

T7

# Cognitive Systems

*2020 edition*

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# PSI 3560 – COGNITIVE SYSTEMS

*class T7*

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Department of Electronic Systems Engineering  
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# MACHINE LEARNING AND THE CONNECTIONISM

Statistical learning, traditional neural network approach, deep learning,  
advanced networks

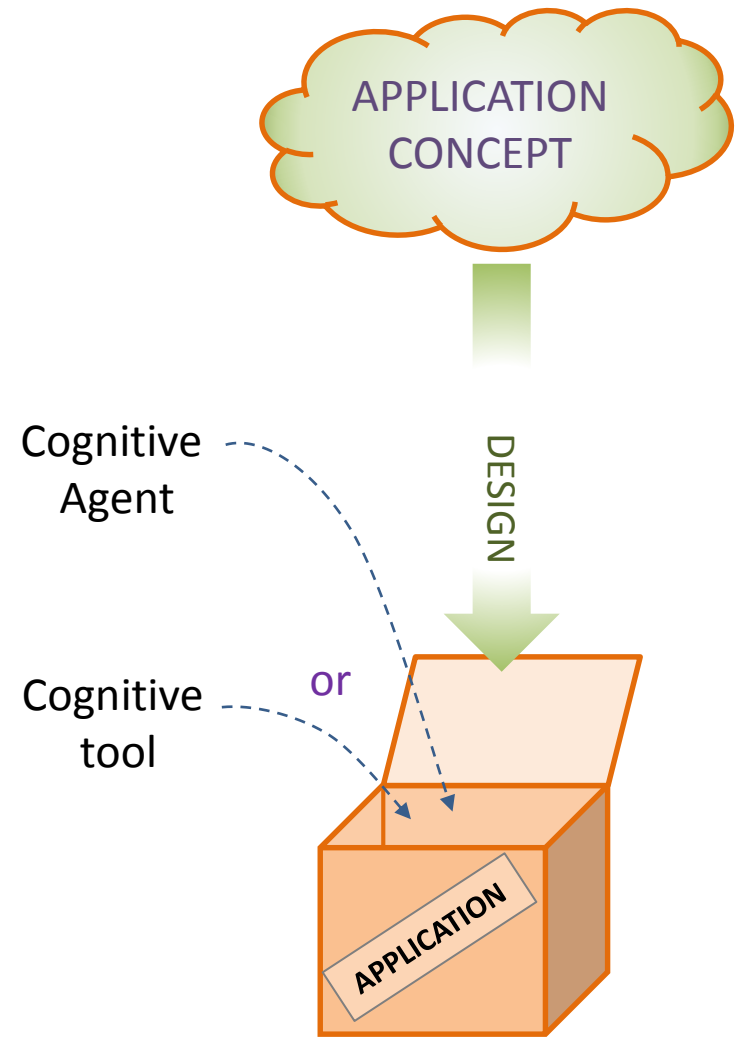
Session T7

# Summary

- Second session ( 9:20 – 11:00 )
- Inductive inference via statistical learning
  - Introduction to deep neural networks
    - Example: MNIST database handwritten number recognition
    - Limitations

# Design of a Cognitive System, again...

- Conceptual analysis:
  - What the application does ?
    - » It is a **cognitive system** that does... ?
  - How does it do that ?
    - » Agent or tool ?
- After the formal statement of what the application does,
- Then comes the problem of **modelling the cognitive system**
  - We used Marr's approach



# Design of a Cognitive System

## MODELLING THE COGNITIVE SYSTEM

### – Marr's approach

- Three levels of analysis

- Computational model

- » What kind of computations are required ?

- » What is the nature of the computations ?

- Logical, statistical , both ?

- ARTIFICIAL INTELLIGENCE


- MACHINE LEARNING



- Algorithmic specification

- Physical implementation

# Deductive versus Inductive

- The cognitive quest
  - Cognition → Knowledge
    - Build it, use it...
    - Change deductive inference to inductive inference
      - Probabilistic inference
      - Machine Learning 
        - » Is here a hope for building knowledge ?
        - » Knowledge can be learned from the data ...
        - » ... through an inductive process
          - The inductive process detects patterns in the data
            - These patterns bring the invariants
              - ... that make the knowledge...

# Introduction to deep neural networks

- We will start with a brief introduction to machine learning via deep neural networks
  - By following an example of application
    - Handwritten numbers recognition
      - MNIST database
        - » The MNIST database (Modified National Institute of Standards and Technology database) is a large database of handwritten digits that is commonly used for training various image processing systems
          - Yann LeCun et al - <http://yann.lecun.com/exdb/mnist/>

