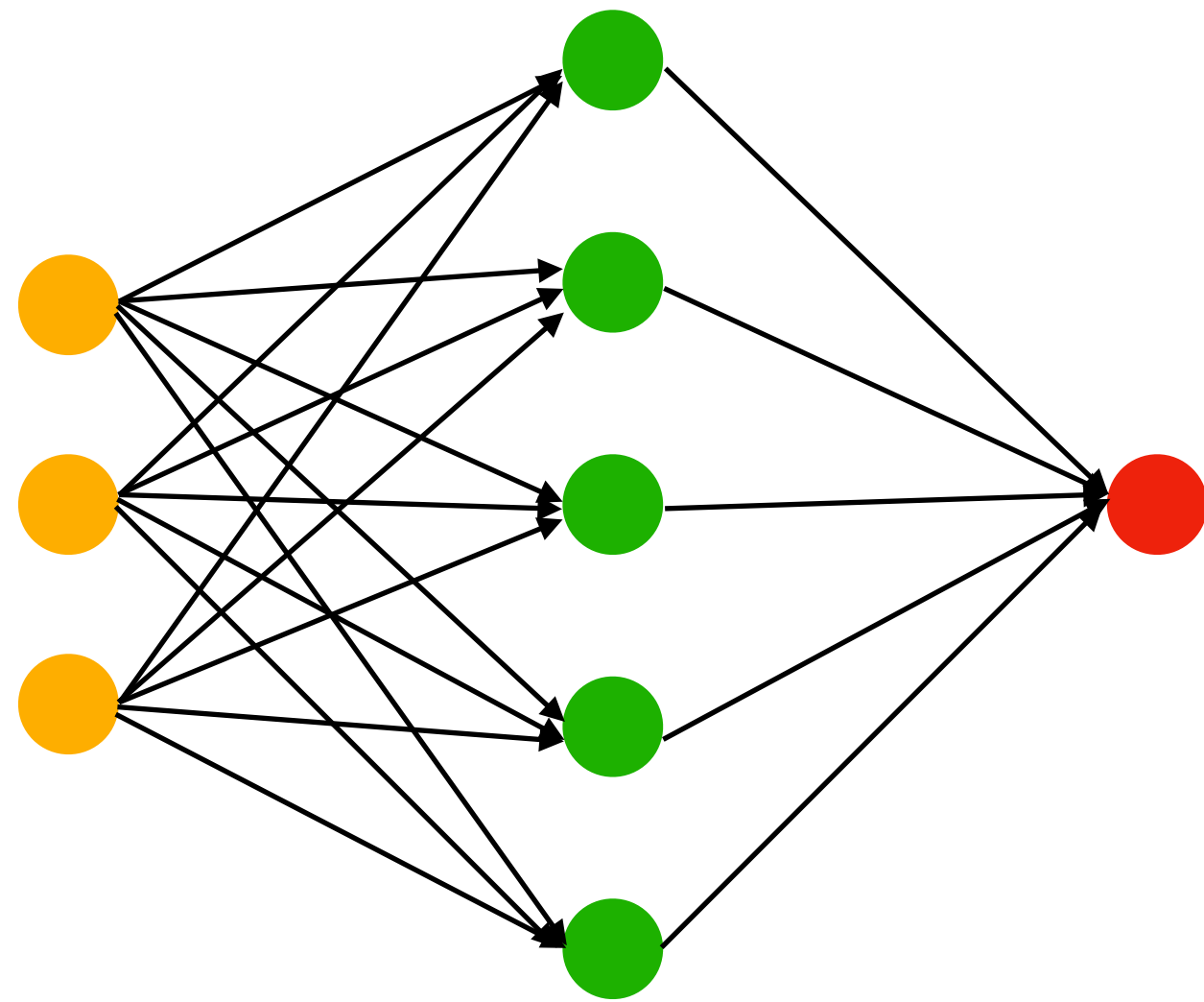
Recurrent NN (RNN)



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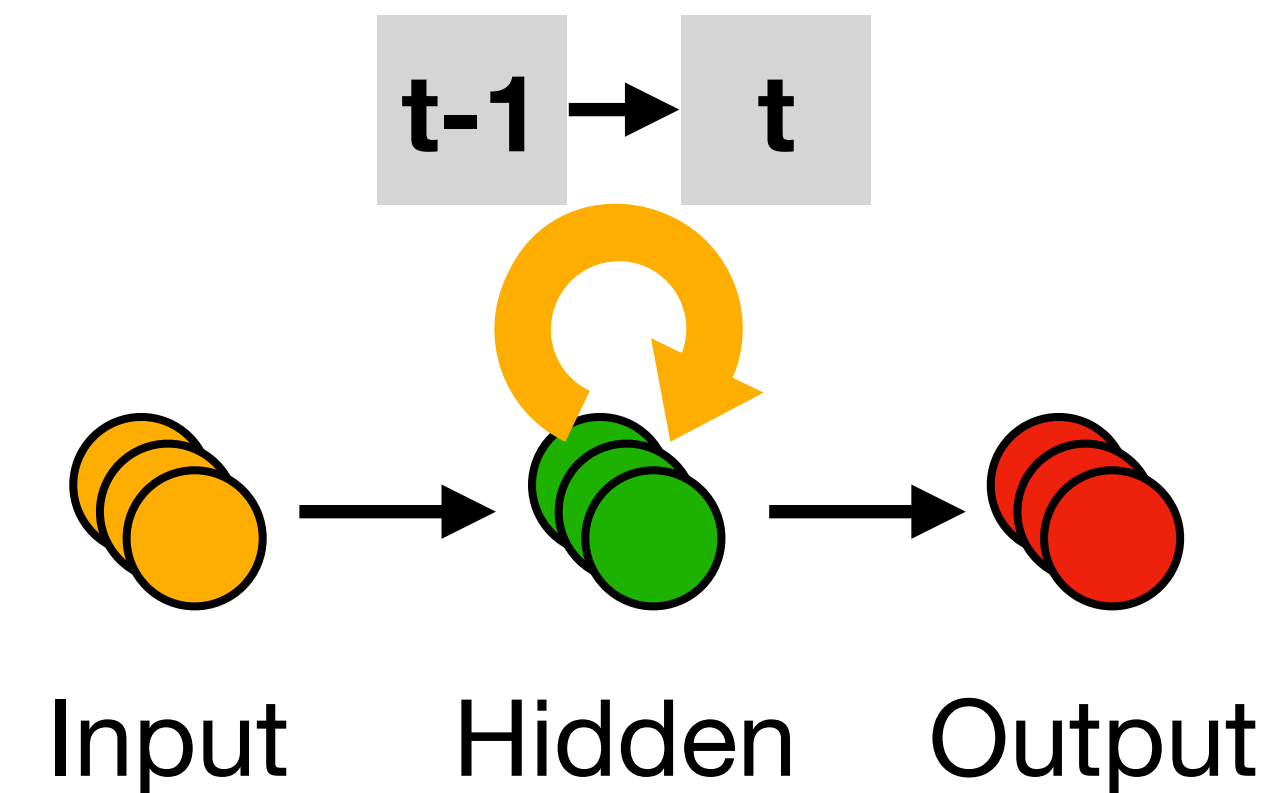
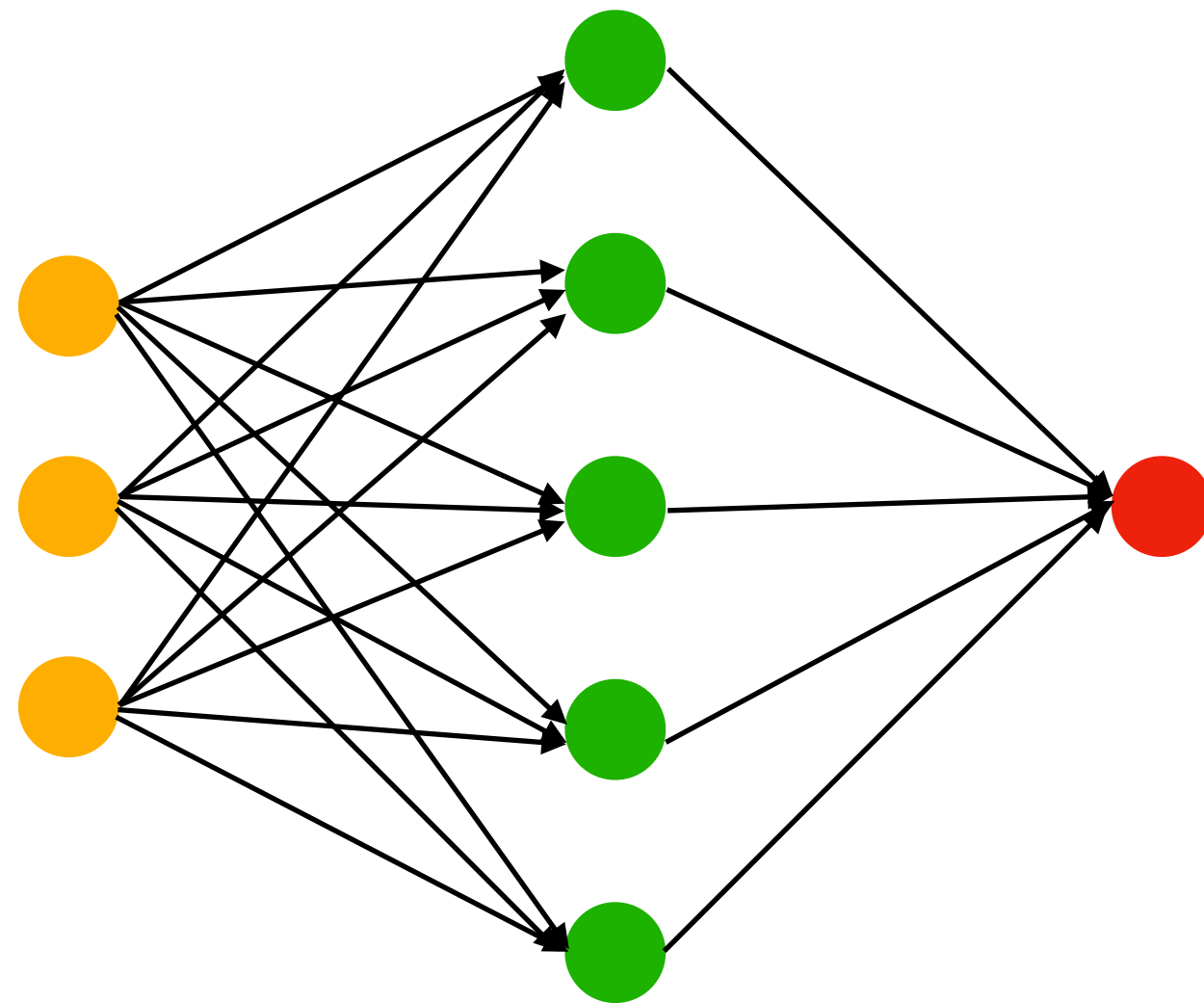


Recurrent NN (RNN)



- Ideal for sequential data, temporal correlation

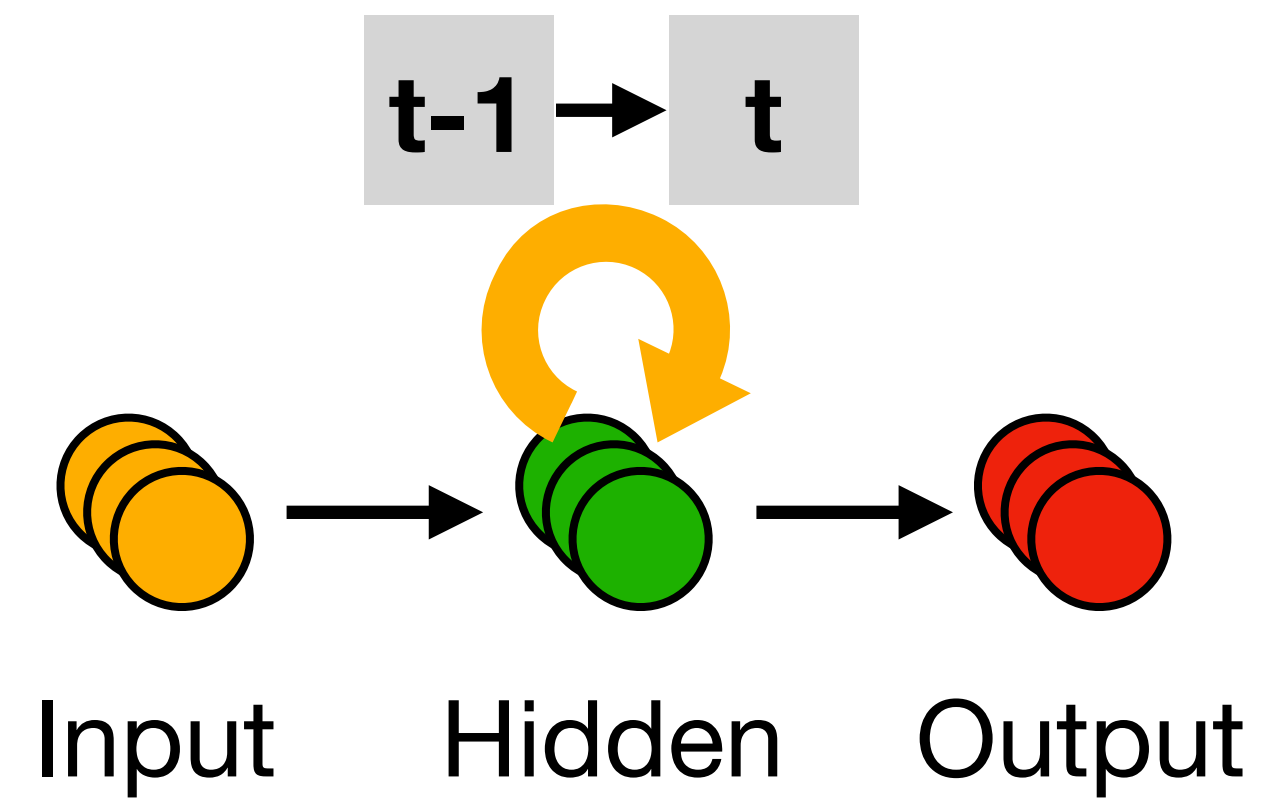
Recurrent NN (RNN)



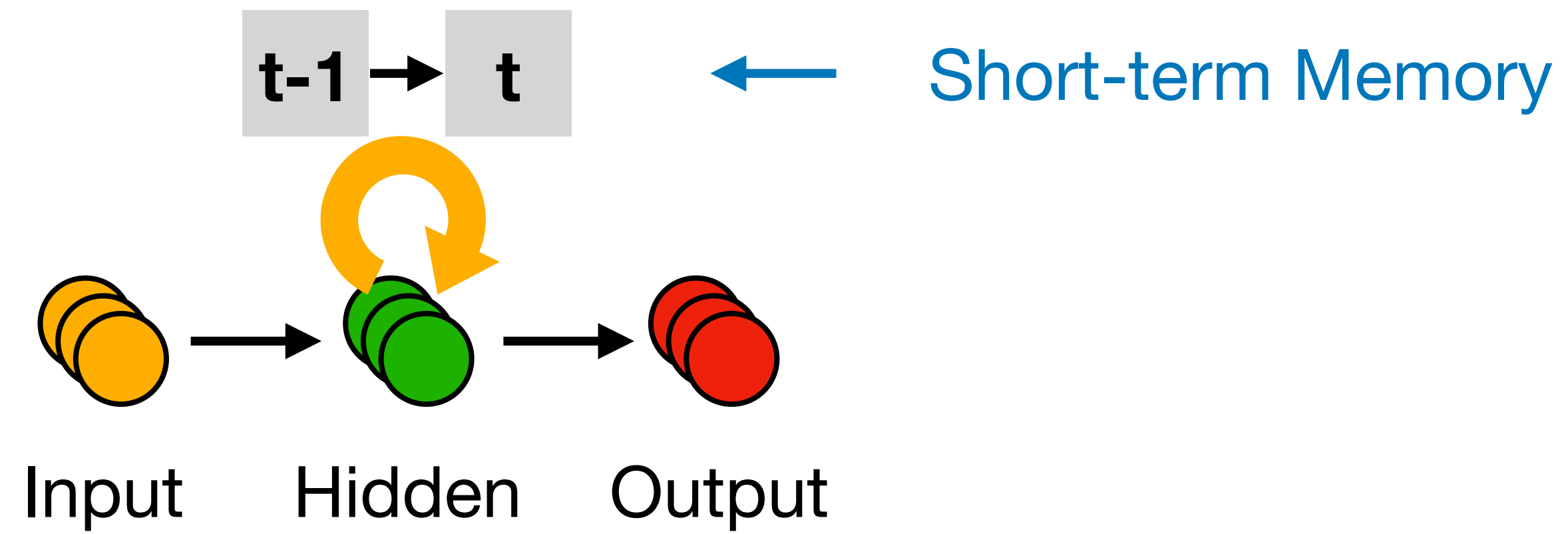
- Ideal for sequential data, temporal correlation
- e.g. time series, text, speech, sequential signals

