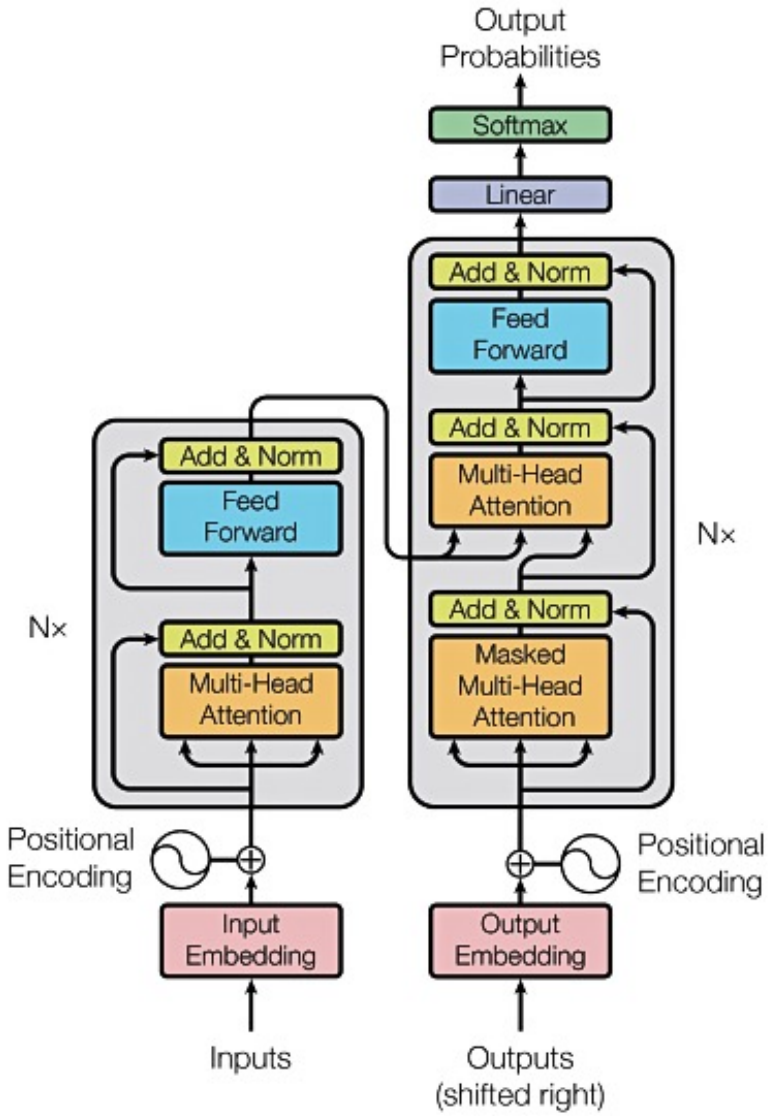


Transformers

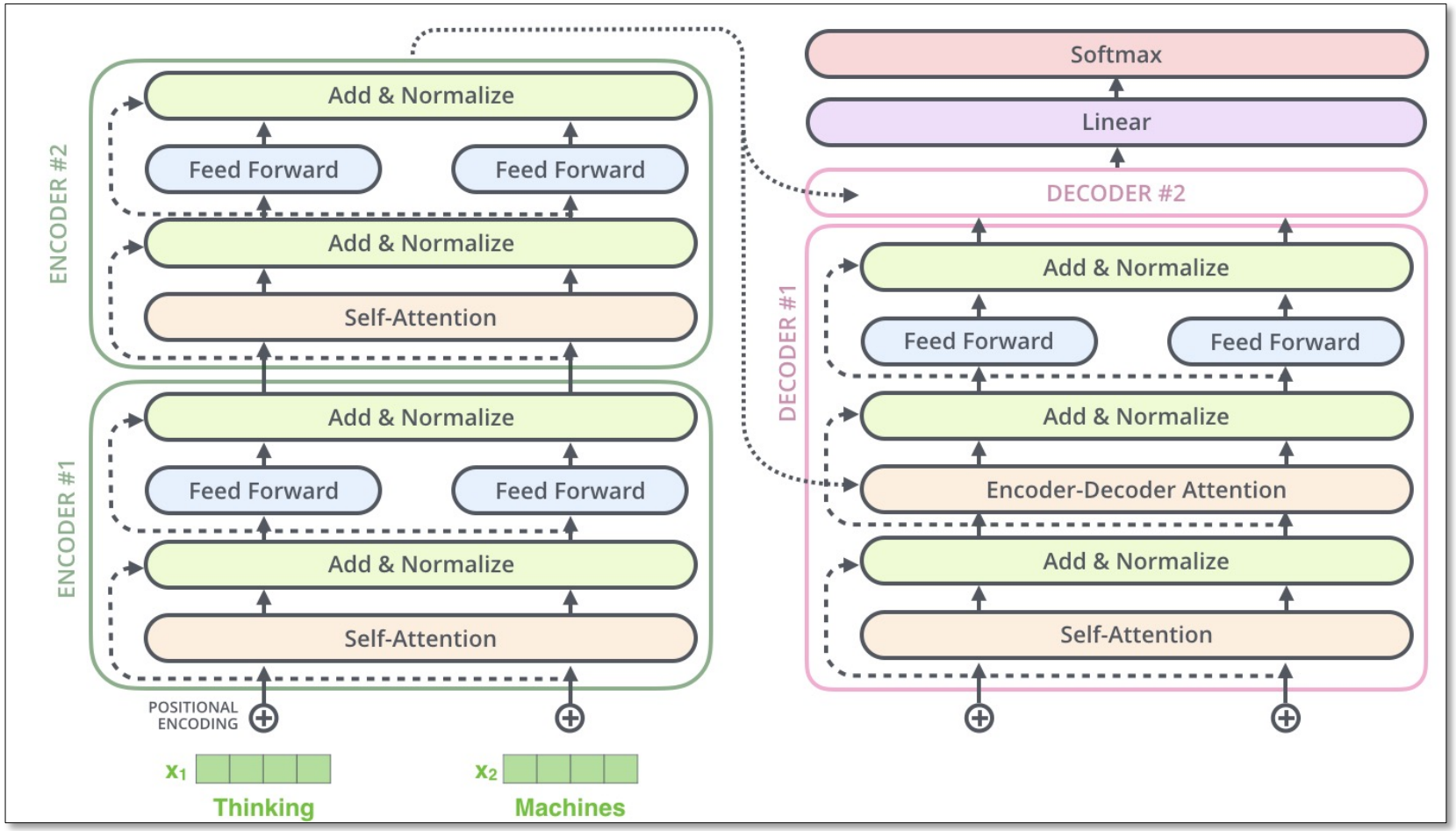
Background (1)

- The **RNN** and **LSTM** neural models were designed to process language and perform tasks like classification, summarization, translation, and sentiment detection
  - RNN: Recurrent Neural Network
  - LSTM: Long Short Term Memory
- In both models, layers get the next input word and have access to some previous words, allowing it to use the word's left context