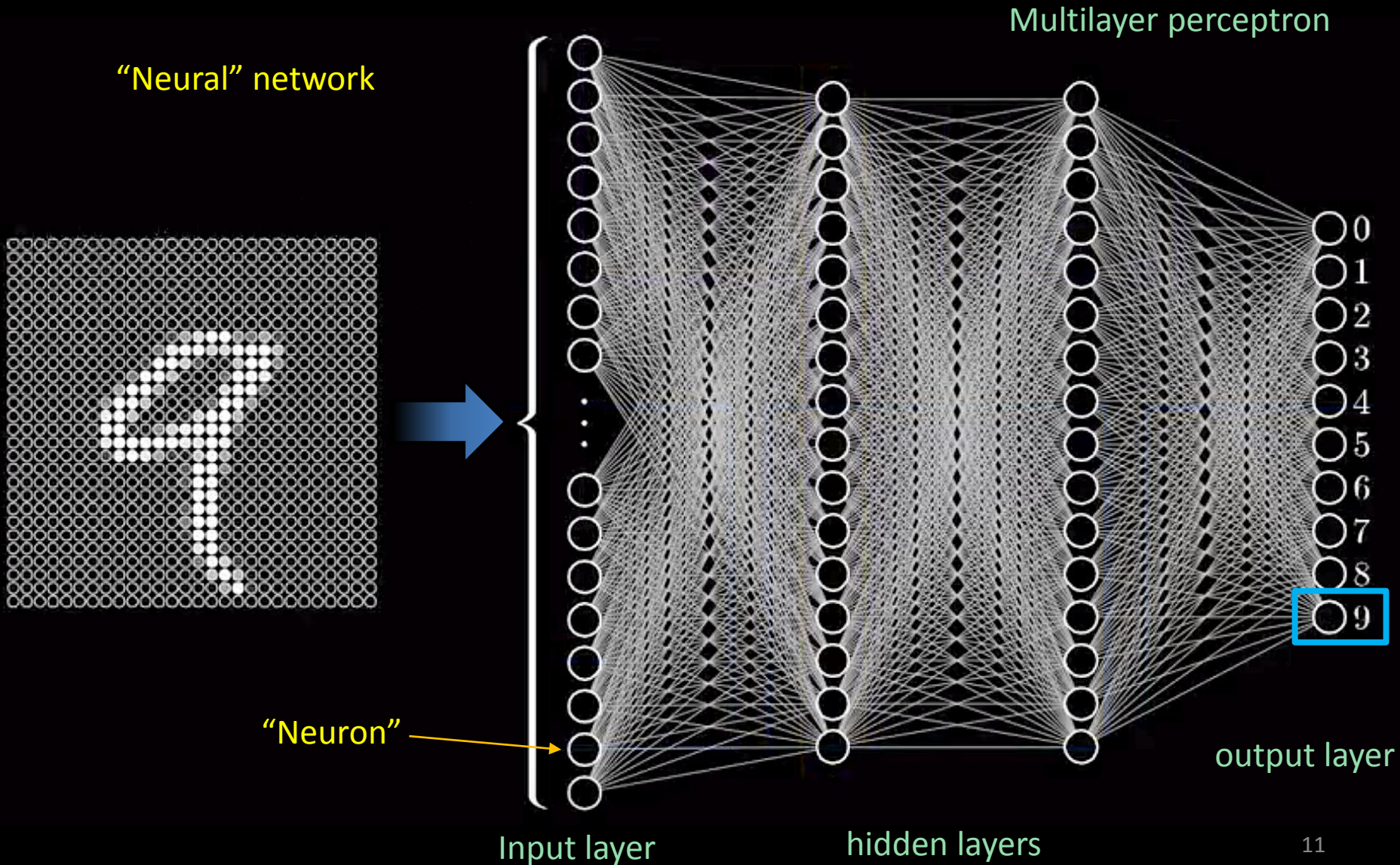




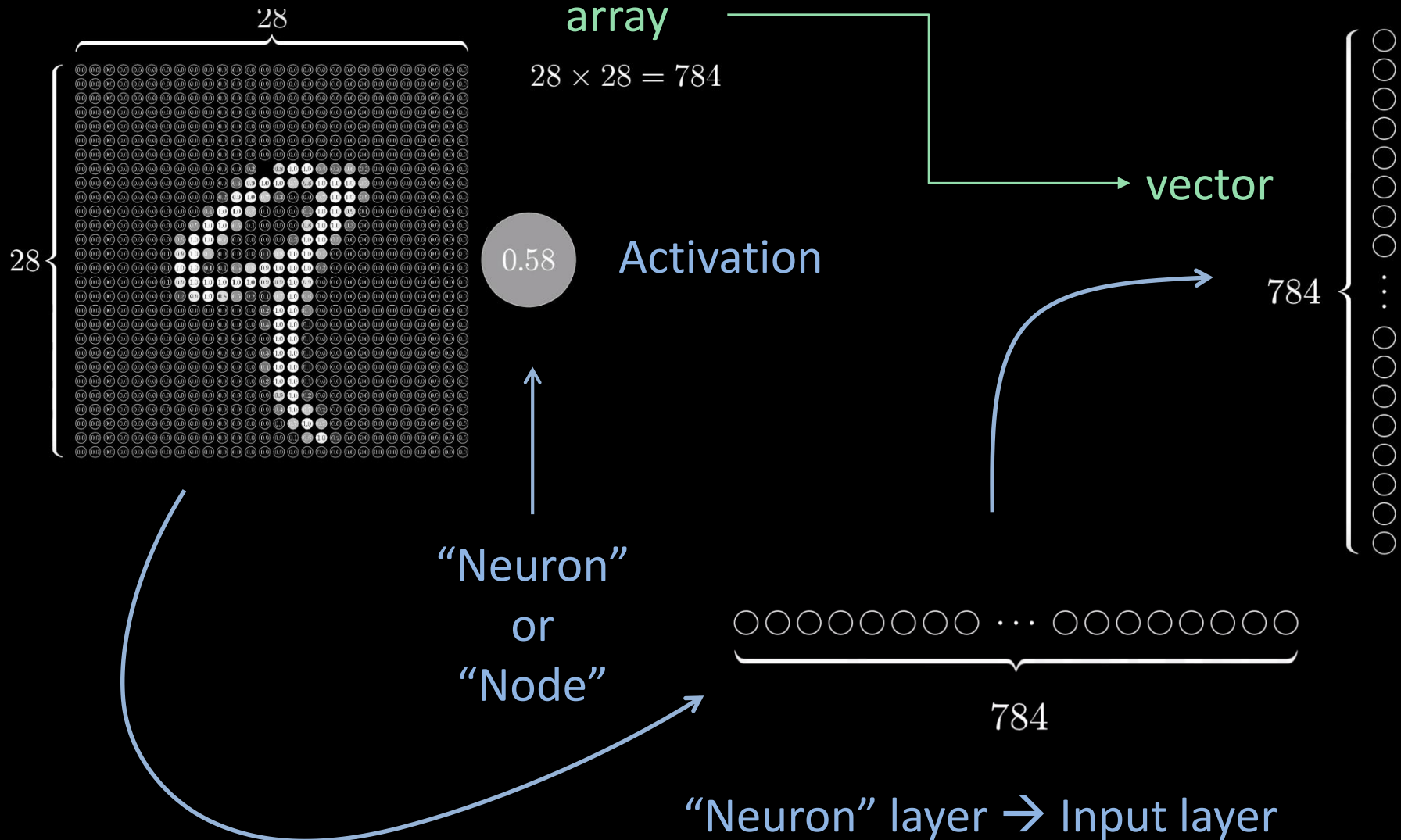




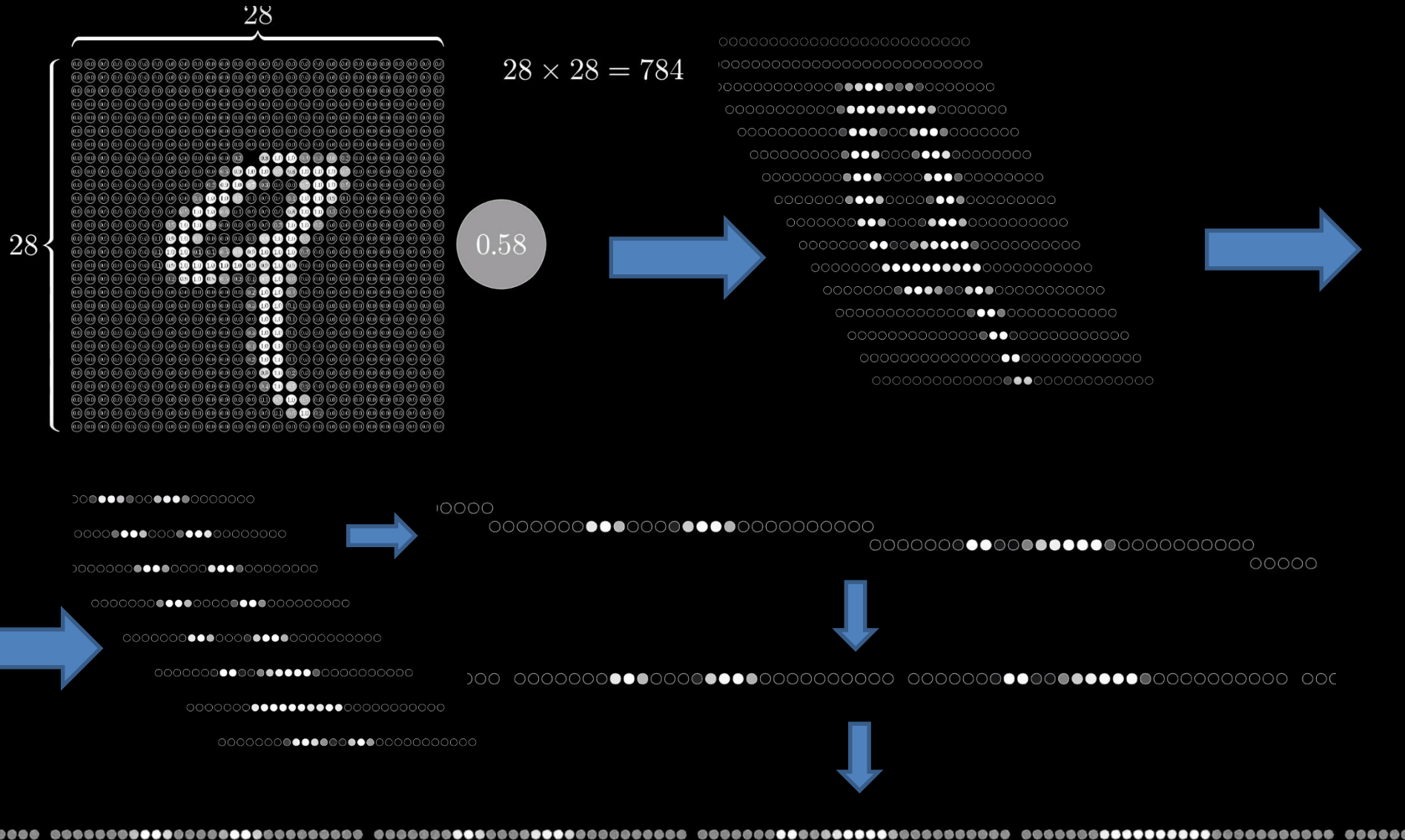
# Handwritten number recognition



# Handwritten number recognition

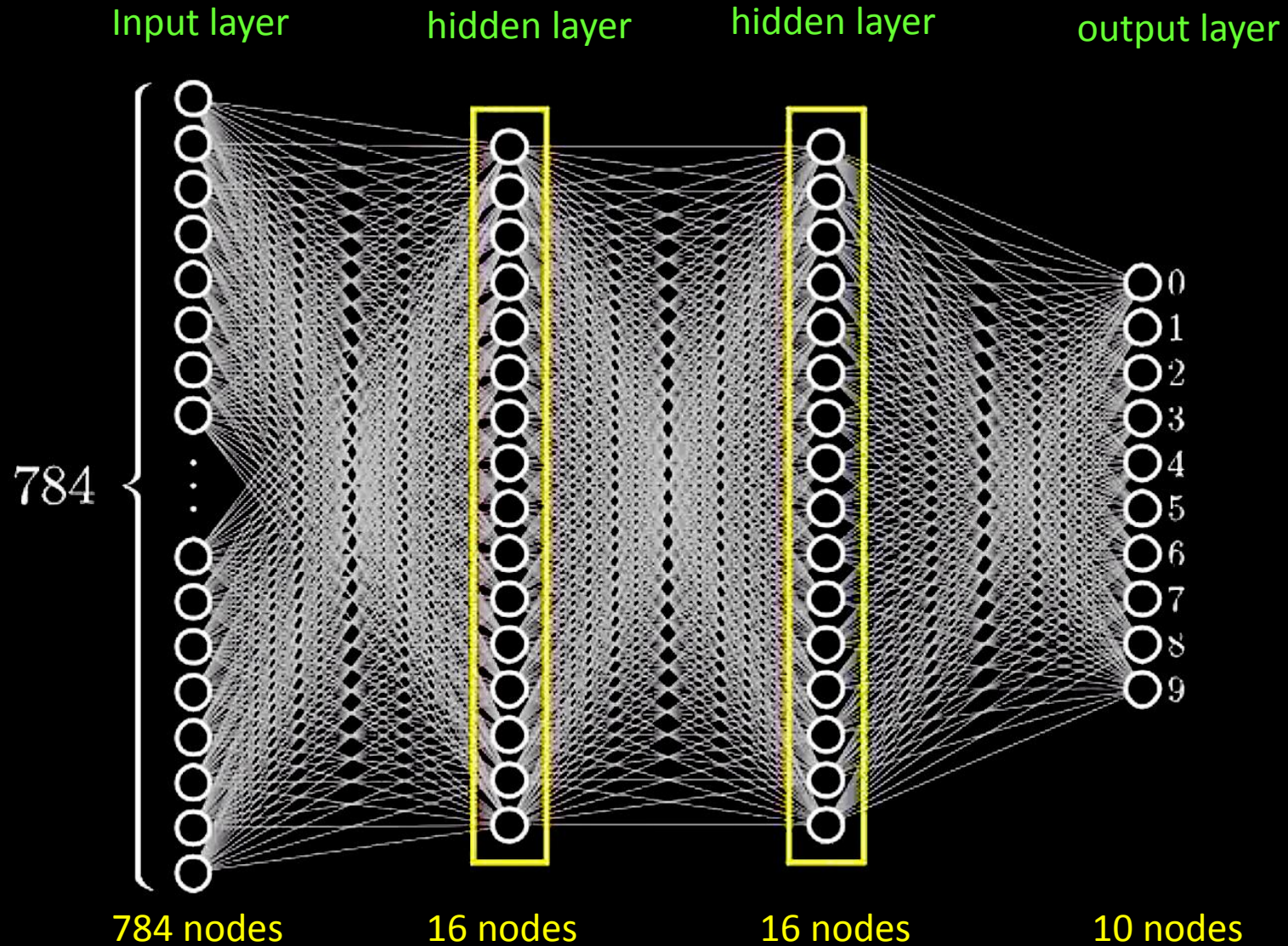