Long Short-Term Memory (LSTM)

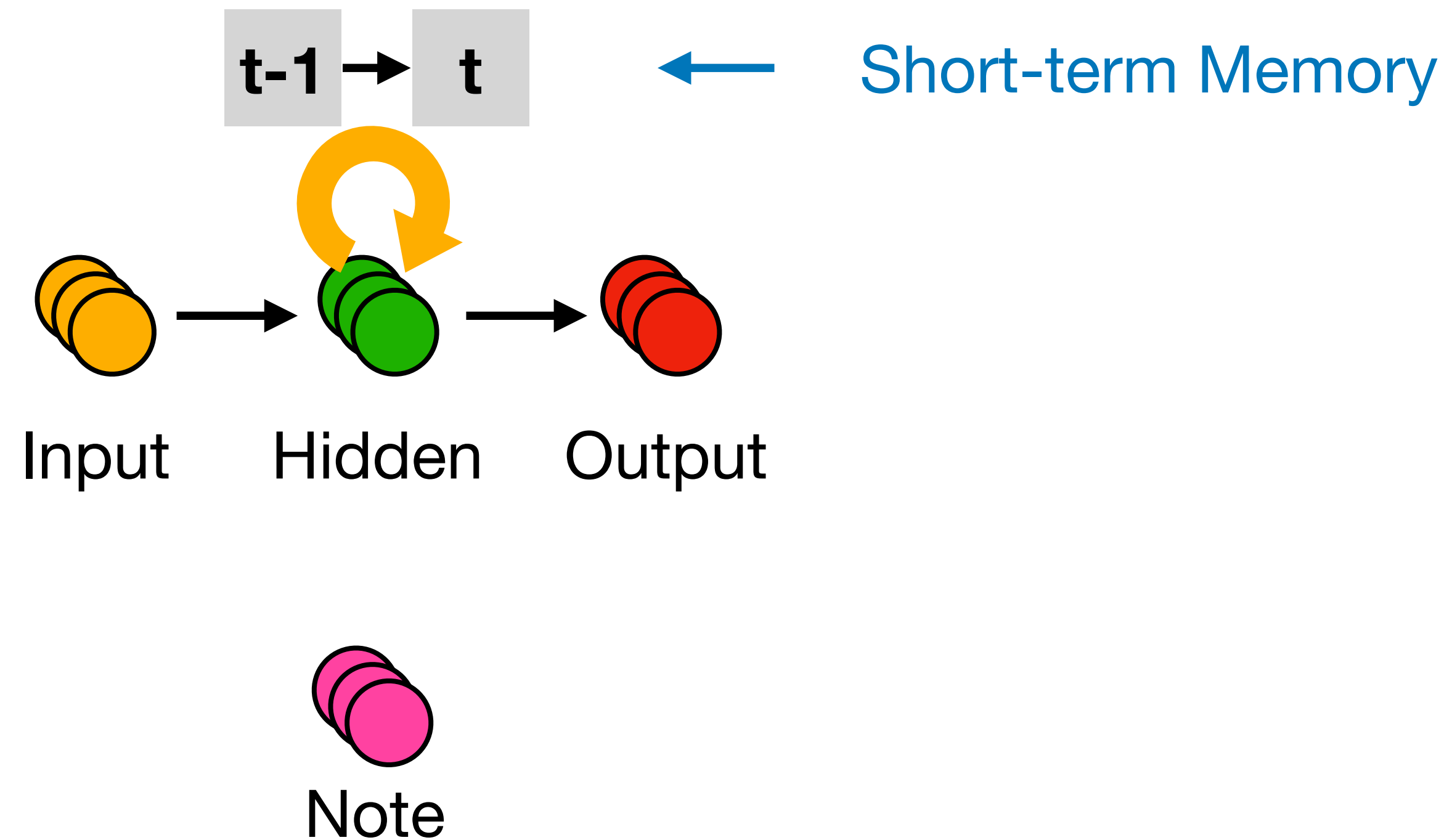
Long Short-Term Memory (LSTM)



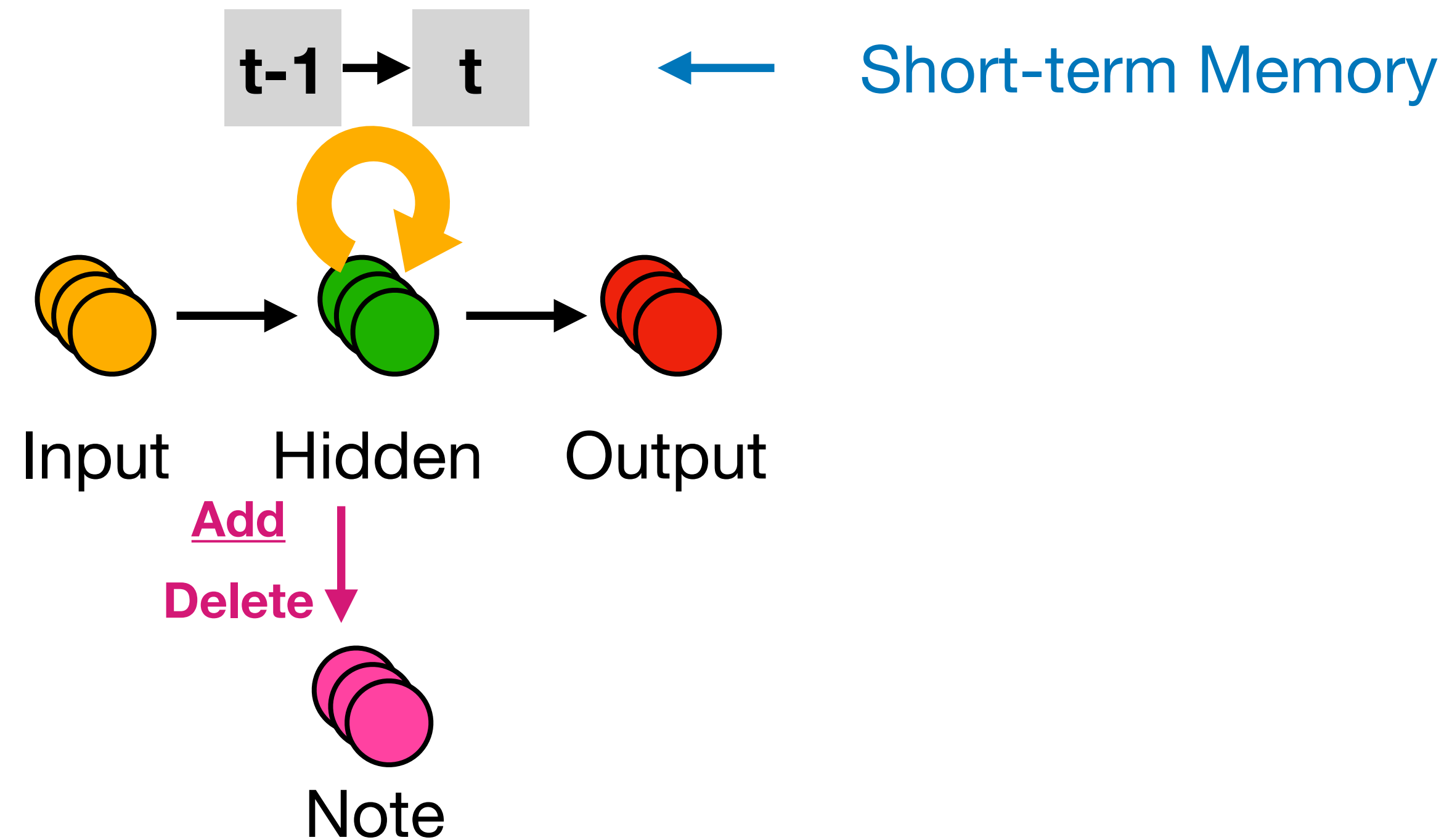
Long Short-Term Memory (LSTM)



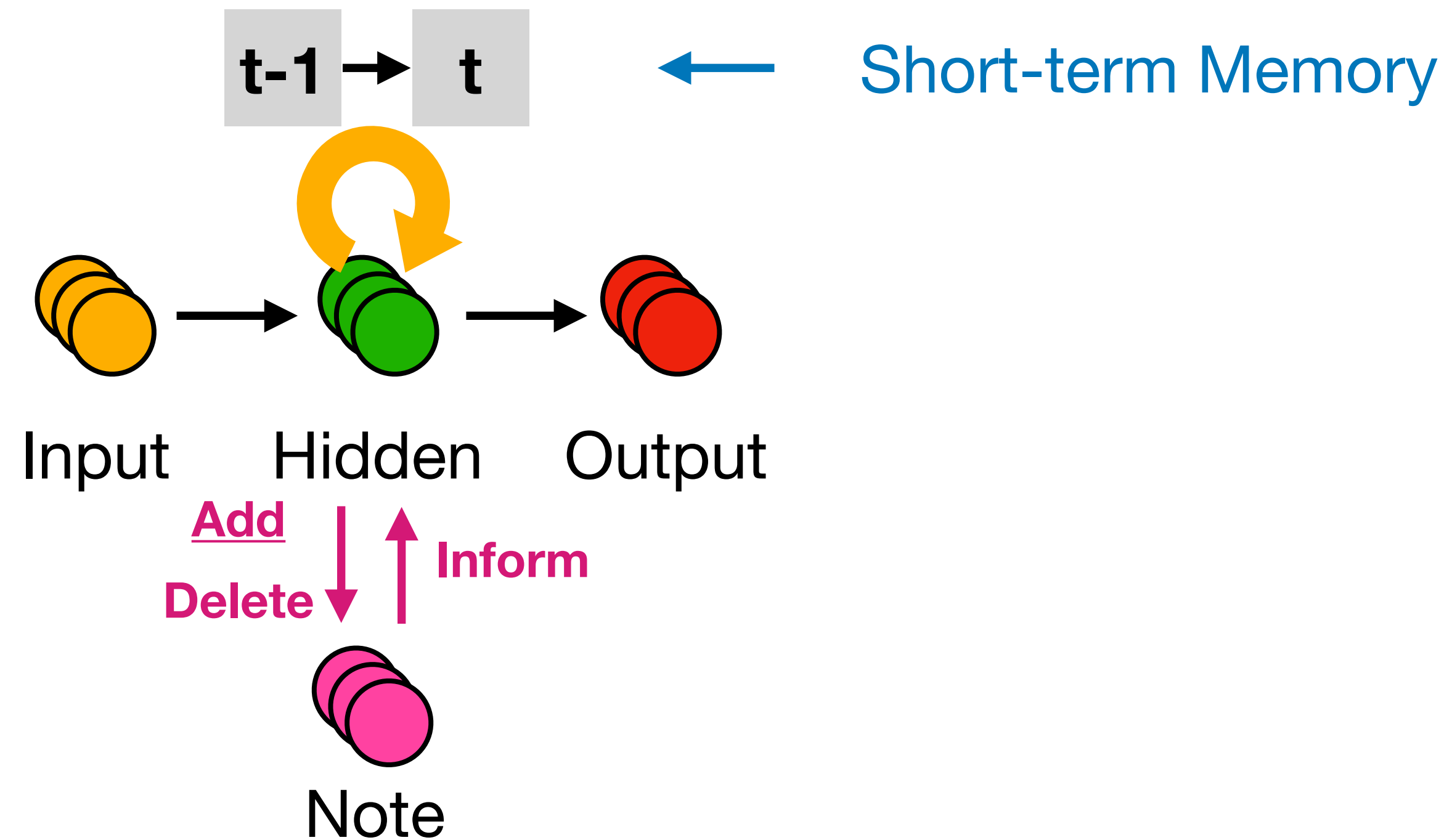
Long Short-Term Memory (LSTM)



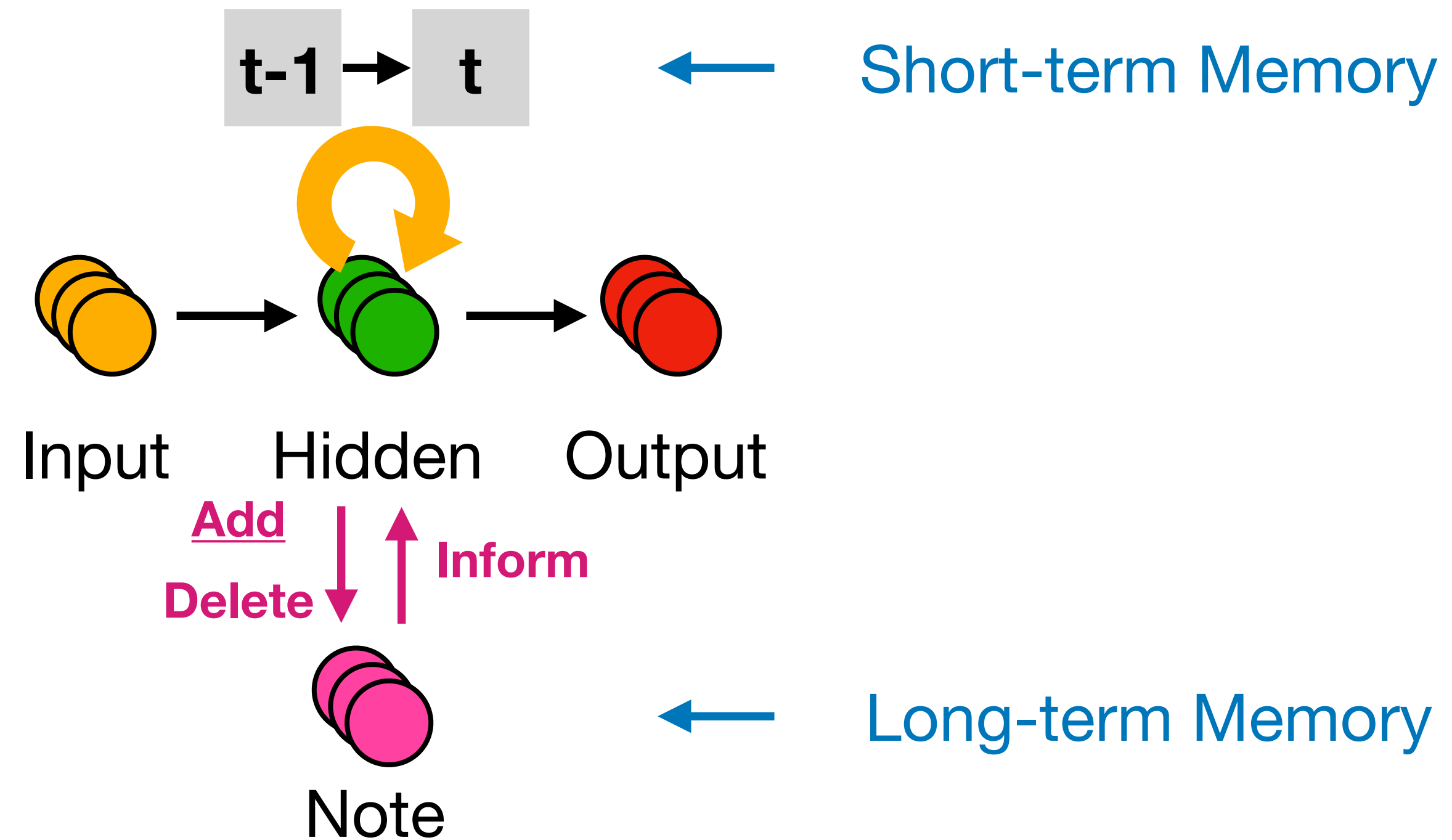
Long Short-Term Memory (LSTM)



