



Visual Studio **LIVE!**
EXPERT SOLUTIONS FOR .NET DEVELOPERS

SQL Server **LIVE!**
TRAINING FOR DBAs AND IT PROS

TECHMENTOR

Artificial
Intelligence **LIVE!**
AI FOR DEVELOPERS AND DATA SCIENTISTS

Office &
SharePoint **LIVE!**
ON-PREMISE, CLOUD & CROSS-PLATFORM TRAINING

Modern Apps **LIVE!**
MOBILE, CROSS-DEVICE & CLOUD DEVELOPMENT

Getting Started with Deep Learning

David Smith @revodavid
Cloud Advocate, AI/ML
Microsoft
Level: Intermediate

The Ultimate Education Destination

2018
Orlando

Agenda

- Stages of AI
- Pre-trained AI
- Computer Vision and Transfer Learning
- Training Deep Learning models
- Deploying a Computer Vision application

About David Smith

Data Scientist

Cloud Advocate (AI & ML), Microsoft

Co-author, *Introduction to R*

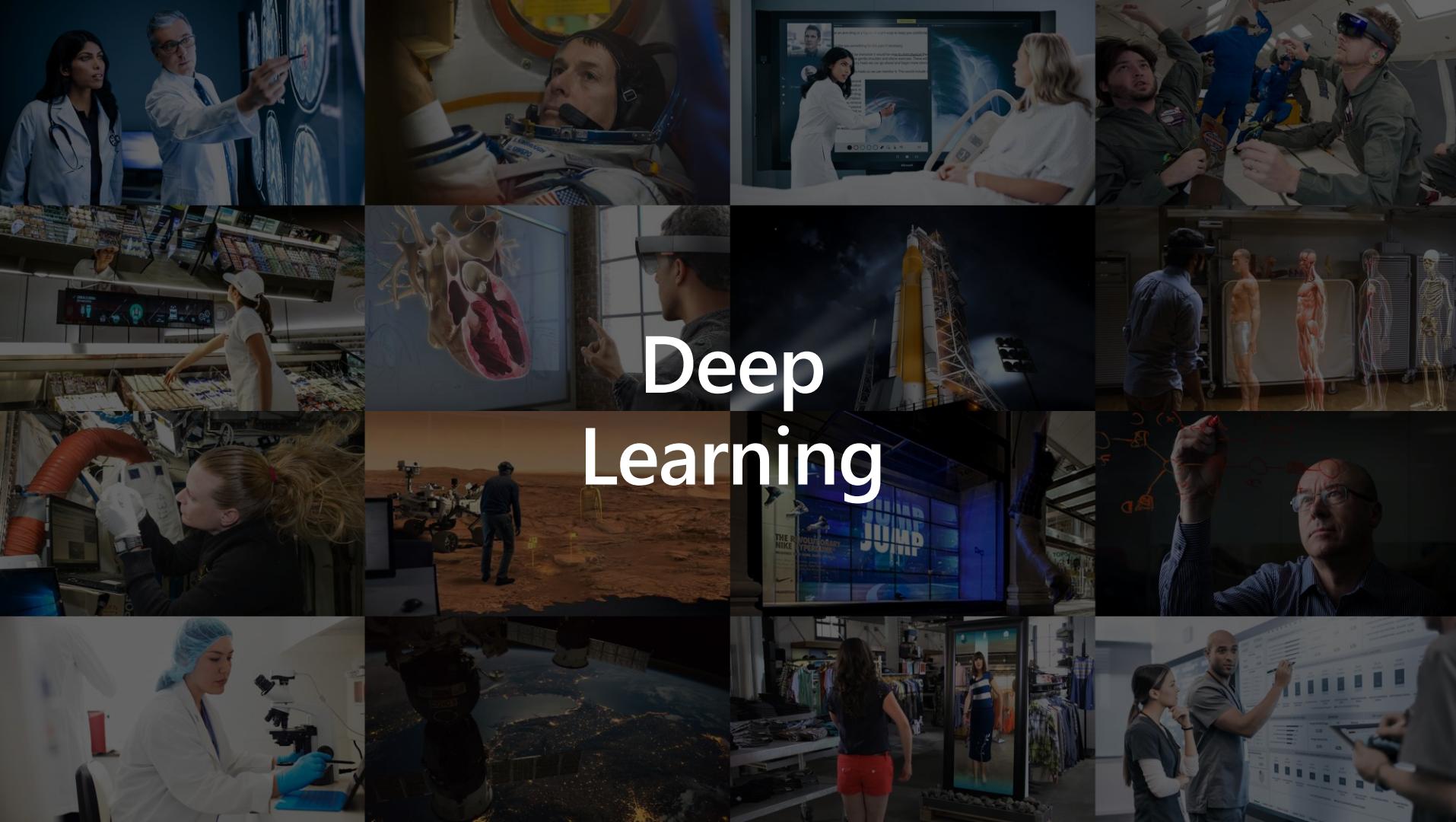
Editor, *Revolutions* blog blog.revolutionanalytics.com