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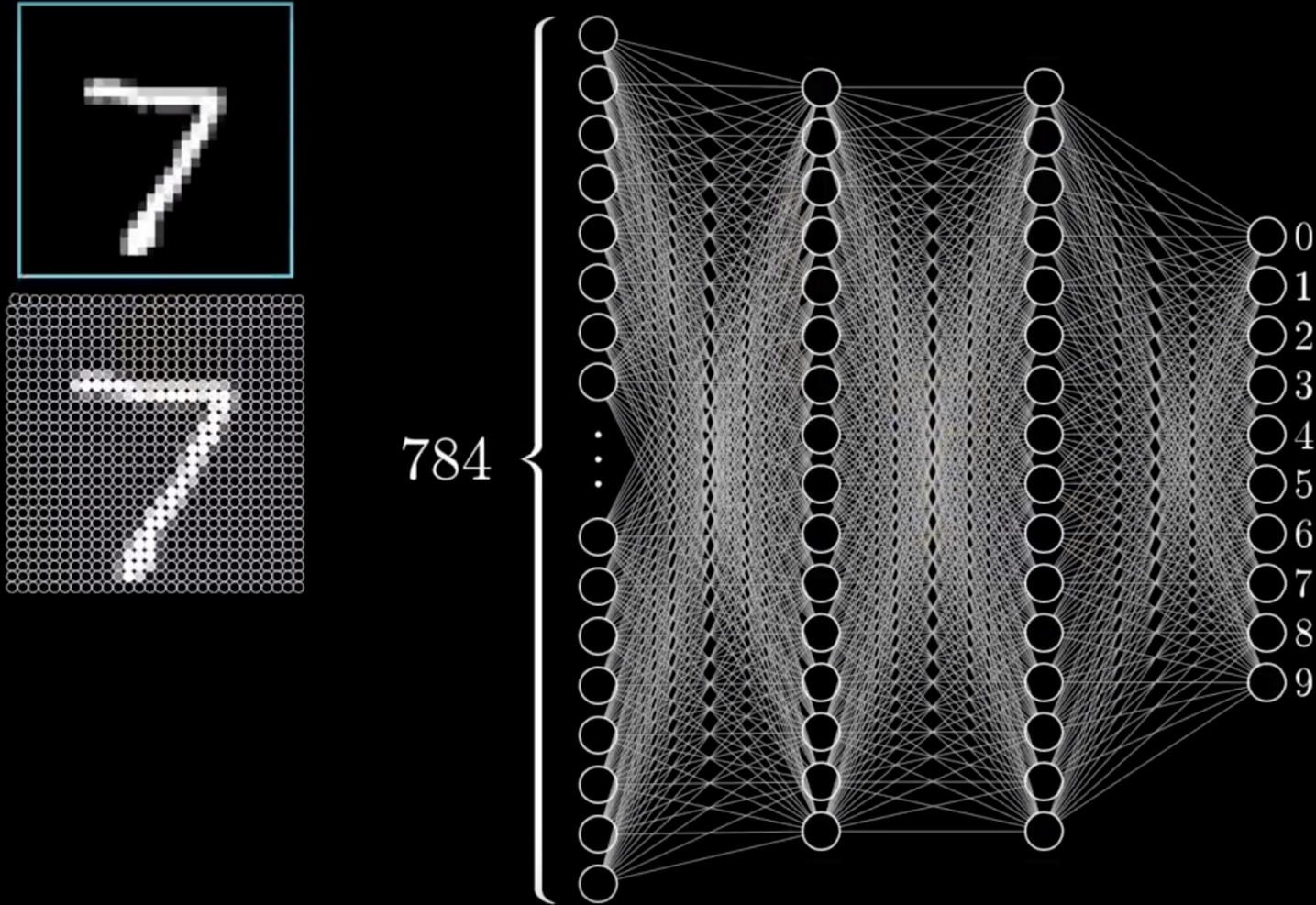




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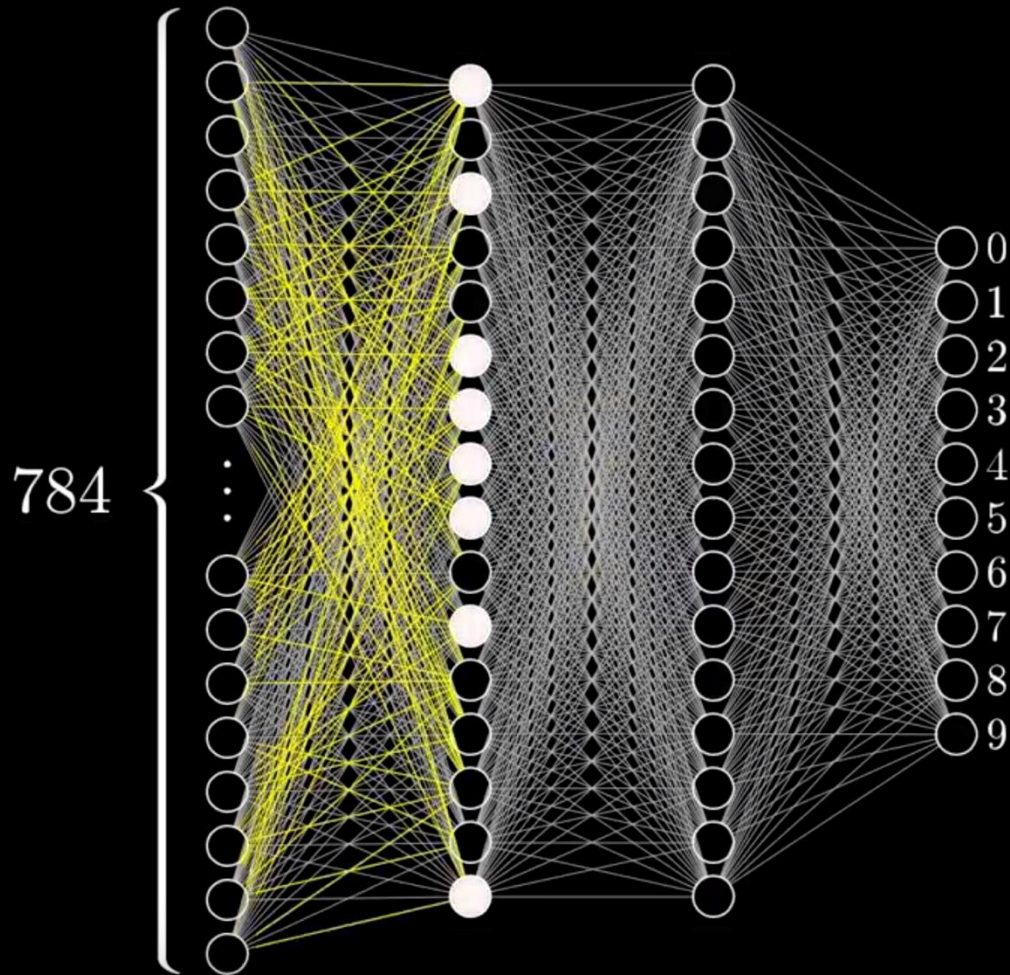