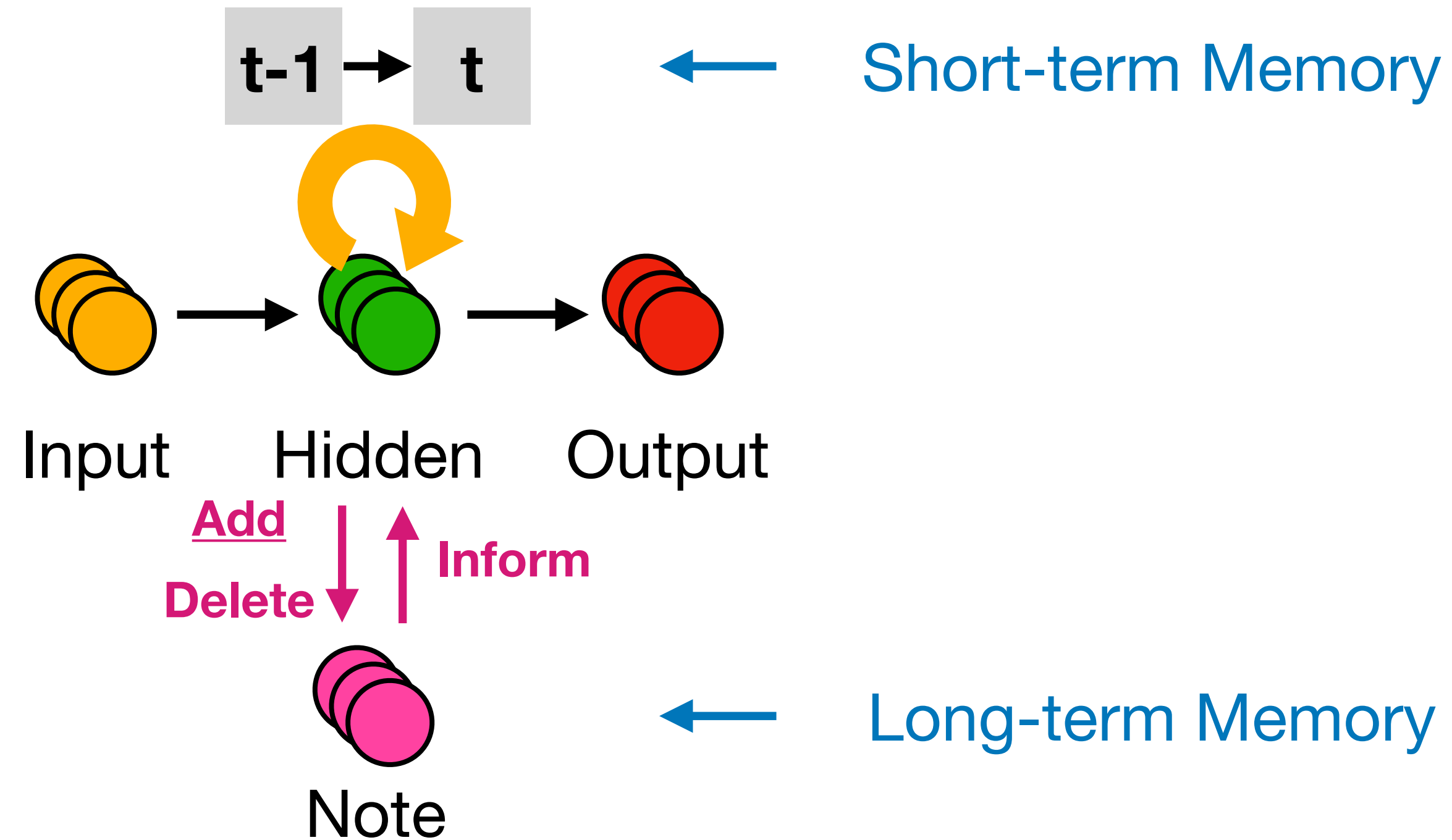
Long Short-Term Memory (LSTM)



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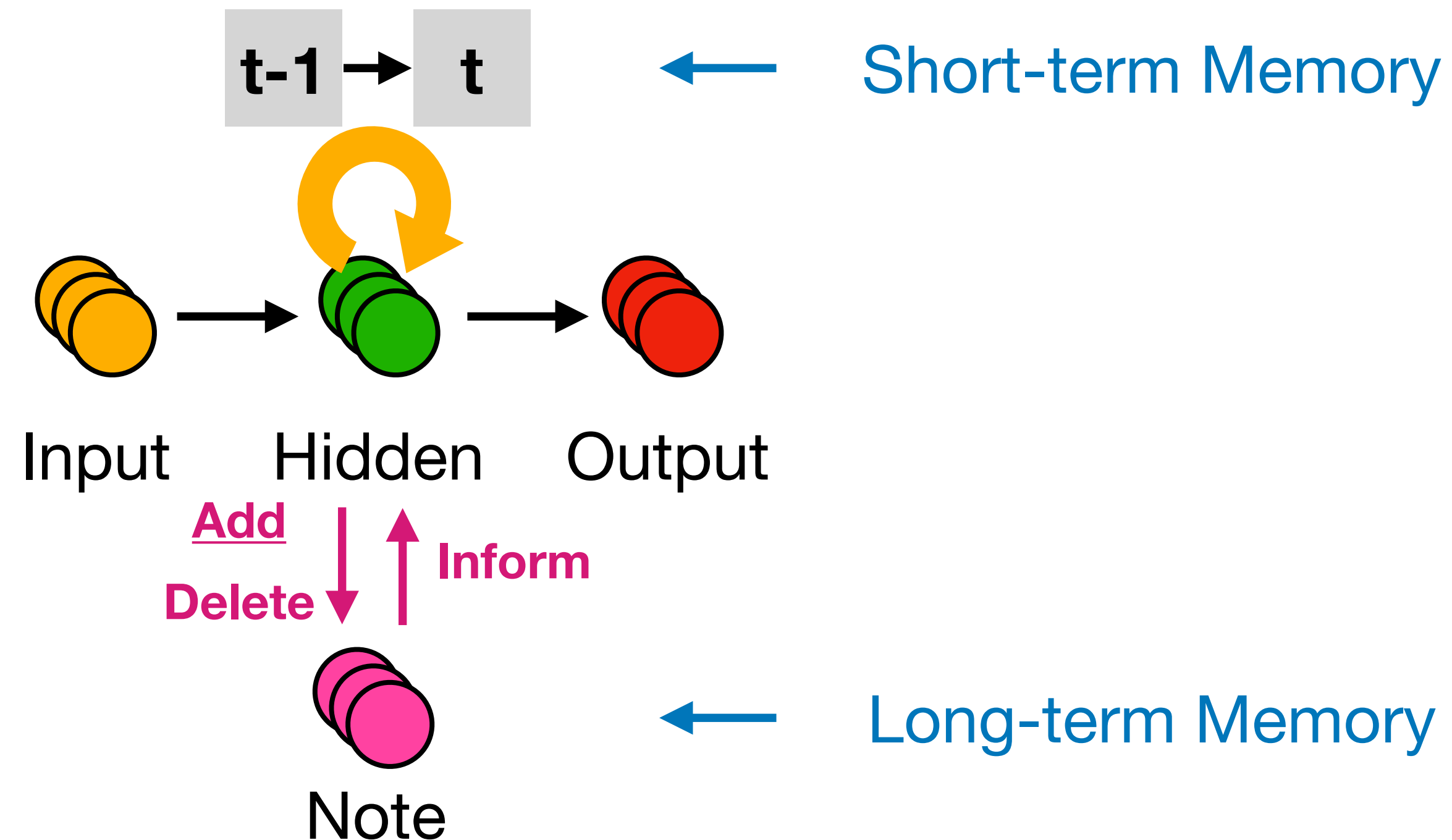


Long Short-Term Memory (LSTM)



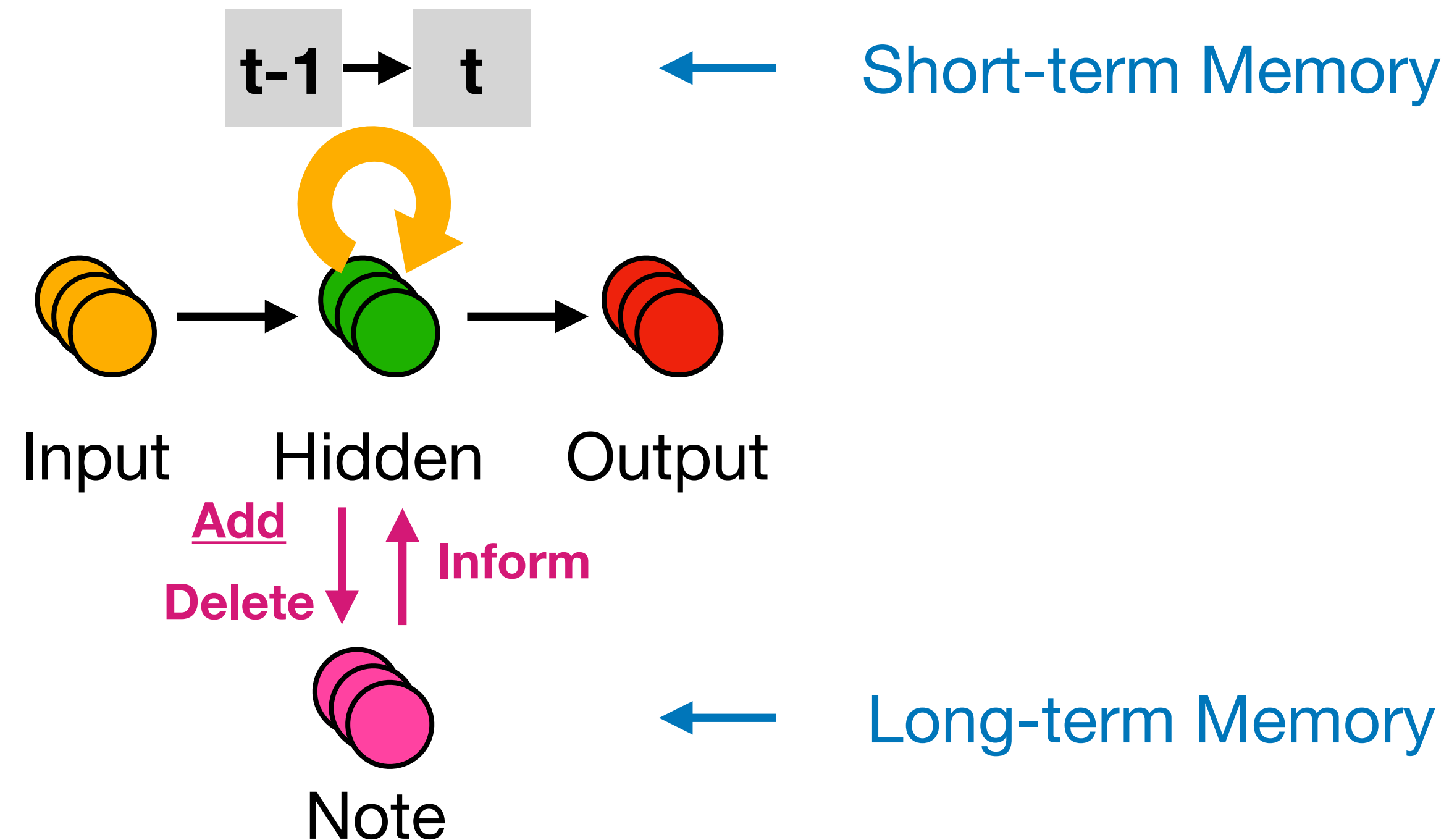
- Improved performance on sequential data

Long Short-Term Memory (LSTM)



- Improved performance on sequential data
- e.g. time series, speech recognition, translation

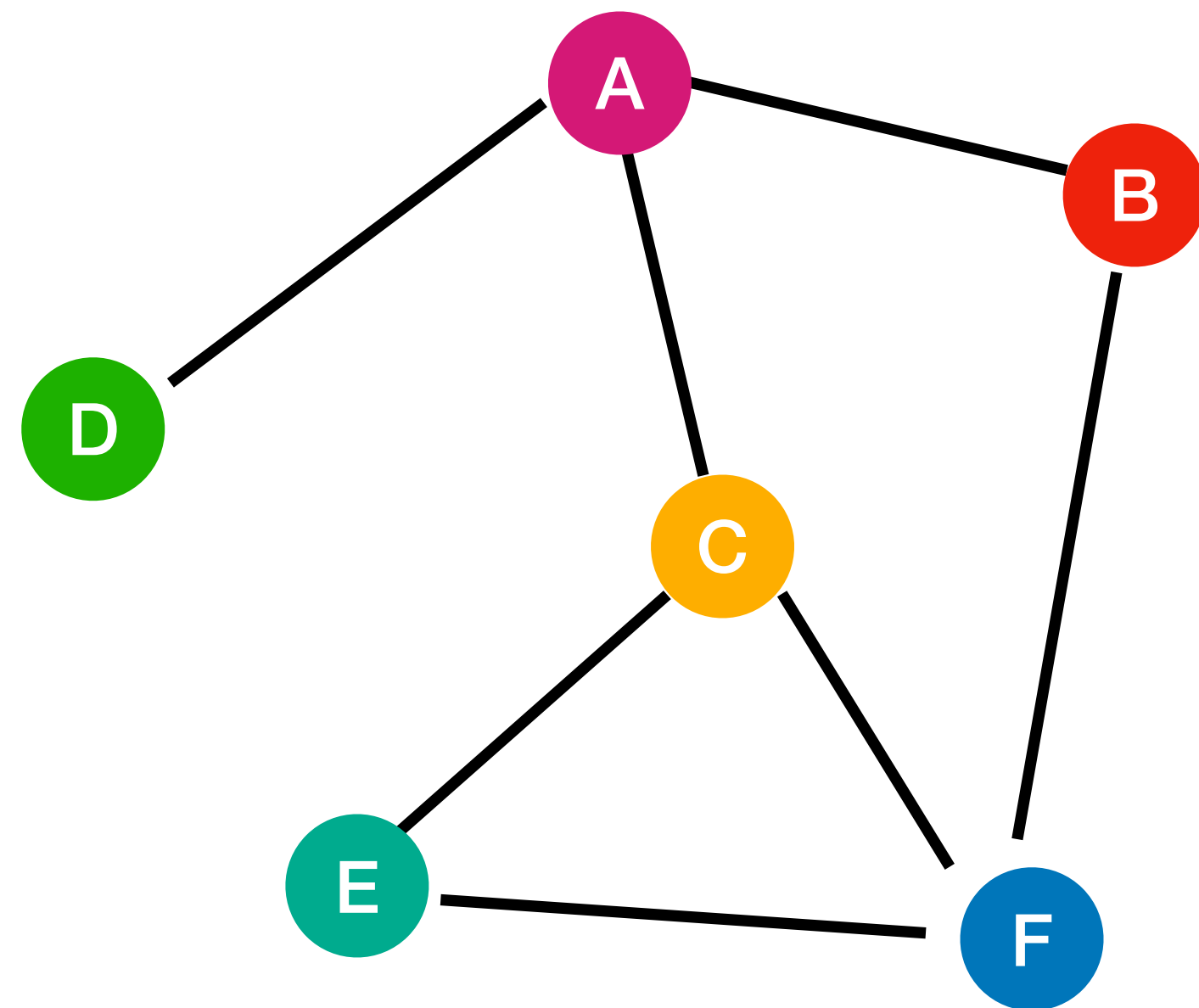
Long Short-Term Memory (LSTM)