davidsmi@microsoft.com

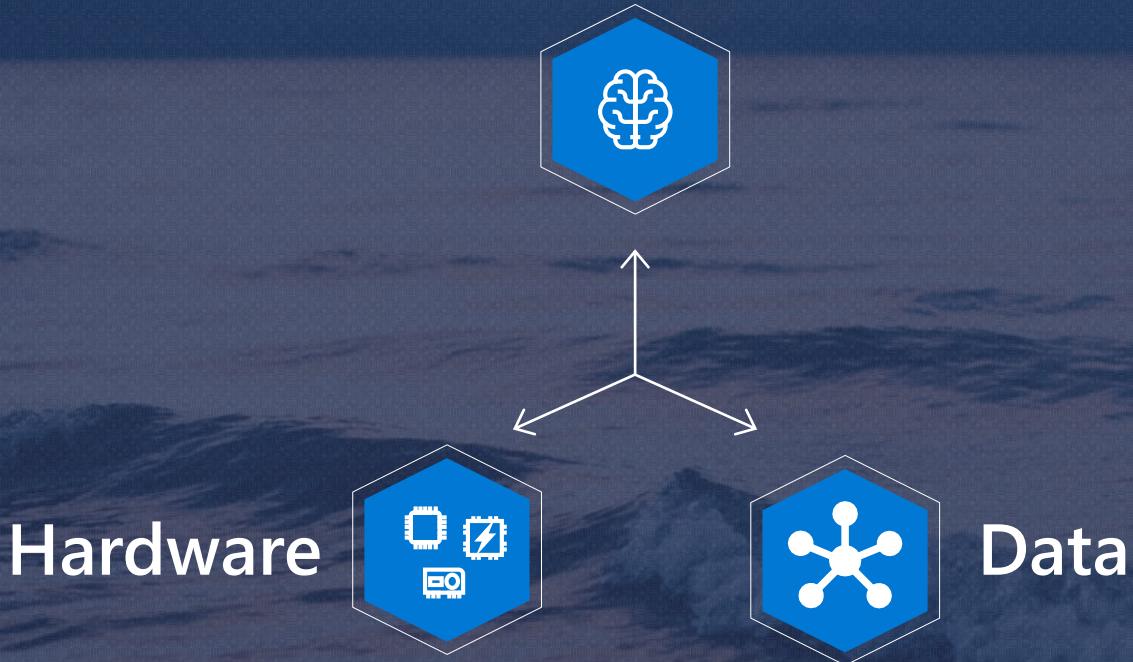
@revodavid



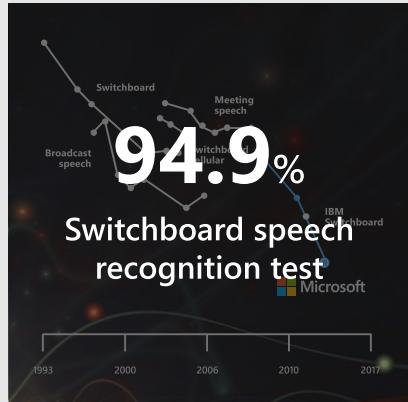
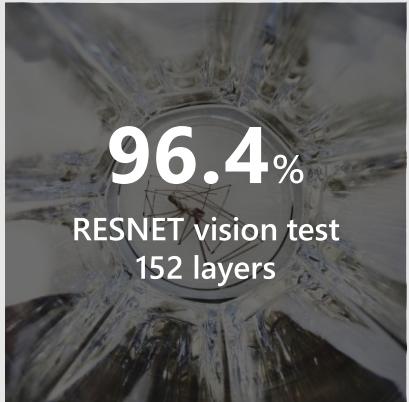
Deep Learning



Algorithms



AI can be as good as humans



2016

Object recognition
Human parity

2017

Speech recognition
Human parity

January 2018

Machine reading comprehension
Human parity

March 2018

Machine translation
Human parity

Values and principles for AI

 Enable people

 Inclusive

 Ethical



The AI Journey

Pre-Trained AI



Cognitive Services
Developer APIs

Data for inference

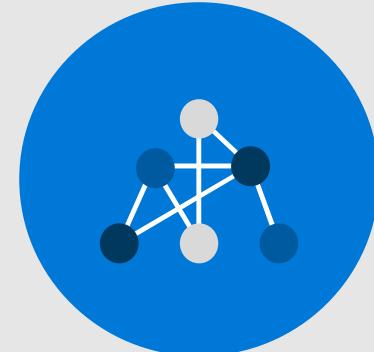
Enhanced AI



Pre-Trained models
Transfer Learning

Some training data

Bespoke AI



Developer Tools
Frameworks

Extensive training data

Microsoft Cognitive Services

Give your apps a human side



Speech

Speak to and hear your users, filtering environmental noise.
Use with **Language** for max results



Vision

From objects to faces and feelings, enable your apps to analyze still images and video



Language

Analyze text to extract user feeling and intent.
Extract knowledge from existing sources and make it easily accessible to users
Translate between 60+ languages and growing



Search

Access billions of web pages, images, videos, and news with the power of Bing

Seeing AI

Turning the visual world
into an audible experience

Designed for the blind and low vision community, this research project harnesses the power of AI to describe people, text, and objects.

