Neural Networks: Using pre-trained models

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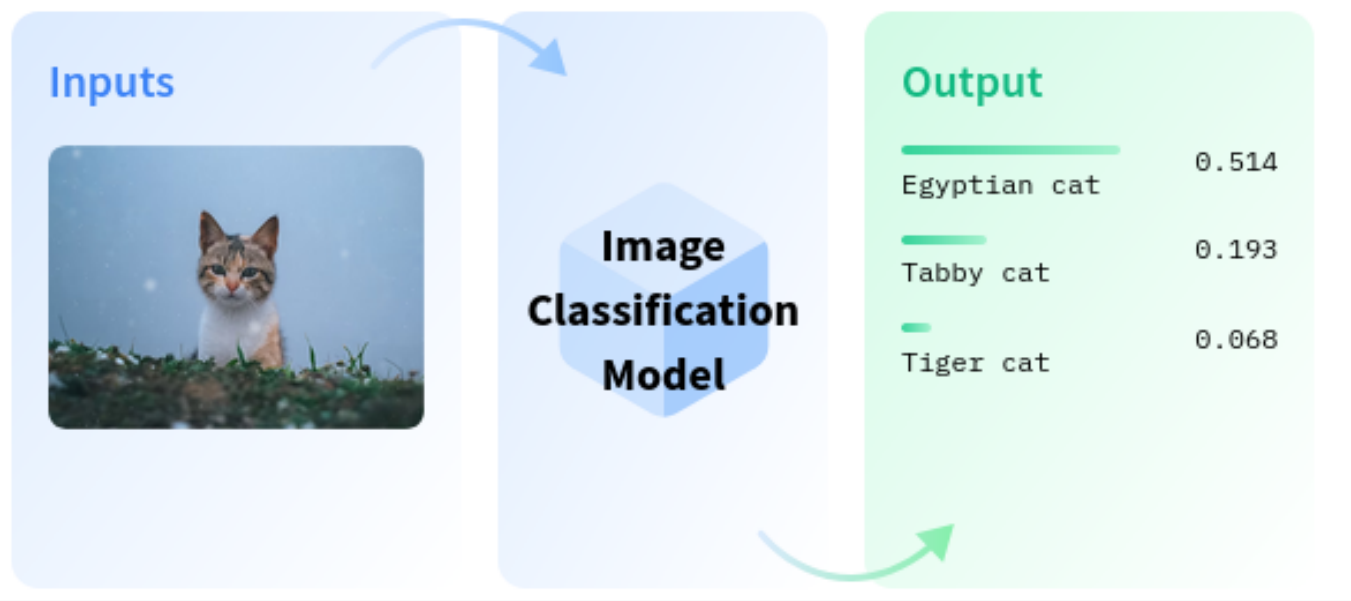
Machine learning problems