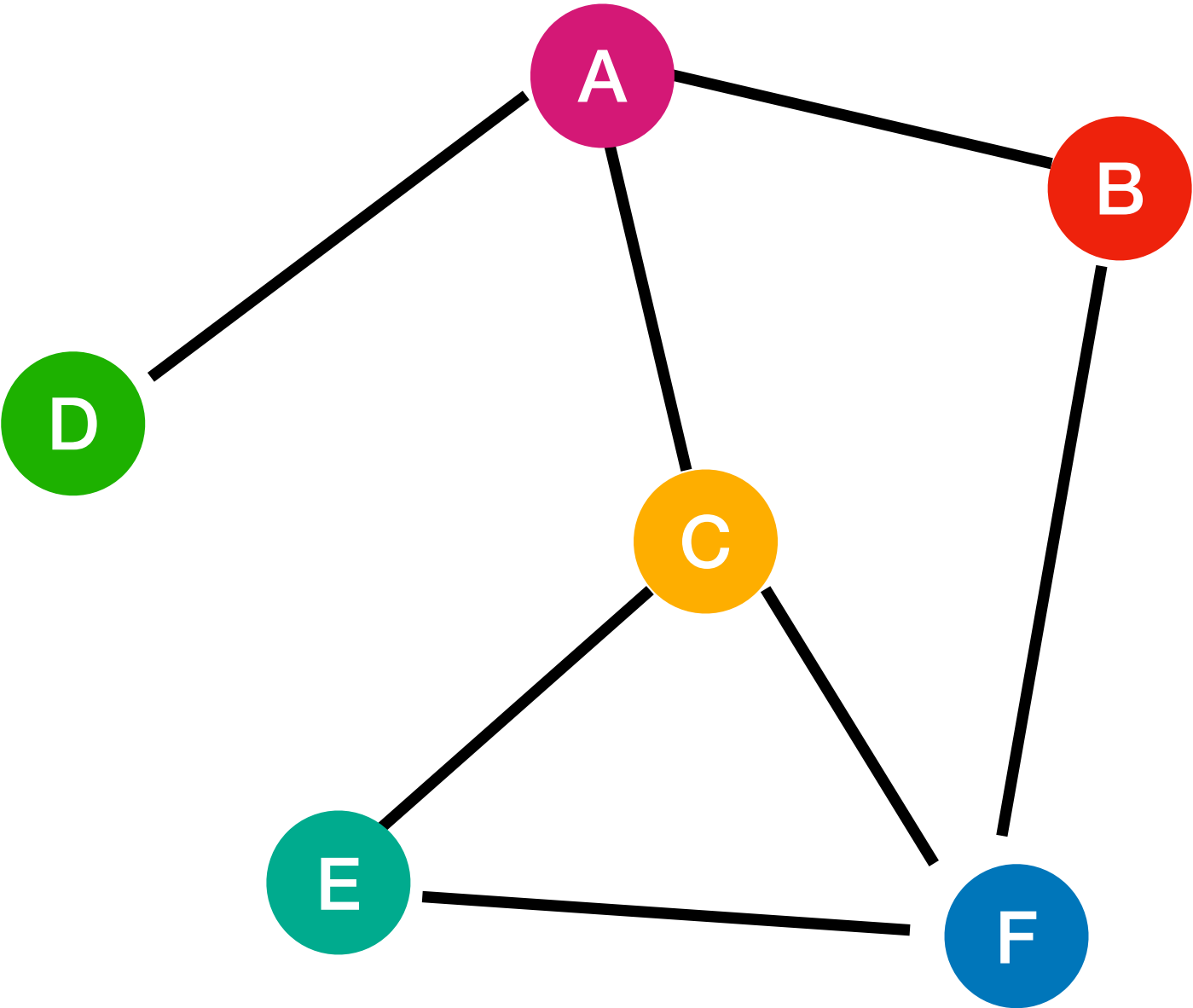
- Improved performance on sequential data
- e.g. time series, speech recognition, translation

Graphic NN (GNN)

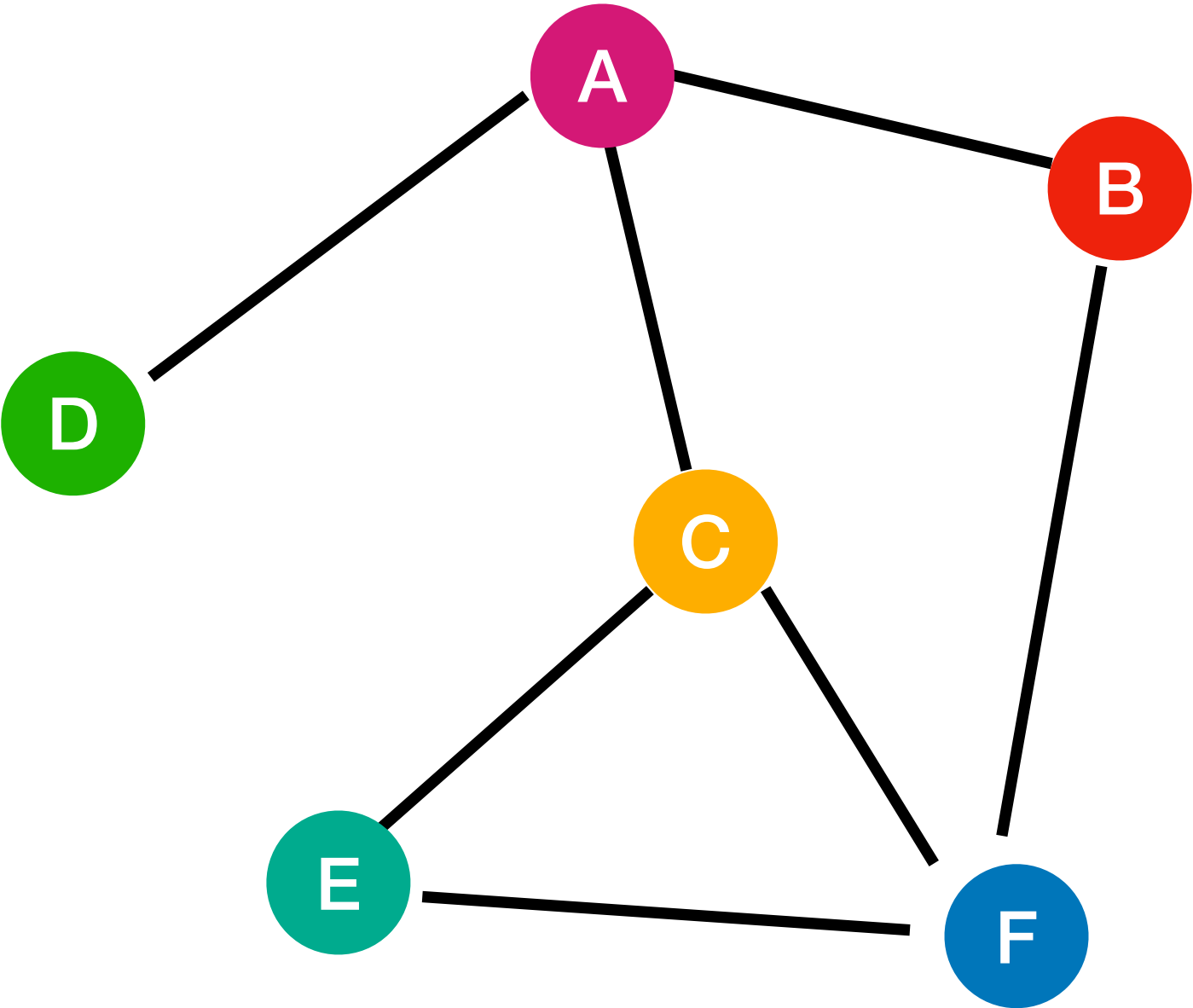
Graphic NN (GNN)



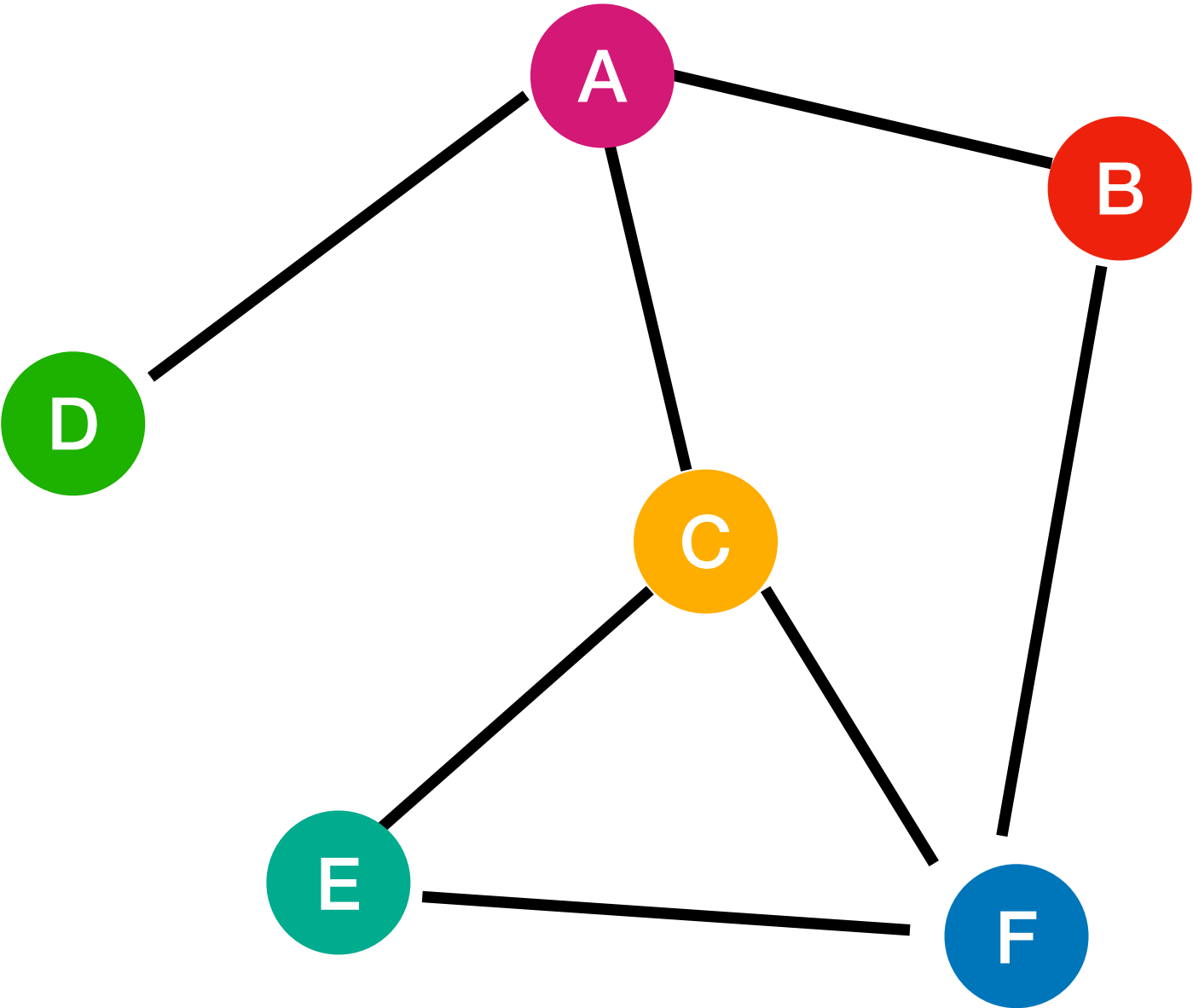
Graphic NN (GNN)



Graphic NN (GNN)



Graphic NN (GNN)



A

F

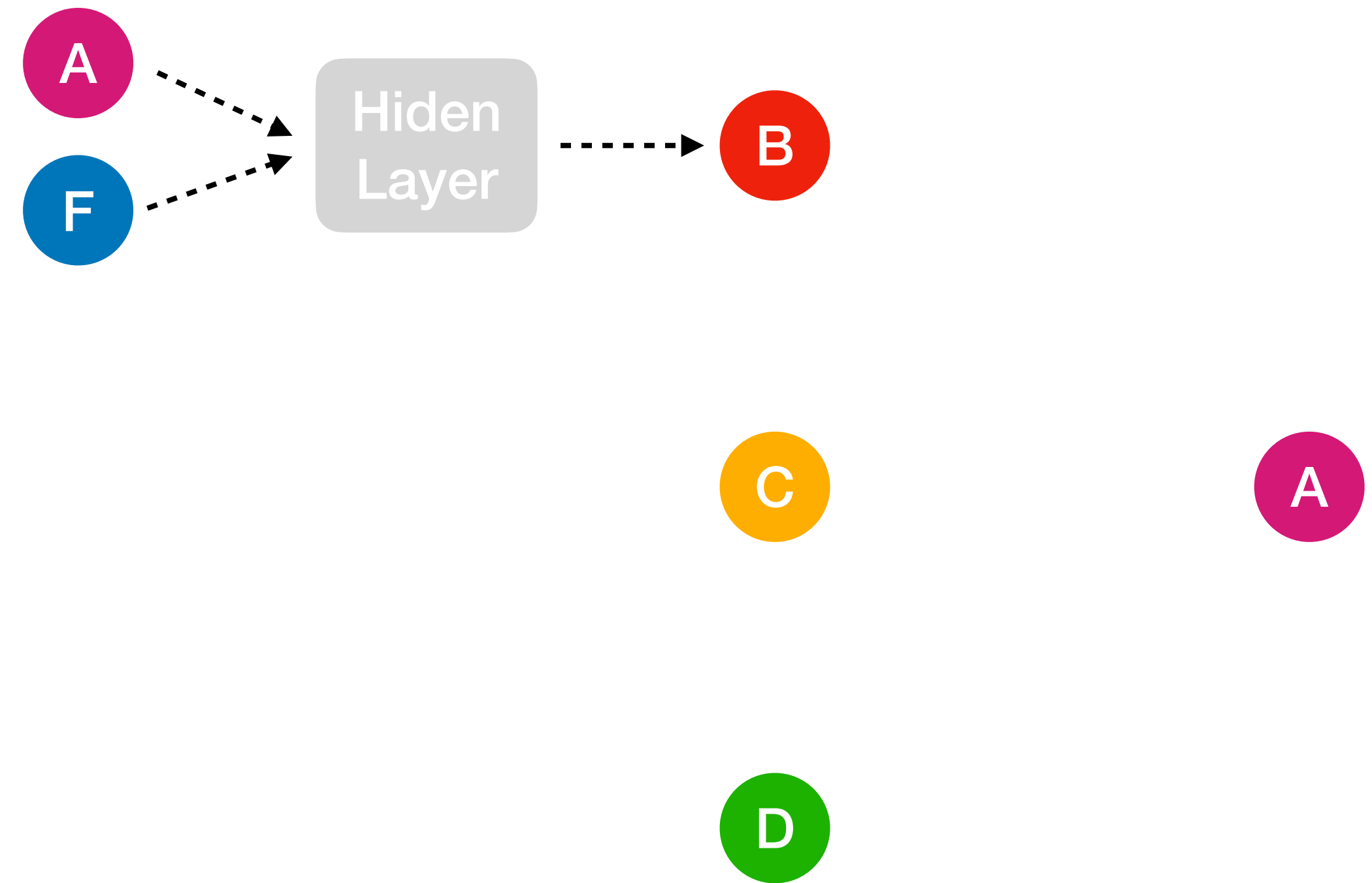
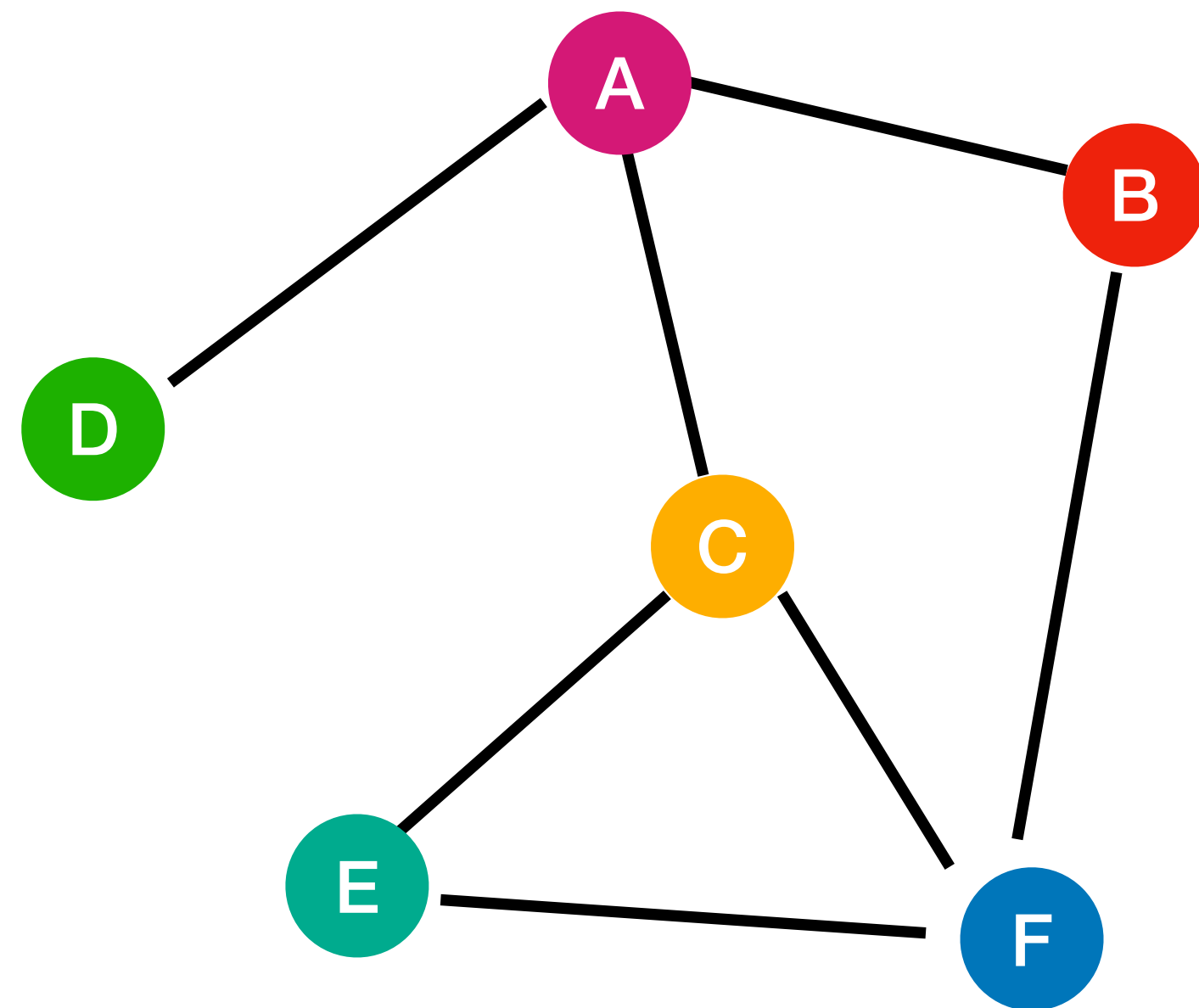
B

