

Matlab and Artificial Intelligence

Piotr POWROŹNIK

University of Zielona Góra

Institute of Metrology, Electronics and Computer Science



p.powroznik@imei.uz.zgora.pl

Agenda

- I. Neural Network Fundamentals
- II. Deep Learning in Practice
- III. MATLAB Deep Learning Model Hub
 - A. Vision: Image, Object, and Video Analysis
 - B. Natural Language Processing & Audio: Text, Transformers, and Speech Processing
 - C. Model Selection
- IV. Ollama and Large Language Models with MATLAB

Predict Using Layer Structure of Neural Network Classifier

Load the sample file `fisheriris.csv`, which contains iris data including sepal length, sepal width, petal length, petal width, and species type. Read the file into a table.

```
fishertable = readtable('fisheriris.csv');
```

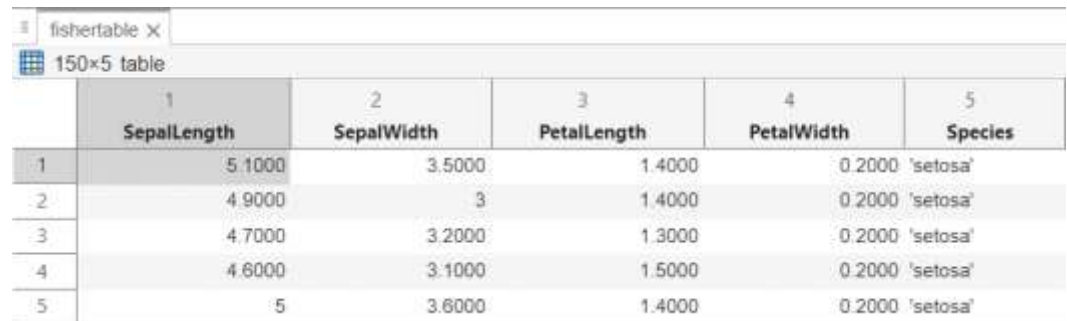
Train a neural network classifier using the data set. Specify the Species column of `fishertable` as the response variable.

```
Mdl = fitcnet(fishertable,"Species");
```

Check that the predictions match those returned by the `predict` object function.

```
[predictedLabel,predictedScores] = predict(Mdl, [6 3 4 2])
```

```
predictedLabel = 1x1 cell array  
    {'versicolor'}  
predictedScores = 1x3  
    0    0.9602    0.0398
```



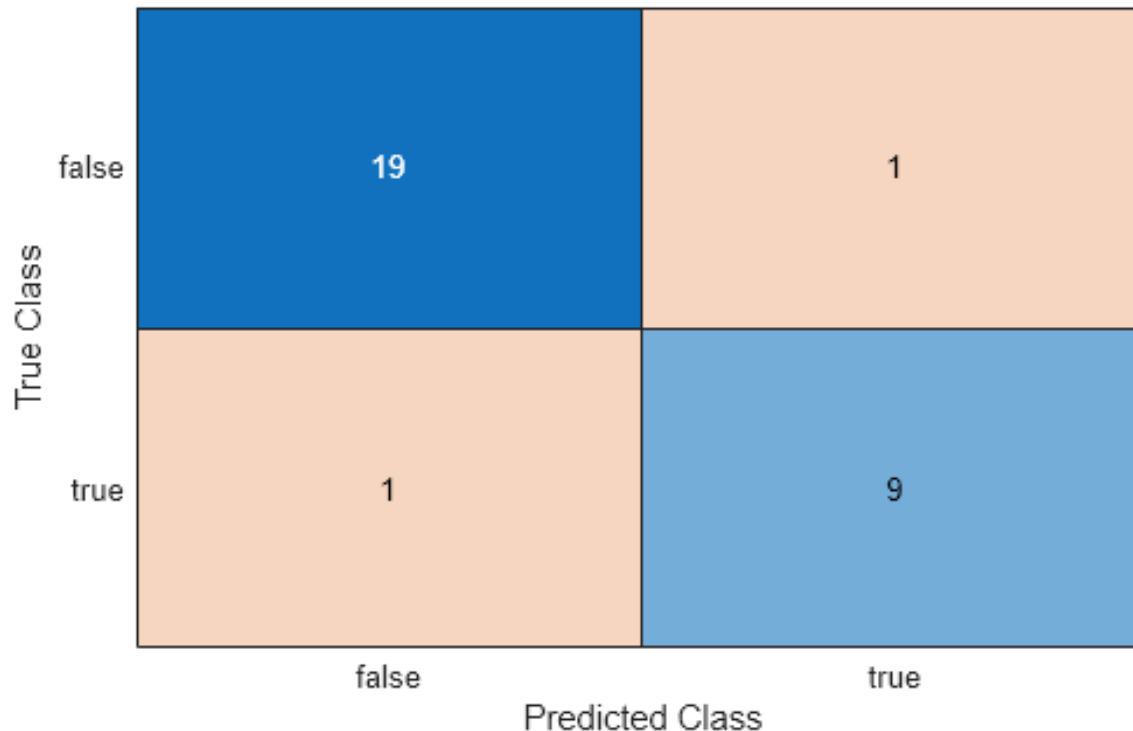
	1 SepalLength	2 SepalWidth	3 PetalLength	4 PetalWidth	5 Species
1	5.1000	3.5000	1.4000	0.2000	'setosa'
2	4.9000	3	1.4000	0.2000	'setosa'
3	4.7000	3.2000	1.3000	0.2000	'setosa'
4	4.6000	3.1000	1.5000	0.2000	'setosa'
5	5	3.6000	1.4000	0.2000	'setosa'

source: <https://www.mathworks.com/help/stats/classificationneuralnetwork.predict.html>

Classify Test Set Observations Using Neural Network

```
load patients
tbl = table(Diastolic,Systolic,Gender,Height,Weight,Age,Smoker);
```

Separate the data into a training set `tblTrain` and a test set `tblTest` by using a stratified random sampling method. For the training data, use `rng("default")` and `cvpartition` to create a training and test index. Then, use `tblTrain` and `tblTest` to create a neural network model. Finally, use `classify` to predict the class for the test set observations.



Age	Smoker
38	true
43	false
38	false
40	false
49	false

Smoker column
predictors.

on matrix.

source: <https://www.mathworks.com/help/stats/classificationneuralnetwork.predict.html>

Deep Learning - An Example Using GoogLeNet

Requirements:

- Deep Learning Toolbox™
- Support package for using webcams in MATLAB
- Support package for using GoogLeNet

