Processing and classifying images

WORKING WITH HUGGING FACE

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Pixels in images

Pixels in images

- Images are made of pixels
- Pixels contain info about color and more
- Number of pixels from 1 to infinite

Pixels in images

- Images are made of pixels
- Pixels contain info about color and more
- Number of pixels from 1 to infinite
- More pixels = higher resolution

Importance of pre-processing images

- Models have expectations for the images
- Maintains consistency
- Target specific parts of images

Common pre-processing steps

- Cropping
- Resizing

Common pre-processing steps

Cropping

Common pre-processing steps

Cropping

- Removing unwanted portions of the image

Resizing

- Change dimensions of the image

Common pre-processing steps

Cropping

- Removing unwanted portions of the image

Resizing

- Change dimensions of the image

Transforming images

```
from transformers import image_transforms
```

```
from PIL import Image

original_image = Image.open("my_image.jpeg")
```

```
import numpy as np

image_array = np.array(original_image)
```

```
array([[[43, 32, 14],...,[77, 47, 23]]], dtype=uint8)
```

Cropping an image

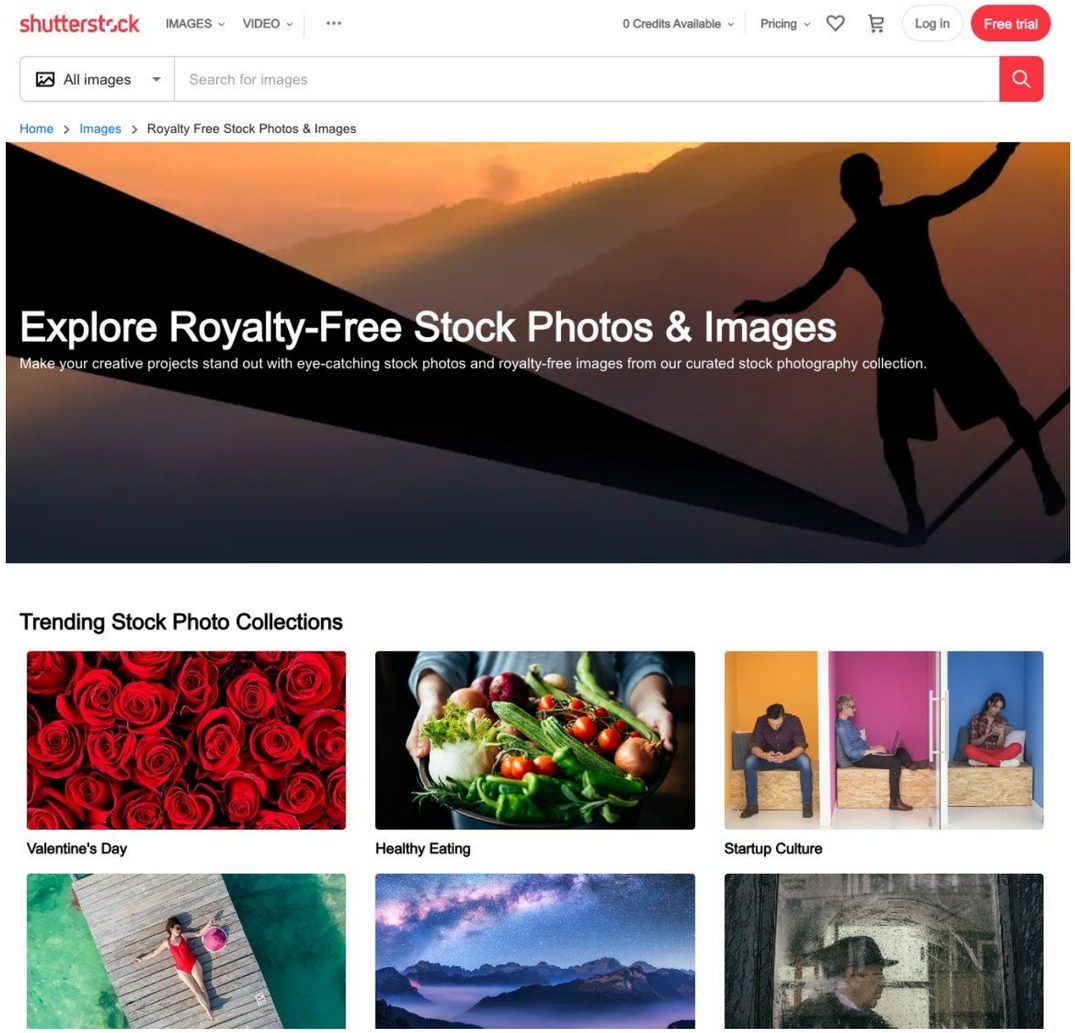
```
cropped_image = image_transforms \
    .center_crop(
      image=np.ndarray,
      size=(1000, 1000)
)
```

Original image

Cropped image

What is image classification?