C

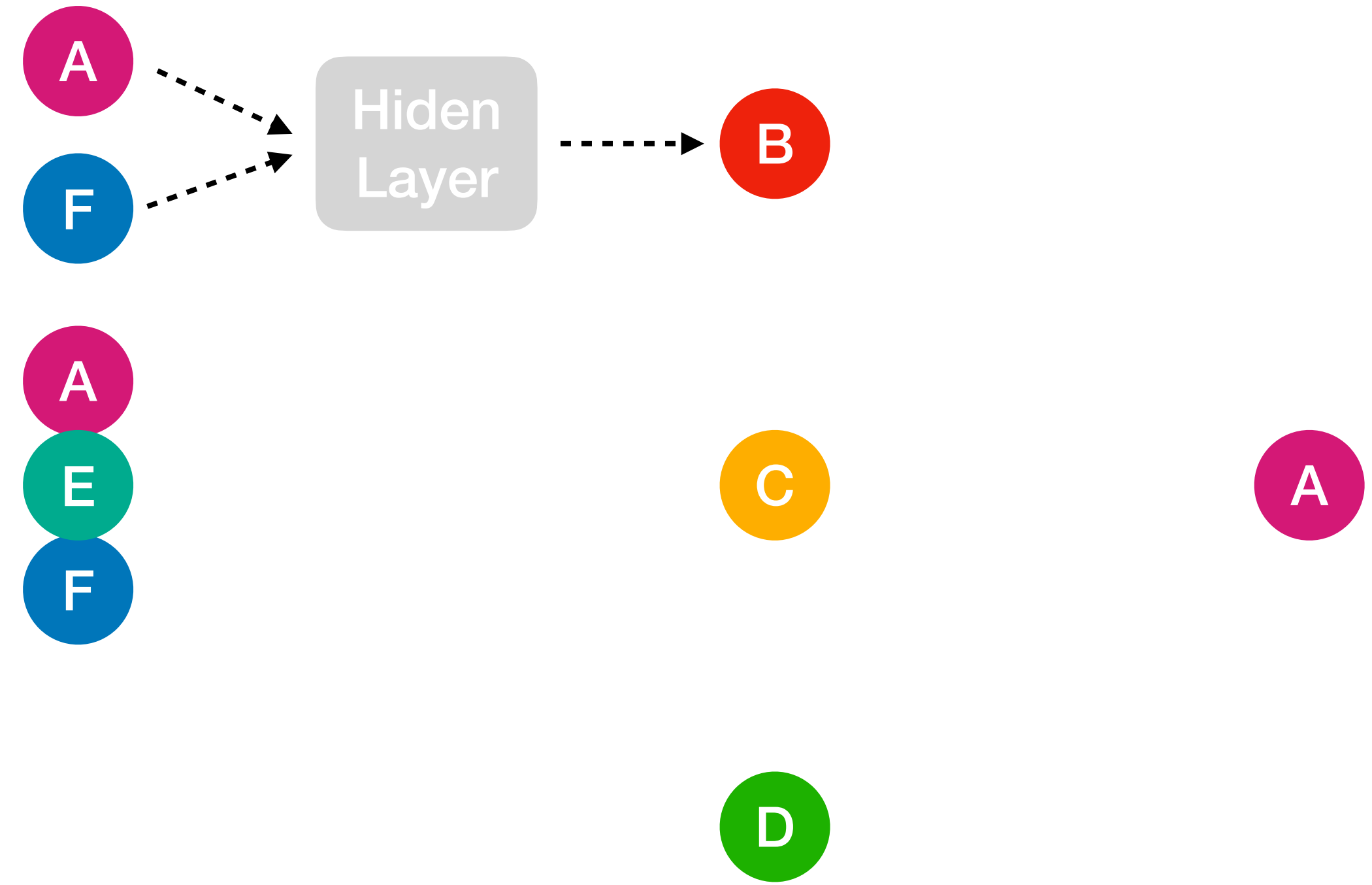
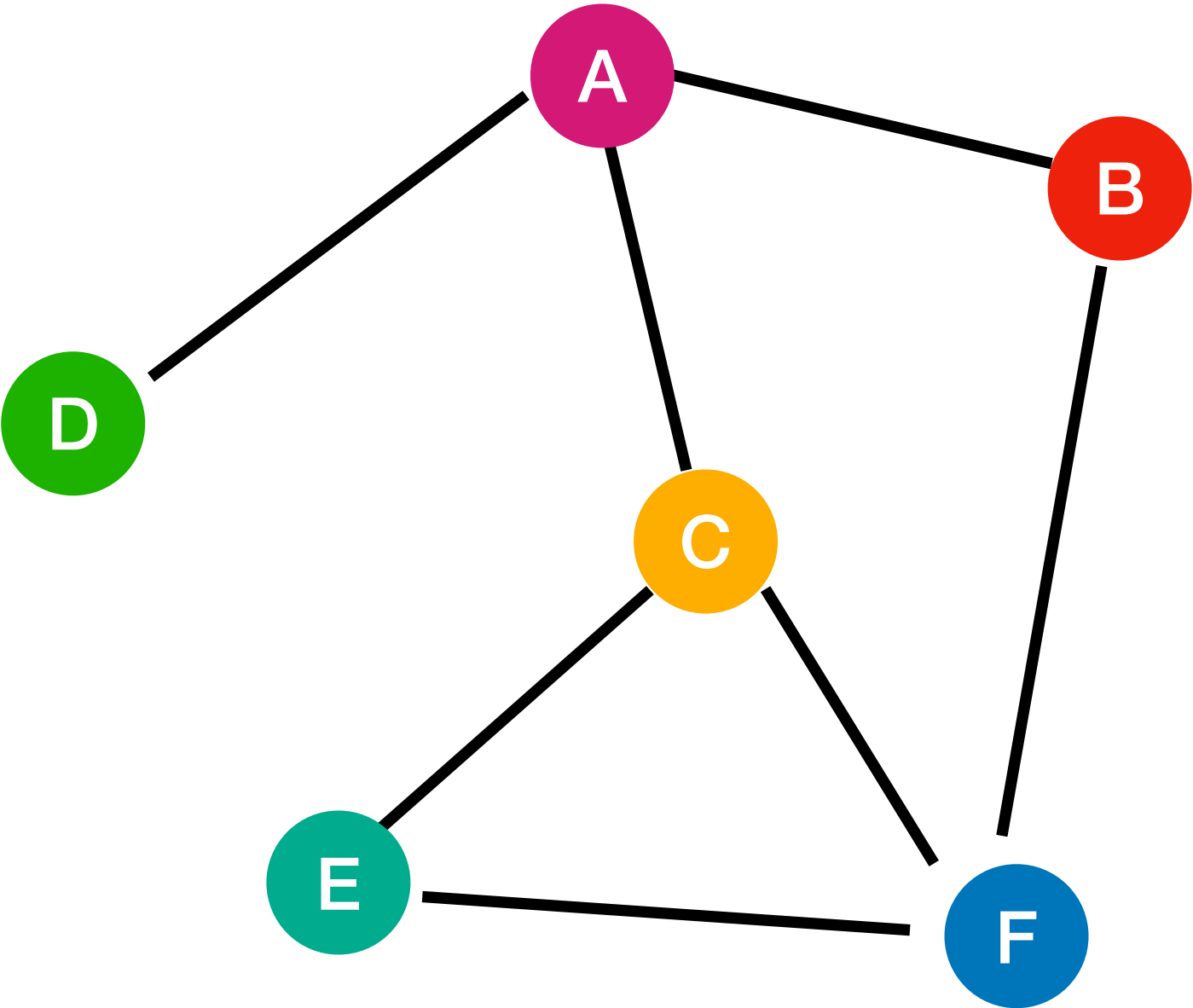
D

A

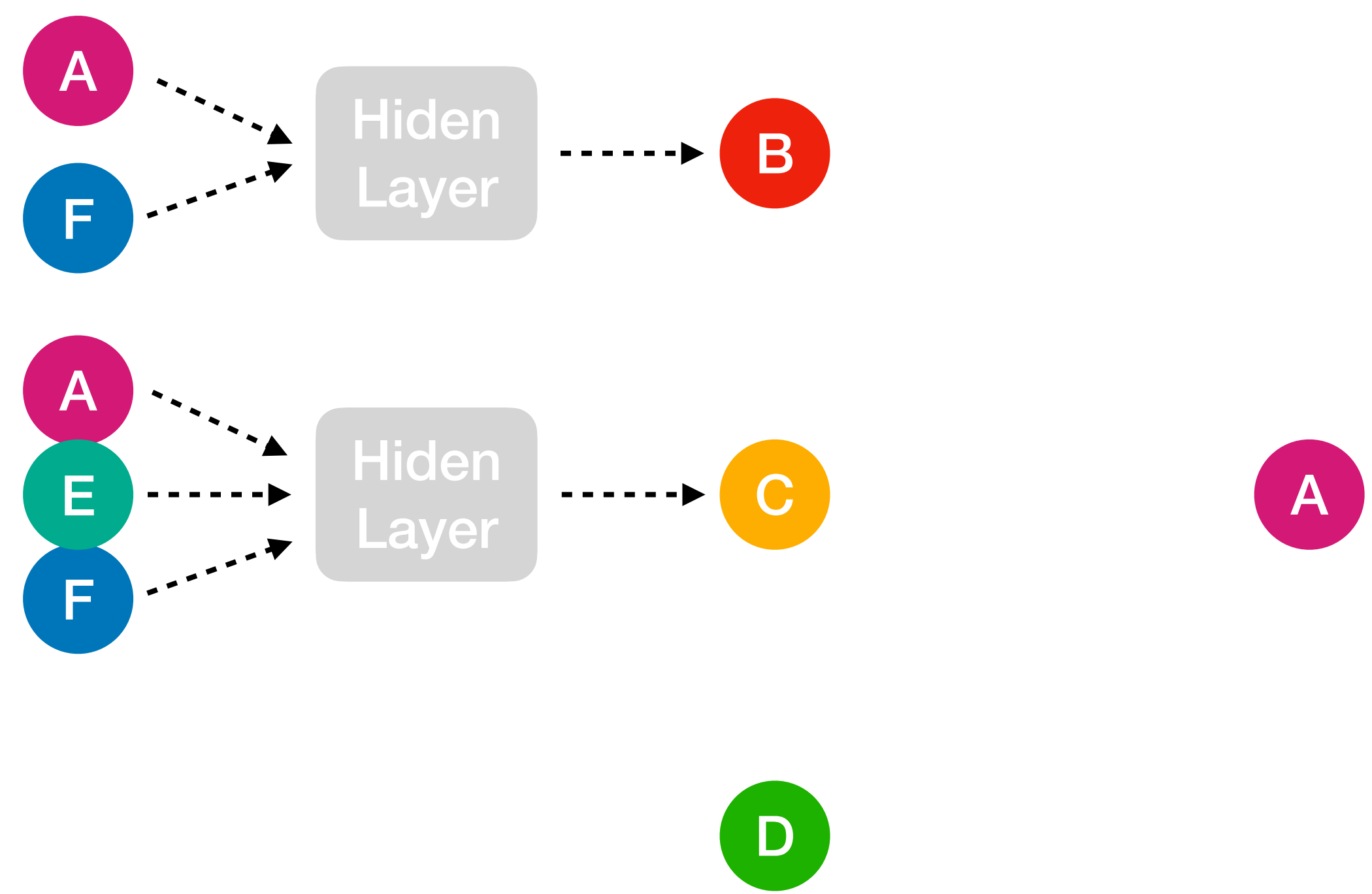
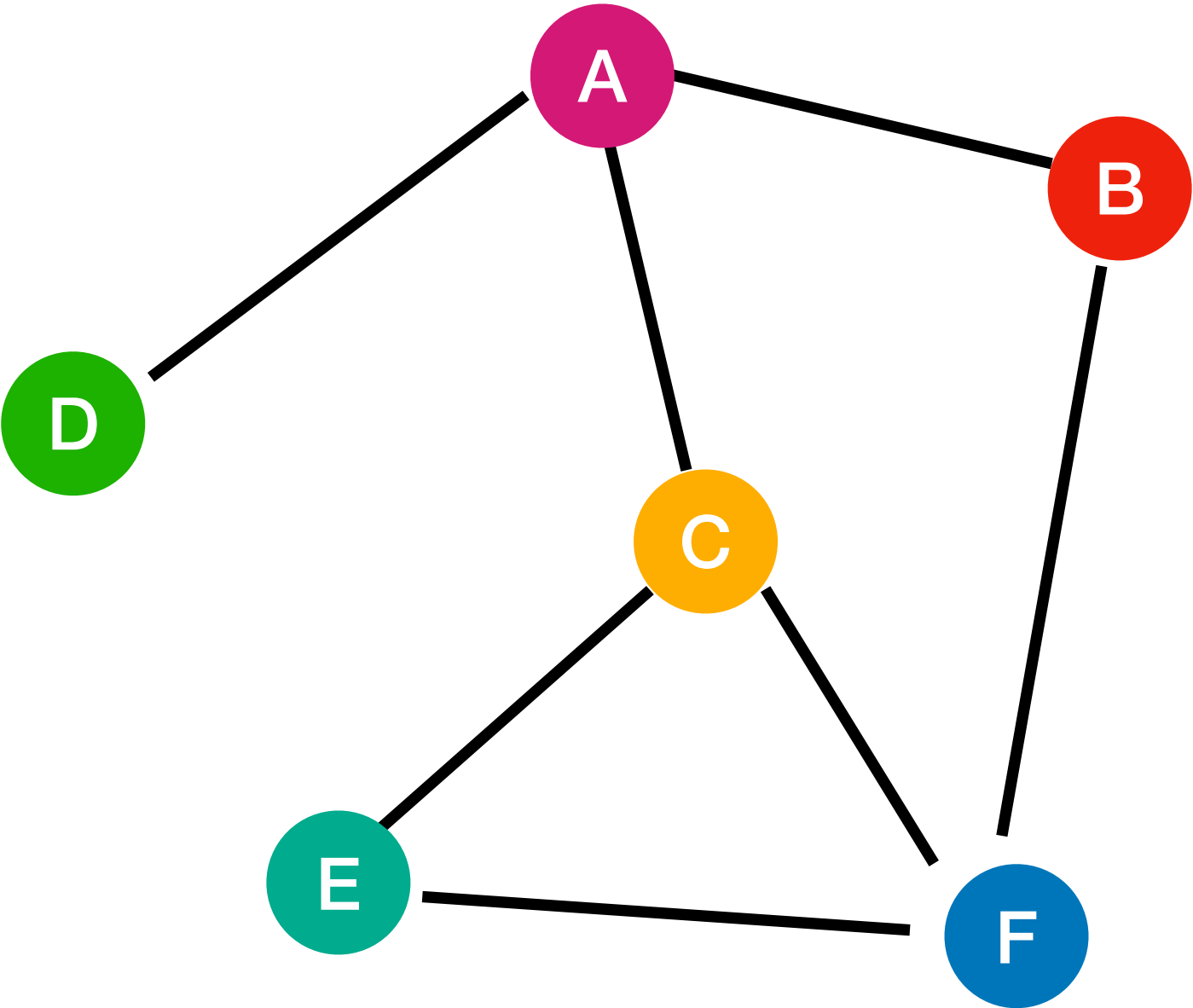
Graphic NN (GNN)