- They used word embeddings where each word was encoded as a vector of 100-300 real numbers representing its meaning

Background (2)

- Transformers extend this to allow the network to process a word input knowing the words in both its left and right context
- This provides a more powerful context model
- Transformers add additional features, like **attention**, which identifies the important words in this context
- And break the problem into two parts:
  - An encoder (e.g., Bert)
  - A decoder (e.g., GPT)

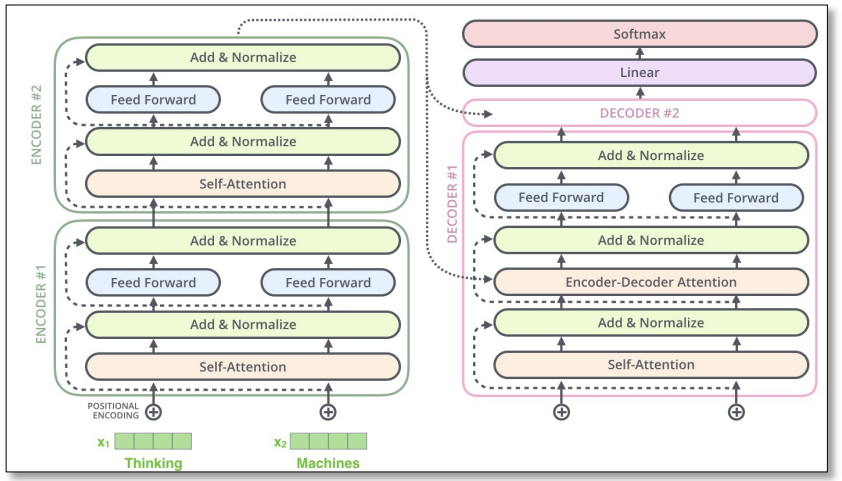
Transformer model



Encoder (e.g., BERT)