- The process of assigning labels to an image
- Stock photography



[1] https://www.shutterstock.com/photos

What is image classification?

- The process of assigning labels to an image
- Stock photograph
- Agriculture

[1] https://phys.org/news/2021-03-crop-diseasesthere-app.html

What is image classification?

- The process of assigning labels to an image
- Stock photograph
- Agriculture
- Wildlife monitoring

Image classification pipeline

```
from transformers import pipeline


classifier = pipeline(task="image-classification",
                      model="google/vit-base-patch16-224")
```

Image classification pipeline

```
# http link to image
classifier("https://www.pexels.com/photo/elephants.jpeg")
```

```
# local path to image
classifier("/my_folder/elephants.jpeg")
```

```
# PIL image
from PIL import Image
image = Image.open("/my_folder/elephants.jpeg")
classifier(image)
```

```
classifier(["image1.jpeg", "image2.jpeg"])
```

Top K parameter

```
from transformers import pipeline

classifier = pipeline(task="image-classification",
                      model="google/vit-base-patch16-224")

results = classifier(image, top_k=2)

print(results[0]['label'])
```

```
African elephant, Loxodonta africana
```

Let's practice!

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Question answering and multi-modal tasks

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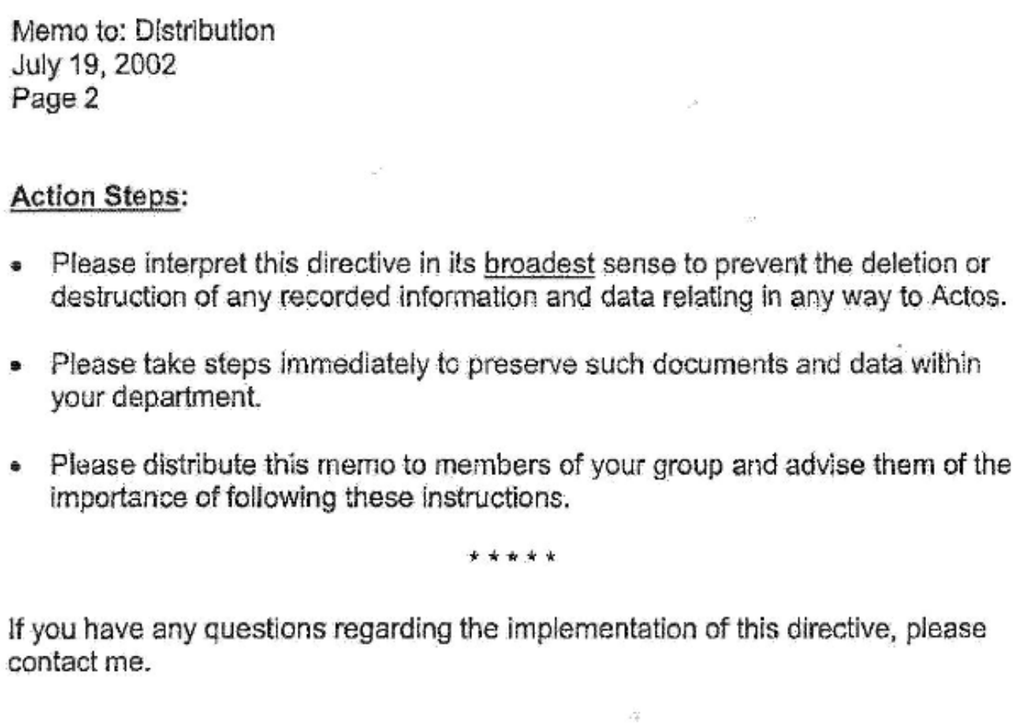
What is document question and answering?

- Answering questions about content of document
- Document is a text-based image
- Question is specific to the document
- Answer can be direct quote or paraphrased response



Memo to: Distribution
July 19, 2002
Page 2

Action Steps:

- Please interpret this directive in its broadest sense to prevent the deletion or destruction of any recorded information and data relating in any way to Actos.
- Please take steps immediately to preserve such documents and data within your department.
- Please distribute this memo to members of your group and advise them of the importance of following these instructions.

