Fine-tuning a model

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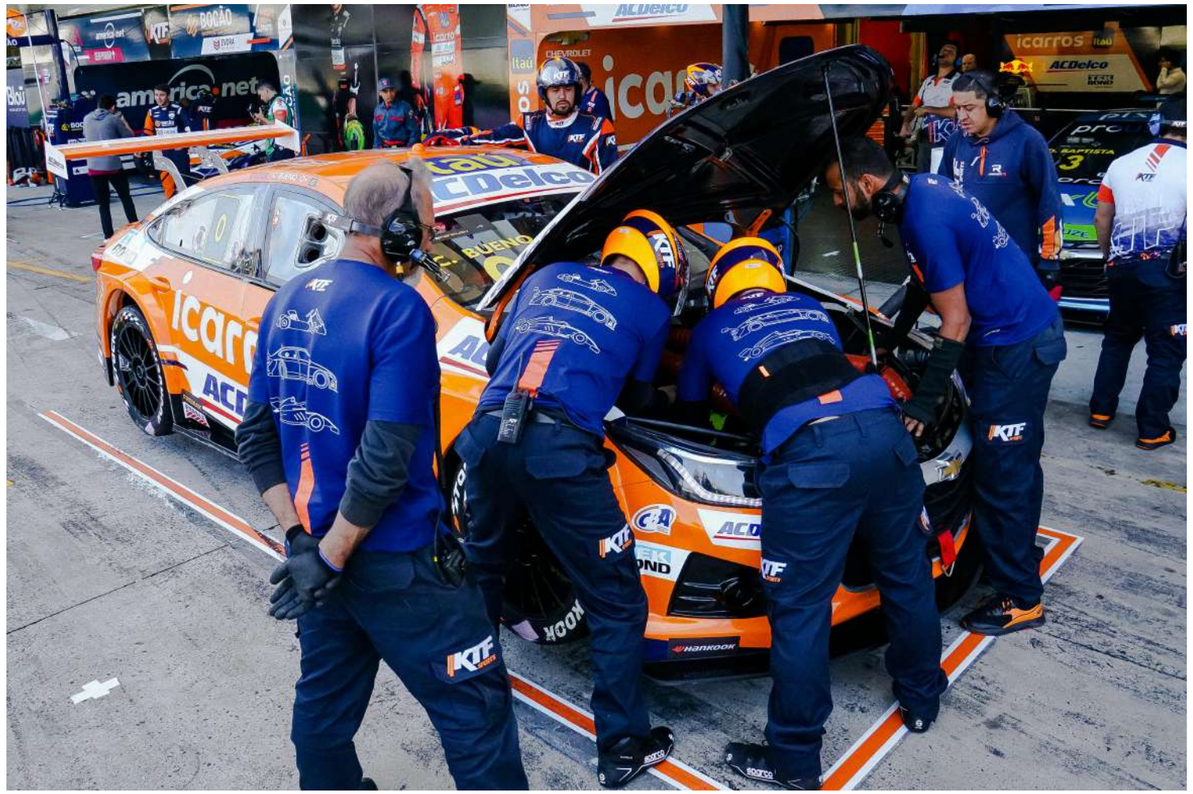
What is fine-tuning?

- Fine-tuning: adjusting a pre-trained model for a specific task or dataset
- Pre-trained model: algorithm developed on extensive data to performance a task



Why fine-tune?

Learn new task or domain

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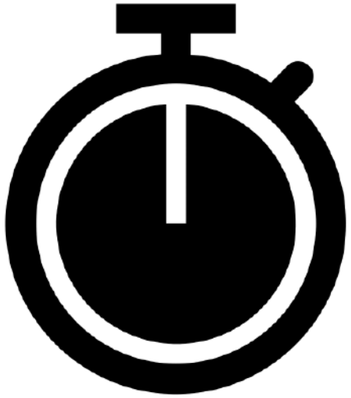
Learn new task or domain



Reduced time and computation

How to fine-tune a model

Identify the Model

How to fine-tune a model

Identify the Model

Prepare the Data

How to fine-tune a model

Identify the Model

Prepare the Data

Build Trainer

How to fine-tune a model

Identify the Model

Prepare the Data

Build Trainer

Train the Model

Identifying the model

```
from transformers import AutoModelForSequenceClassification


model_name = "bert-base-cased"
model = AutoModelForSequenceClassification.from_pretrained(model_name)
```

Preparing the dataset

```
# Identifying the model
from transformers import AutoModelForSequenceClassification

model_name = "bert-base-cased"
model = AutoModelForSequenceClassification.from_pretrained(model_name)
```

```
# Prepare the dataset
from transformers import AutoTokenizer

tokenizer = AutoTokenizer.from_pretrained(model_name)
dataset = dataset.map(
    lambda row: tokenizer(row['text'])
)
```

Create the training loop

```
from transformers import (
    Trainer,
    TrainingArguments
)

training_args = TrainingArguments(
    output_dir = "./results")
```

- `Trainer` used for fine-tuning a model
- `TrainingArguments` are parameters passed into the trainer object
- `output_dir` directory to store results

[1] https://huggingface.co/docs/transformers/main_classes/trainer

Training the model

```
training_args = TrainingArguments(
    output_dir = "./results")

trainer = Trainer(
    model=model,
    args=training_args,
    train_dataset=dataset['train'],
    eval_dataset=dataset['test']
)
```

Training the model

```
trainer.train()

local_path = "./fine_tuned_model"

trainer.save_model(local_path)
```

Final fine-tuned model

```
from transformers import pipeline

classifier = pipeline(task="text-classification", model=local_path)

classifier(dataset['text'])
```

```
[{"Label": "Science", "Score":0.987}]
```

Let's practice!