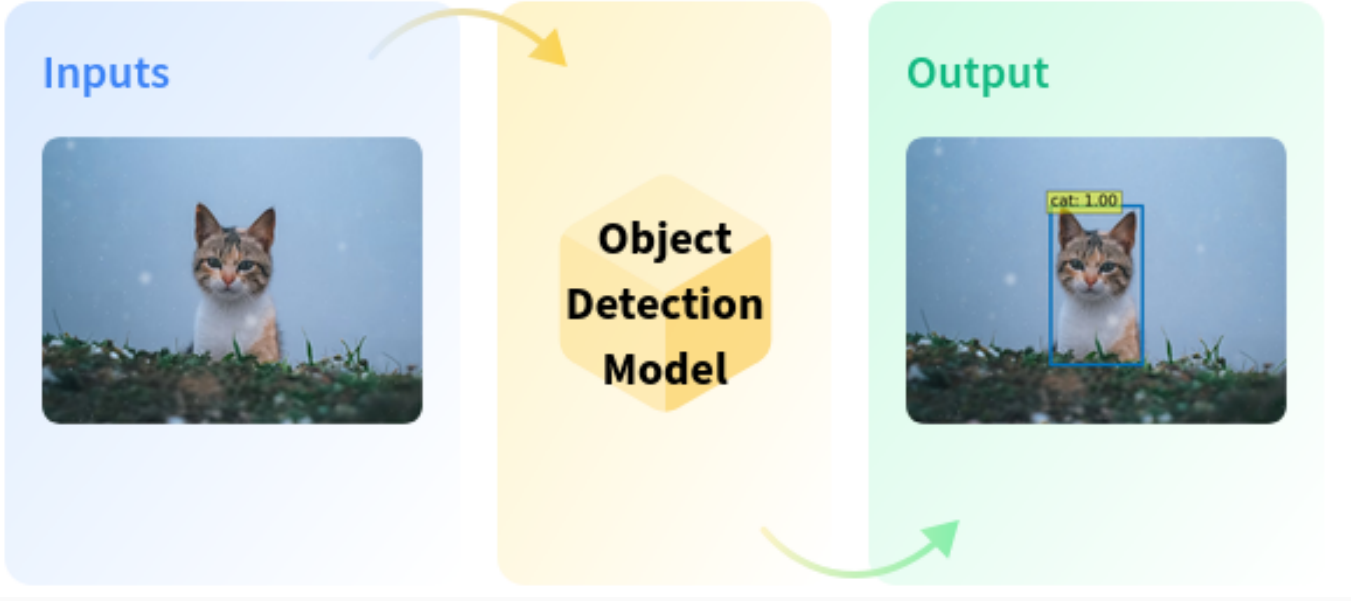
Classified on basis of type of input

1. Computer Vision
2. Natural language processing
3. Audio processing
4. Multi-modal machine learning
5. Tabular machine learning

Computer vision

1. Image Classification
2. Object Detection