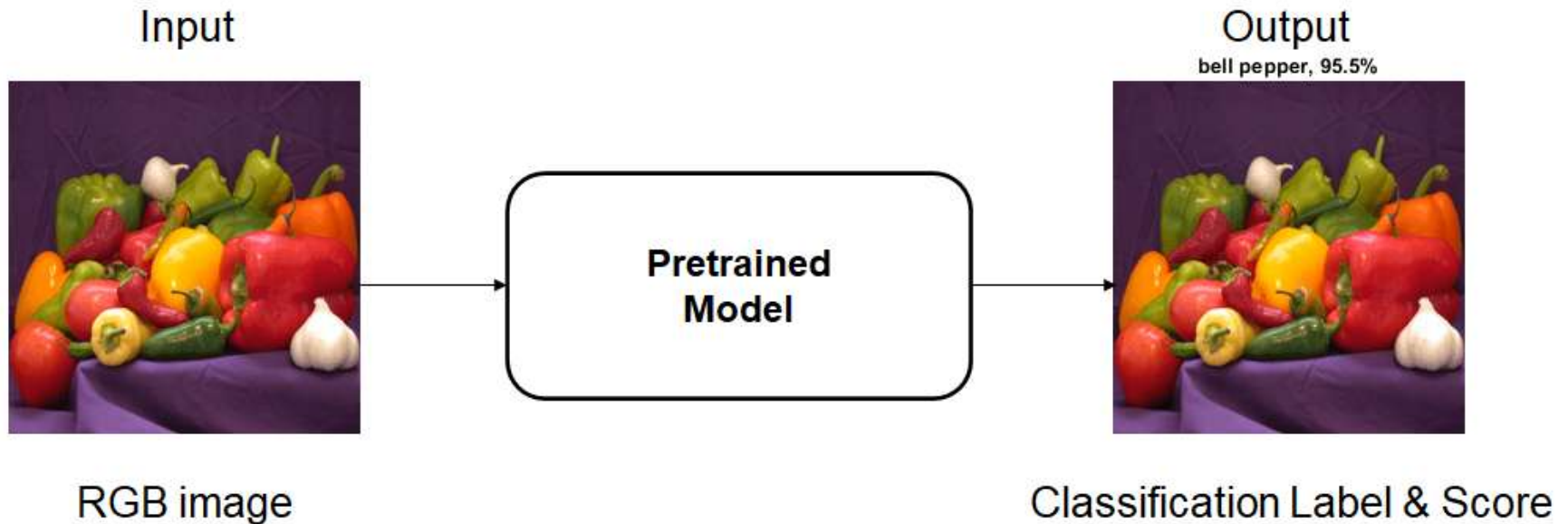


```
camera = webcam;
nnet = googlenet;
picture = camera.snapshot;
picture = imresize(picture,[224,224]);
label = classify(nnet, picture);
image(picture);
title(char(label));
```

% Connect to the camera
% Load the neural net
% Take a picture
% Resize the picture
% Classify the picture
% Show the picture
% Show the label

source: <https://www.mathworks.com/campaigns/offers/next/deep-learning-ebook.html>

MATLAB Deep Learning Model Hub - Image Classification



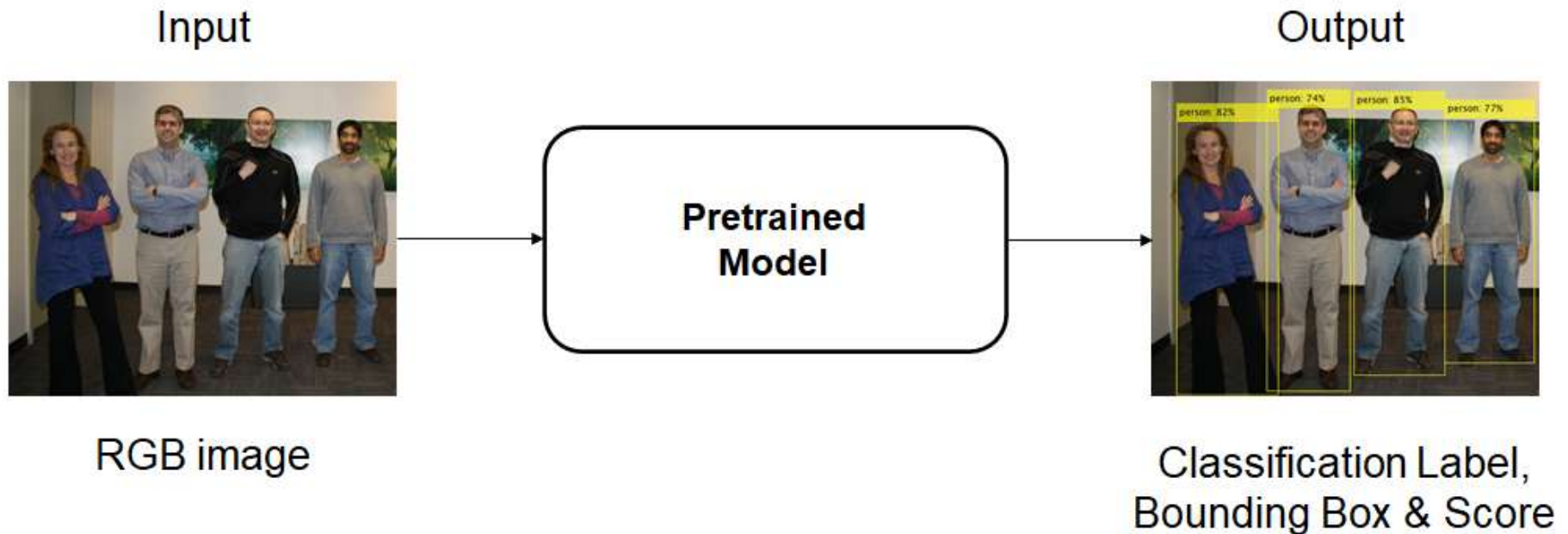
```
[net, classes] = imagePretrainedNetwork("googlenet");
```

source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Image Classification

Network	Size (MB)	Classes	Accuracy %	Location
googlenet	27	1000	66.25	Doc GitHub
squeezenet	5.2	1000	55.16	Doc
alexnet	227	1000	54.10	Doc
resnet18	44	1000	69.49	Doc GitHub
resnet50	96	1000	74.46	Doc GitHub
resnet101	167	1000	75.96	Doc GitHub
mobilenetv2	13	1000	70.44	Doc GitHub
vgg16	515	1000	70.29	Doc
vgg19	535	1000	70.42	Doc
inceptionv3	89	1000	77.07	Doc
inceptionresnetv2	209	1000	79.62	Doc
xception	85	1000	78.20	Doc
darknet19	78	1000	74.00	Doc
darknet53	155	1000	76.46	Doc
densenet201	77	1000	75.85	Doc
shufflenet	5.4	1000	63.73	Doc
nasnetmobile	20	1000	73.41	Doc
nasnetlarge	332	1000	81.83	Doc
efficientnetb0	20	1000	74.72	Doc
ConvMixer	7.7	10	-	GitHub
Vison Transformer	Large-16 - 1100 Base-16 - 331.4 Small-16 - 84.7 Tiny-16 - 22.2	1000	Large-16 - 85.59 Base-16 - 85.49 Small-16 - 83.73 Tiny-16 - 78.22	Doc