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Text generation

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What is text generation?

- Produces new text from input
- Useful for developing content
- Plays role in many ML tasks
- Can be fine-tuned for specific tasks

Inputs for text generation

Text input

Inputs for text generation

GPT-2
LARGE

Text input

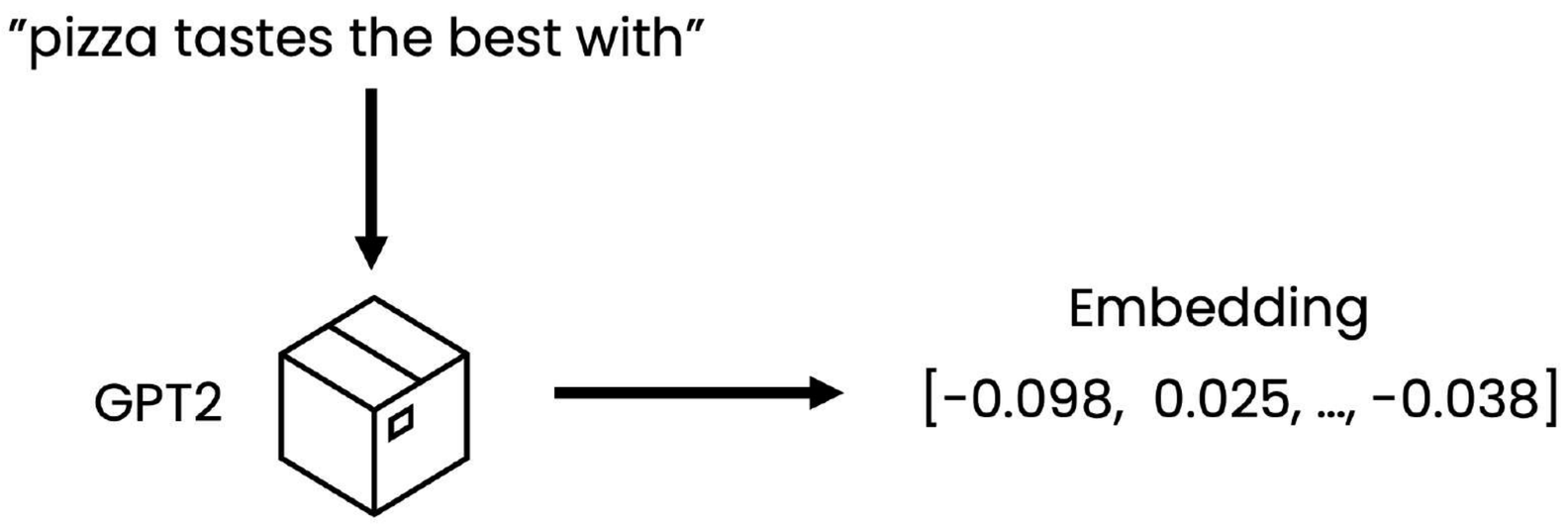
Microsoft

Generative Image-to-text Transformer

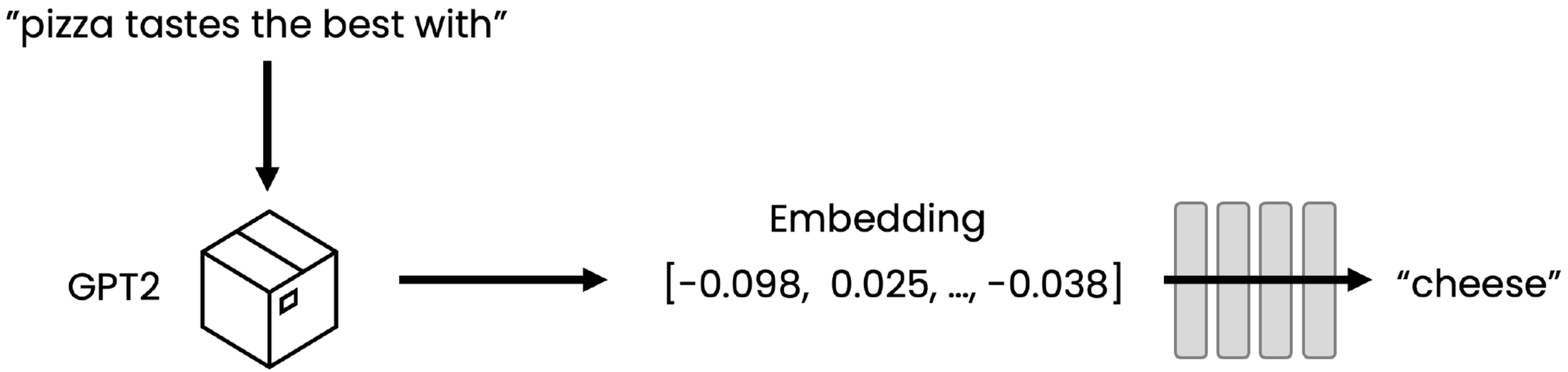
Image input

How do models generate text?

How do models generate text?



How do models generate text?