3. Depth Estimation
4. Image Segmentation
5. Image-to-Image (example drawing to realistic picture)
6. Mask Generation
7. Video Classification





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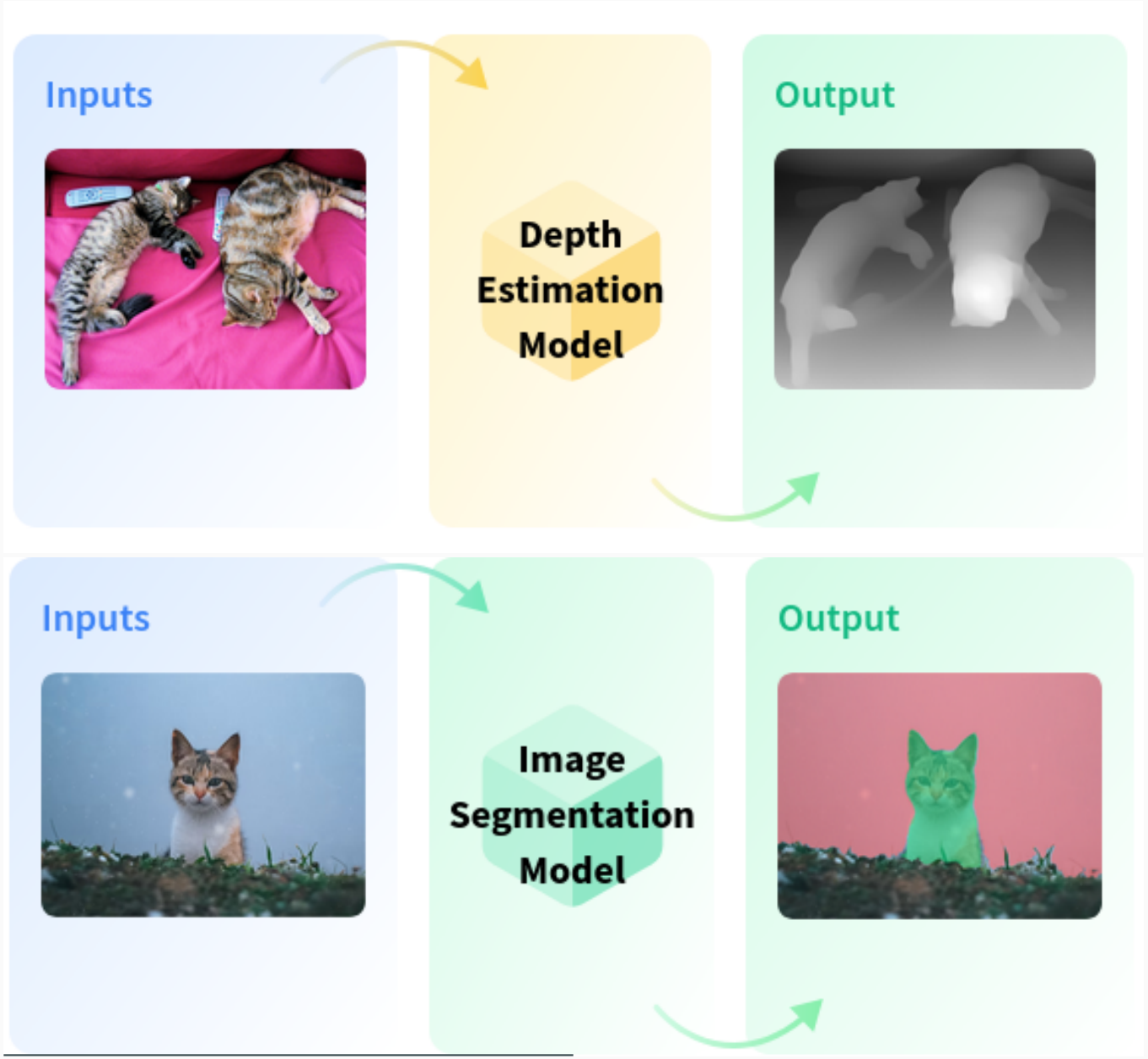
[1]Image source: huggingface.co