MATLAB Deep Learning Model Hub - Object Detection







source: <https://www.mathworks.com/solutions/deep-learning/models.html>

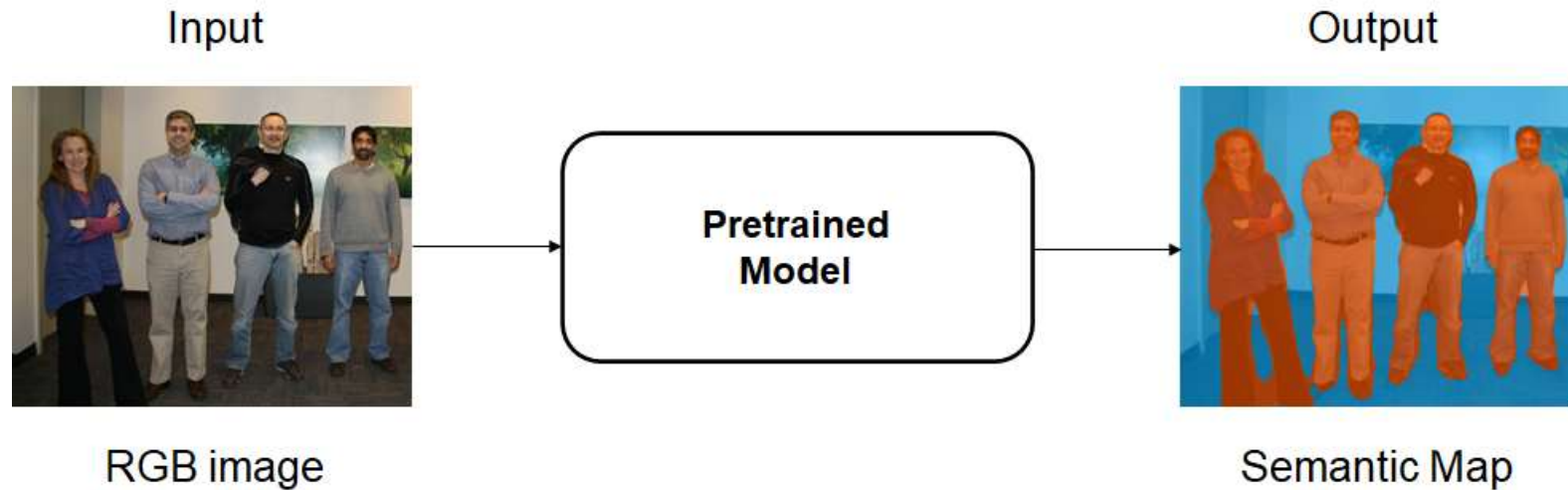
MATLAB Deep Learning Model Hub - Object Detection

Network	Network variants	Size (MB)	Mean Average Precision (mAP)	Object Classes	Location
EfficientDet-D0	efficientnet	15.9	33.7	80	GitHub
YOLO v9	yolo9t	7.5	38.3	80	GitHub
	yolo9s	25	46.8		
	yolo9m	67.2	51.4		
	yolo9c	85	53.0		
	yolo9e	190	55.6		
YOLO v8	yolo8n	10.7	37.3	80	GitHub
	yolo8s	37.2	44.9		
	yolo8m	85.4	50.2		
	yolo8l	143.3	52.9		
	yolo8x	222.7	53.9		
YOLOX	YoloX-s	32	39.8	80	Doc GitHub
	YoloX-m	90.2	45.9		
	YoloX-l	192.9	48.6		
YOLO v4	yolov4-coco	229	44.2	80	Doc GitHub
	yolov4-tiny-coco	21.5	19.7		
YOLO v3	darknet53-coco	220.4	34.4	80	Doc
	tiny-yolov3-coco	31.5	9.3		
YOLO v2	darknet19-COCO	181	28.7	80	Doc GitHub
	tiny-yolo_v2-coco	40	10.5		

MATLAB Deep Learning Model Hub - Object Detection

Network	Application	Size (MB)	Location	Example Output
Spatial-CNN	Lane detection	74	GitHub	
RESA	Road Boundary detection	95	GitHub	
Single Shot Detector (SSD)	Vehicle detection	44	Doc	
Faster R-CNN	Vehicle detection	118	Doc	

MATLAB Deep Learning Model Hub - Semantic Segmentation






source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Semantic Segmentation

Network	Size (MB)	Mean Accuracy	Object Classes	Location
DeepLabv3+	209	0.87	20	GitHub

Network	Size (MB)	Example Location
segmentAnythingModel	358	Doc

Network	Application	Size (MB)	Location	Example Output
U-net	Raw Camera Processing	31	Doc	
3-D U-net	Brain Tumor Segmentation	56.2	Doc	
AdaptSeg (GAN)	Model tuning using 3-D simulation data	54.4	Doc	

MATLAB Deep Learning Model Hub - Image Translation

Input

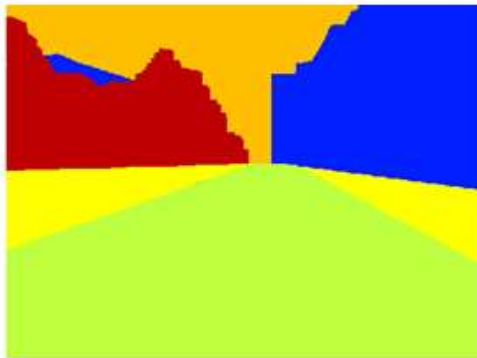


Image
(E.g. Semantic Map)

Pretrained
Model



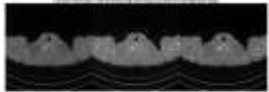
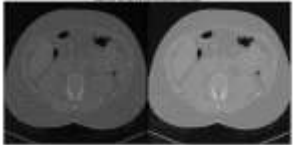

Output



Translated Image
(E.g. Synthetic Image)

source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Image Translation

Network	Application	Size (MB)	Location	Example Output
Pix2PixHD(CGAN)	Synthetic Image Translation	648	Doc	
UNIT (GAN)	Day-to-Dusk Dusk-to-Day Image Translation	72.5	Doc	
UNIT (GAN)	Medical Image Denoising	72.4	Doc	
CycleGAN	Medical Image Denoising	75.3	Doc	
VDSR	Super Resolution (estimate a high-resolution image from a low-resolution image)	2.4	Doc	