Generating text using Hugging Face

```python
from transformers import pipeline

generate_text = pipeline(task="text-generation")
```

```python
from transformers import (
    AutoTokenizer,
    AutoModelForCausalLM
)

tokenizer = AutoTokenizer.from_pretrained("gpt2")
model = AutoModelForCausalLM.from_pretrained("gpt2")
```

Generating text using Hugging Face

```
prompt = "Yogurt tastes better when topped with"

input_ids = tokenizer.encode(prompt, return_tensors="pt")
```

```
tensor([[  101, 10930, 27390,  2102, 16958,  2488,  2043,  9370,  2007,   102]])
```

```
output = model.generate(input_ids, num_return_sequences=1)
generated_text = tokenizer.decode(output[0])
print(generated_text)
```

```
Yogurt tastes better when topped with a little bit of honey.
```

Generating text from an image

```
from transformers import (
    AutoProcessor,
    AutoModelForCausalLM)
from PIL import Image

proc = AutoProcessor.\
    from_pretrained(
        "microsoft/git-base-coco")
model = AutoModelForCausalLM.\
    from_pretrained(
        "microsoft/git-base-coco")
```

```
img = Image.open("jacob_original.jpeg")
```

Generating text from an image

```
pixel_values = proc(images=img, return_tensors="pt").pixel_values

generated_ids = model.generate(pixel_values=pixel_values, max_length=50)

generated_caption = proc.batch_decode(
    generated_ids,
    skip_special_tokens=True)

print(generated_caption[0])
```

```
a man in a yellow beanie
```

Let's practice!

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Embeddings

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What are embeddings?

Vector

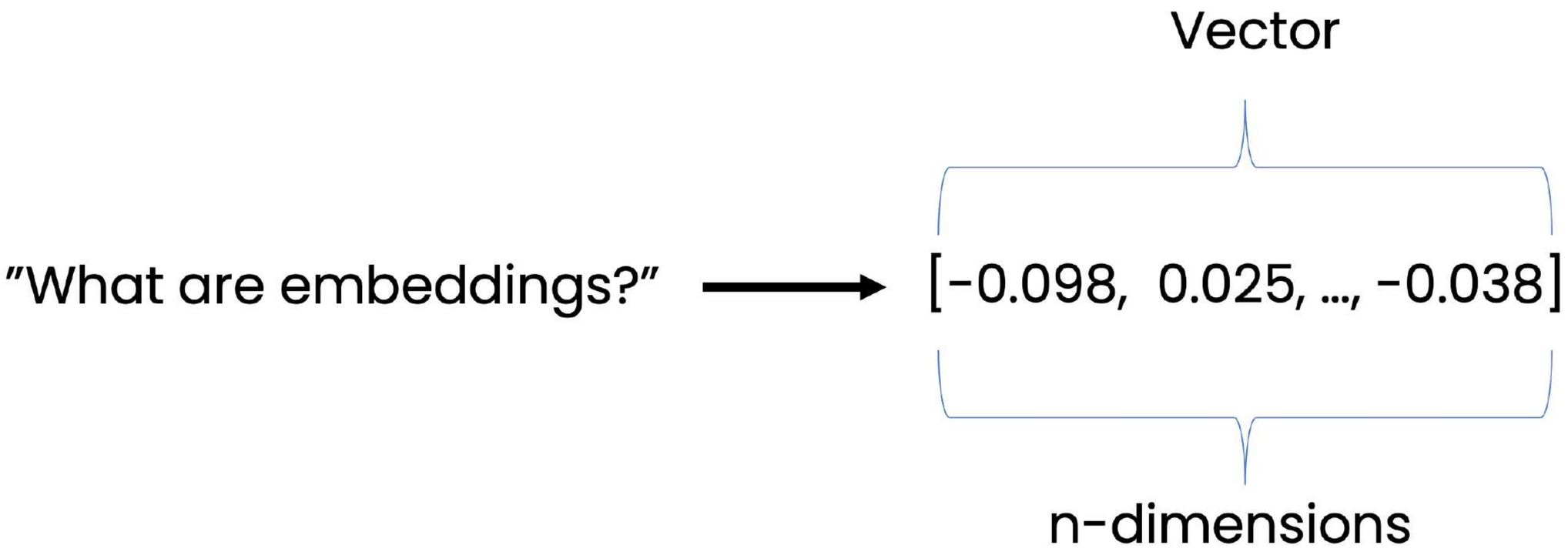
[-0.098, 0.025, ..., -0.038]

What are embeddings?

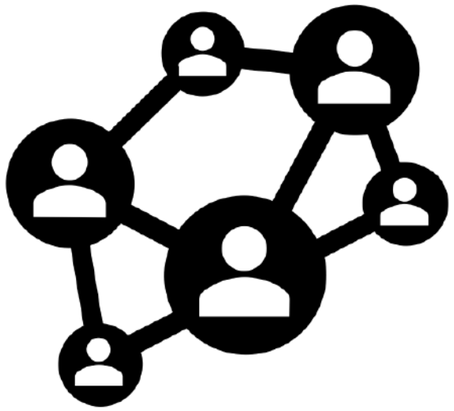
Vector

"What are embeddings?" → [-0.098, 0.025, ..., -0.038]

What are embeddings?