Hugging face tasks

- Image classification pre-trained Colab
- Object classification pre-trained Colab



[2]

[2]Image source: huggingface.co

Natural Language Processing

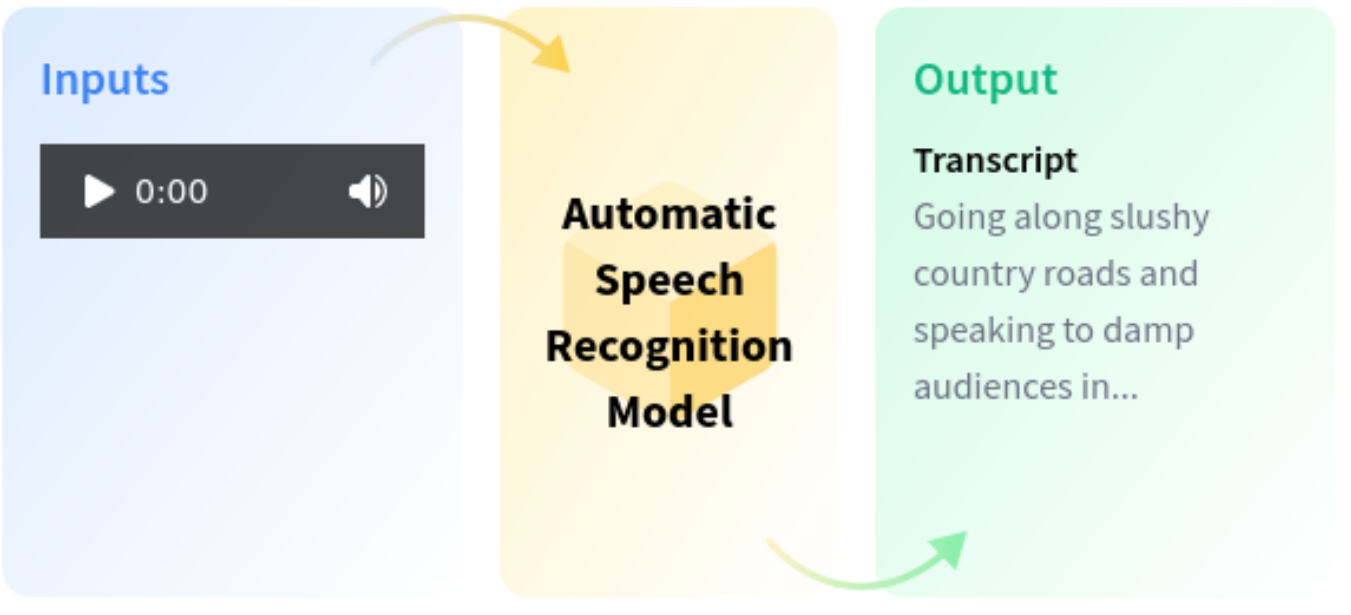
1. Conversational (e.g. ChatGPT)
2. Fill-Mask (Fill in the blanks)
3. Question Answering
4. Sentence Similarity
5. Summarization
6. Text Classification (e.g Sentiment classification)
7. Text Generation (e.g. auto-completion)
8. Token Classification (e.g. noun, adjectives or person, place etc)
9. Translation