* * * * *

If you have any questions regarding the implementation of this directive, please contact me.

Question: "What are the action steps?"

Visual question and answering

- Ask a question of an actual image or video
- Pipeline requires the image and question

Question: "What type of animal is in this picture?"

Use cases: information retrieval

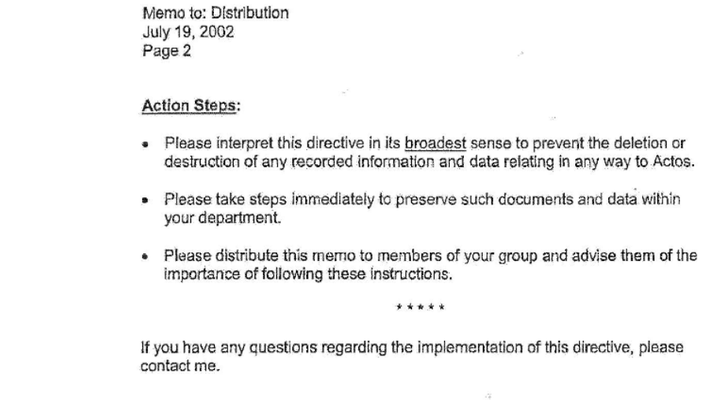
Customer Support

Legal Compliance

Search

Preprocessing for multi-modal tasks

- Multi-modal
- Process each data type
- Tokenization for text
- Resizing for images



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Document Q&A pipeline

```
from transformers import pipeline

dqa = pipeline(
    task="document-question-answering",
    model="naver-clova-ix/donut-base-finetuned-docvqa")
document_image = "memo.jpg"
question_text = "What is this memo about?"

results = dqa(document_image, question_text)
```

Results of document Q&A pipeline

```
print(results)
```

```
{
  "score": 0.789,
  "start": 1,
  "end": 2,
  "answer": "distribution",
  "words": [102]
}
```

- `score` is the probability of the answer
- `answer` is the answer to the question
- `start` is the start word index of the answer
- `end` is the last word index of the answer
- `words` is a list of all indices for each word in the answer

```
dqa(image=image,
    question=question,
    max_answer_len=15)
```

- 79% probability the memo is about distribution

Visual Q&A pipeline

```
from transformers import pipeline

vqa = pipeline(
    task="visual-question-answering",
    model="dandelin/vilt-b32-finetuned-vqa"
    )
```

```
result = vqa(
    image="image.jpeg",
    question="what's the person wearing?")
```

Results of visual Q&A pipeline

```
print(result)
```

```
[
    {'score': 0.9795706272125244,
    'answer': 'hat'
    },
    ...,
    {'score': 0.02153933234512806,
    'answer': 'hoodie'
    }
]
```

- `label` label identified by the model
- `score` probability of the label from the model

Let's practice!