MATLAB Deep Learning Model Hub - Pose Estimation

Input



RGB Image

Pretrained
Model

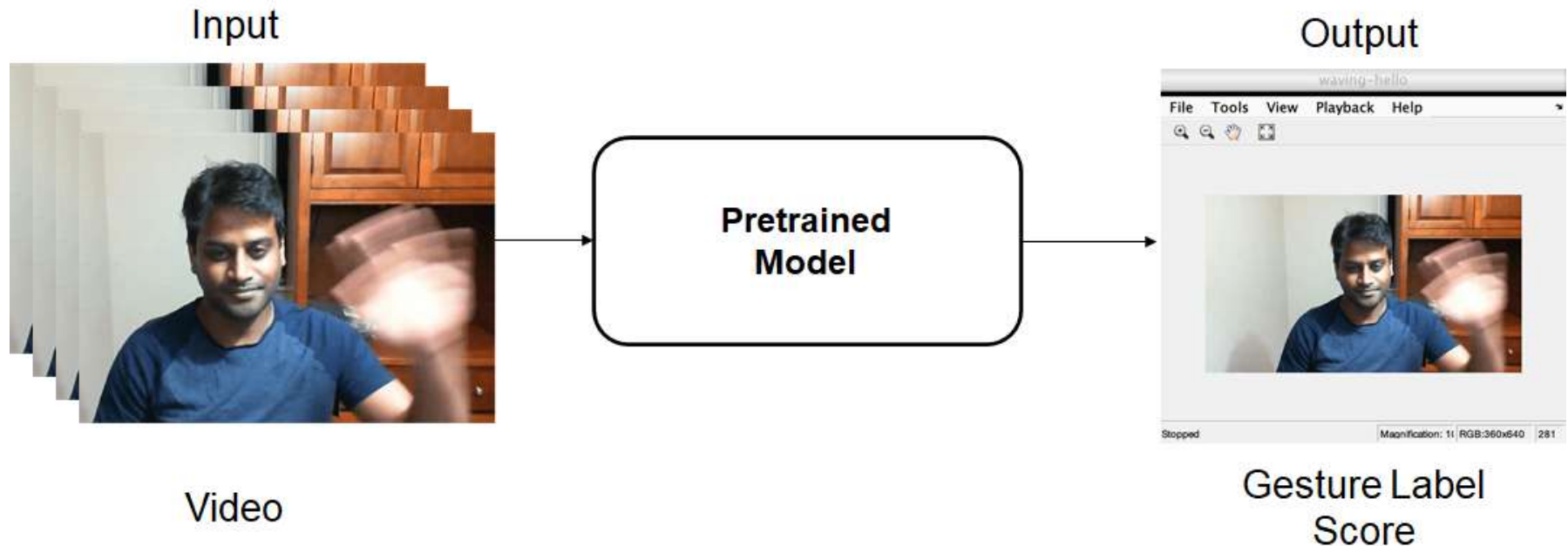
Output



Pose Estimate
(via Post Processing)

Network	Backbone Networks	Size (MB)	Location
OpenPose	vgg19	14	Doc
HR Net	human-full-body-w32	106.9	Doc
	human-full-body-w48	237.7	

MATLAB Deep Learning Model Hub - Video Classification



source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Video Classification

Network	Inputs	Size(MB)	Classifications (Human Actions)	Description	Location
SlowFast	Video	124	400	Faster convergence than Inflated-3D	Doc
R(2+1)D	Video	112	400	Faster convergence than Inflated-3D	Doc
Inflated-3D	Video & Optical Flow data	91	400	Accuracy of the classifier improves when combining optical flow and RGB data.	Doc

MATLAB Deep Learning Model Hub - Text Detection and Recognition

Input



RGB Image

**Pretrained
Model**

Output




Region score
Affinity score

source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Text Detection and Recognition

Network	Application	Size (MB)	Location
CRAFT	Trained to detect English, Korean, Italian, French, Arabic, German and Bangla (Indian).	3.8	Doc GitHub

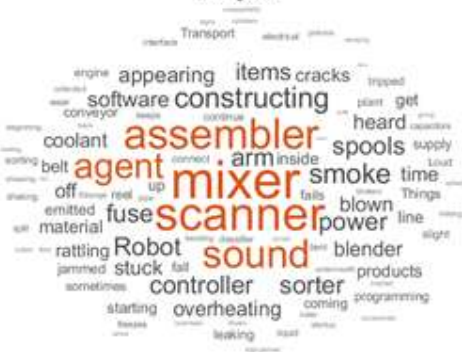
Network	Application	Size (MB)	Location	Example Output
Seven Segment Digit Recognition	Seven segment digit recognition using deep learning and OCR. This is helpful in industrial automation applications where digital displays are often surrounded with complex background.	3.8	Doc GitHub	 7-segment Text Recognition

source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Transformers (Text)

Input

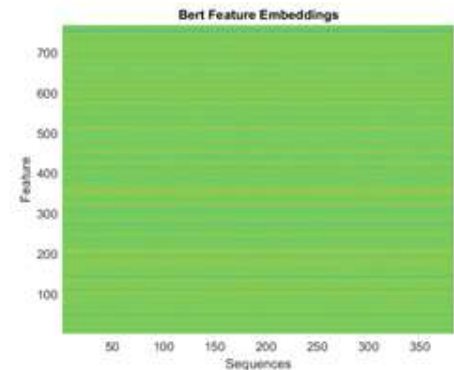
Training Data



Text

Pretrained
Model

Output



Feature
Embeddings

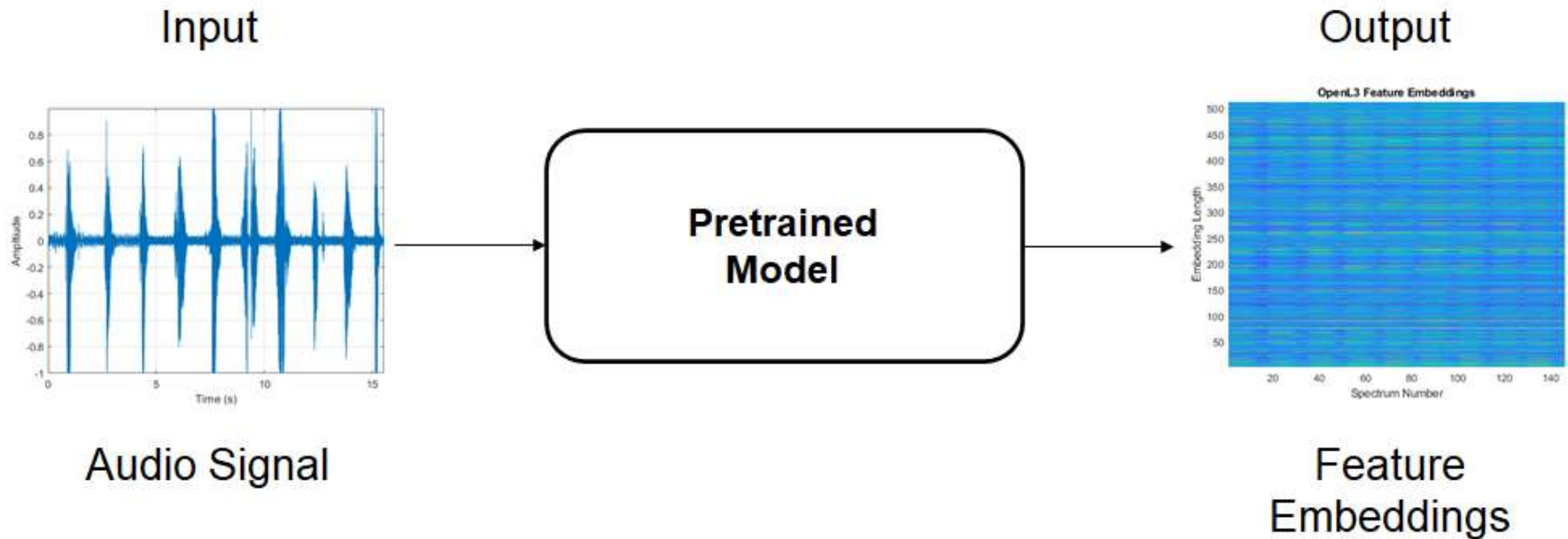
source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Transformers (Text)

Network	Applications	Size (MB)	Location
BERT	Feature Extraction (Sentence and Word embedding), Text Classification, Token Classification, Masked Language Modeling, Question Answering	390	GitHub Doc
all-MiniLM-L6-v2	Document Embedding, Clustering, Information Retrieval	80	Doc
all-MiniLM-L12-v2	Document Embedding, Clustering, Information Retrieval	120	Doc