Can we run chatbots

- MetaAi LLAMA Clib/Llama-2-13B-chat-GGML

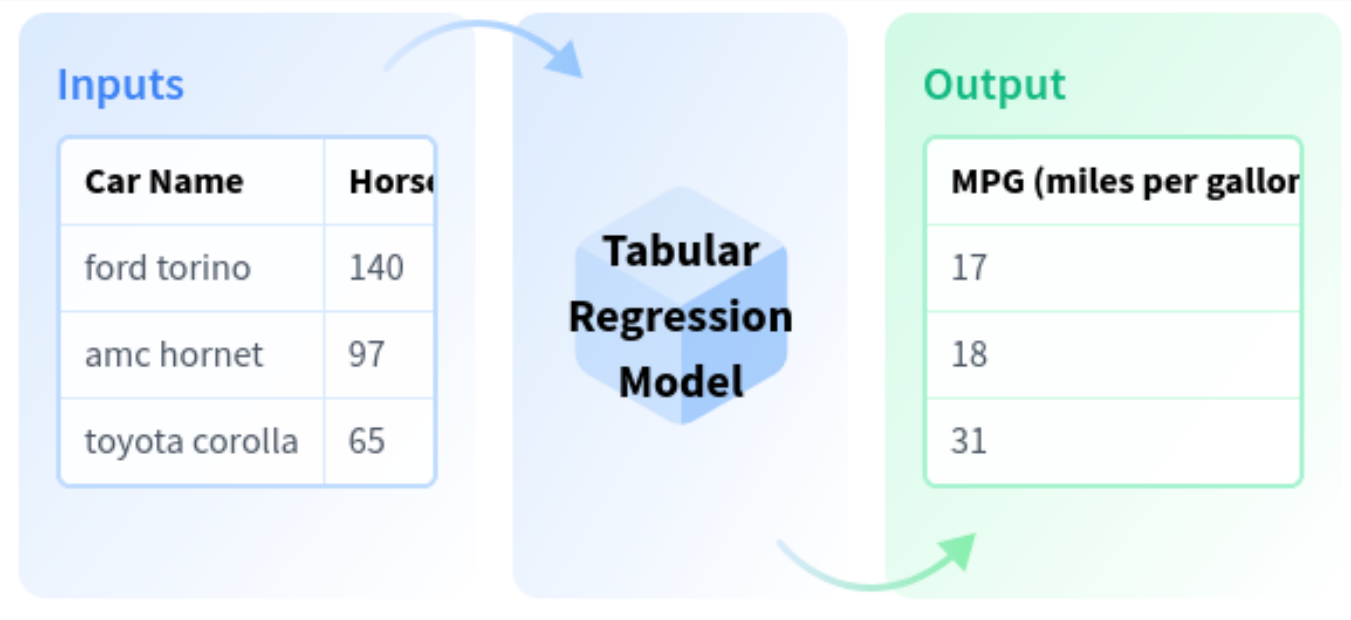
Audio

1. Audio Classification
2. Audio-to-Audio
3. Automatic Speech Recognition
4. Text-to-Speech



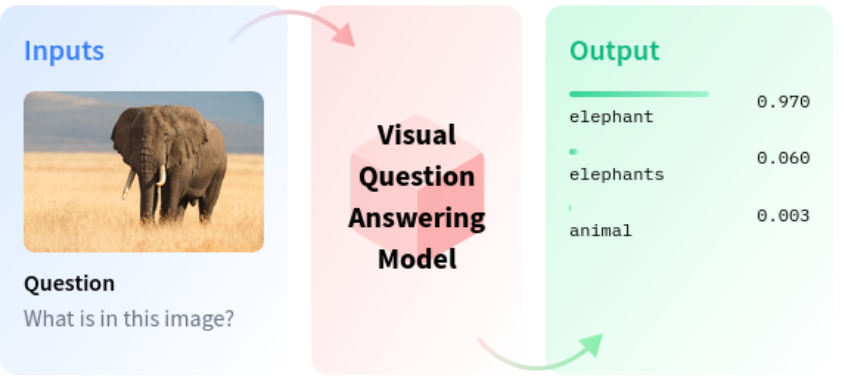
Tabular

1. Tabular Classification
2. Tabular Regression



Mutimodal

1. Document Question Answering
2. Feature Extraction
3. Image-to-Text
4. Text-to-Image
5. Text-to-Video
6. Visual Question Answering
7. Text-to-3D
8. Image-to-3D



Using pre-trained models

1. Same as using other people's code.
2. Have to find the model that has been trained on a "similar problem"
3. Options:
    - Search on Google/Google Scholar/Github (most options, least standardized)
    - Search on Tensorflow Hub: tensorflow.org/hub
    - Search on Pytorch Hub: pytorch.org/hub
    - Search on ONNX Hub: onnx.ai
    - Search on Huggingface tasks (fewest options, most standardized)

Homework 2: Using Pre-trained model

- Think of a project that you might want to do in this class.
- Find out the closest Hugging face task to your project
- Demonstrate that you can run at least one pre-trained Hugging face model on the standard task and a standard dataset on Google Colab or locally.

Dataset, Pre-processing, Models, and Learning

Data as Vectors: Pre-processing

$$\mathcal{D} = \{(\mathbf{x}_1, y_1), \ldots, (\mathbf{x}_i, y_i), \ldots, (\mathbf{x}_n, y_n)\}$$

Models as functions

A predictor as a function, $f : \mathbb{R}^d \mapsto \mathbb{R}$

1. Example: Linear Model: $f(\mathbf{x}; \mathcal{W}) = \mathbf{w}^\top \mathbf{x} + w_0$
2. Example: Non-linear model (Two layer neural network) $f(\mathbf{x}; \mathcal{W}) = \mathbf{w}_2^\top \sigma(\mathbf{W}_1 \mathbf{x} + \mathbf{w}_0)$, where $\sigma : \mathbb{R} \mapsto \mathbb{R}$ is some non-linear activation function like ReLU, sigmoid or **tanh**.