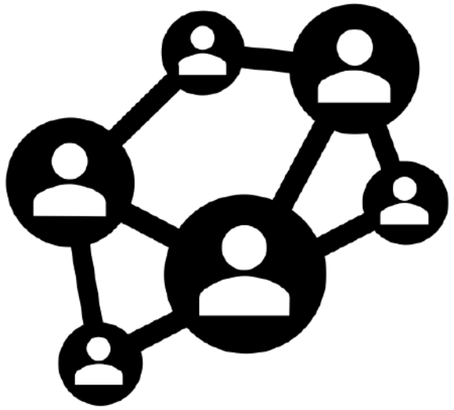


Use cases for embeddings



Recommender Systems

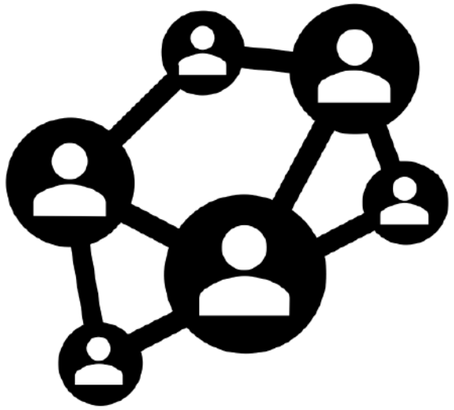
Use cases for embeddings



Recommender Systems

Search

Use cases for embeddings



Recommender Systems

Search

Fraud Detection

Benefits

- Semantic understanding
- Features
- Improved generalization

Challenges

- Require lots of data
- Inherit biases
- Interpretability

Using embeddings in Hugging Face

```
pip install sentence_transformers
```

```
from sentence_transformers import SentenceTransformer

model_name = "all-MiniLM-L6-v2"

embedder = SentenceTransformer(model=model_name)
```

Using embeddings in Hugging Face

```
sentence = "What are embeddings?"

embedding = embedder.encode([sentence])

print(embedding)
```

```
array([[-1.73364417e-03, -8.55376422e-02,...]])
```

```
print(embedding.shape)
```

```
(384)
```

Let's practice!

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Semantic search

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Keyword search

- Traditional approach
- Uses a set of keywords to find documents
- Best for simple or precise queries
- Less computationally intensive

search: monkey gene blockers

keywords: ["monkey", "gene", "blockers"]

document: ***AG News Article***

Gene Blocker Turns Monkeys Into Workaholics - Study (Reuters) Reuters - Procrastinating monkeys were turned\into workaholics using a gene treatment to block a key brain\compound, U.S. researchers reported on Wednesday

Semantic search

- Understand intent and context
- Uses query input and other context
- Find content matching the meaning

User Info

Location

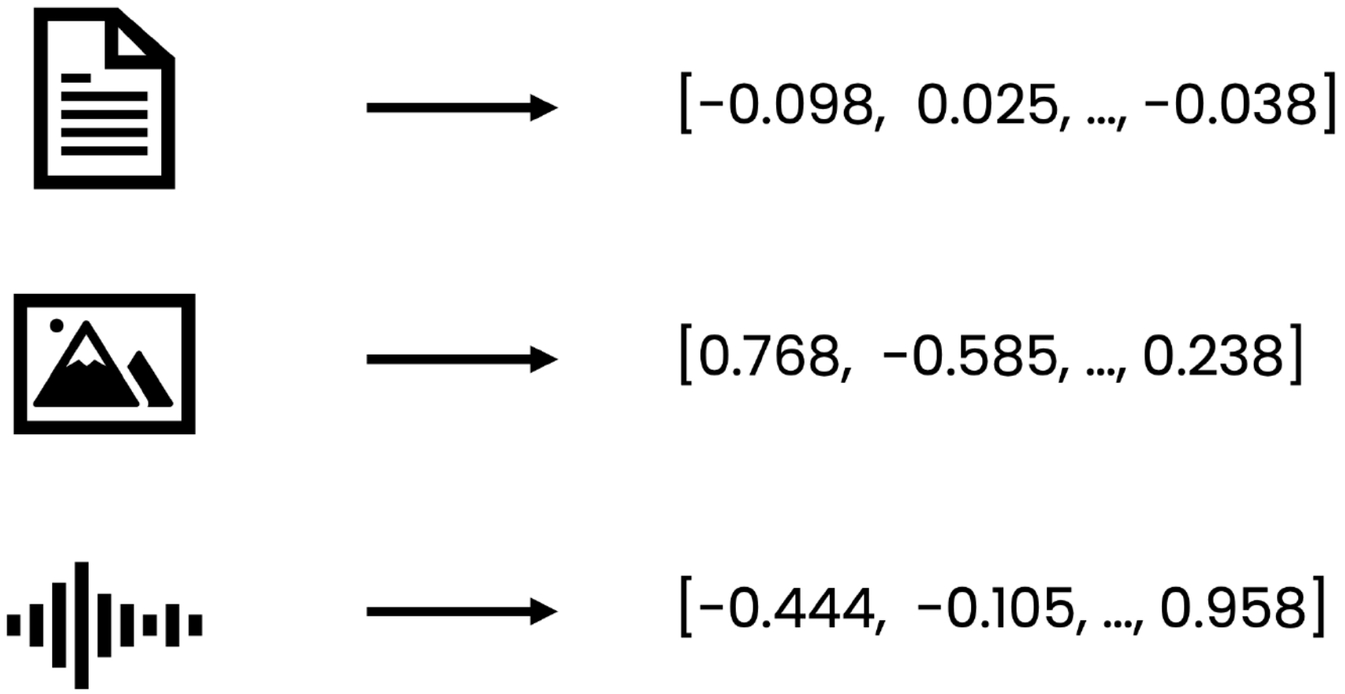
History

How does semantic search work?

- Vector search based on embeddings

How does semantic search work?

- Vector search based on embeddings



How does semantic search work?