Demonstrates the practical value of computer vision.



TASKS

<

< PREV

RANDOM

NEXT >

>



IN CS, IT CAN BE HARD TO EXPLAIN THE DIFFERENCE BETWEEN THE EASY AND THE VIRTUALLY IMPOSSIBLE.

<

< PREV

RANDOM

NEXT >

>

AI for Earth

Access | Education | Innovation





is an online community of citizen scientists recording data on the distribution of Earth's biodiversity

>500k

Online registered users

>6M

Observations recorded

>120k

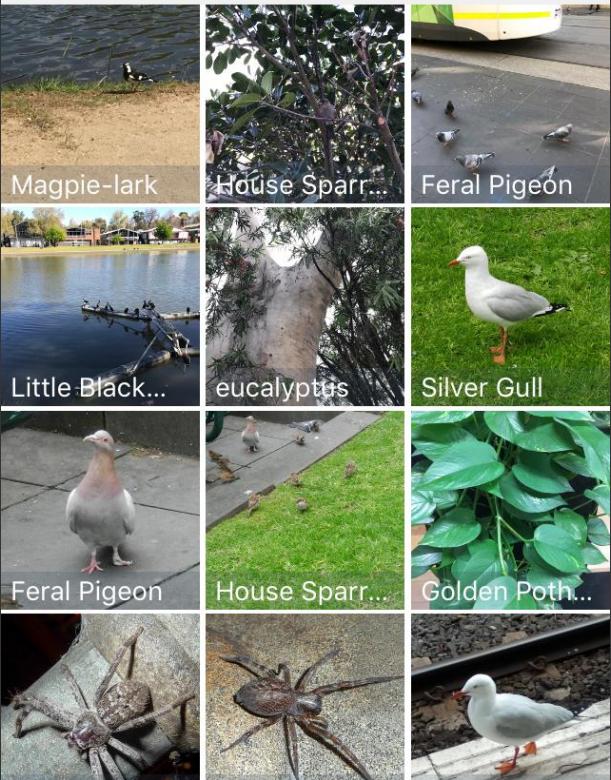
Distinct species observed





Stats

Restricted to current map area



Explore



Activity



Observe



Me



More



davidsmith4



fireweed

TN8, Edenbridge, England,...

1mo

3



Midland Hawthorn

TN8, Edenbridge, England,...

1mo

2



Chamomiles, yarrows,...

Grey Barn Hill Hoath Road,...

1mo

1



European Comma

New Cottages Hill Hoath R...

1mo

1



common bracken

TN8, Edenbridge, England,...

1mo

1



Alpaca

Bothy Cottage Hever Castl...

1mo



rugosa rose

Private Road, Edenbridge,...

1mo



apple

Private Road, Edenbridge,...

1mo



Sweet Chestnut

1mo



Explore



Activity



Observe



Me



More

< Details

✓ 1st



Grey Heron

Ardea cinerea

Notes



Jul 14, 2018 10:00 PM GMT+02:00



Dialoggatan 3, 141 75 Kungens Kurva,...

Lat: 59.2654067 Lon: 17.91557766 Acc. 7



Location is Open



It is captive or cultivated



Add to project(s)

0

<

Species Search

We're pretty sure it's in this genus:



Great Herons

Genus Ardea



Here's our top 10 species suggestions:



Grey Heron

Ardea cinerea

Visually Similar / Seen Nearby



Great Blue Heron

Ardea herodias

Visually Similar



Coco Heron

Ardea cocoi

Visually Similar



Great Egret

Ardea alba

Visually Similar

<

Grey Heron



Photo: (c) Stuart Shearer, some rights reserved (CC BY-NC)