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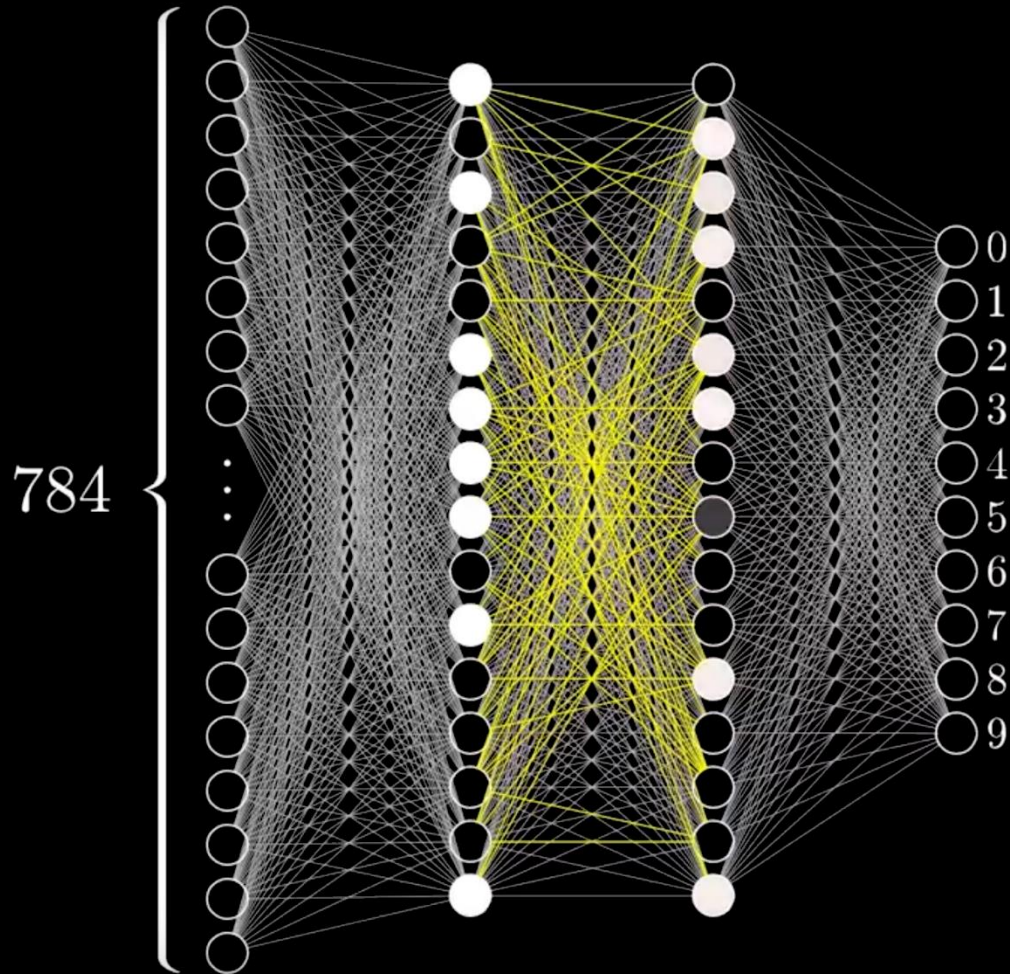


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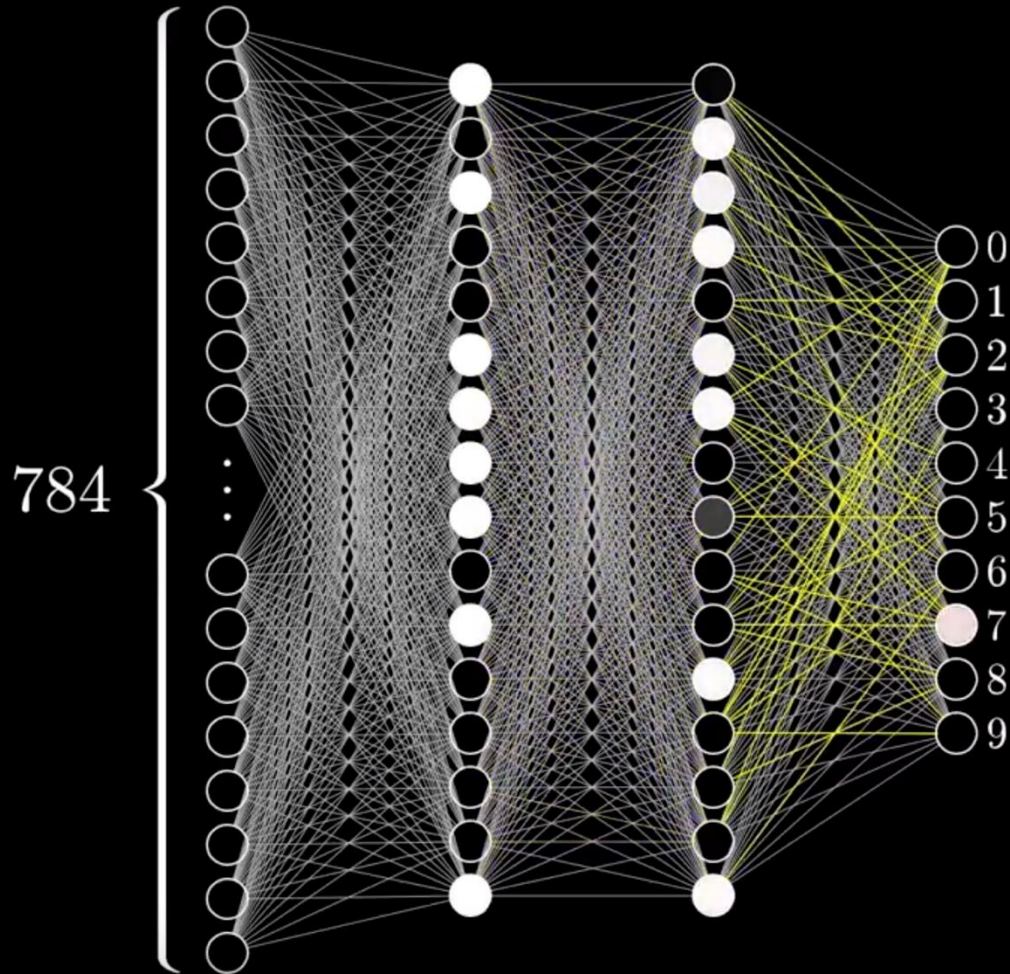




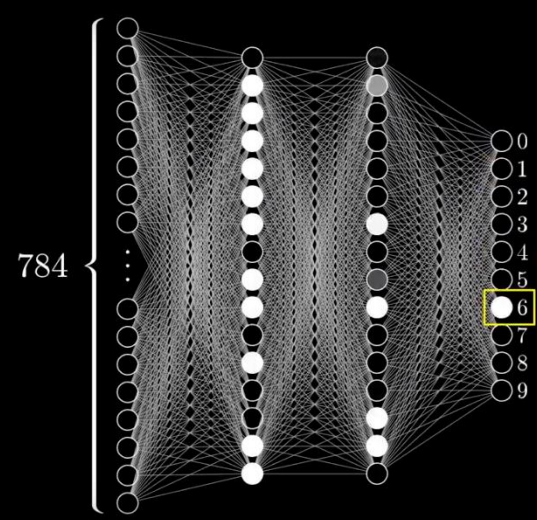
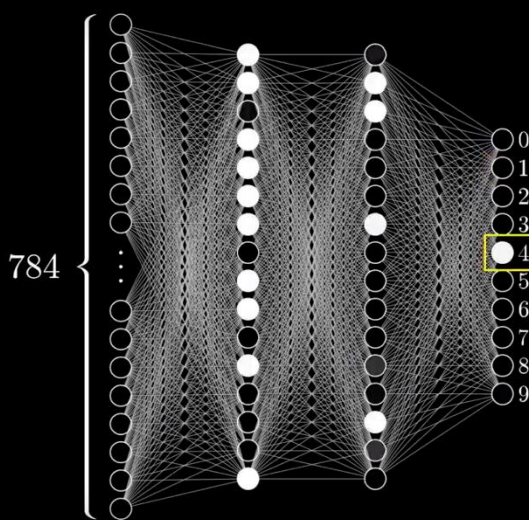
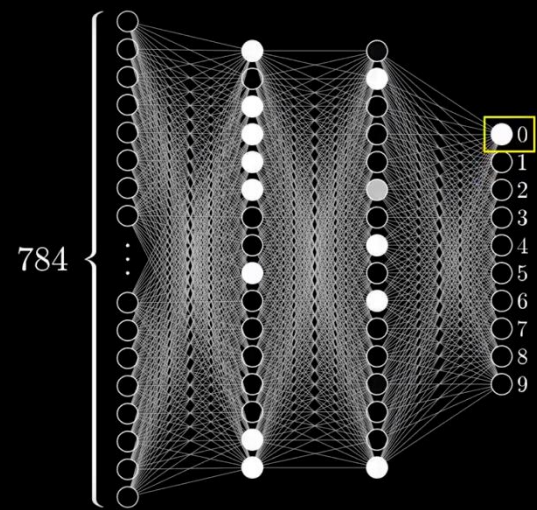
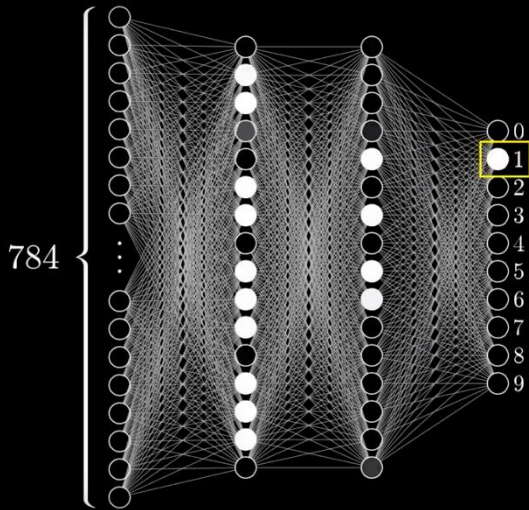
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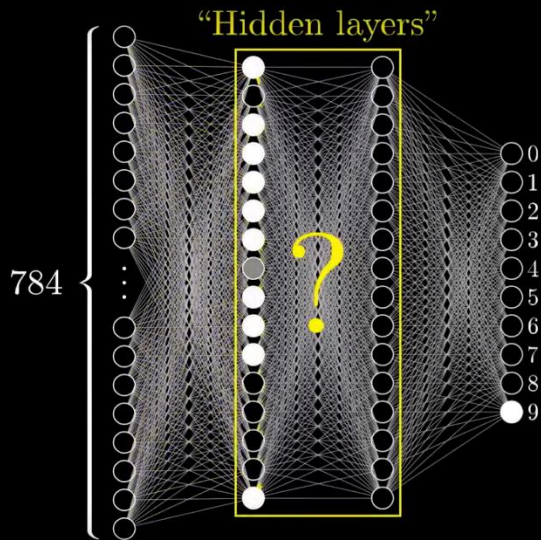