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Audio classification

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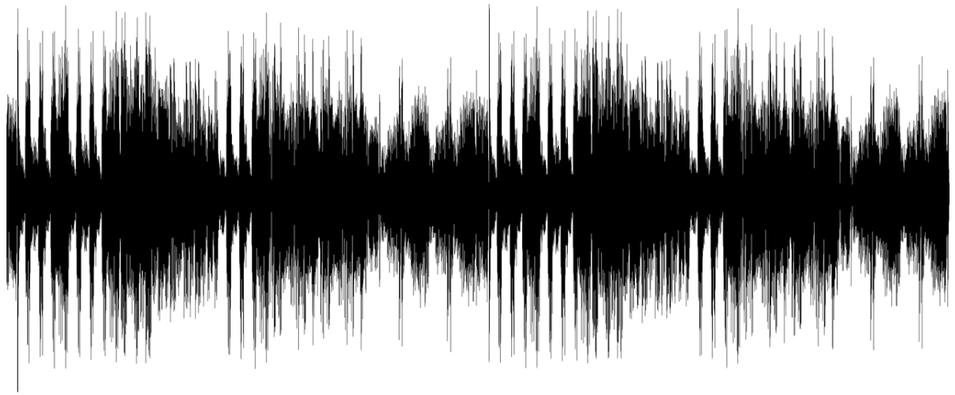
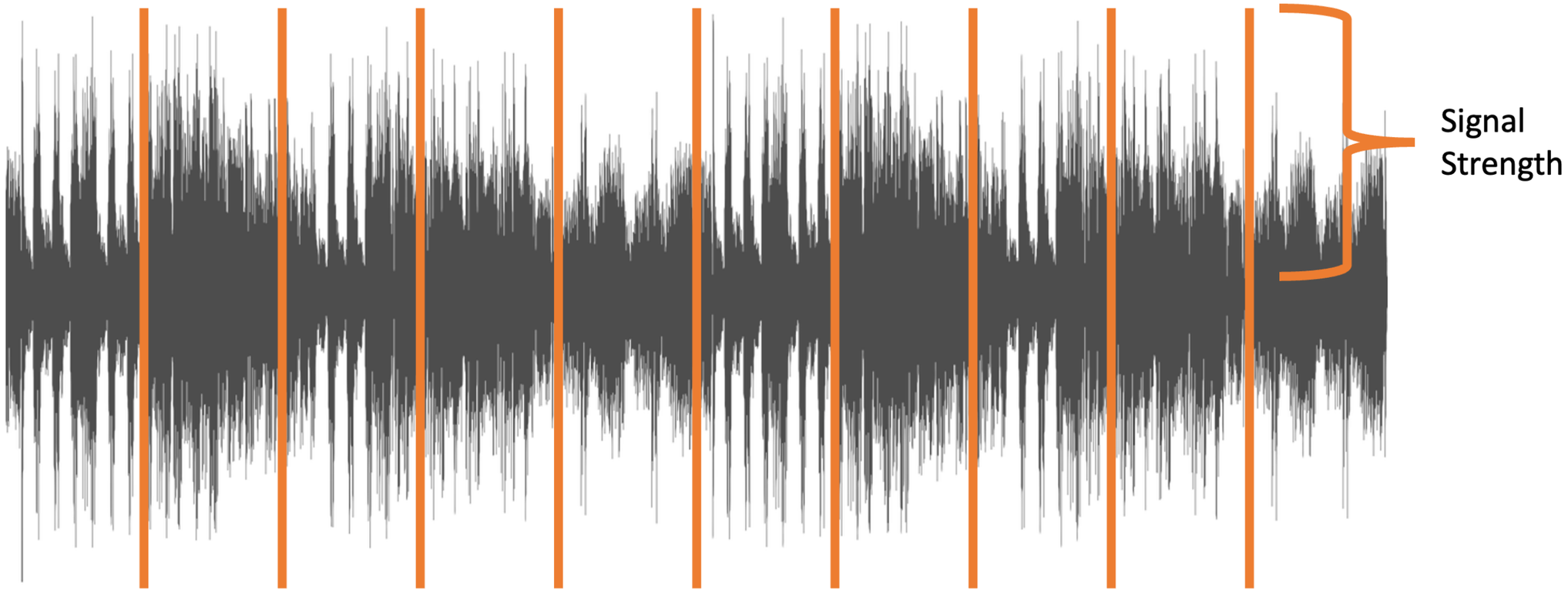
What is audio data?

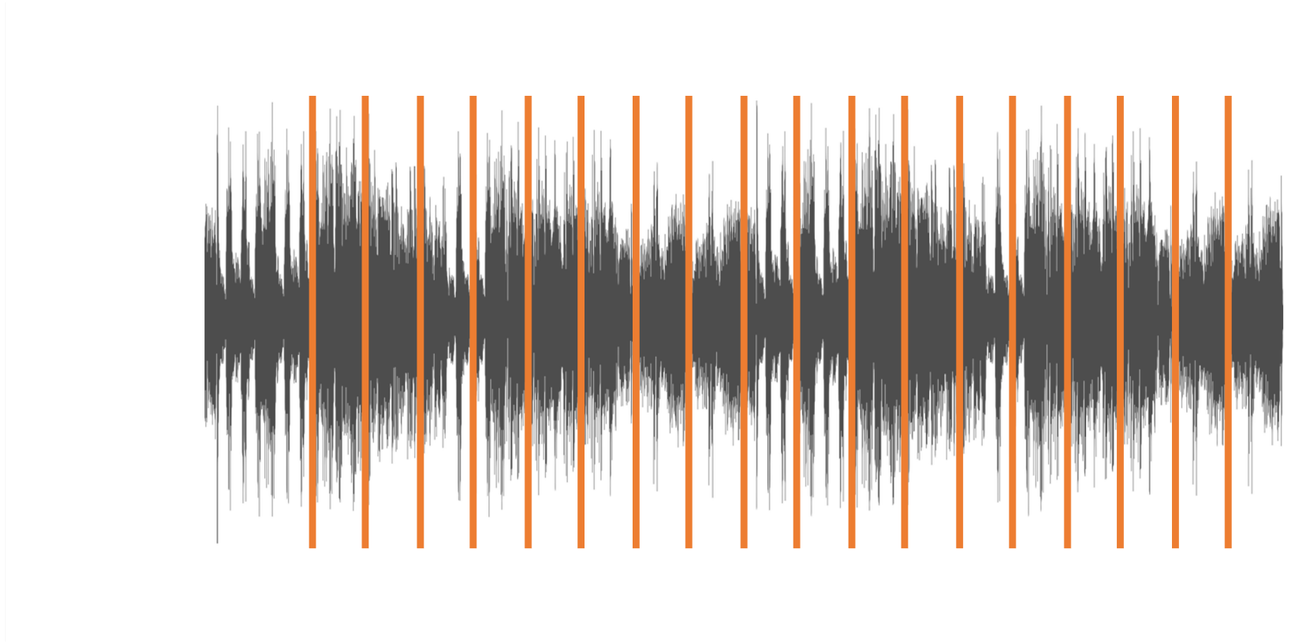
- Continuous signal called a sound wave
- Length and amplitude
- Converted into series of discrete values
- Results in a digital representation
- Conversion helps ML algorithms process and use audio
- Sampling is an important step