Network	Application	Size (MB)	Location	Output Example
FinBERT	The FinBERT model is a BERT model for financial sentiment analysis	388	GitHub	<pre>>> mdl = finbert; >> str = "Experts estimate the value of its remaining stake in the company at \$ 27 million."; >> tokens = encode(tokenizer,str); >> X = padsequences(tokens,2,"PaddingValue",mdl.Tokenizer.PaddingCode); >> sentiment = finbert.sentimentModel(X,mdl.Parameters) sentiment = categorical neutral</pre>
GPT-2	The GPT-2 model is a decoder model used for text summarization.	1.2GB	GitHub	<pre>>> inputText = help('magic') >> summary = generateSummary(mdl,inputText) summary = 'Magic square.'</pre>

MATLAB Deep Learning Model Hub - Audio Embeddings

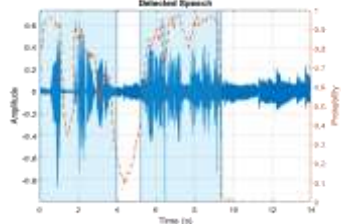
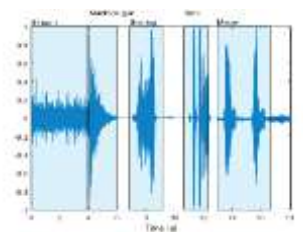
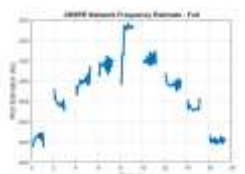


```
1. net = audioPretrainedNetwork("vggish");
```

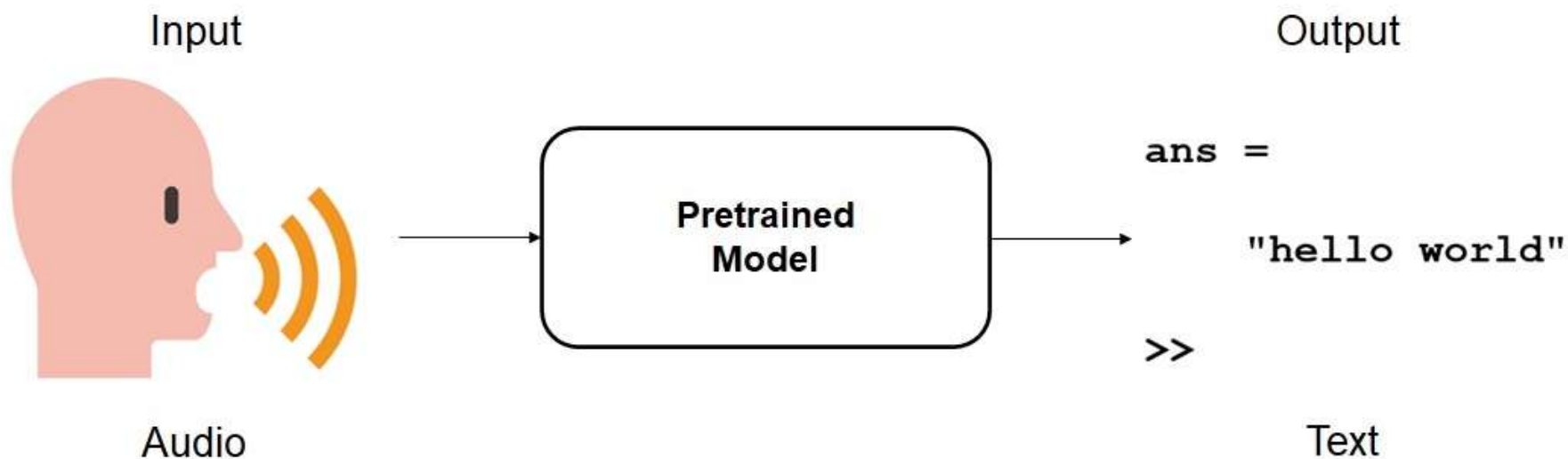
source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Audio Embeddings

Network	Application	Size (MB)	Location
VGGish	Feature Embeddings	257	Doc
OpenL3	Feature Embeddings	200	Doc

Network	Application	Size (MB)	Output Classes	Location	Output Example
vadnet	Voice Activity Detection (regression)	0.427	-	Doc	
YAMNet	Sound Classification	13.5	521	Doc	
CREPE	Pitch Estimation (regression)	132	-	Doc	

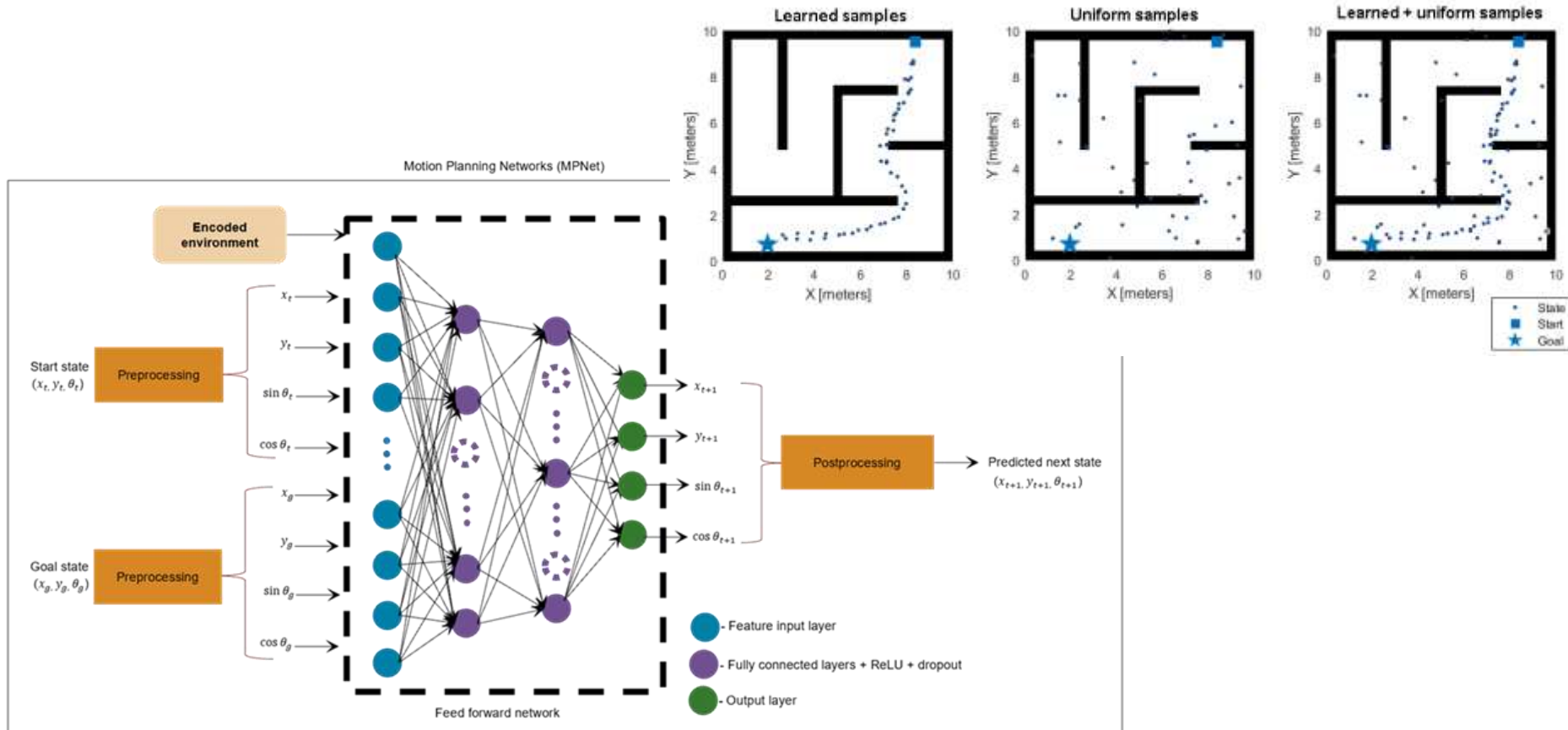
MATLAB Deep Learning Model Hub - Speech to Text