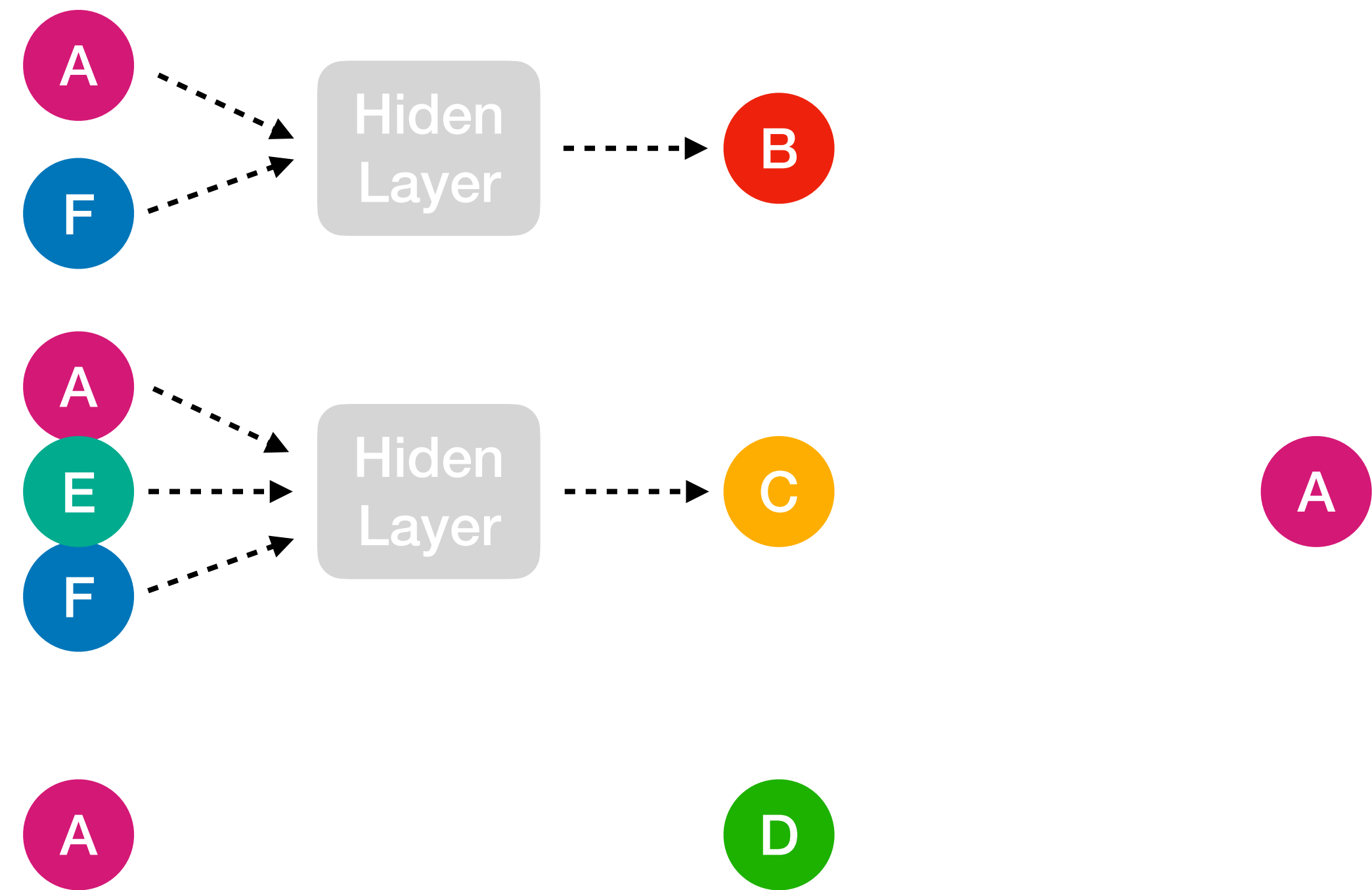
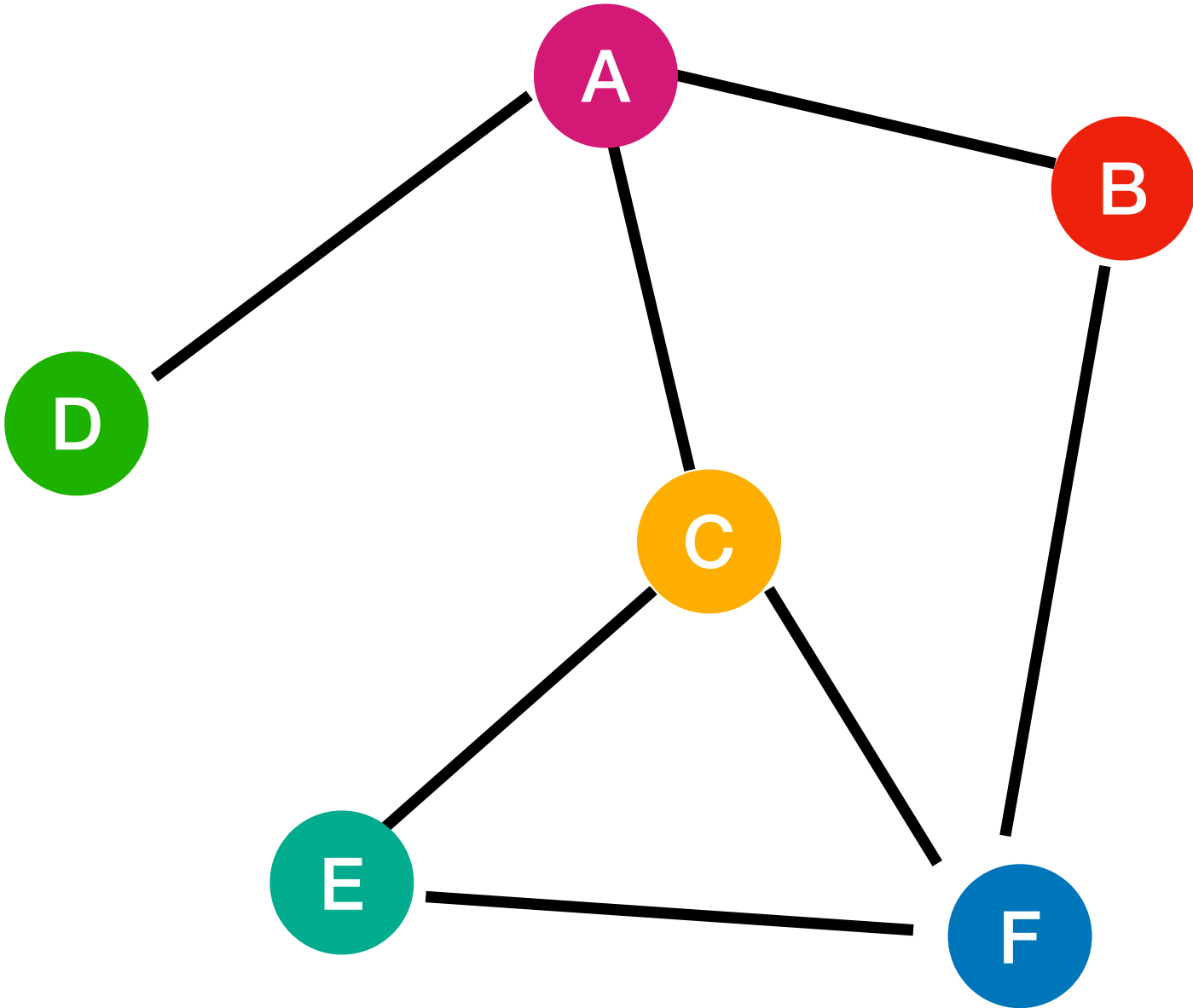
Graphic NN (GNN)



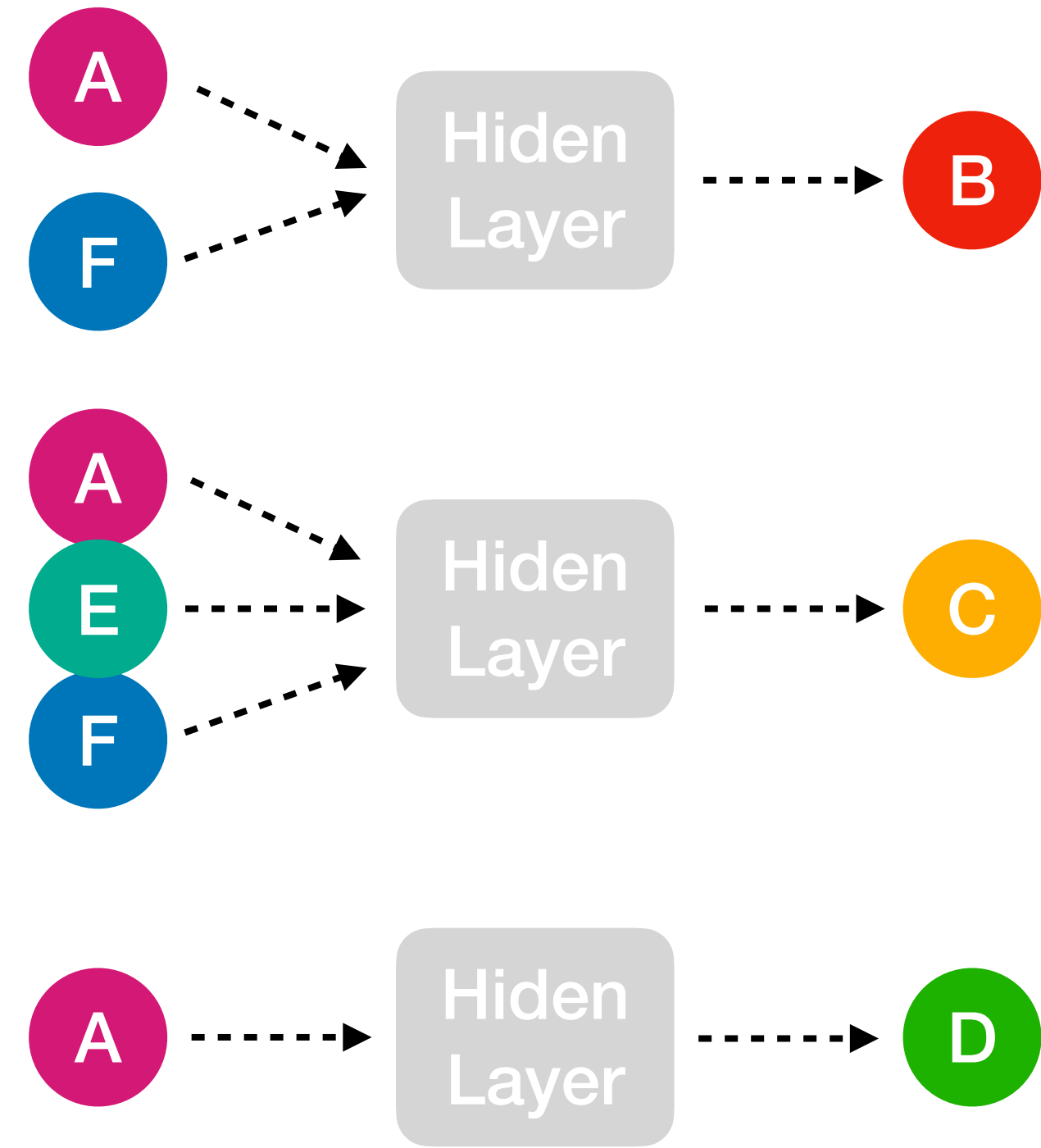
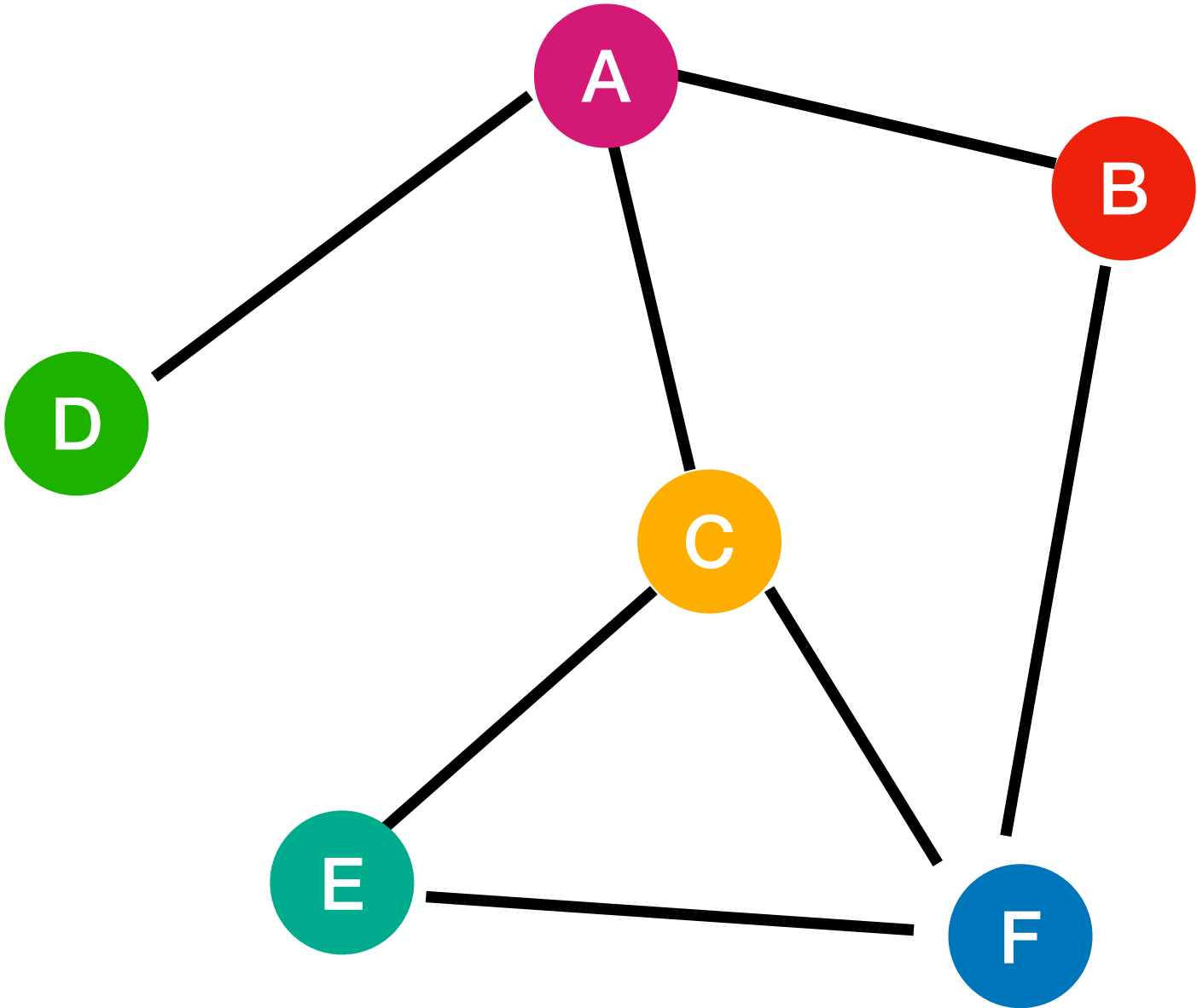
Graphic NN (GNN)