Decoder (e.g., GPT)

Transformers, GPT-2, and BERT



1. A transformer uses an **encoder stack** to model input, and uses **decoder stack** to model output (using input information from encoder side)
2. If we do not have input, we just want to model the “next word”, we can get rid of the encoder side of a transformer and output “next word” one by one. This gives us **GPT**
3. If we are only interested in training a language model for the input for some other tasks, then we do not need the decoder of the transformer, that gives us **BERT**

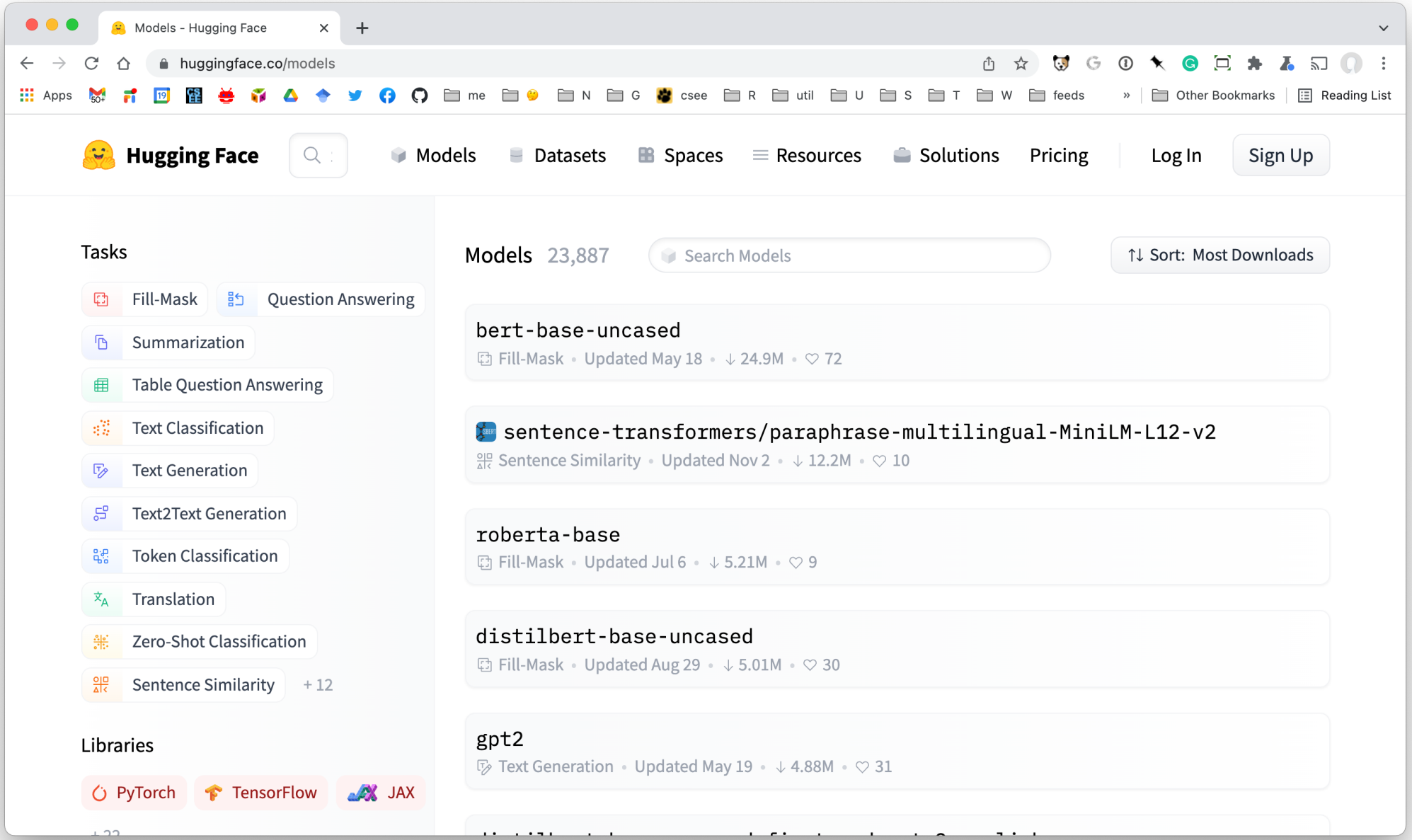
Training a Transformer

- Transformers typically use semi-supervised learning with