Network	Application	Size (MB)	Word Error Rate (WER)	Location
wav2vec	Speech to Text	236	3.2	GitHub
deepspeech	Speech to Text	167	5.97	GitHub

source: <https://www.mathworks.com/solutions/deep-learning/models.html>

MATLAB Deep Learning Model Hub - Manipulator Motion Planning



Network

[mazeMapTrainedMPNET](#)

Application

Path Planning

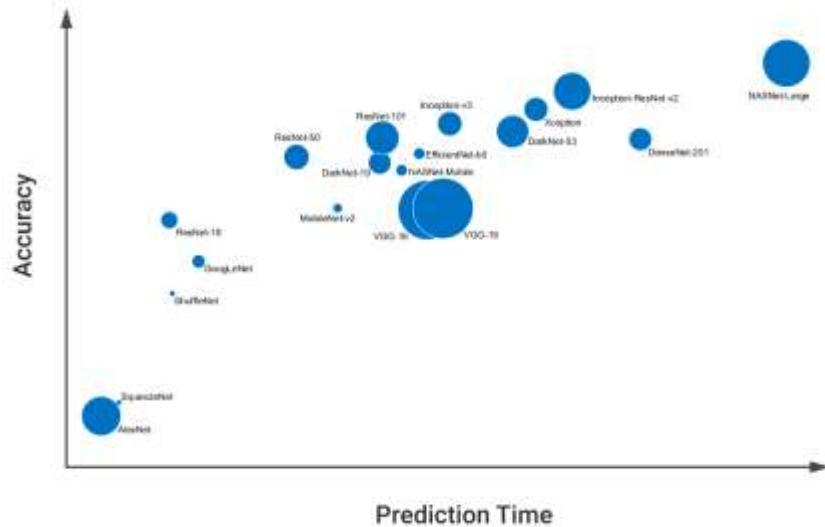
Size (MB)

0.23

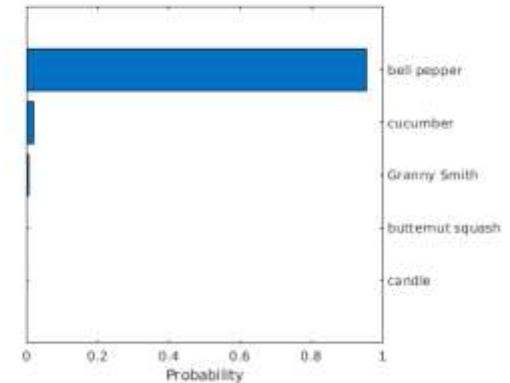
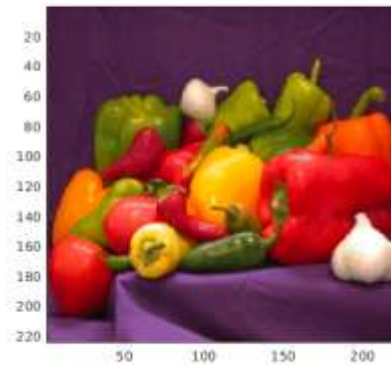
Location

[Doc](#)

MATLAB Deep Learning Model Hub - Tips to Select Models



Top Five Predictions That Use GoogLeNet

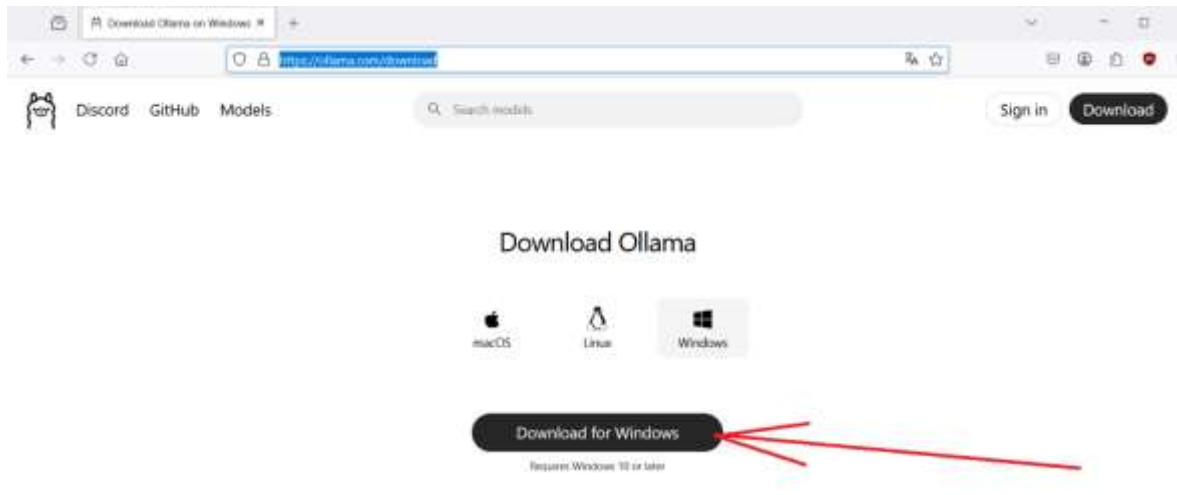


When selecting pretrained models, consider:

- speed (faster models like SqueezeNet or GoogLeNet for quick iteration),
- accuracy (more accurate models like Inception-v3 or ResNet-50 for improved results),
- size.

Start with speed, then optimize for accuracy.