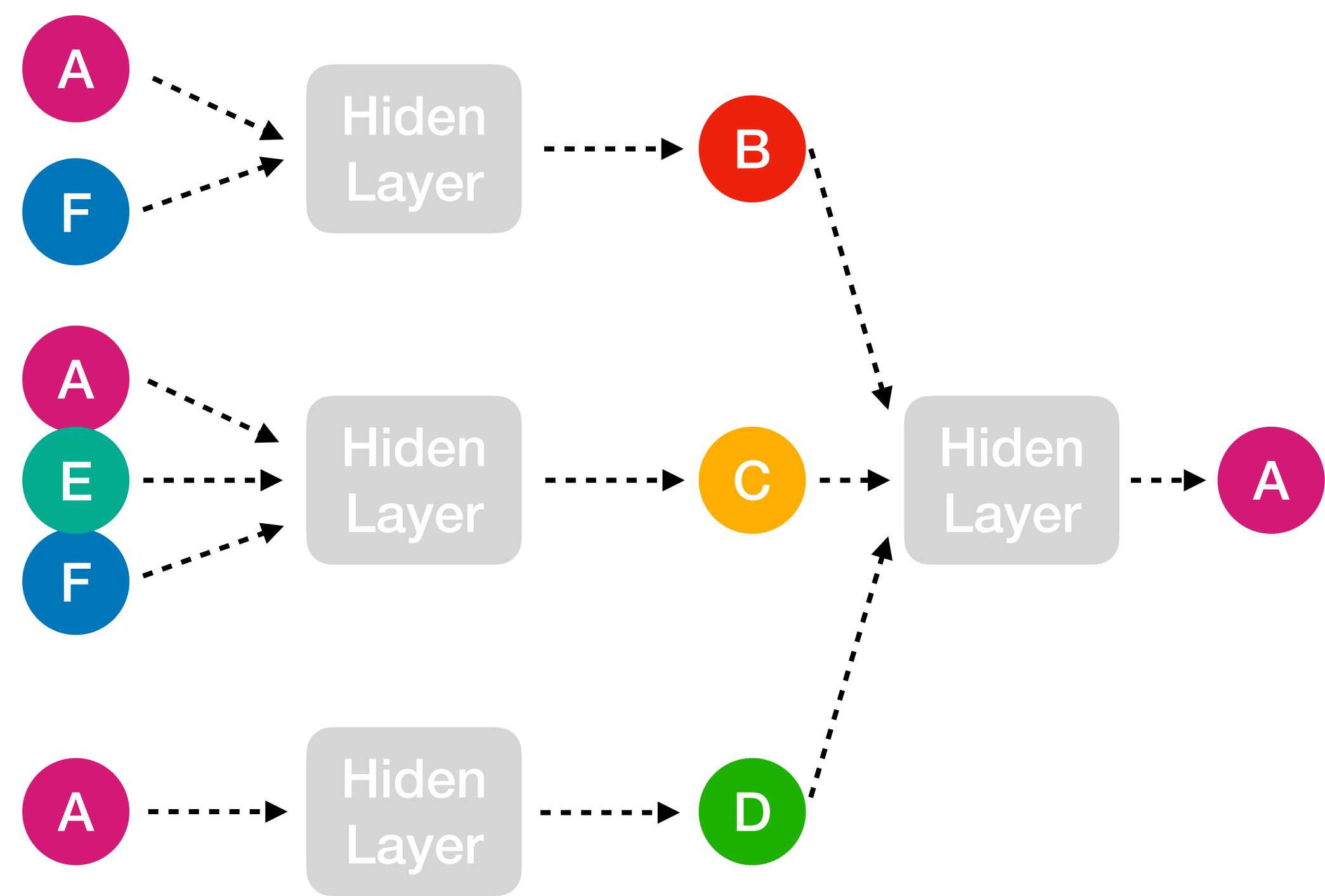
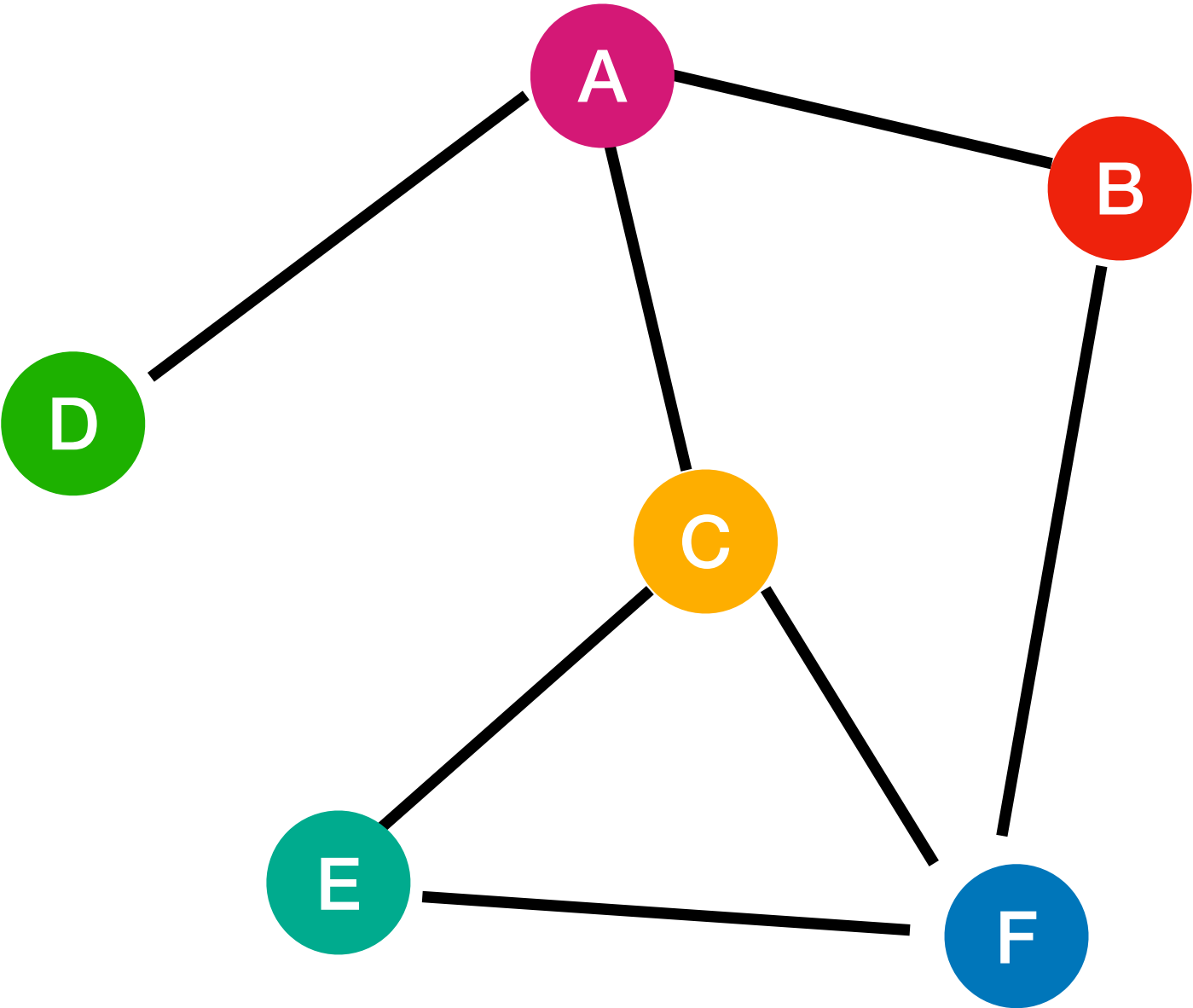
Graphic NN (GNN)



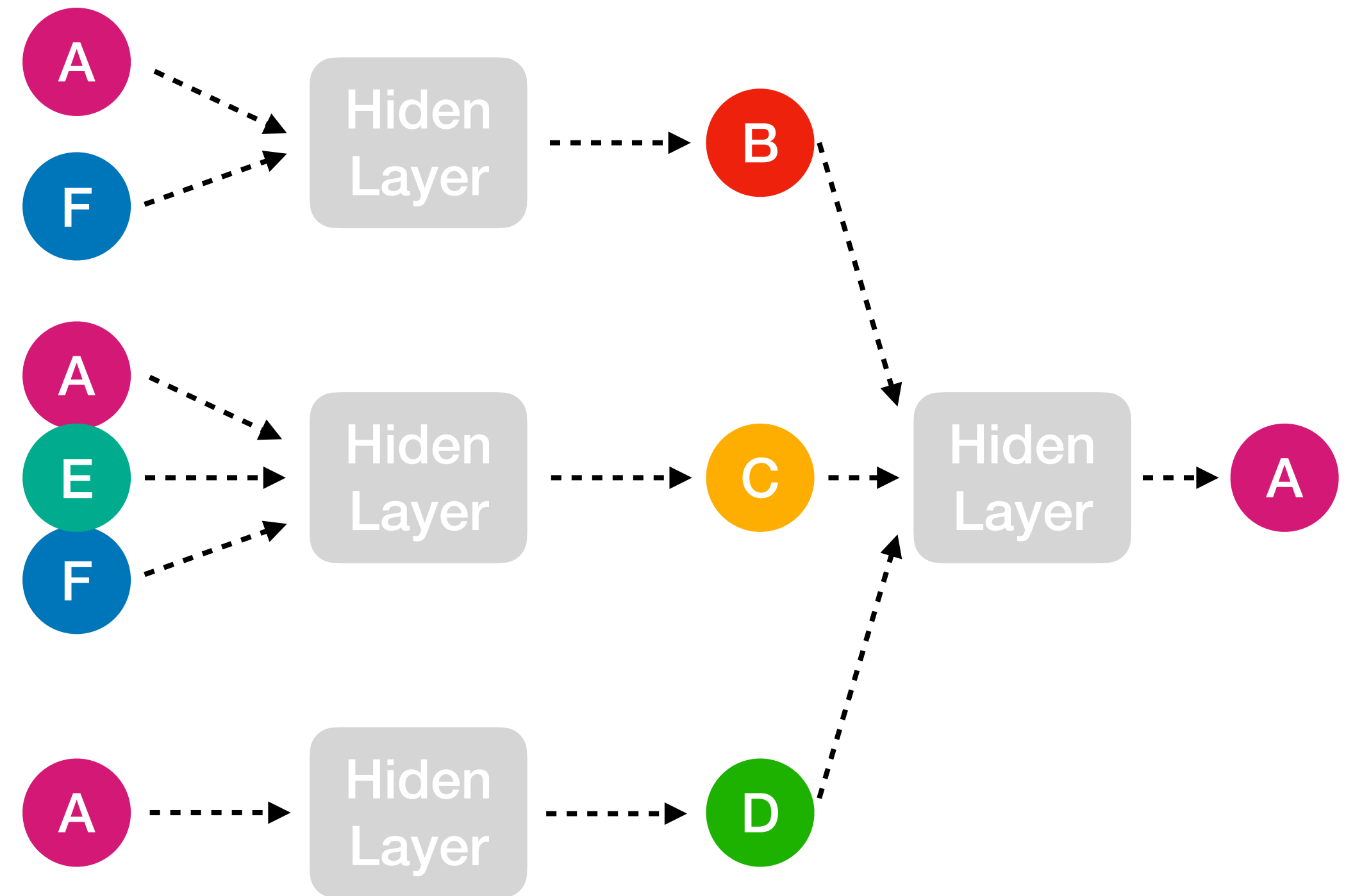
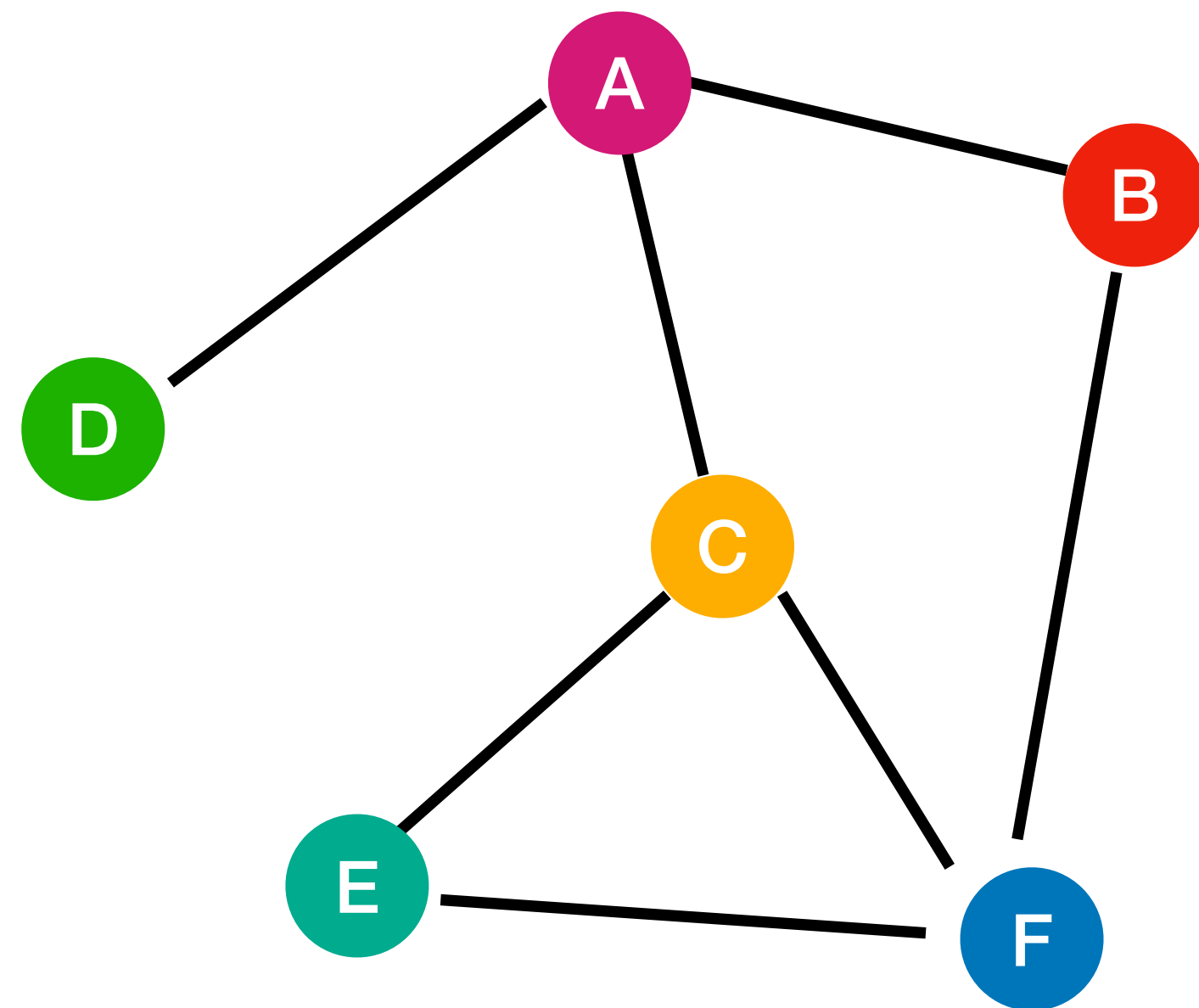
Graphic NN (GNN)