Loss functions and Learning

$$R_{\text{emp}}(f, \mathbf{X}, \mathbf{y}) = \frac{1}{n} \sum_{i=1}^{n} l(y_i, \hat{y}_i)$$

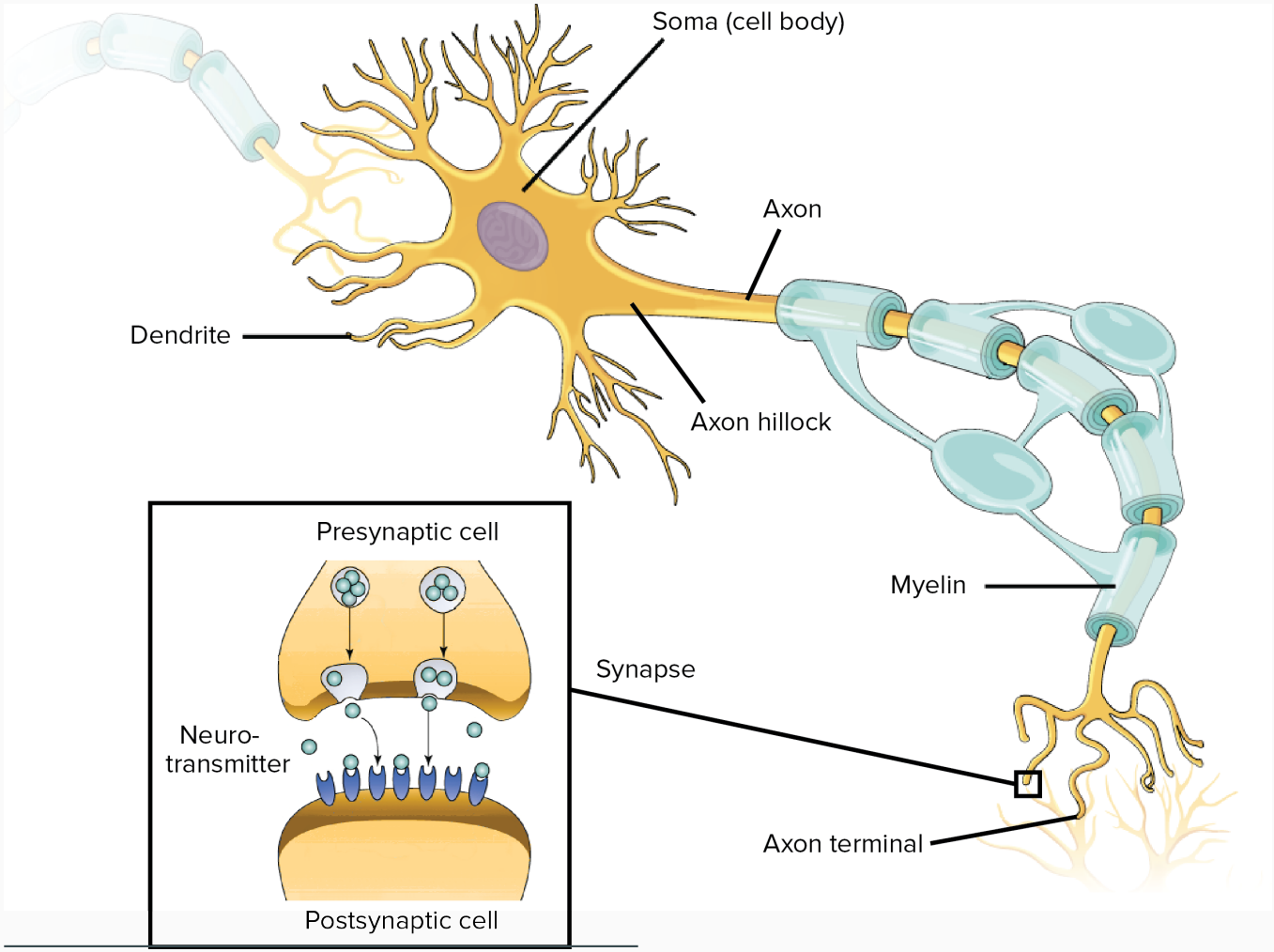
, where $\hat{y}_i = f(\mathbf{x}_i; \mathcal{W})$.

$R_{\text{emp}}(f, \mathbf{X}, \mathbf{y})$ is called the empirical risk.

Learning

Learning is the process of finding parameters $\mathcal{W}$ that minimize the empirical risk, $R_{\text{emp}}(f, \mathsf{X}, \mathsf{y})$.