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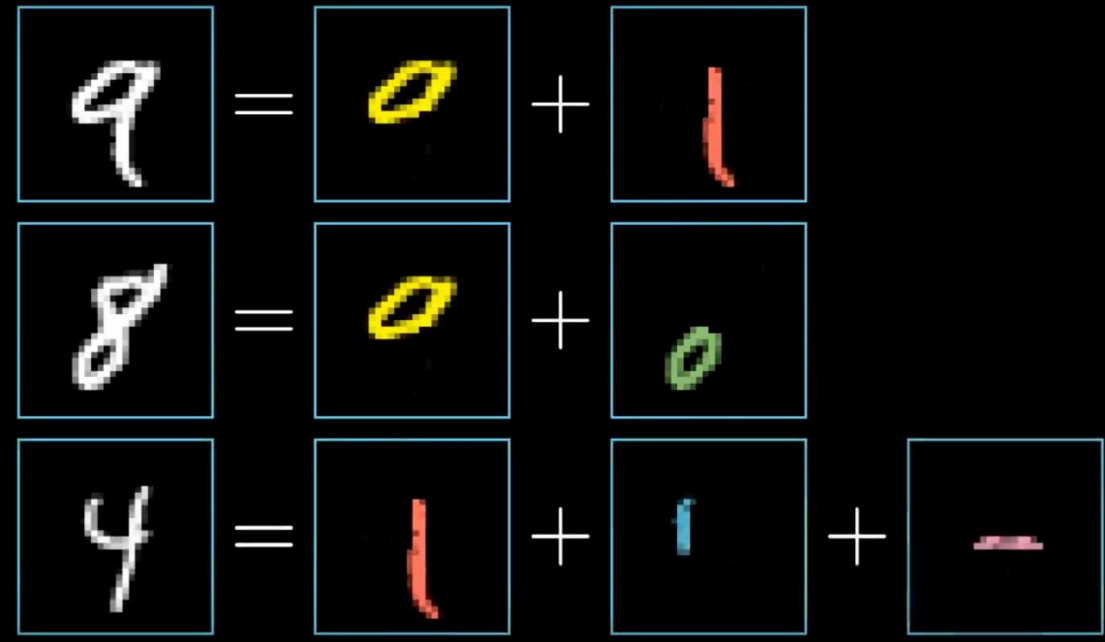
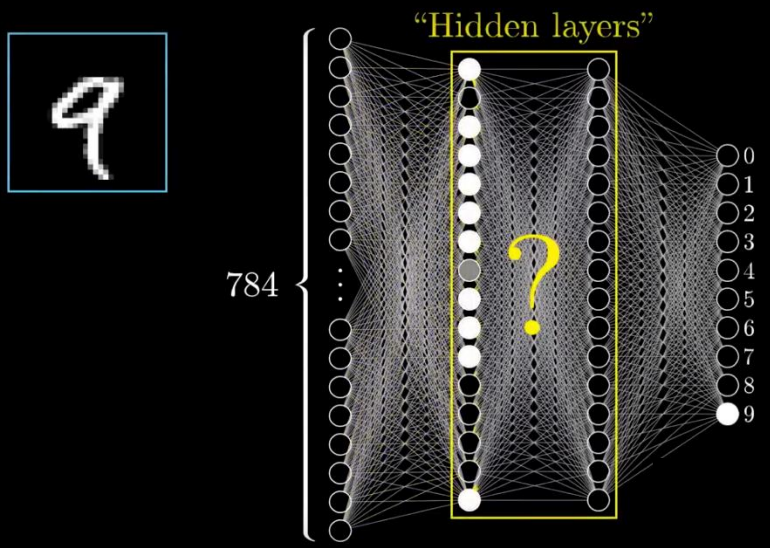