Graphic NN (GNN)

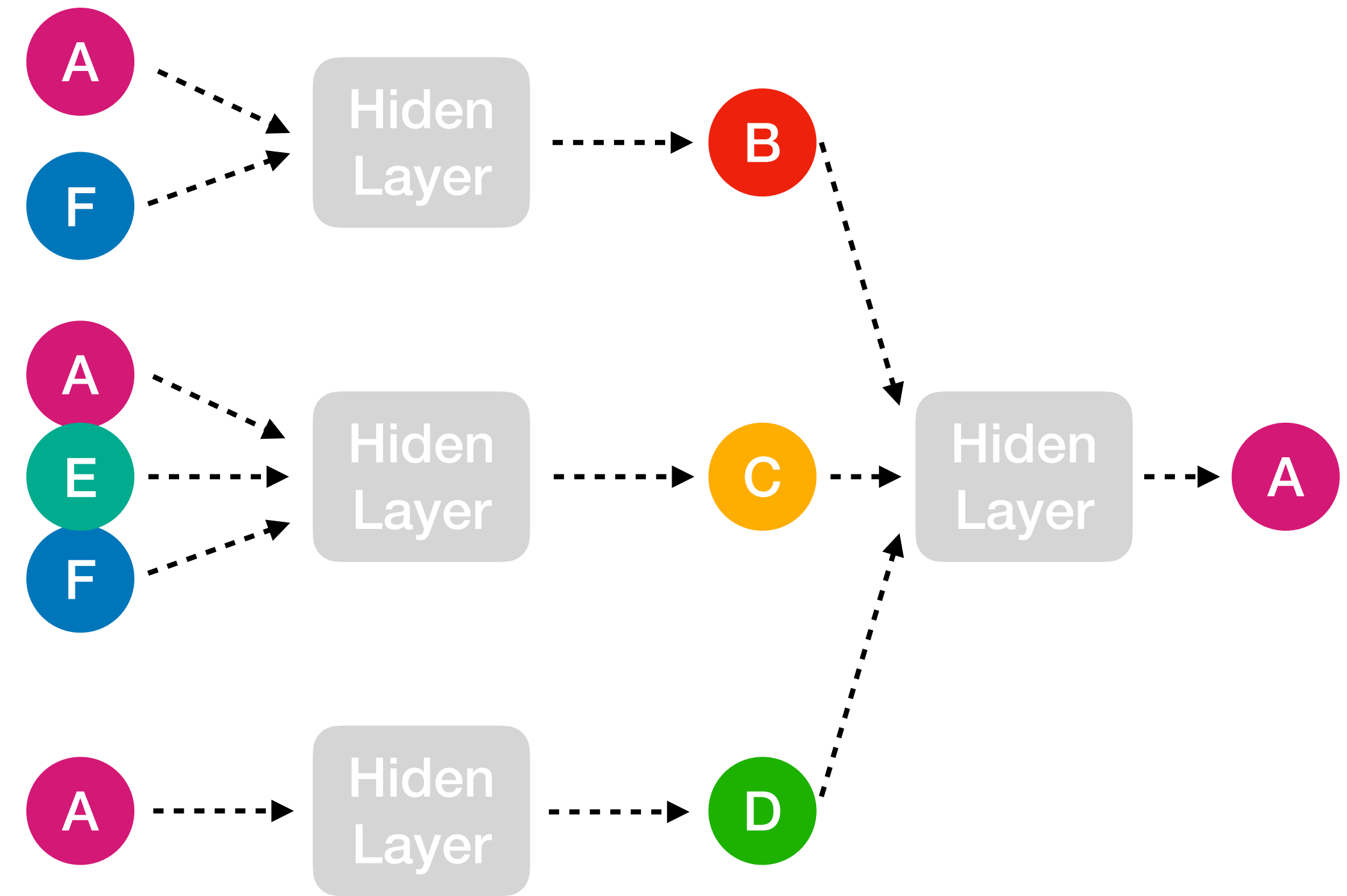
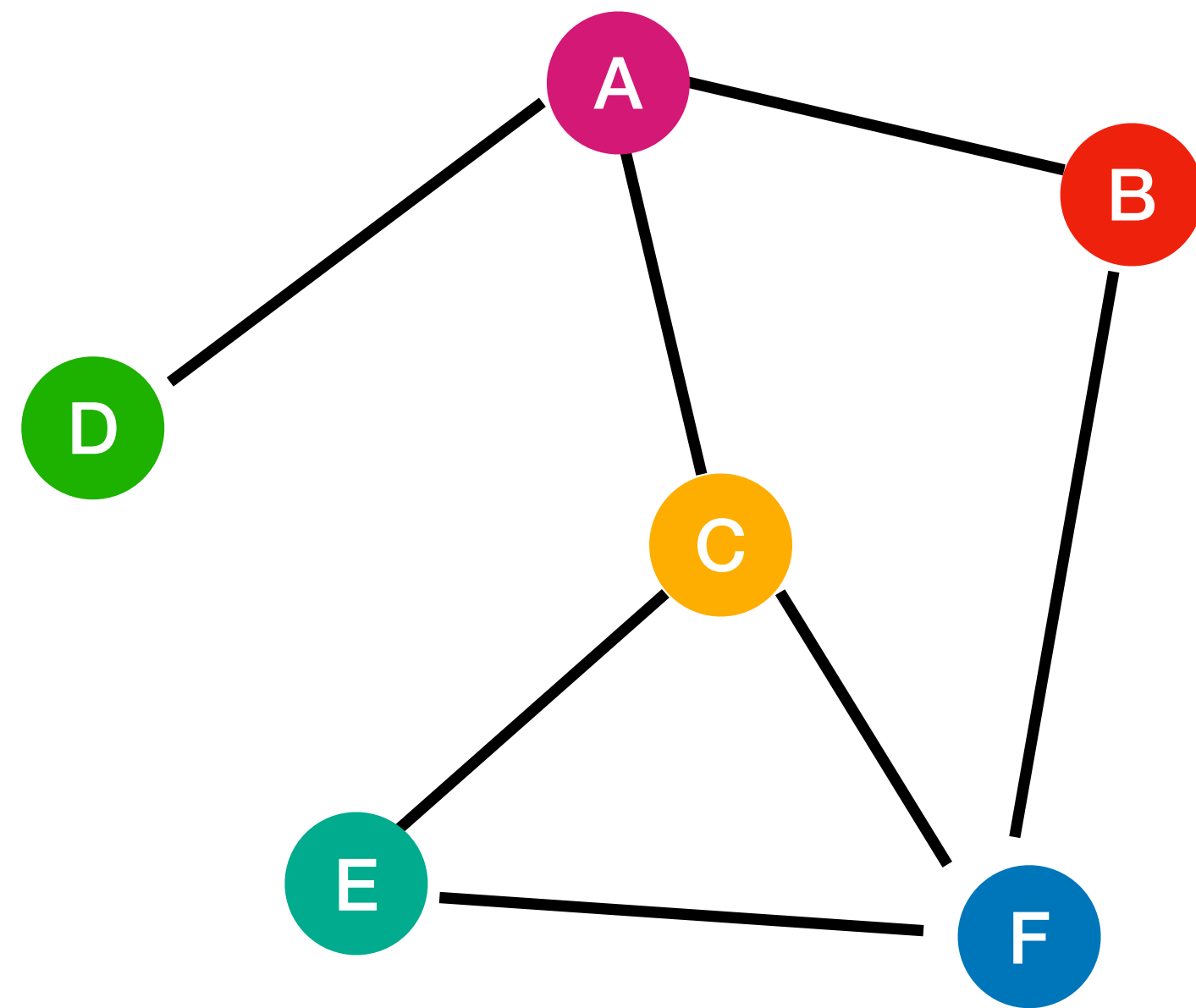


Graphic NN (GNN)



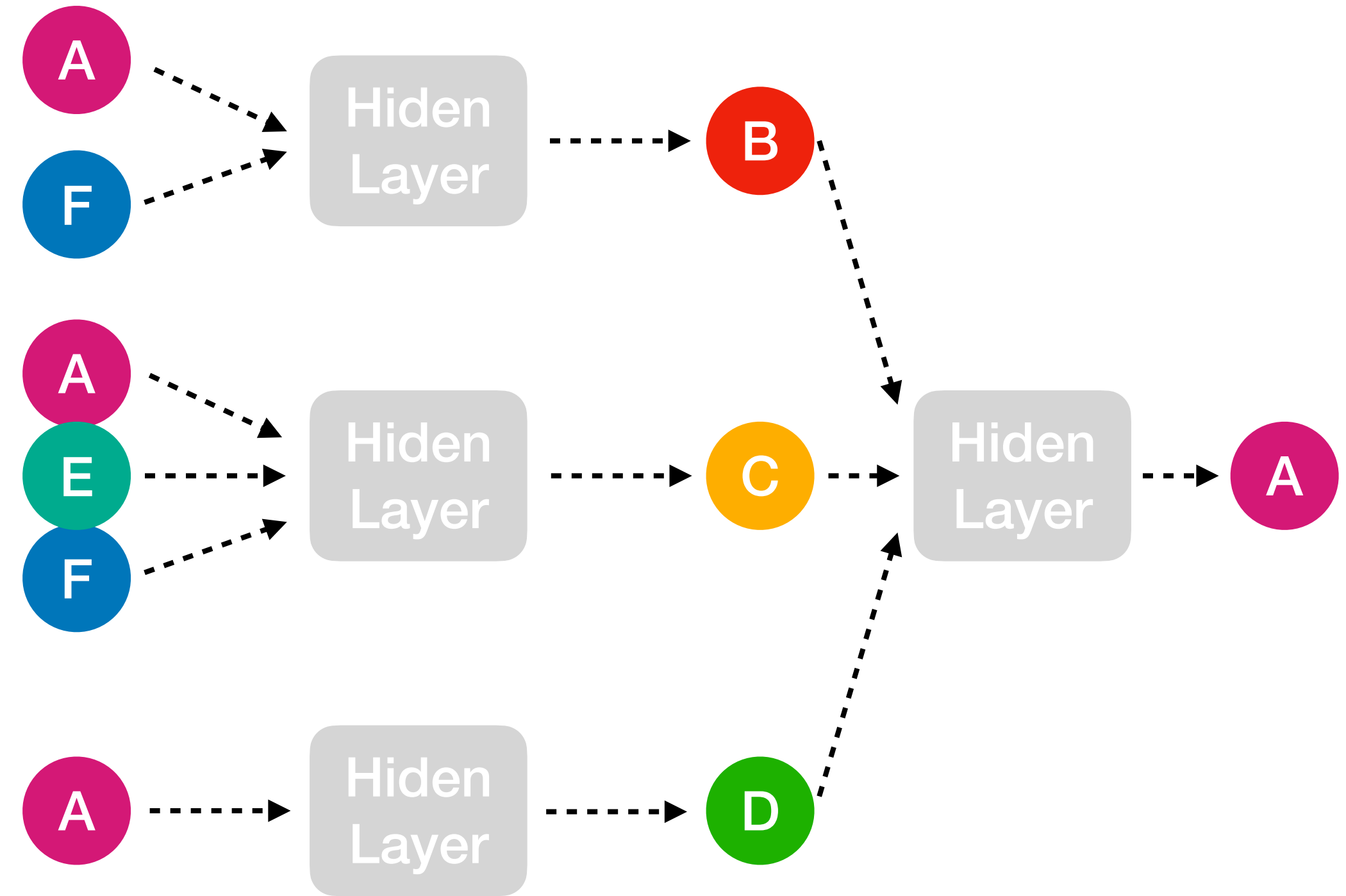
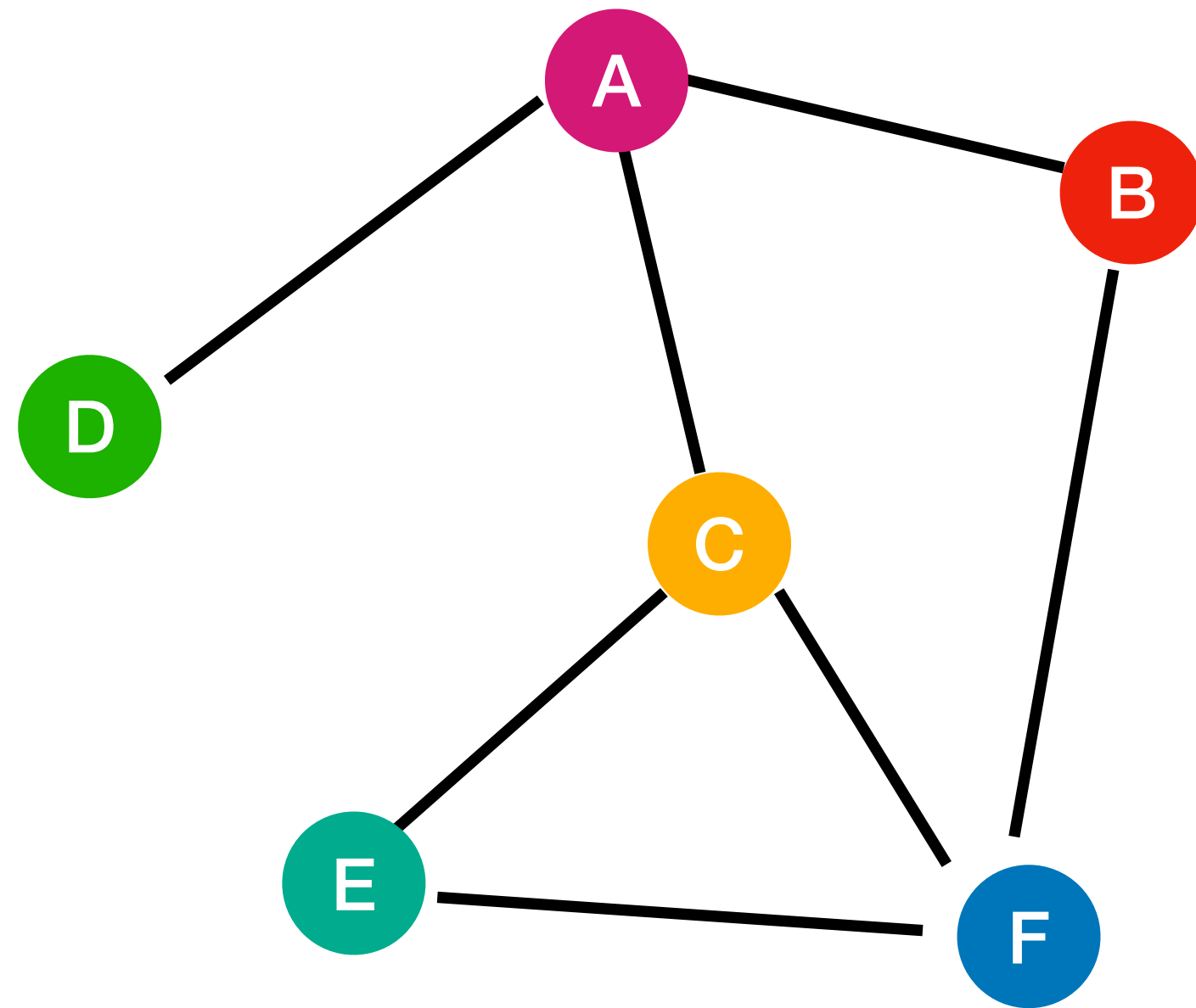
- Ideal for complex interdependencies between objects.

Graphic NN (GNN)



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- e.g. I/O analysis, medicine, material, social network

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