Neural Networks: Biology vs Artificial

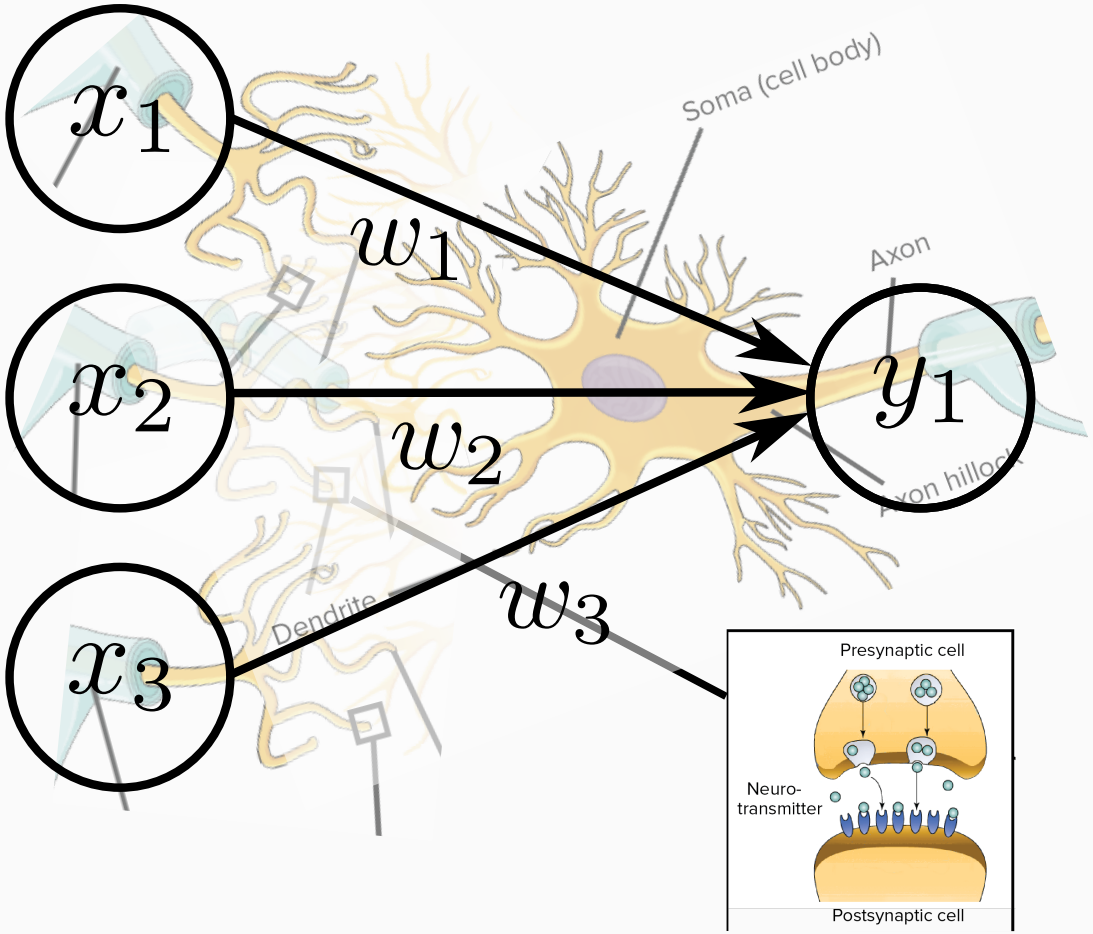


[3]

[3] Source: https://openstax.org/books/biology/pages/35-2-how-neurons-communicate

