ICTSS00120 - Artificial Intelligence Skill Set

Session 12: Introduction to Transformers and Hugging Face

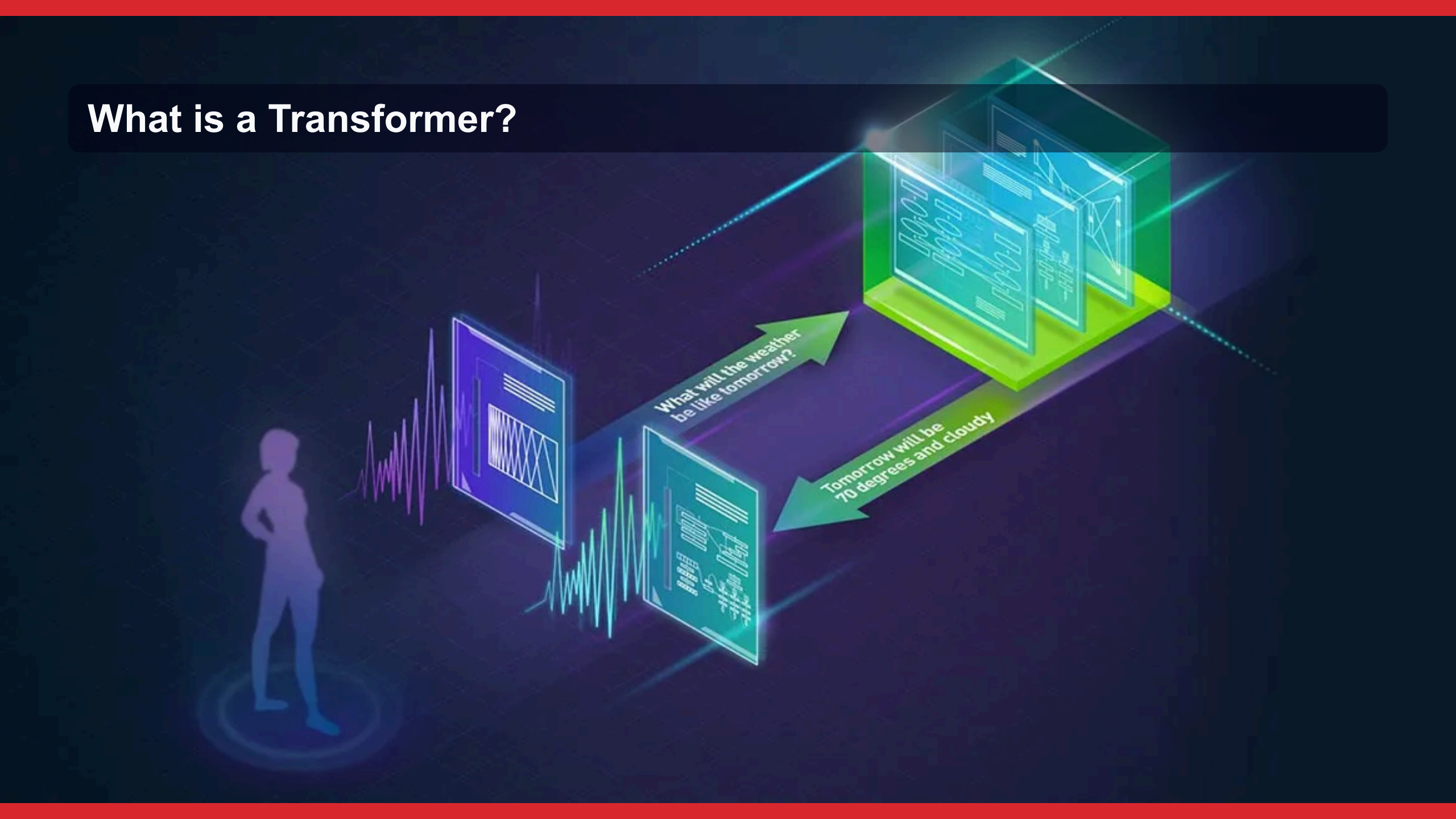
Lecturer: Jordan Hill

GOVERNMENT OF WESTERN AUSTRALIA
TAFE WA North Metropolitan

Learning Objectives

- Understand the basic concepts of Transformer models.
- Explore the architecture and applications of Transformers.
- Introduction to Hugging Face and its tools.
- Learn how to get started with Transformers using Hugging Face.

What is a Transformer?



What is a Transformer?

Overview

- **Transformer**: A deep learning model designed for handling sequential data, introduced in the paper *"Attention is All You Need"* by Vaswani et al.
- **Core Component**: Attention mechanism which allows the model to focus on different parts of the input sequence.