The importance of sampling

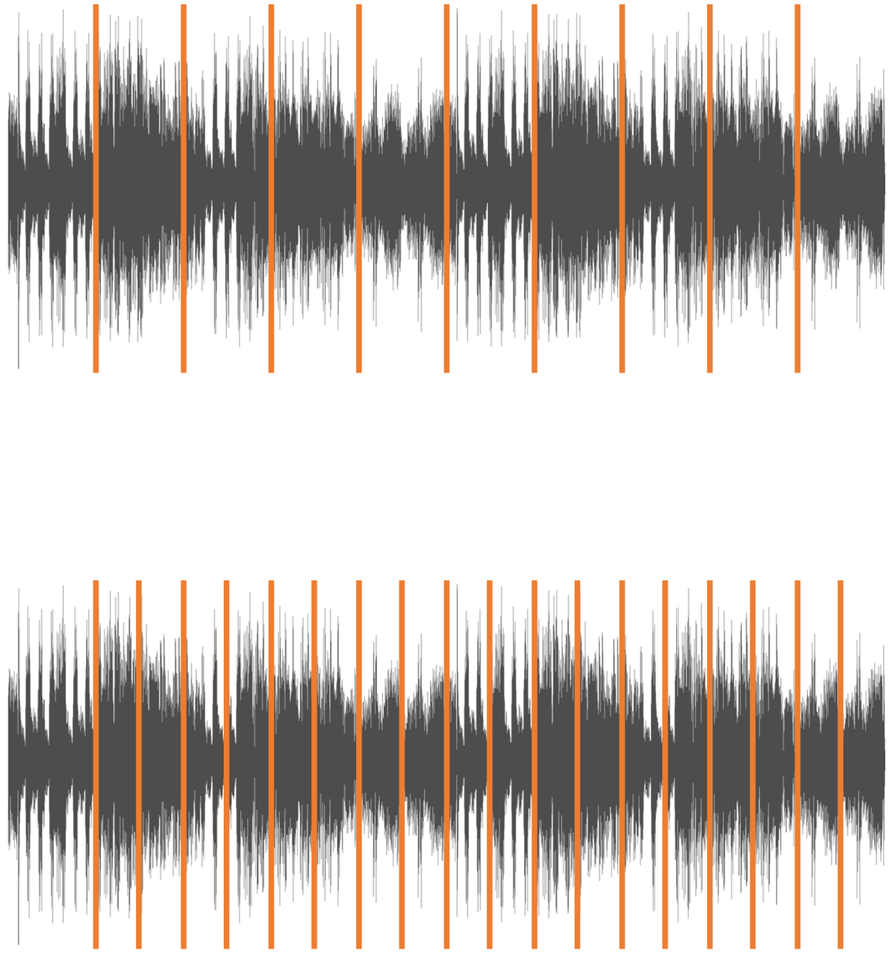


The importance of sampling



- Speech models trained at 16kHz
- Sampling rate specified in the model card

Resampling



- Aligns sample rates across all files
- Ensures consistency
- Helps with processing

Resampling using Hugging Face

```
from datasets import Audio


songs = songs.cast_column("audio", Audio(sampling_rate=16_000))
```

Finding the sampling rate:

```
print(songs[0]["audio"]["sampling_rate"])
```

```
16_000
```

Filtering

Benefits

- Ensure enough audio for inference or training
- Reduce computation by limiting file size

```
import librosa
```

Filtering

```
durations = []

for row in songs["path"]:
    durations.append(librosa.get_duration(path=row))

songs.add_column("duration", durations)

songs = dataset.filter(
    lambda d: d < 10.0, input_columns=["duration"]
)
```

What is audio classification?