- Vector search based on embeddings
- Compare embeddings using similarity measures
- More powerful with ambiguity and complexity

Similarity with cosine

Politics

Wildlife

Hip Hop

Similarity with cosine

Politics → [-0.098, 0.025, ..., -0.038]

Wildlife → [0.768, -0.585, ..., 0.238]

Hip Hop → [-0.444, -0.105, ..., 0.958]

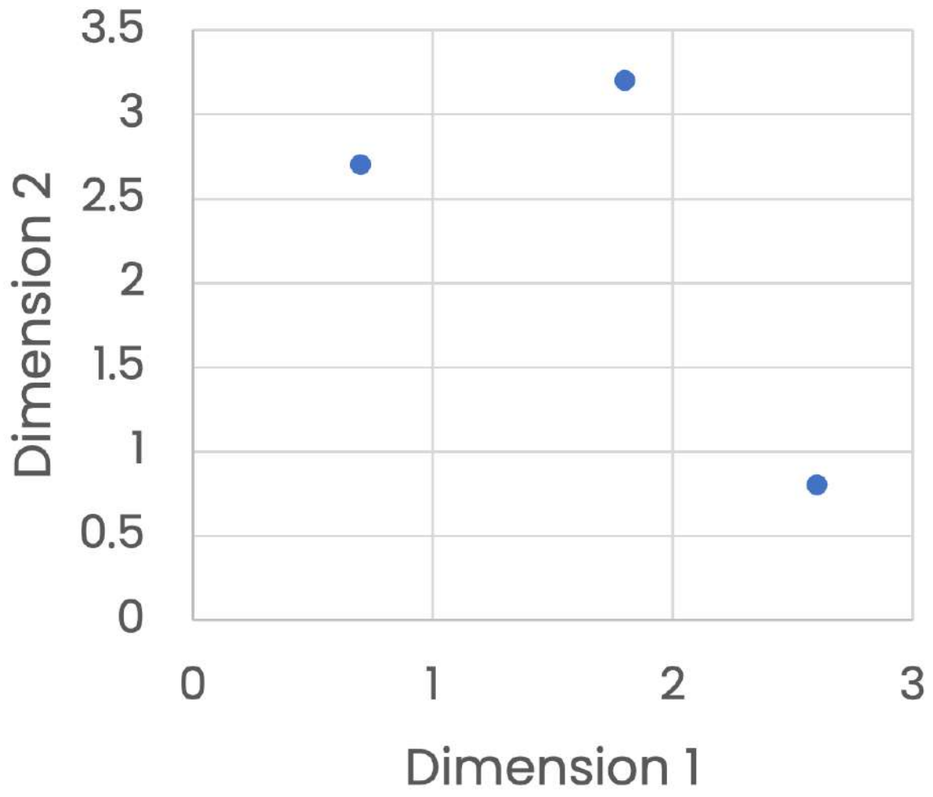
Similarity with cosine

n-dimensions

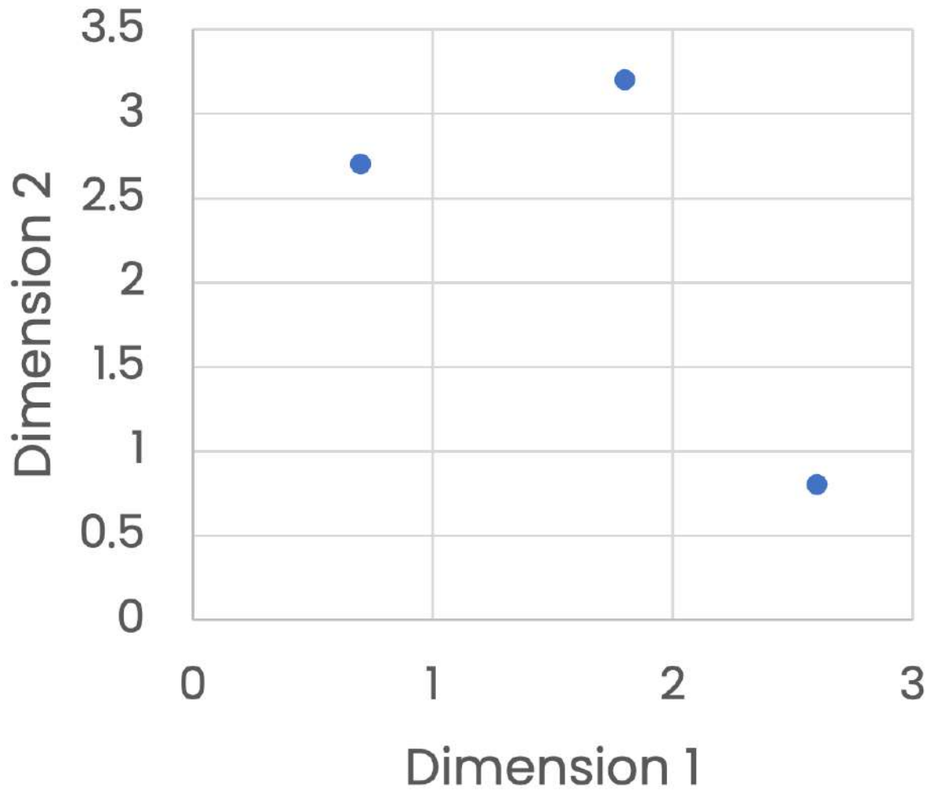
[0.768, -0.585, ..., 0.238]