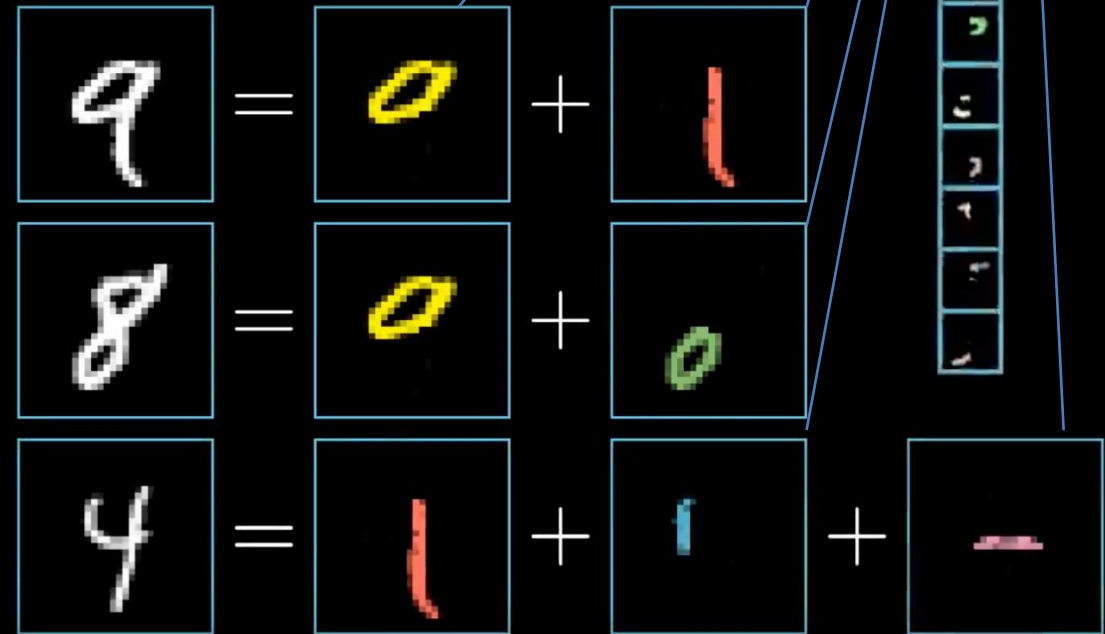
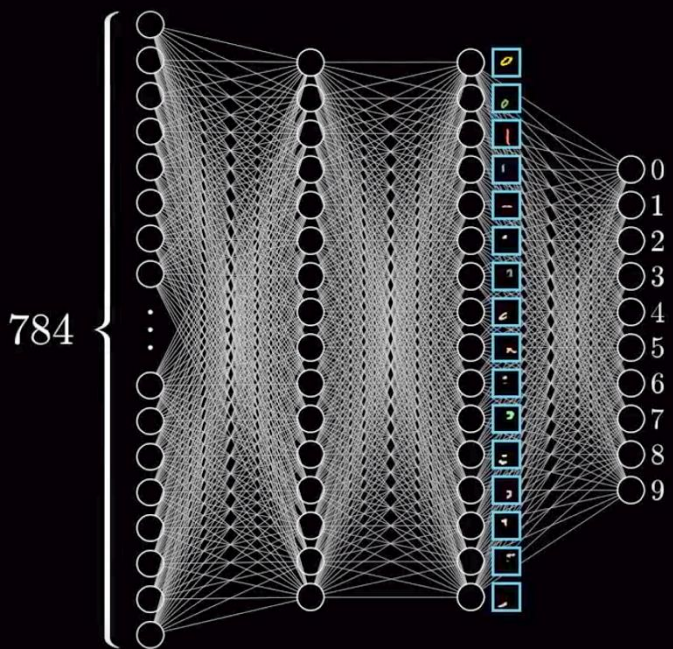
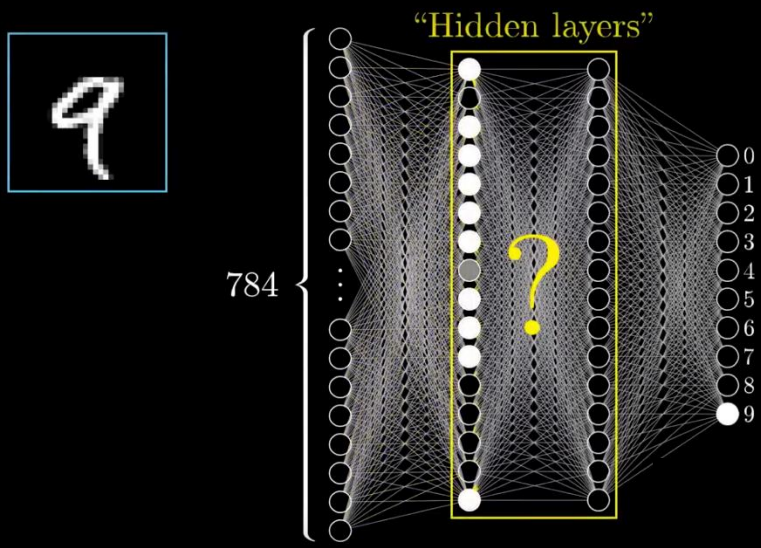
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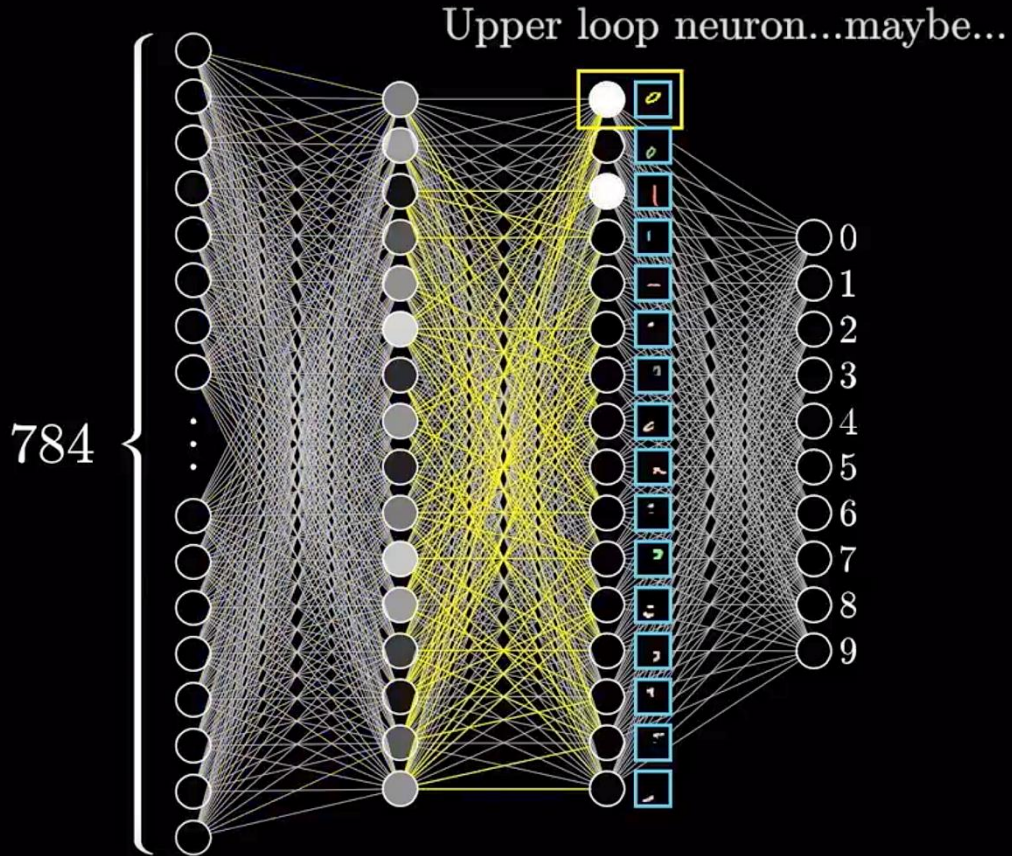
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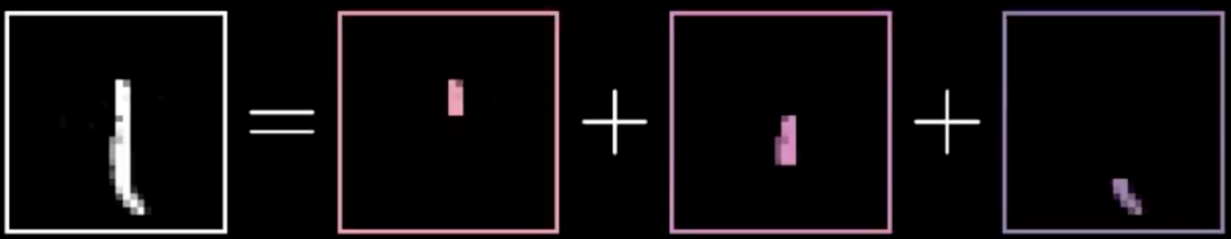
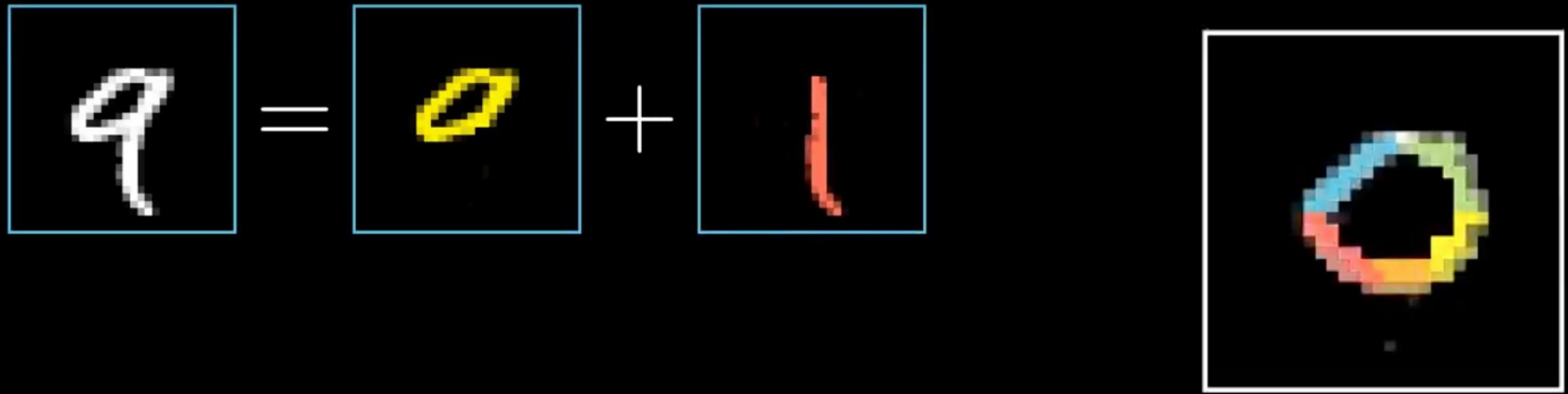
# Handwritten number recognition



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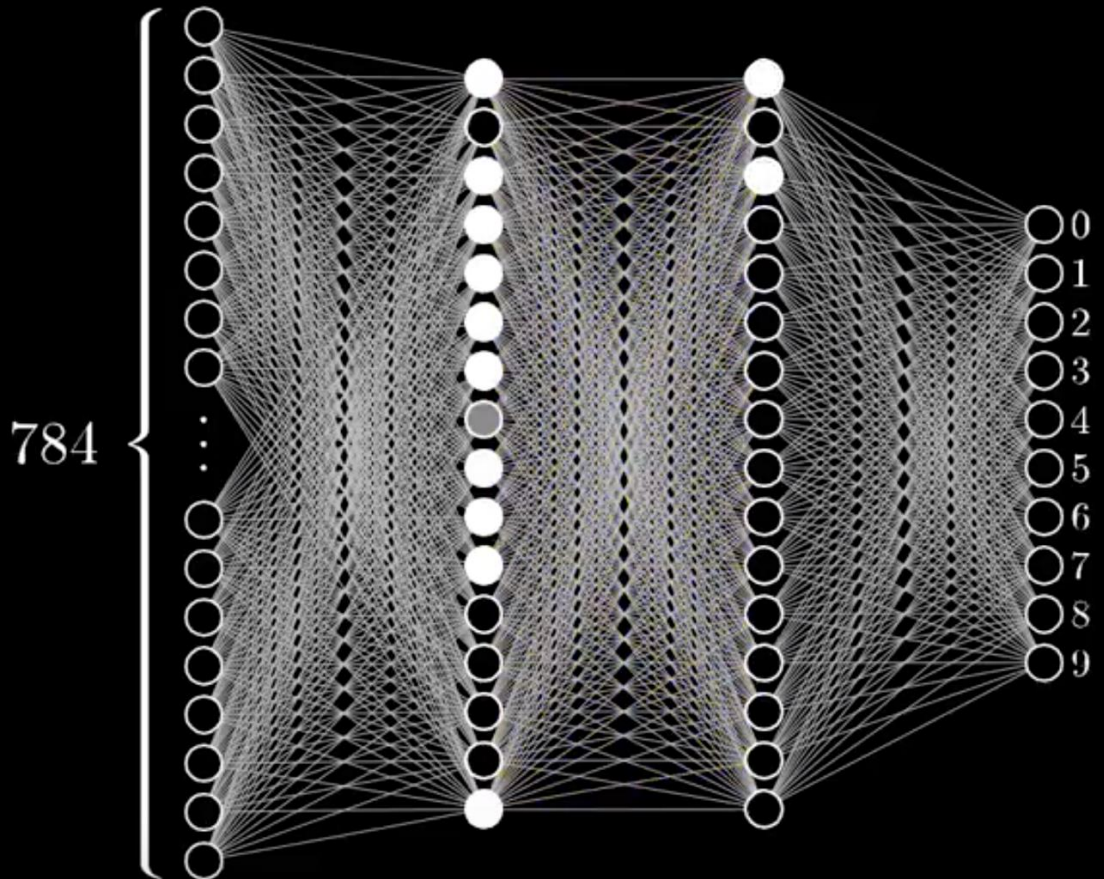