That is an encoder-decoder transformer

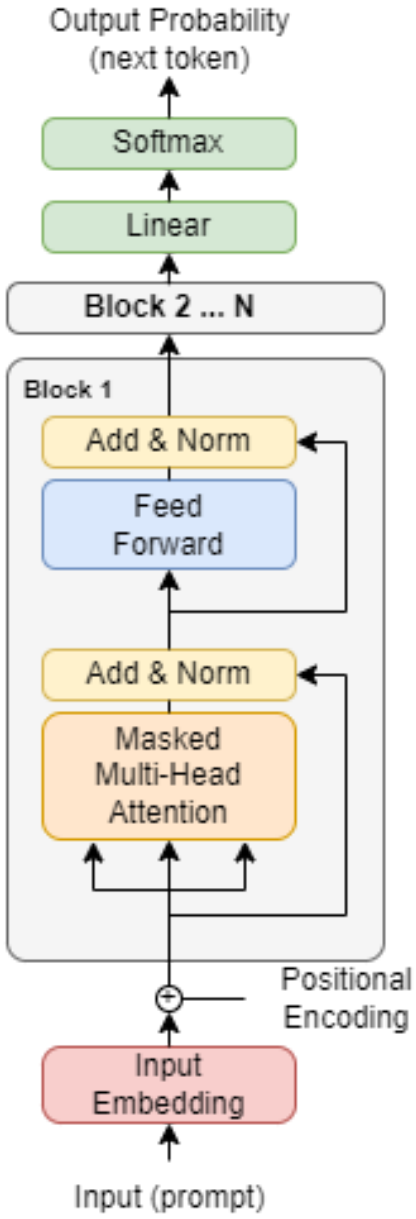
Most LLMs use self-attention

This is to say Decoder-only

What??

Reference: this stackexchange response is actually really good summary!

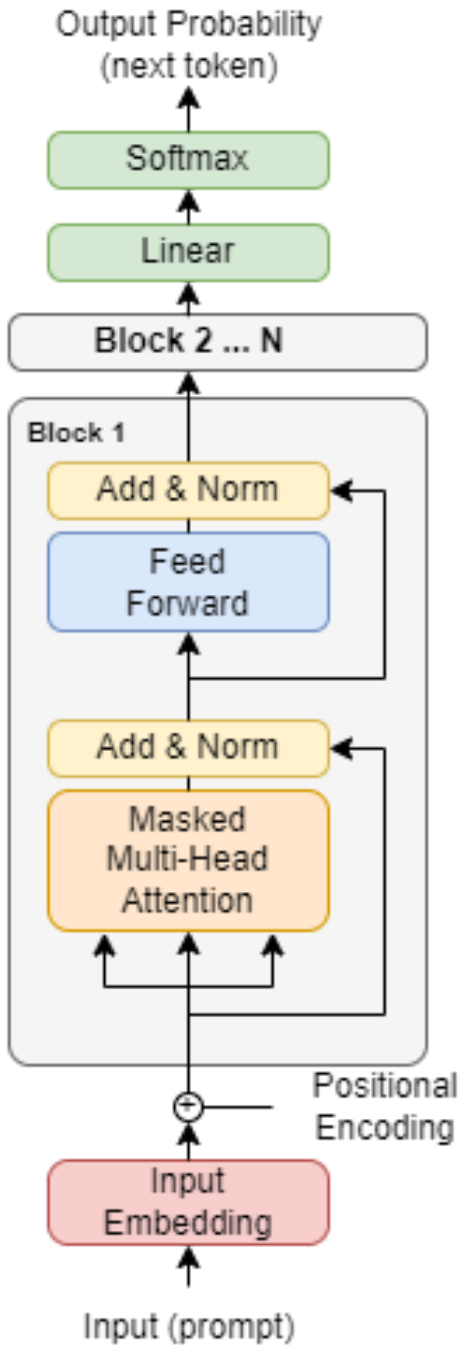
We'll talk more about this attention stuff next week...