Ollama and Local AI



```
Administrator: Wiersz polecenia

C:\>ollama
Usage:
  ollama [flags]
  ollama [command]

Available Commands:
  serve    Start ollama
  create   Create a model from a Modelfile
  show     Show information for a model
  run      Run a model
  stop     Stop a running model
  pull     Pull a model from a registry
  push     Push a model to a registry
  list     List models
  ps       List running models
  cp       Copy a model
  rm       Remove a model
  help     Help about any command

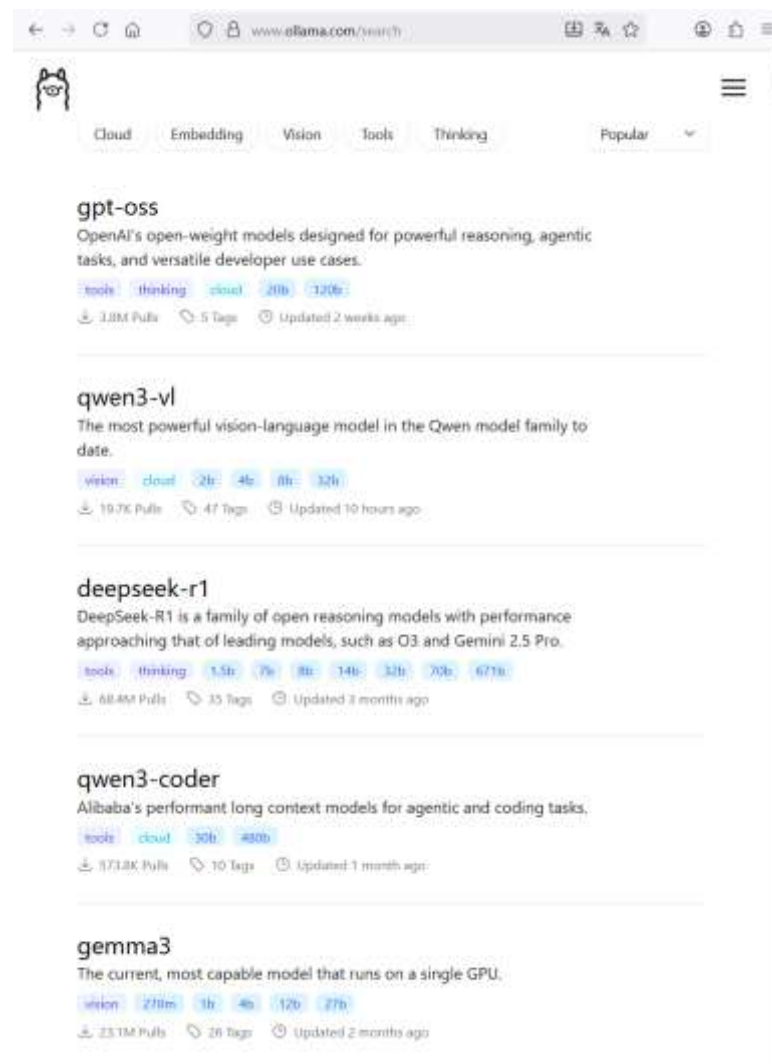
Flags:
  -h, --help            help for ollama
  -v, --version          Show version information

Use "ollama [command] --help" for more information about a command.

C:\>
```

source: <https://ollama.com/download>

Ollama and Local AI



source: <https://ollama.com/search>

Ollama and Local AI



mistral-nemo

ollama run mistral-nemo



2.8M Downloads Updated 3 months ago

A state-of-the-art 12B model with 128k context length, built by Mistral AI in collaboration with NVIDIA.

tools 12b

Models

[View all →](#)

Name	Size
mistral-nemo:latest	7.1GB
mistral-nemo:12b latest	7.1GB

```
Administrator: Wiersz polecenia - ollama: run mistral-nemo
run      Run a model
stop     Stop a running model
pull     Pull a model from a registry
push     Push a model to a registry
list     List models
ps       List running models
cp       Copy a model
rm       Remove a model
help     Help about any command

Flags:
-h, --help      help for ollama
-v, --version   Show version information

Use "ollama [command] --help" for more information about a command.

C:\>ollama list
NAME      ID      SIZE   MODIFIED
mistral-nemo:latest  b559938ab7a0...  7.1 GB
mistral-nemo:12b     f023d1ce0e55...  688 B
mistral-nemo:12b     43070e2d4e53...  11 KB
mistral-nemo:12b     ed11eda7790d...  30 B
mistral-nemo:12b     65d37de20e59...  486 B

C:\>ollama run mistral-nemo
pulling manifest
pulling b559938ab7a0... 100% B
pulling f023d1ce0e55... 100% B
pulling 43070e2d4e53... 100% B
pulling ed11eda7790d... 100% B
pulling 65d37de20e59... 100% B
verifying sha256 digest
writing manifest
success
>>> Send a message (/t for help)
```

Ollama and Local AI

Administrator: Wiersz polecenia - ollama run mistral-nemo

```
C:\>ollama run mistral-nemo
```

```
>>> What does the abbreviation BIP mean in the Erasmus program?
```

```
In the context of the Erasmus+ program, "BIP" stands for "Basic Information Package." The Basic Information Package is a document provided by higher education institutions participating in the Erasmus+ program to their incoming Erasmus students. It contains essential information about the institution, the city/country, and practical arrangements for the student's stay abroad.
```

```
The BIP typically includes information such as:
```

- General information about the host institution
- Practical information (e.g., arrival assistance, accommodation, insurance)
- Academic information (e.g., course registration, academic calendar)
- Cultural information about the city/country
- Emergency contact numbers and other useful resources

```
>>> Send a message (/? for help)
```

Ollama



What does the abbreviation BIP mean in the Erasmus program?

In the Erasmus+ program, BIP stands for **Bilateral Programme Agreement**.

Here's a breakdown:

- **Bilateral Agreements:** These are agreements between individual countries participating in the Erasmus+ program. They outline specific cooperation arrangements, often focusing on student and staff mobility.
- **BIP (Bilateral Programme Agreement):** This is the formal name for these agreements. They detail things like:
 - The number of students/staff exchanges allowed.
 - Financial support for these exchanges.
 - Recognition of studies/training abroad.

Essentially, a BIP is the foundational document that allows for direct exchange partnerships between institutions in two different Erasmus+ participating countries.

You're more likely to encounter the term when universities are discussing their partnership agreements.



Send a message

gemma3:12b v

Ollama and Local AI



February 2, 2024



Ollama Vision

Welcome to the era of open-source multimodal models.

Open-source models available now

New LLaVA models

The LLaVA (Large Language-and-Vision Assistant) model collection has been updated to version 1.6 supporting:

- **Higher image resolution:** support for up to 4x more pixels, allowing the model to grasp more details.
- **Improved text recognition and reasoning capabilities:** trained on additional document, chart and diagram data sets.
- **More permissive licenses:** distributed via the Apache 2.0 license or the LLaMA 2 Community License.

These models are available in three parameter sizes: 7B, 13B and a new 34B model:

- `ollama run llava:7b`
- `ollama run llava:13b`

source: <https://ollama.com/blog/vision-models>

llama3.2-vision

`ollama run llama3.2-vision`



2.6M Downloads Updated 5 months ago

Llama 3.2 Vision is a collection of instruction-tuned image reasoning generative models in 11B and 90B sizes.

vision 11b 90b

Models

[View all →](#)

Name	Size	Context	Input
llama3.2-vision:latest	7.8GB	128K	Text, Image
llama3.2-vision:11b latest	7.8GB	128K	Text, Image
llama3.2-vision:90b	55GB	128K	Text, Image