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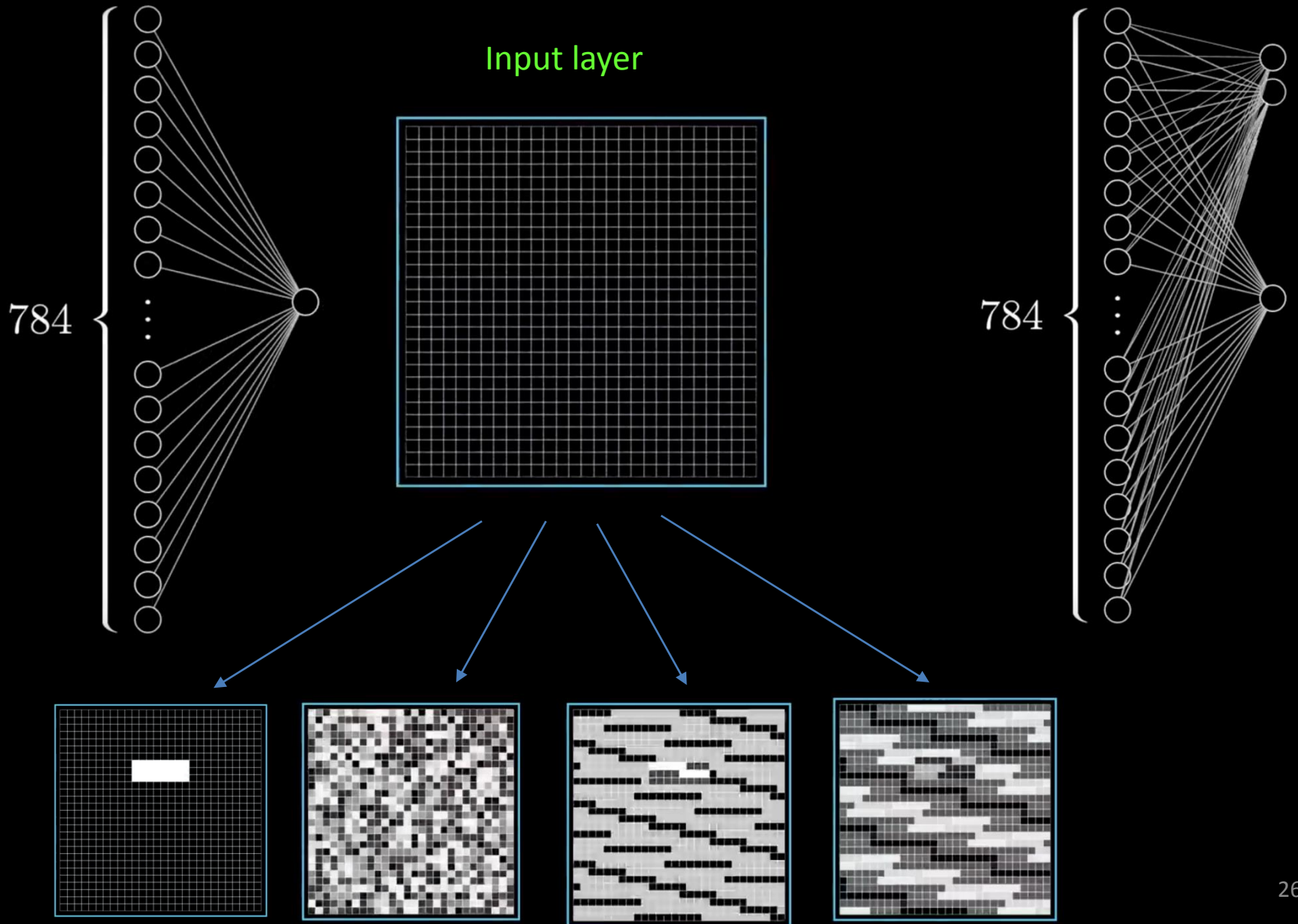




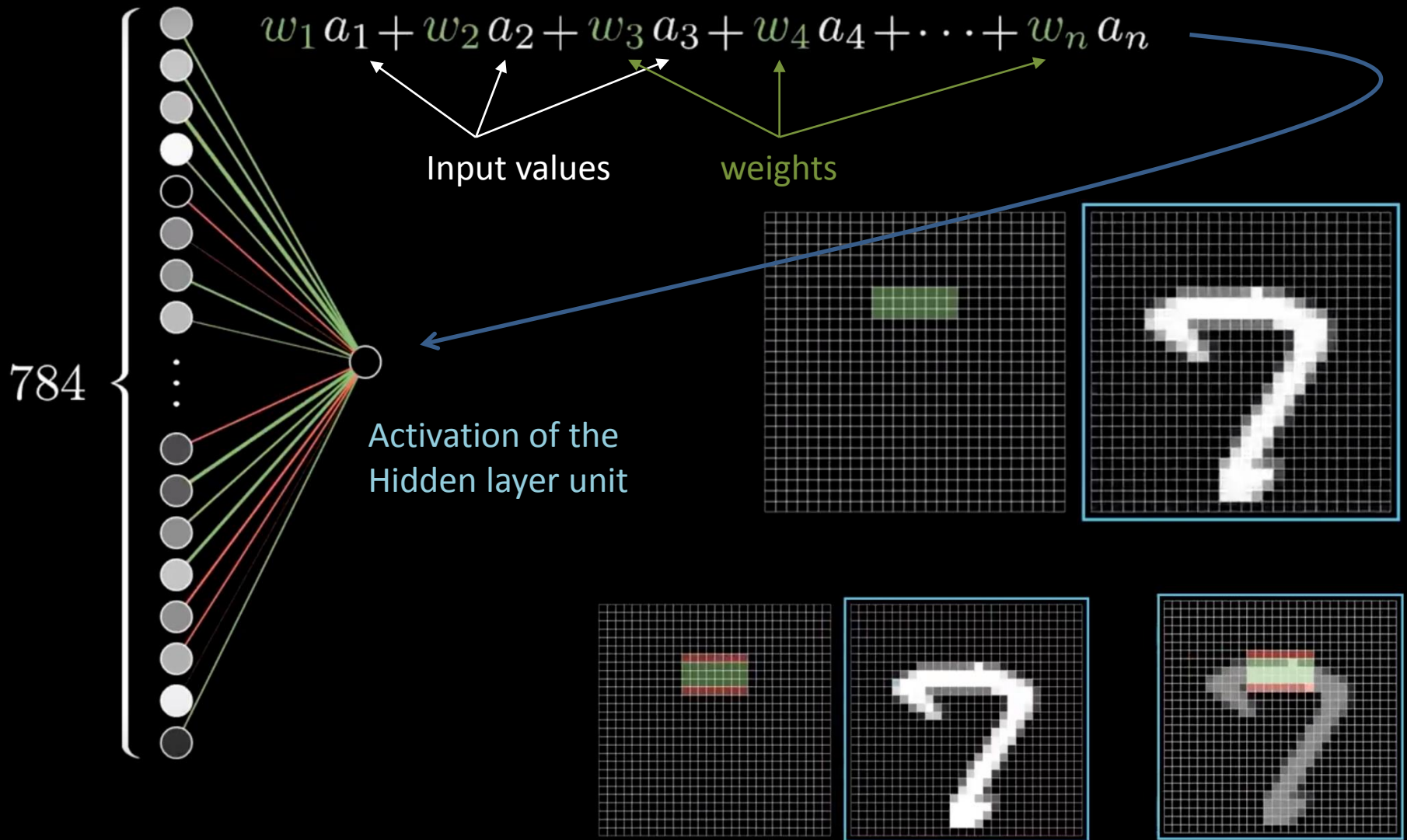
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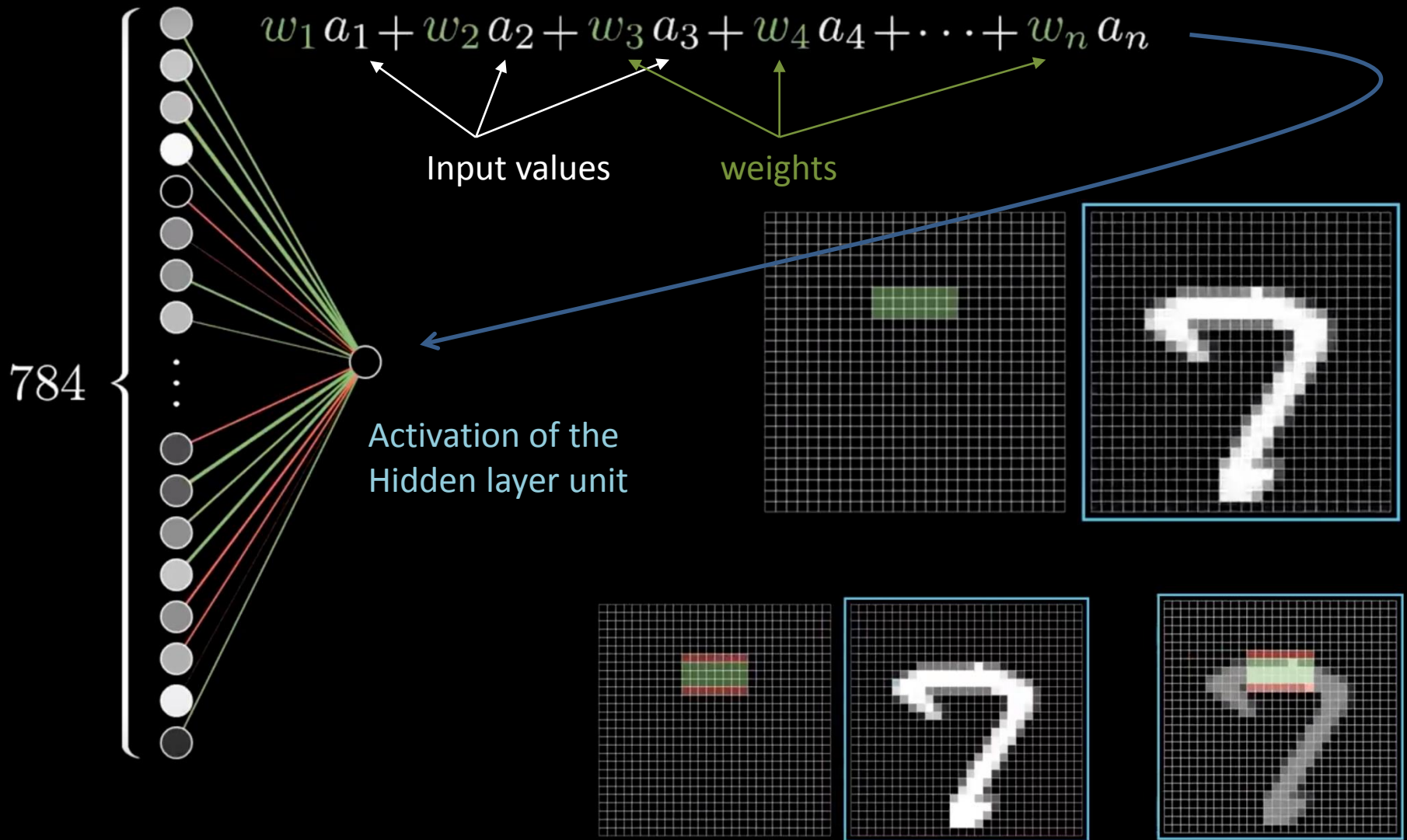
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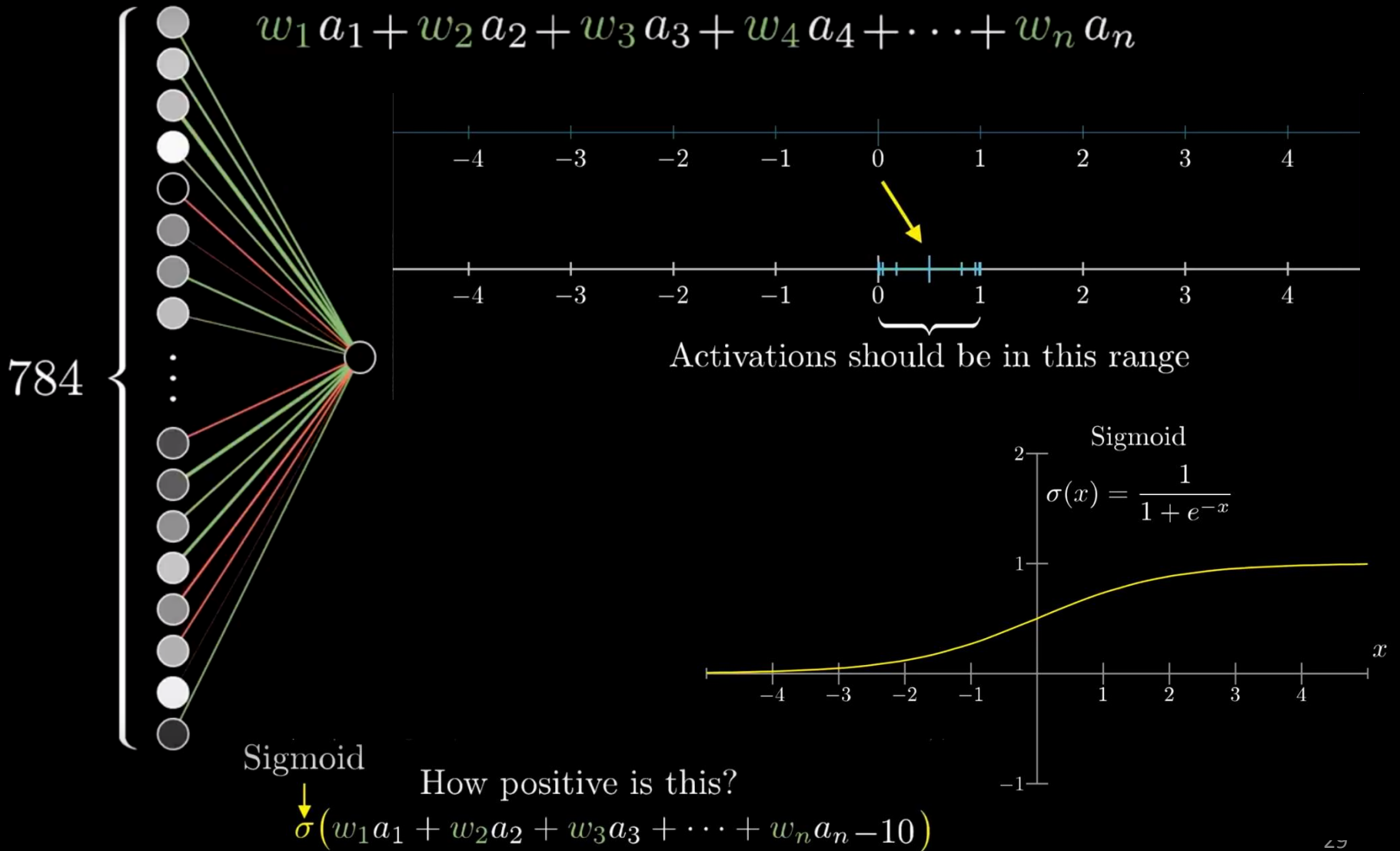