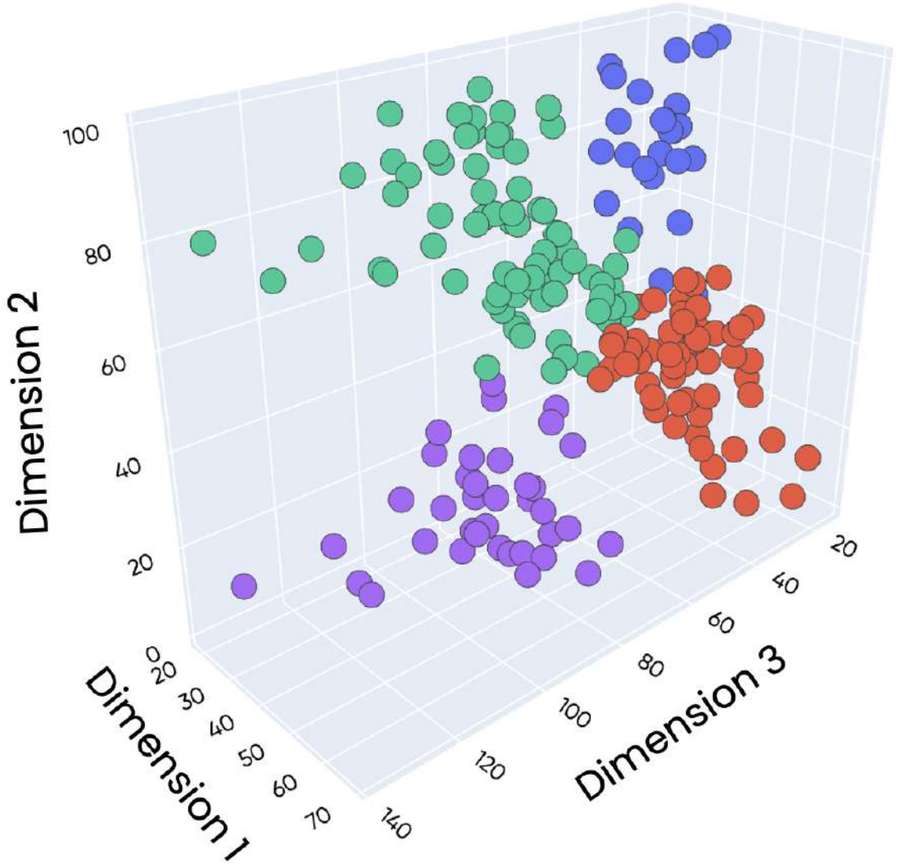
1 2 ... n

Similarity with cosine



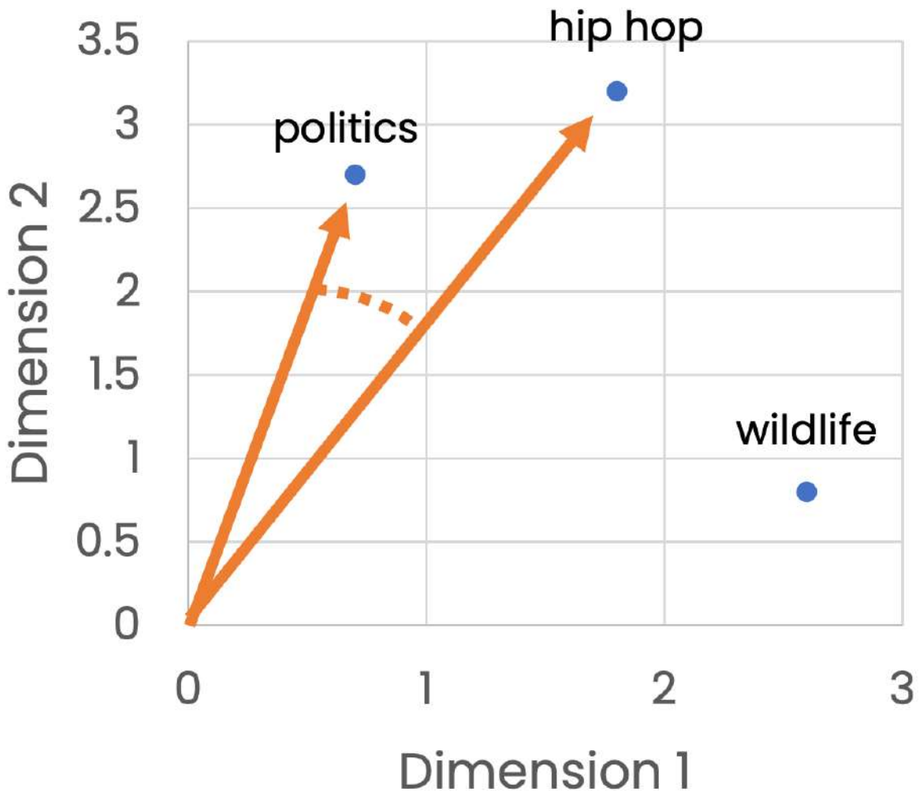
Similarity with cosine



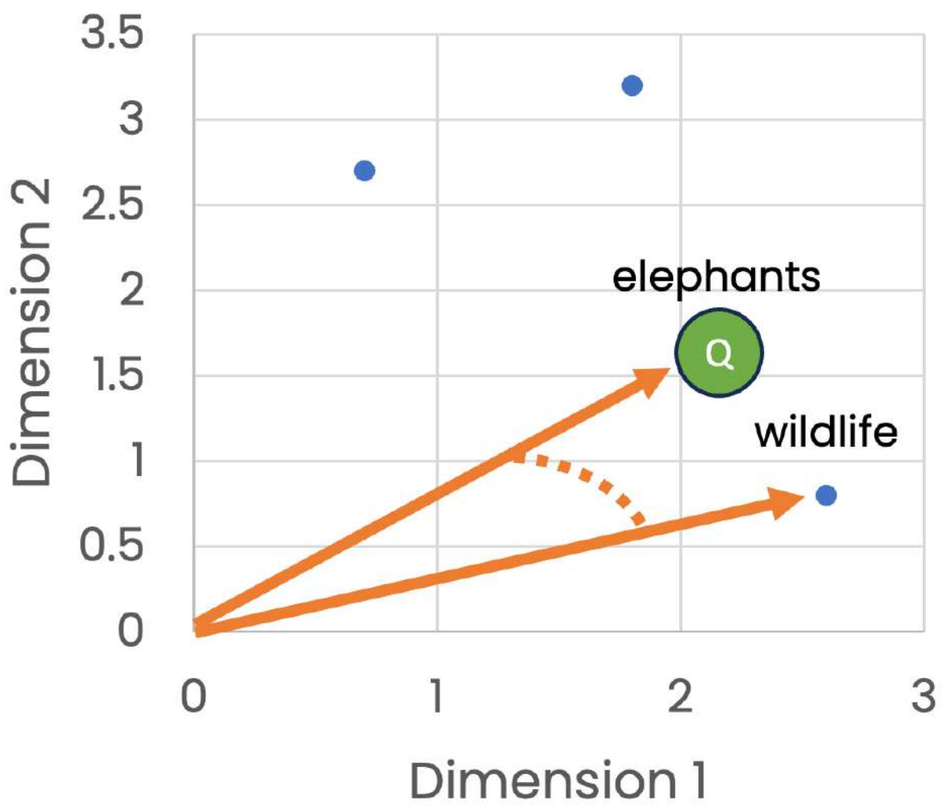


Cosine similarity

- Quantify distance between two points in n-dimensional space
- Calculated using the angle between two vectors for the points
- Similarity represented by dotted line
- Smaller = closer = similar



Searching with cosine



Semantic search with Hugging Face

```
from sentence_transformers import SentenceTransformers

encoder = SentenceTransformers(model="all-MiniLM-L6-v2")

document_embeddings = encoder.encode(documents)

query = "What are the most recent wildlife articles?"