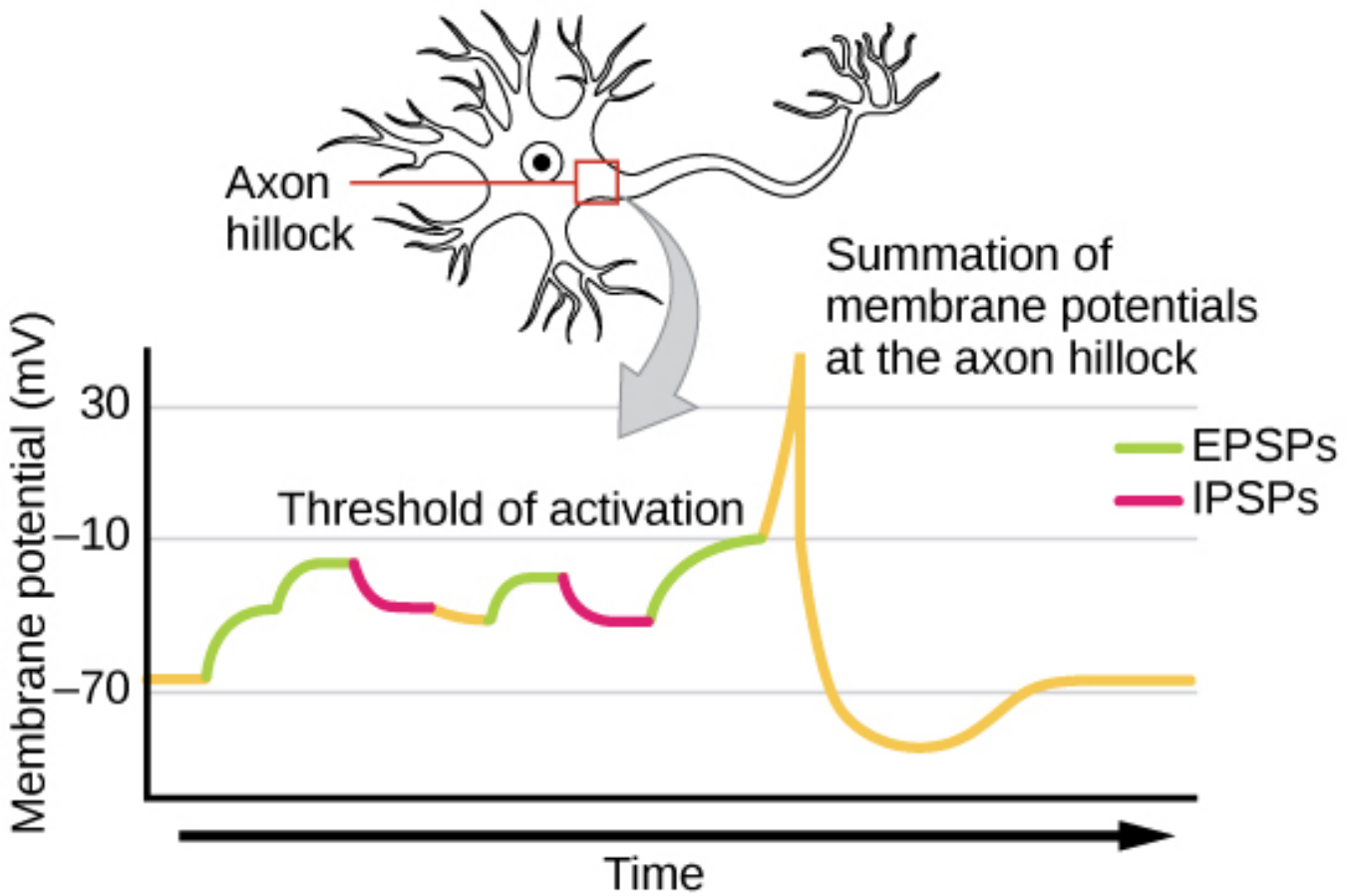
Similarities

$$y_1 = \sigma(w_1 x_1 + w_2 x_2 + w_3 x_3 + w_4)$$



- The excitation or firing of a biological neuron can be equated to a high positive value of units (x_1, x_2, x_3) in

Differences



- Biological neuron is all or None
- Biological neuron has a time component