source: <https://ollama.com/library/llama3.2-vision>

Ollama and Local AI

```
Wiersz polecenia
C:\Users\Piotr\Desktop\zdzj>ollama run llava "describe this image: banercucee3.png"
This is a digital image that displays what appears to be a close-up view of a food item, possibly a crustacean given its shell-like structure and the pattern on it. The background is not fully visible due to the focus being on the food item itself. There are no texts or other objects present in this image.

C:\Users\Piotr\Desktop\zdzj>ollama run llava "describe this image: cuceebanerlogotitle.png"
The image is a digital graphic of a logo for "CuceeBaner". The logo consists of text elements and graphic design. The main component of the logo is the text "CuceeBaner" written in uppercase letters, with the font being bold and sans-serif. To the left of the text, there is a stylized representation of what appears to be a banana. The color scheme of the logo includes shades of green and yellow. The overall style of the image is modern and corporate, suggesting that "CuceeBaner" may be a brand or company name.

C:\Users\Piotr\Desktop\zdzj>ollama run llama3.2-vision "describe this image: banercucee3.png"
Unfortunately, I don't have the ability to view images, so I'll have to rely on a text-based description.

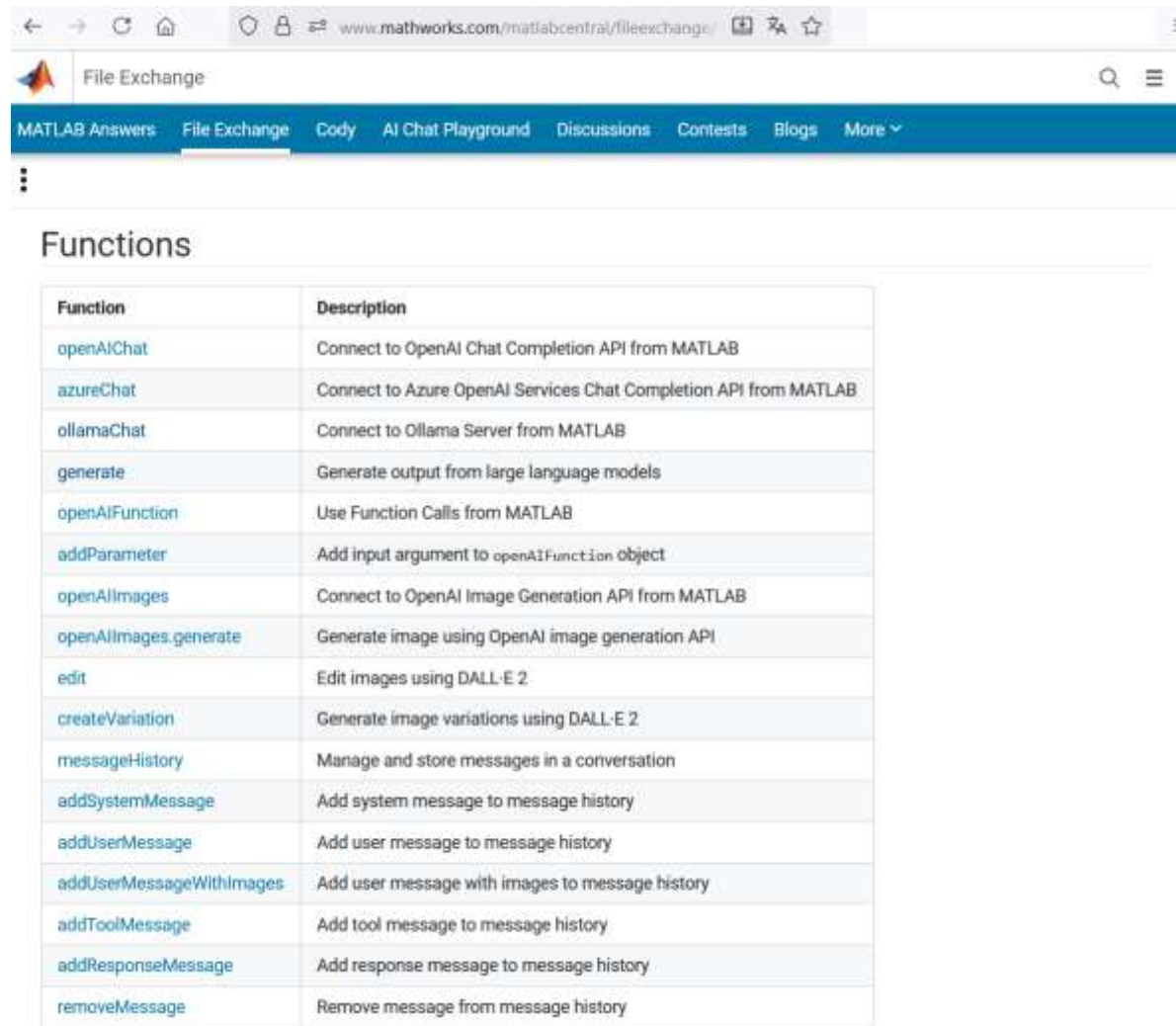
Based on the filename "banercucee3.png", I would describe the image as a banner or logo featuring the name "Cucee" in a bold, eye-catching font, possibly with a background color or texture that adds visual interest. The image may be a simple graphic with a clean design, possibly used as a logo or branding element for a business or organization.

C:\Users\Piotr\Desktop\zdzj>ollama run llama3.2-vision "describe this image: cuceebanerlogotitle.png"
The image "cuceebanerlogotitle.png" appears to be a logo or icon, but without further context or information, it's difficult to provide a detailed description. However, based on the file name, it seems to be related to CuCeebaner, which could be a brand, company, or organization.

If I had to provide a general description, I would say that the image is a visual representation of the CuCeebaner brand, possibly featuring a combination of letters, symbols, or other design elements that are meant to convey the brand's identity or values.

C:\Users\Piotr\Desktop\zdzj>
```


Large Language Models (LLMs) with MATLAB



The screenshot shows the MATLAB File Exchange page for the topic 'Large Language Models (LLMs) with MATLAB'. The page features a navigation bar with links to MATLAB Answers, File Exchange, Cody, AI Chat Playground, Discussions, Contests, Blogs, and More. Below the navigation bar, the title 'Functions' is displayed. A table lists 18 functions, each with a description of its purpose.

Function	Description
openAIChat	Connect to OpenAI Chat Completion API from MATLAB
azureChat	Connect to Azure OpenAI Services Chat Completion API from MATLAB
ollamaChat	Connect to Ollama Server from MATLAB
generate	Generate output from large language models
openAIFunction	Use Function Calls from MATLAB
addParameter	Add input argument to openAIFunction object
openAIImages	Connect to OpenAI Image Generation API from MATLAB
openAIImages.generate	Generate image using OpenAI image generation API
edit	Edit images using DALL-E 2
createVariation	Generate image variations using DALL-E 2
messageHistory	Manage and store messages in a conversation
addSystemMessage	Add system message to message history
addUserMessage	Add user message to message history
addUserMessageWithImages	Add user message with images to message history
addToolMessage	Add tool message to message history
addResponseMessage	Add response message to message history
removeMessage	Remove message from message history

source: <https://www.mathworks.com/matlabcentral/fileexchange/163796-large-language-models-llms-with-matlab>

Large Language Models (LLMs) with MATLAB

```
chat = ollamaChat("mistral-nemo");  
generate(chat,"What does the abbreviation BIP mean in the Erasmus program?")
```

ans =

*"In the context of the Erasmus+ programme, "BIP" stands for ****Bilateral Agreements****. Here's a brief explanation:*

*****Erasmus+ Bilateral Agreements****: These are agreements between countries participating in the Erasmus+ programme to promote mobility between their institutions. Each agreement specifies the number of scholarships that each country will receive annually and how these scholarships will be distributed among the institutions.*

So, when you see "BIP" in relation to Erasmus+, it's likely referring to these Bilateral Agreements. However, to avoid confusion, it's always a good idea to ask for clarification if you're unsure about the context of an abbreviation."

source: <https://www.mathworks.com/matlabcentral/fileexchange/163796-large-language-models-llms-with-matlab>

Thank you for your attention