query_embedding = encoder.encode([query])
```

Semantic search with Hugging Face

```
from sentence_transformers import util
```

```
hits = util.semantic_search(query_embedding, document_embeddings, top_k=2)
```

```
for hit in hits[0]:
    print(documents[hit['corpus_id']], "(Score: {:.4f})".format(hit['score']))
```

```
"Migration of elephants across the ..." (Score: 0.9561)

"What do birds do in the winter when ..." (Score: 0.8011)
```

Let's practice!

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Congratulations

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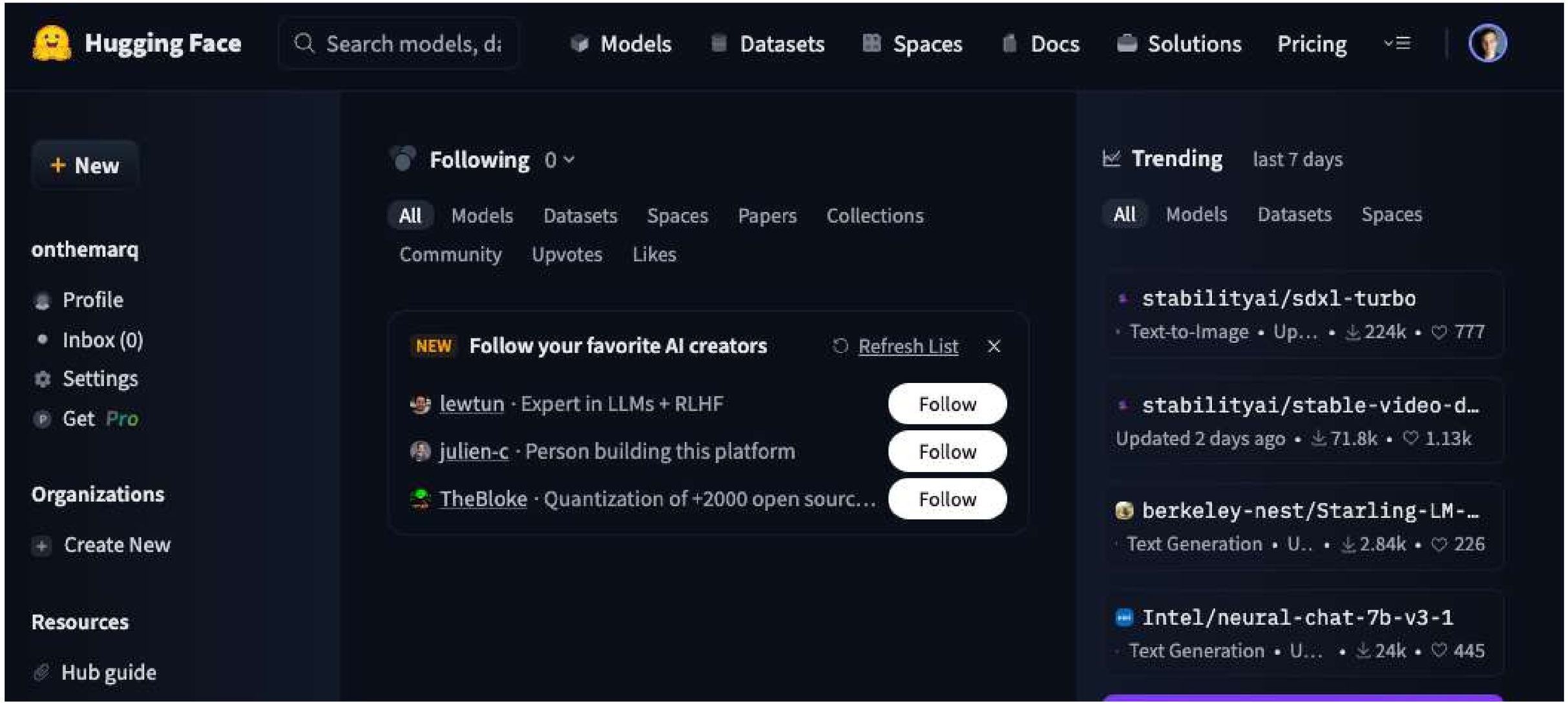
Chapter 1 - Hugging Face