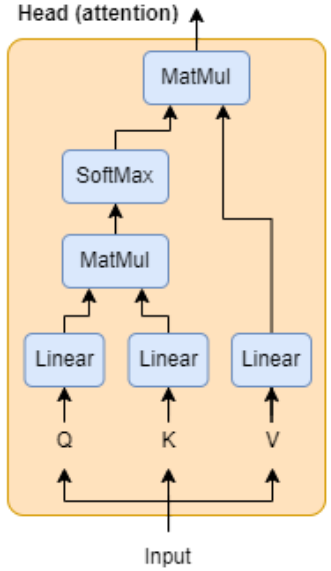


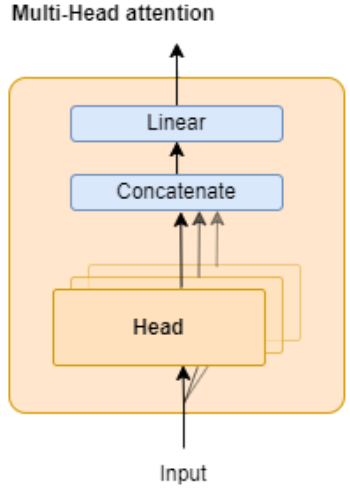
This is a **Decoder-Only** model.

These simply pass all the information one way through multiple blocks (Attention & FNN)

You just start with the input sequence (tokenized/embedded) and get the next token out the other end.







Back to the encoder-decoder...

These 'pay attention' to the input and another sequence and uses the other sequence (Output embedding) to influence **the logits** / Next token.

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Transformer Architecture

Key Components

- **Encoder-Decoder Structure**:
  - **Encoder**: Processes the input data and generates a representation.
  - **Decoder**: Uses the representation from the encoder to generate the output.
- **Attention Mechanisms**:
  - **Self-Attention**: Allows the model to weigh the importance of different words in a sentence relative to each other.
  - **Multi-Head Attention**: Multiple attention mechanisms run in parallel to capture different aspects of the data.

<iframe width="100%" height="580" src="https://www.youtube.com/embed/wjZofJX0v4M" title="But what is a GPT? Visual intro to transformers | Chapter 5, Deep Learning" frameborder="0" allow="accelerometer; autoplay; clipboard-write; encrypted-media; gyroscope; picture-in-picture; web-share" referrerpolicy="strict-origin-when-cross-origin" allowfullscreen></iframe>

Applications of Transformers

Real-World Use Cases

Domain	Applications
Natural Language Processing (NLP)	• Machine Translation • Text Summarization • Question Answering • Sentiment Analysis
New Domains	• Protein Folding (AlphaFold) — This is a really big deal! • Image Recognition (Vision Transformers - ViTs) • DNA Sequence Analysis

Hugging Face!

Overview

- **Hugging Face**: An open-source AI research organization known for its NLP library called Transformers.
- **Transformers Library**: Provides pre-trained models and tools to easily integrate transformers into various applications.

Introduction to Hugging Face

Key Features

- **Model Hub**: Repository of pre-trained models.
- **Datasets**: Access to a wide range of datasets for different tasks.
- **Inference API**: Easily deploy models for prediction.

Exploring Hugging Face

First Stop The Documentation

A huge ecosystem of opensource client libraries!
(Hint: the source code is a massive resource for learning more)

Next Huggingface Learn

Next Stop MODELS!

Finally, Datasets
...also Datasets (the client library)

More than utility

Huggingface has more than directly useful resources—it has a community!

Daily Papers

Blog Articles & News

A new feature is also Spaces

Check out this example app

Getting Started with Hugging Face

The Transformers library gives us access to a huge library of open source model architectures

Install the Transformers Library (pre-installed on Kaggle):

```
pip install transformers
```

It makes it really easy to work with models locally

Let's Start with a simple one

```
from transformers import pipeline

# Load a pre-trained model for sentiment analysis
classifier = pipeline("sentiment-analysis")
```

Make Predictions:

```
result = classifier("I love using the Hugging Face library!")
print(result)
```

A bit more fun

```
import torch
from transformers import pipeline

model_id = "meta-llama/Llama-3.2-1B"

pipe = pipeline(
    "text-generation",
    model=model_id,
    torch_dtype=torch.bfloat16,
    device_map="auto"
)

pipe("What is the meaning of life?")
```

What does your model say is the meaning of life?

Break

Let's take a break before we dive into Training using the transformers library

Intro to Transformers

Getting Started:

1. Huggingface Transformers Quicktour

There are only really two kinds of things we might do with a pre-trained model:

Either Inference or Training

The Trainer API makes it really easy to train LLMs

But it also hides a lot of complexity from you!

Summary and Q&A

Summary:

- Introduction to Transformer models and their architecture.
- Overview of Hugging Face and its tools.
- Hands-on guide to getting started with Transformers using Hugging Face.
- Application examples in NLP and other domains like DNA analysis in marine biology.

Q&A:

- Any questions about today's topics?

Contact: jordan.hill@nmtafe.wa.edu.au