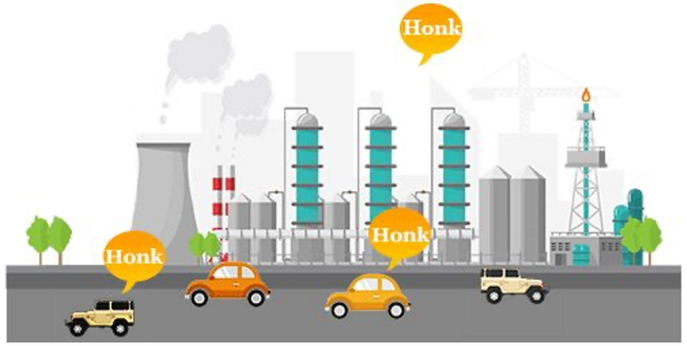
Definition: *process of assigning one or more labels to audio clips based on its content*

Language Identification

What is audio classification?

Definition: *process of assigning one or more labels to audio clips based on its content*

Language Identification

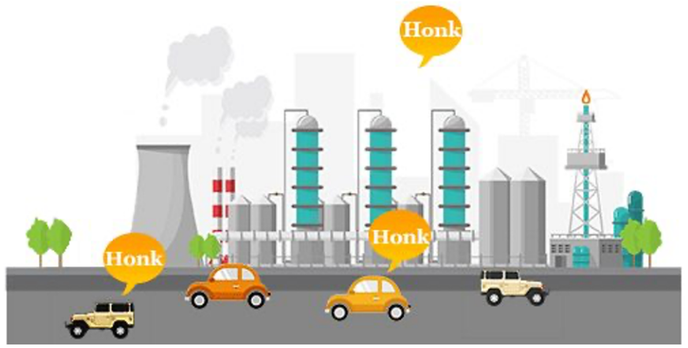


Environmental Sounds

What is audio classification?

Definition: *process of assigning one or more labels to audio clips based on its content*

Language Identification



Environmental Sounds

Speaker Identification

Using Hugging Face pipelines

```
from transformers import pipeline

classifier = pipeline(task="audio-classification",
                      model="superb/wav2vec2-base-superb-ks")

genreClassifier = pipeline(task="audio-classification",
                           model="mtg-upf/discogs-maest-30s-pw-73e-ts")
```

Using Hugging Face pipelines

```
audio = songs[0]['audio']['array']
prediction = genreClassifier(audio)

print(prediction)
```

```
[
{'score': 0.07648807018995285, 'label': 'Non-Music---Field Recording'},
...
{'score': 0.05880315974354744, 'label': 'Electronic---Noise'}
]
```

[1] https://huggingface.co/mtg-upf/discogs-maest-30s-pw-73e-ts

Using Hugging Face pipelines

```
prediction = genreClassifier(audio, top_k=1)
```

```
[
{'score': 0.07648807018995285, 'label': 'Non-Music---Field Recording'}
]
```

Let's practice!

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Automatic speech recognition