Select

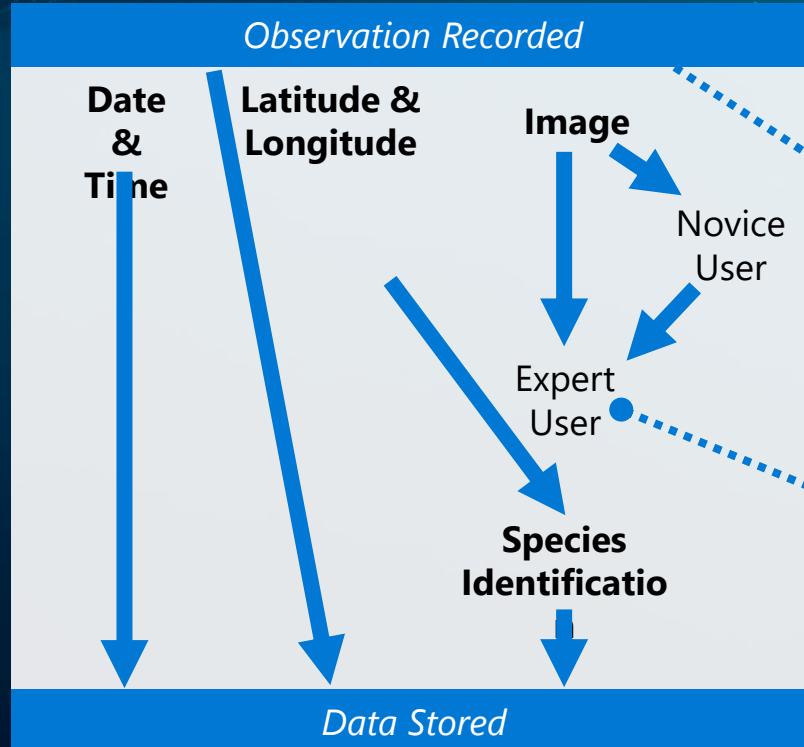
Grey Heron

Ardea cinerea

Map of Observations



How iNaturalist Used to Work



With the iNaturalist app on their mobile phones, users record observations of organisms by taking a geo & time-tagged photo.



Users are responsible for identifying species. ID by novice users need expert verification. This created a **bottleneck** of images awaiting species ID by experts.