  - Unsupervised pretraining over a very large dataset of general text
  - Followed by supervised **fine-tuning** over a focused data set of inputs and outputs for a particular task
- Tasks for pretraining and fine-tuning commonly include:
  - language modeling
  - next-sentence prediction (aka completion)
  - question answering
  - reading comprehension
  - sentiment analysis
  - paraphrasing

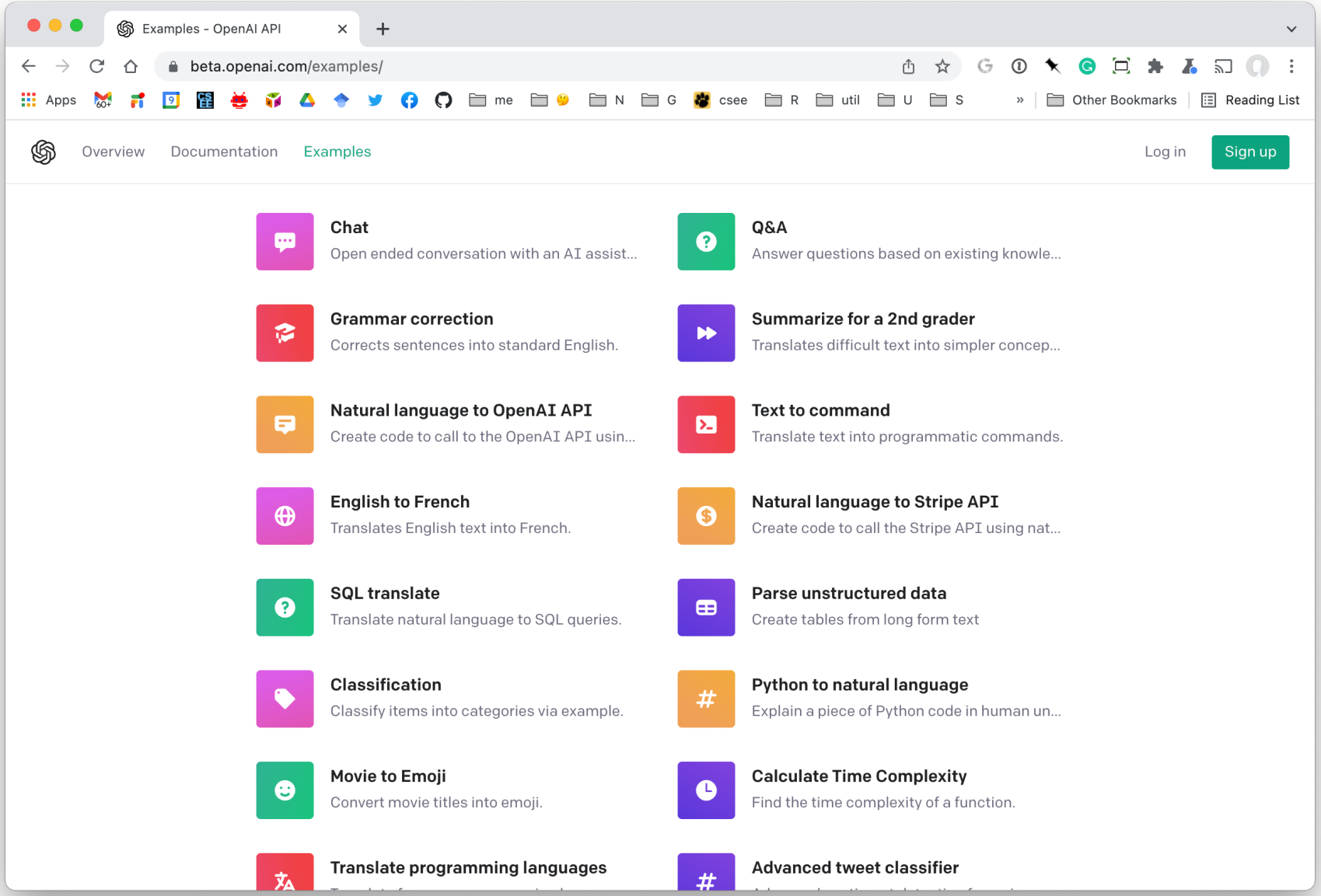
Pretrained models

- Since training a model requires huge datasets of text and significan computation, researchers often use common pretrained models
- Examples (circa December 2021) include
  - Google's BERT model
  - Huggingface's various Transformer models
  - OpenAI's and GPT-3 models