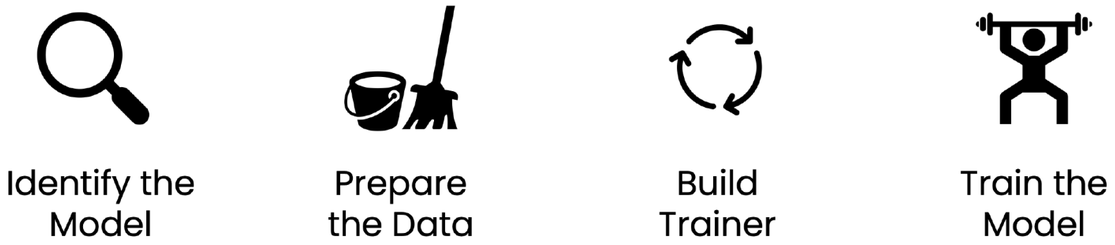
Chapter 2 - Pipelines

```
from transformers import pipeline

my_pipeline = pipeline(
    task="text-classification",
    model="distilbert-base-uncased-finetuned-sst-2-english")

input = "Hi, congrats on finishing the course!"

my_pipeline(input)
```

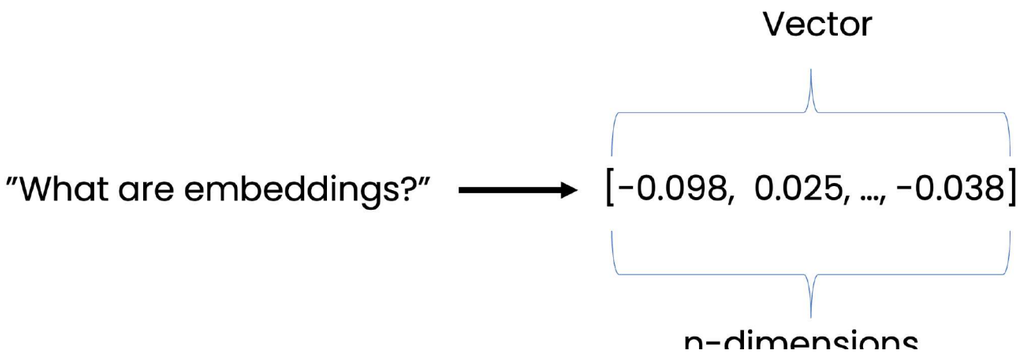
Chapter 3 - Pipelines with image and audio

Chapter 4 - Fine-tuning and advanced topics

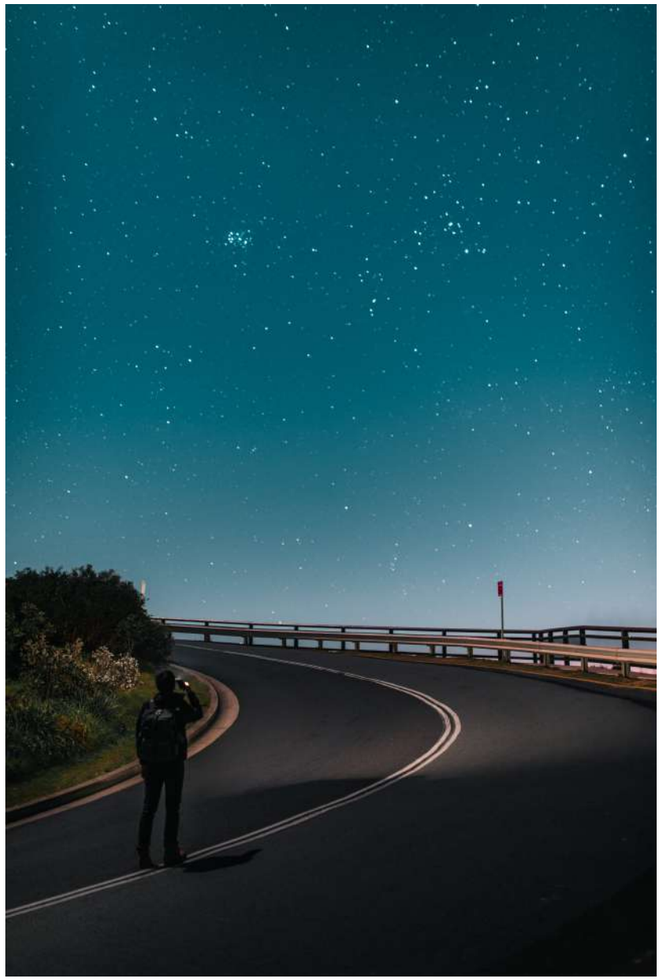
Fine-tuning



Embeddings



Next steps



- Explore the Hugging Face ecosystem
- Complex tasks, models
- Perform end-to-end fine-tuning

Congratulations!

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