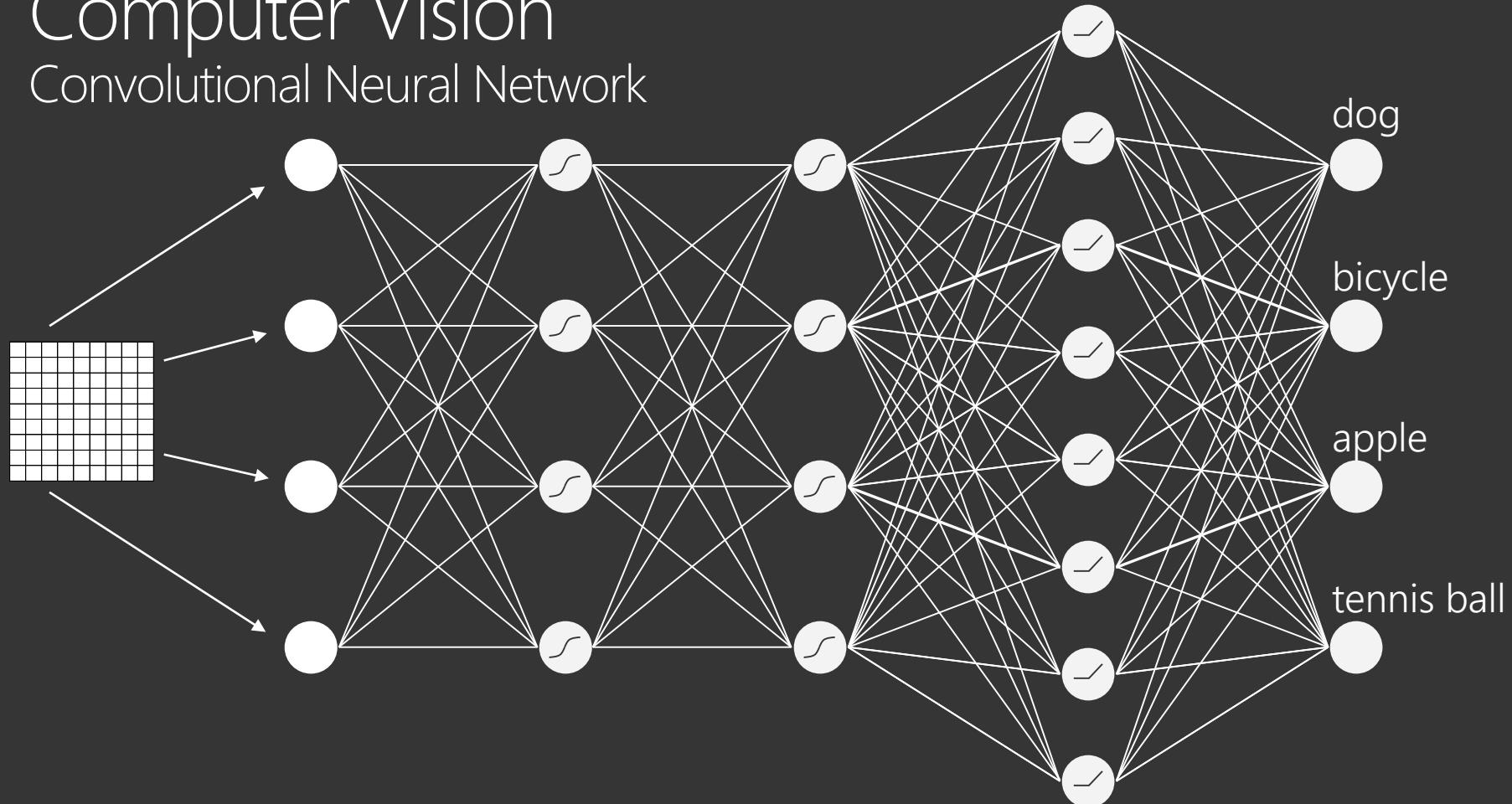
How neural networks work

Brandon Rohrer

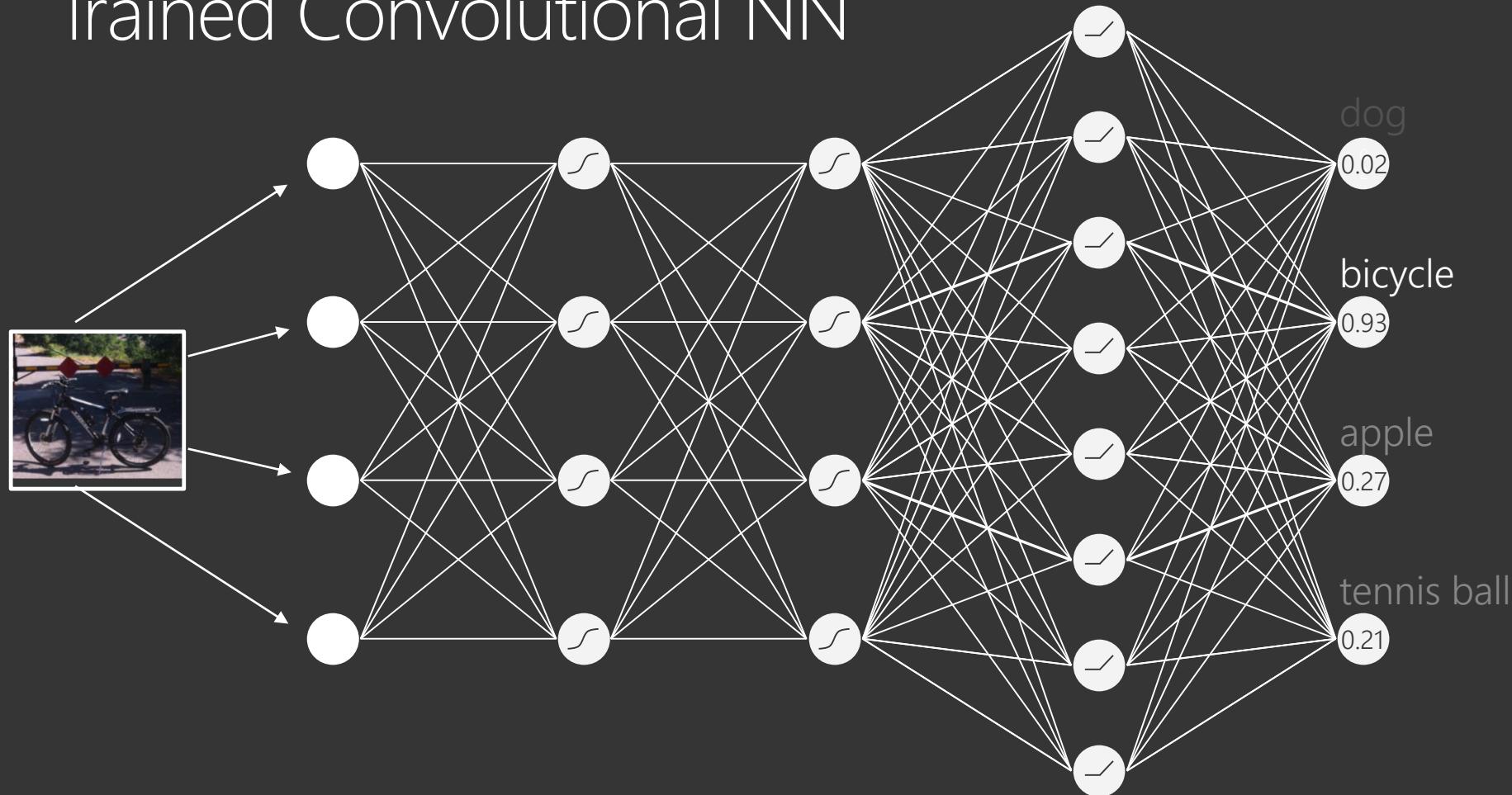
brohrer.github.io/blog.html

Computer Vision

Convolutional Neural Network



Trained Convolutional NN



Filters

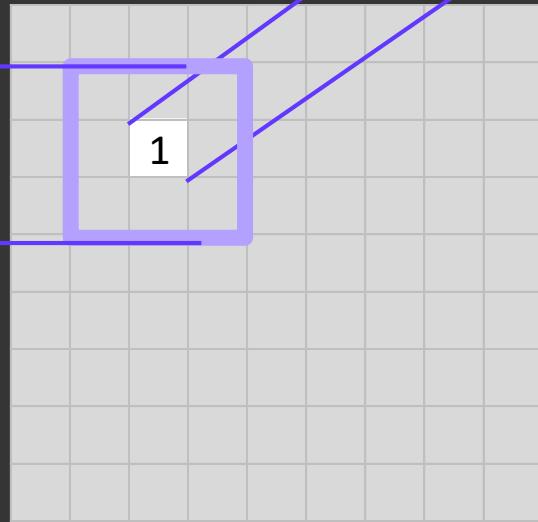
Filters

1	-1	-1
-1	1	-1
-1	-1	1

1	1	1
1	1	1
1	1	1

$$\frac{1 + 1 + 1 + 1 + 1 + 1 + 1 + 1}{9} = 1$$

-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	1	-1	-1	-1	-1	-1	1	-1
-1	-1	1	-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	1	-1	-1	-1
-1	-1	-1	-1	1	-1	-1	-1	-1
-1	-1	-1	-1	1	-1	-1	-1	-1
-1	-1	-1	1	-1	1	-1	-1	-1
-1	1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1