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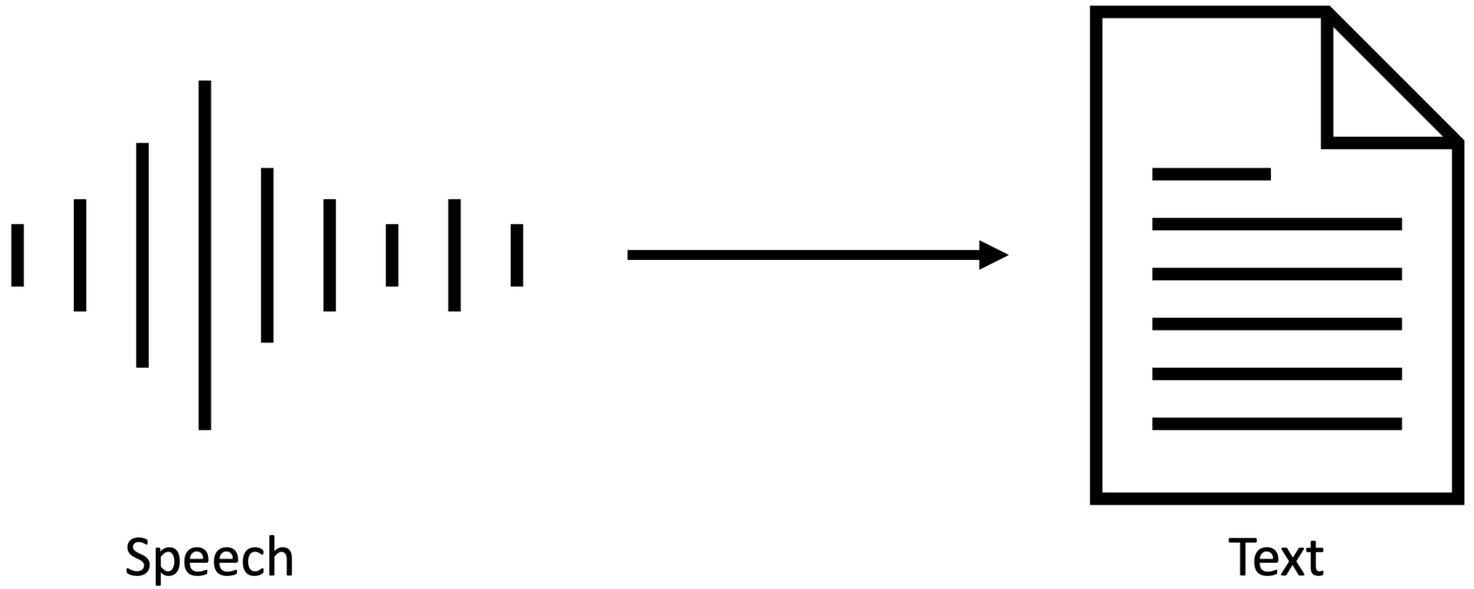
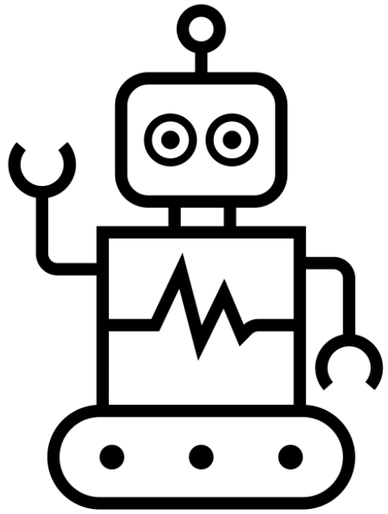
What is automatic speech recognition?

Speech

What is automatic speech recognition?