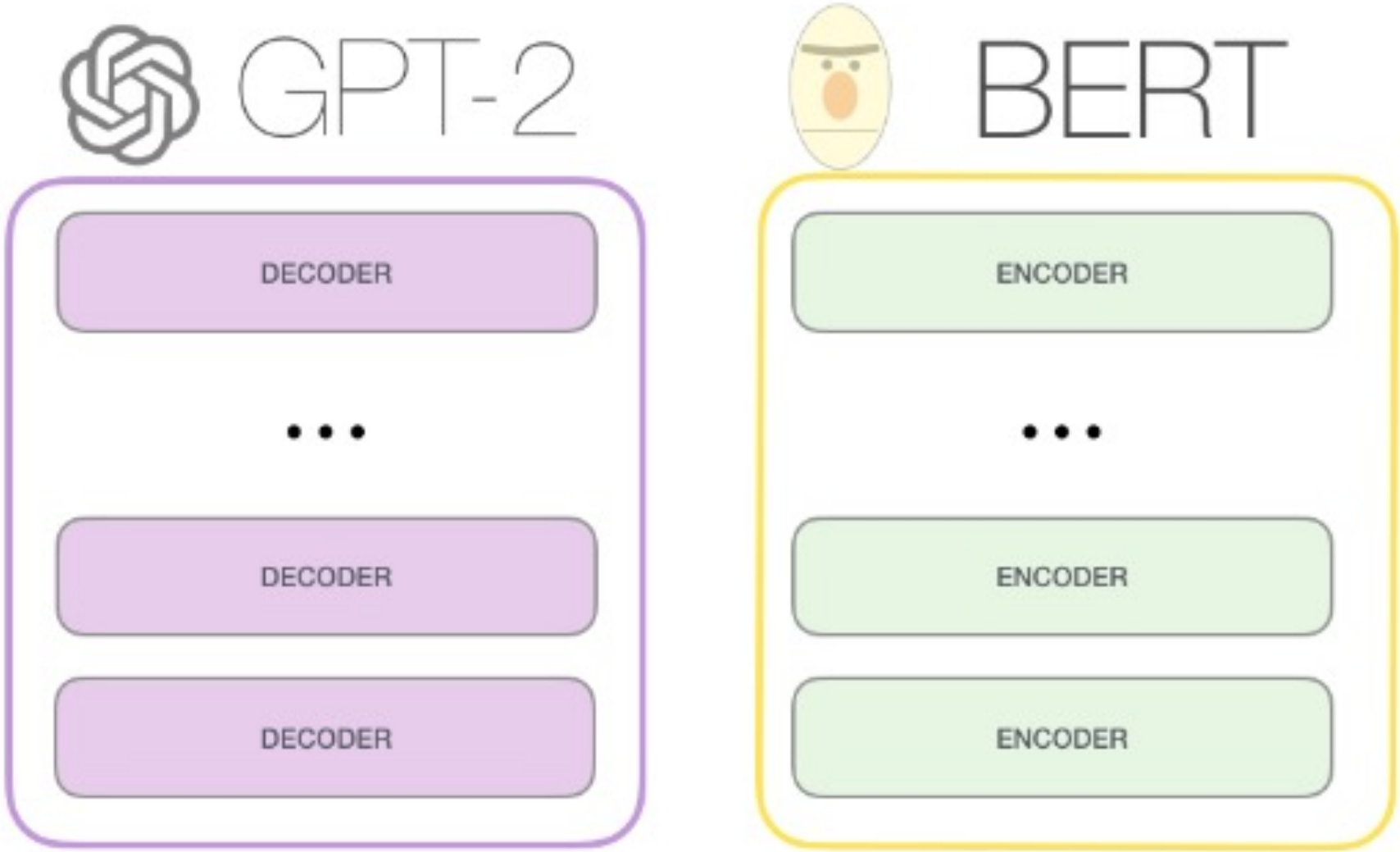
Huggingface Models



OpenAI Application Examples



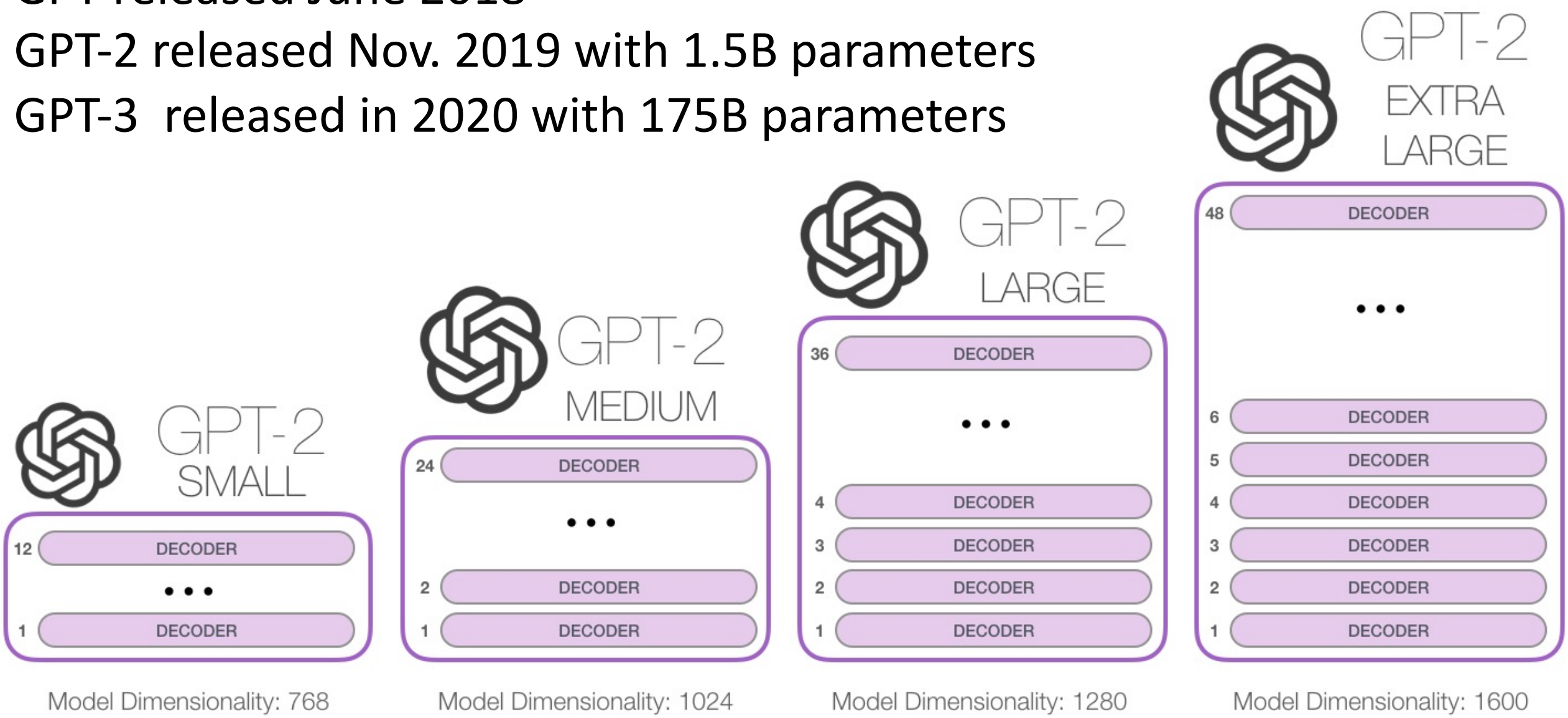
GPT-2, BERT


GPT-2
DECODER
DECODER
DECODER
BERT
ENCODER
ENCODER
ENCODER

GPT released June 2018

GPT-2 released Nov. 2019 with 1.5B parameters

GPT-3 released in 2020 with 175B parameters



117M parameters

345M

762M

1542M