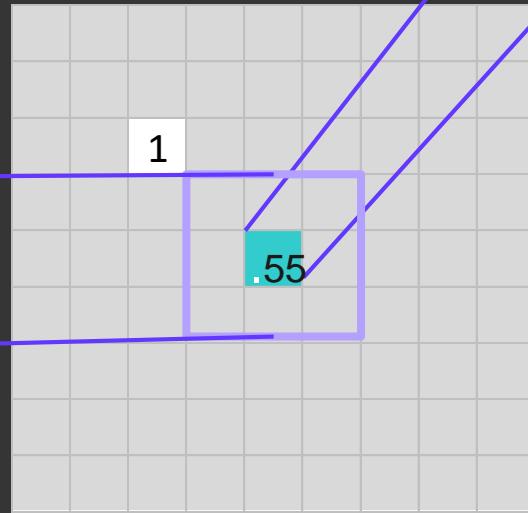
Filters

1	-1	-1
-1	1	-1
-1	-1	1

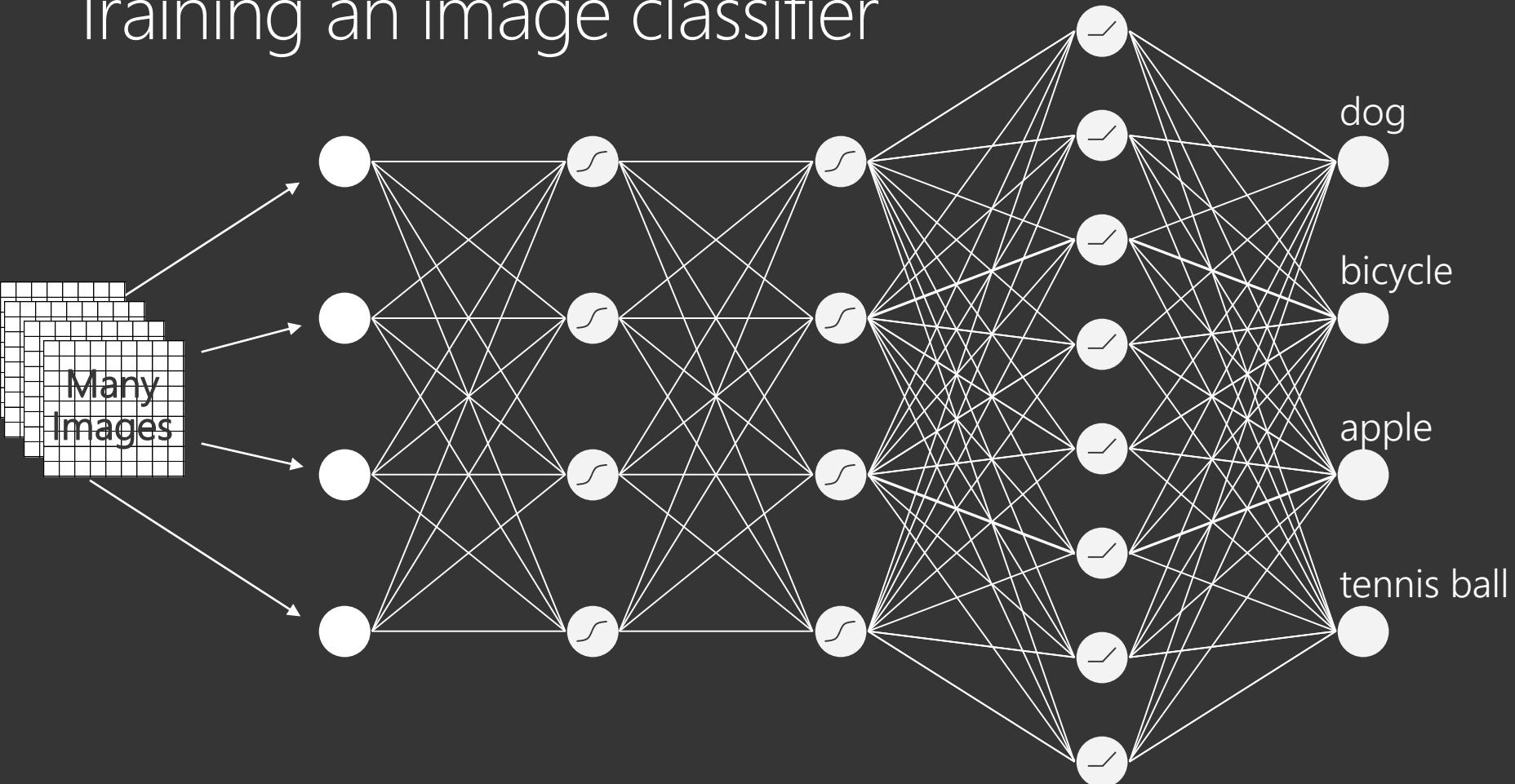
1	1	-1
1	1	1
-1	1	1

$$\frac{1 + 1 - 1 + 1 + 1 + 1 - 1 + 1 + 1}{9} = .55$$

-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	1	-1	-1	-1	-1	-1	1	-1
-1	-1	1	-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	1	-1	-1	-1
-1	-1	-1	-1	1	-1	-1	-1	-1
-1	-1	-1	1	-1	1	-1	-1	-1
-1	-1	1	-1	-1	-1	1	-1	-1
-1	1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1