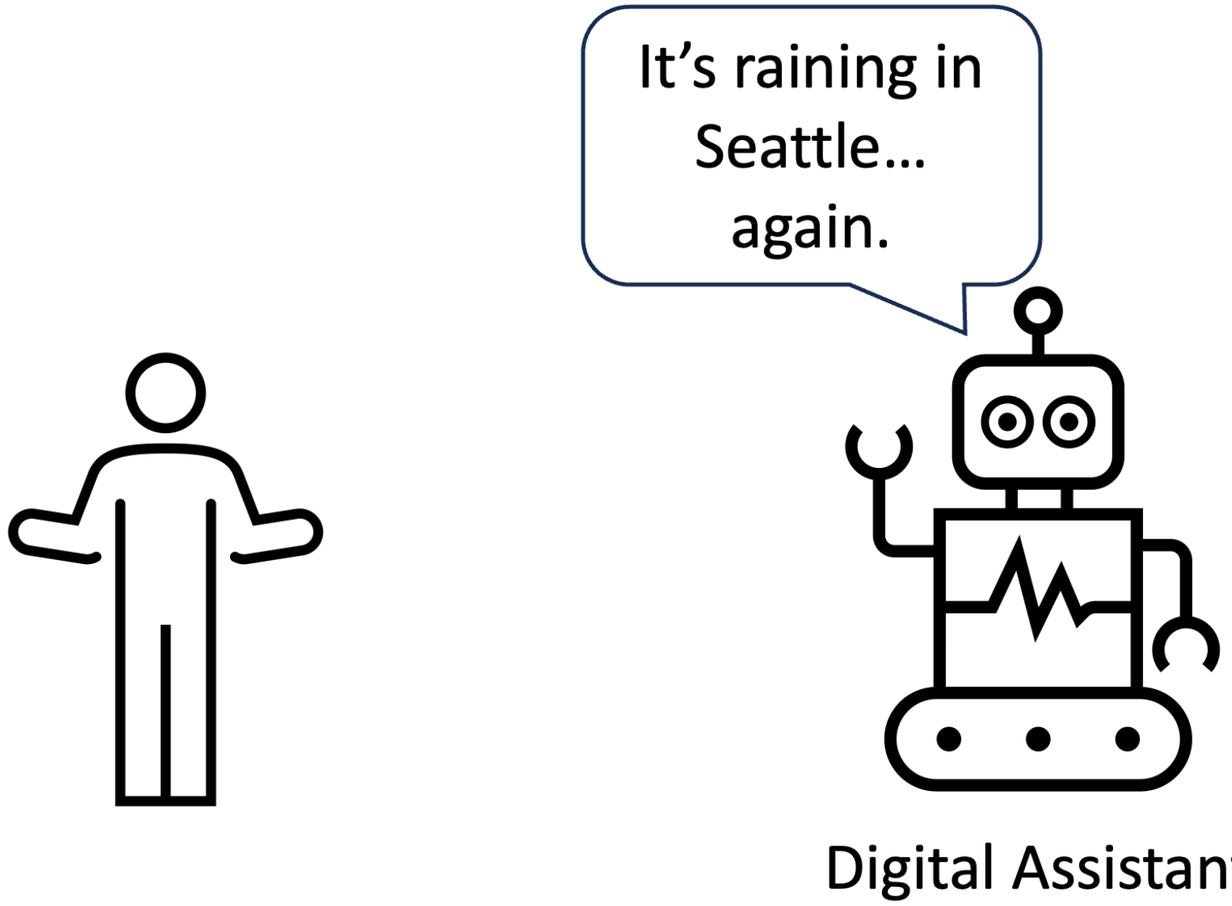


Use cases of ASR



Digital Assistant

Use cases of ASR



Use cases for ASR

- Create transcripts
- Finding relevant documentation and solutions

Use cases for ASR

Models for ASR

Wav2Vec

```
model_id:
"facebook/wav2vec2-base-960h"
```

Models for ASR

`Wav2Vec`

```
model_id:
"facebook/wav2vec2-base-960h"
```

`Whisper`

```
model_id:
”openai/whisper-base"
```

- Whisper performs better with punctuation and casing.

Instantiating a pipeline for ASR

```
transcriber = pipeline(task="automatic-speech-recognition",
                       model="facebook/wav2vec2-base-960h")

# Path to audio file
transcriber("my_audio.wav")

# Numpy array
transcriber(numpy_audio_array)

# Dictionary
transcriber({"sampling_rate" = 16_000,"raw" = "my_audio.wav"})
```

Results from a pipeline

```
sampling_rate = 16_000
dataset = dataset.cast_column("audio", Audio(sampling_rate=sampling_rate))

input = data[0]['audio']['array']

prediction = transcriber(input)
```

```
print(prediction)
```

```
"what game do you want to play"
```

Predicting over a dataset

```
def data():
    for i in range(dataset):
        yield dataset[i]['audio']['array'], dataset[i]['sentence'].lower()

output = []

for audio, sentence in data():
    prediction = transcriber(audio)
    output.append((prediction, sentence))
```

```
[("what a nice black shirt", "what a nice blue shirt"), ...]
```

Evaluating ASR systems

- Word Error Rate (WER)
- Based on Levenshtein Distance
- Metric for the difference between two sequences

$$\frac{(Substitutions + Insertions + Deletions)}{Number of Words Spoken}$$

- Range from 0 to 1
- Smaller value indicates closer similarity

[1] https://en.wikipedia.org/wiki/Levenshtein_distance

Word Error Rate

Correct	Prediction
I love DataCamp courses on AI!	I love DataCamp portraits on hay!

- 2 substitutions required to match to correct

```
2 / 6 = 0.33
```

Computing WER using Hugging Face

```
from evaluate import load

# Instantiate word error rate metric
wer = load("wer")

# Save true sentence as reference
reference = data[0]['sentence']

predictions = "I love DataCamp portraits on hay"
```

[1] https://huggingface.co/spaces/evaluate-metric/wer

Computing WER using Hugging Face

```
# Compute the WER between predictions and reference
wer_score = wer.compute(
  predictions=[prediction],
  references=[reference]
  )

print(wer_score)
```

```
0.33
```

Let's practice!

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