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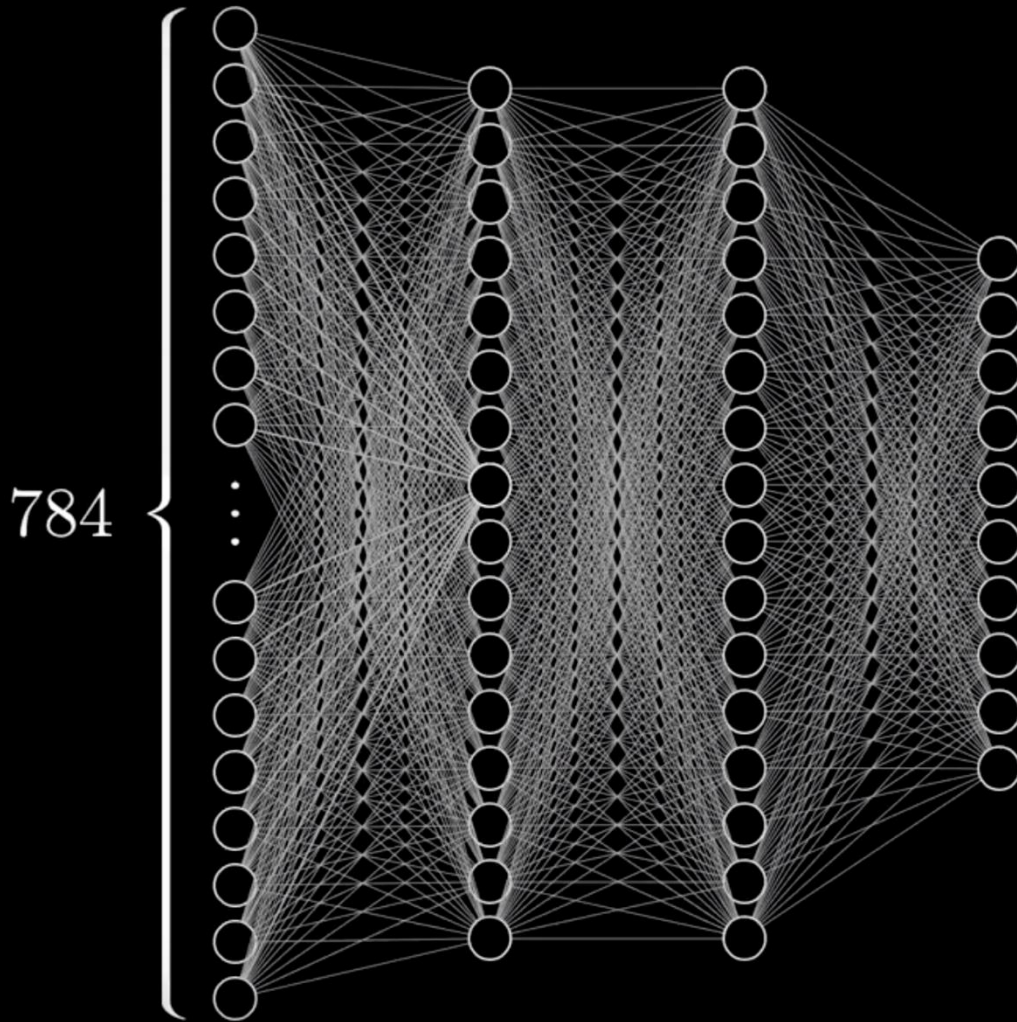




# Handwritten number recognition



# Handwritten number recognition



$$784 \times 16 + 16 \times 16 + 16 \times 10$$

weights

$$16 + 16 + 10$$

biases

$$13,002$$

# Deductive versus Inductive

- The cognitive quest

- Cognition → Knowledge

- Build it, use it...
    - Change deductive inference to inductive inference

- Probabilistic inference

- Machine Learning



- » Is here a hope for building knowledge ?

Not actually !

- » Knowledge can be learned from the data ...

- » ... through an inductive process

- The inductive process detects patterns in the data

- These patterns can be used to build new rules for behavior control, making the system more adaptive

Knowledge here comes actually via training. For unsupervised learning, it is subsumed in the dynamics

Not machine learning



machine learning is just a tool

This is all for today.