Training an image classifier



Learning

$$W_1 := W_0 - \alpha \nabla_w J(W_1, b)$$

updated W

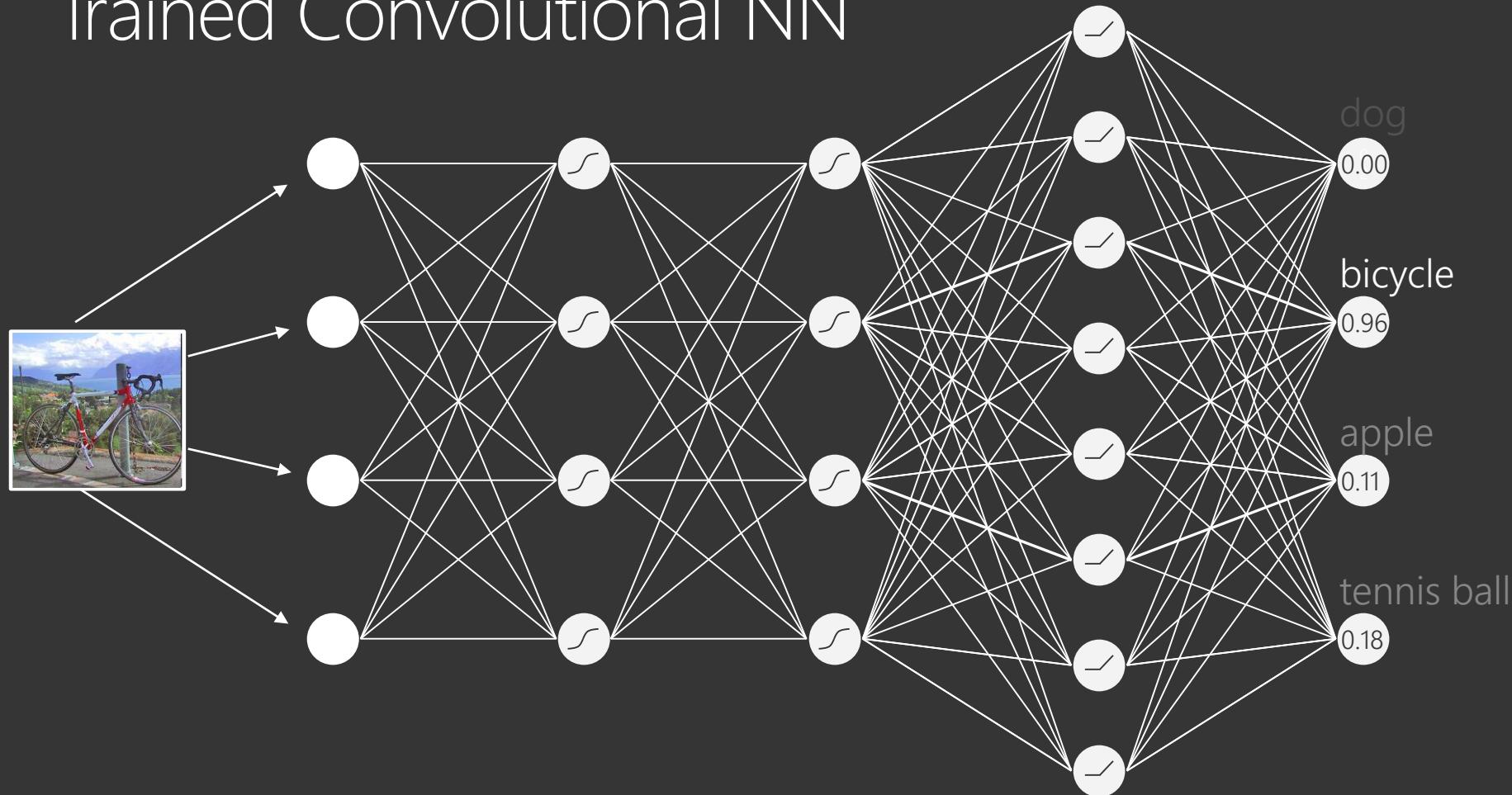
current W

learning
rate

gradient of
cost function

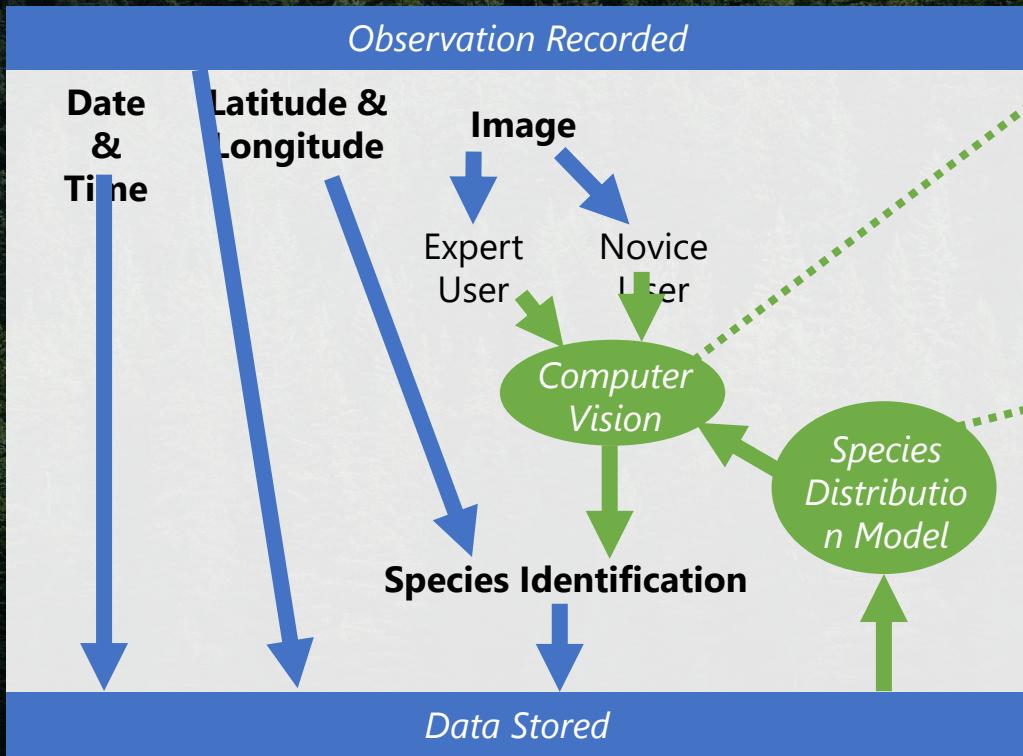
$$\frac{1}{n} \sum [(w^T x + b) - y] \cdot x$$

Trained Convolutional NN





Microsoft AI Augmented System



Computer vision models (MSFT Custom Vision and Cognitive Toolkit) are trained to ID species from images.

This lets anyone instantly and accurately ID species.



Data stored is used for **species distribution model** (MSFT R Server, Data Science Virtual Machine) which predicts where species are located at given time.

This can also increase the prediction accuracy of computer vision model by taking into account location of recorded observation.

Biodiversity Monitoring

Using AI-powered computer vision to automatically identify species in wildlife monitoring images, iNaturalist empowers citizen scientists to collect data that will improve precision decision-making and local conservation interventions.

Challenge

Without action, 38% of all species will go extinct by the end of this century. To coordinate and implement conservation action, decision makers need information on where and when species occur, and how these distributions are changing. Current monitoring data face a bottleneck in identifying the species pictured – since only trained experts can do so.

Solution

Using Microsoft technology, iNaturalist will identify 100k species offline with >90% accuracy by 2020 and analyze how these species distributions are responding in real time to environmental changes.



Microsoft

iNaturalist.org

The AI Journey

Pre-Trained AI



Cognitive Services
Developer APIs

Data for inference

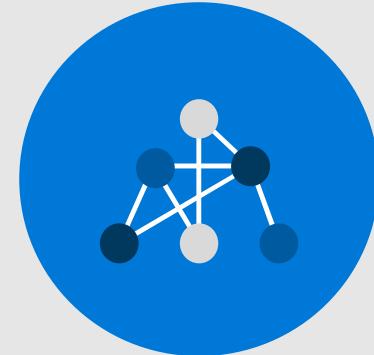
Enhanced AI



Pre-Trained models
Transfer Learning

Some training data

Bespoke AI



Developer Tools
Frameworks

Extensive training data

Limitations of pre-trained AI

The model is pre-defined:

- Pre-defined set of objects that can be recognized by Vision API
- Pre-defined set of words that can be understood by Translation API
- Voices / accents / intonations that don't work with Speech API

Re-training the model can take hours or days, and requires expensive compute resources.

Without re-training, can we extend pre-trained AI to:

- work with input data it wasn't trained for?
- detect new classes it wasn't trained to recognize?

Announcing AI for Humanitarian Action

AI for Humanitarian Action leverages AI to support disaster recovery, address the needs of children, protect displaced people, and promote human rights.

► Watch AI in action

TOD 09:20:07:15
GPS 41.642029-100.128409

DEBRIS

TOD 09:20:07:15
GPS 41.642029-100.128409

DEBRIS

ITEM ID TK235

ITEM ID TK457

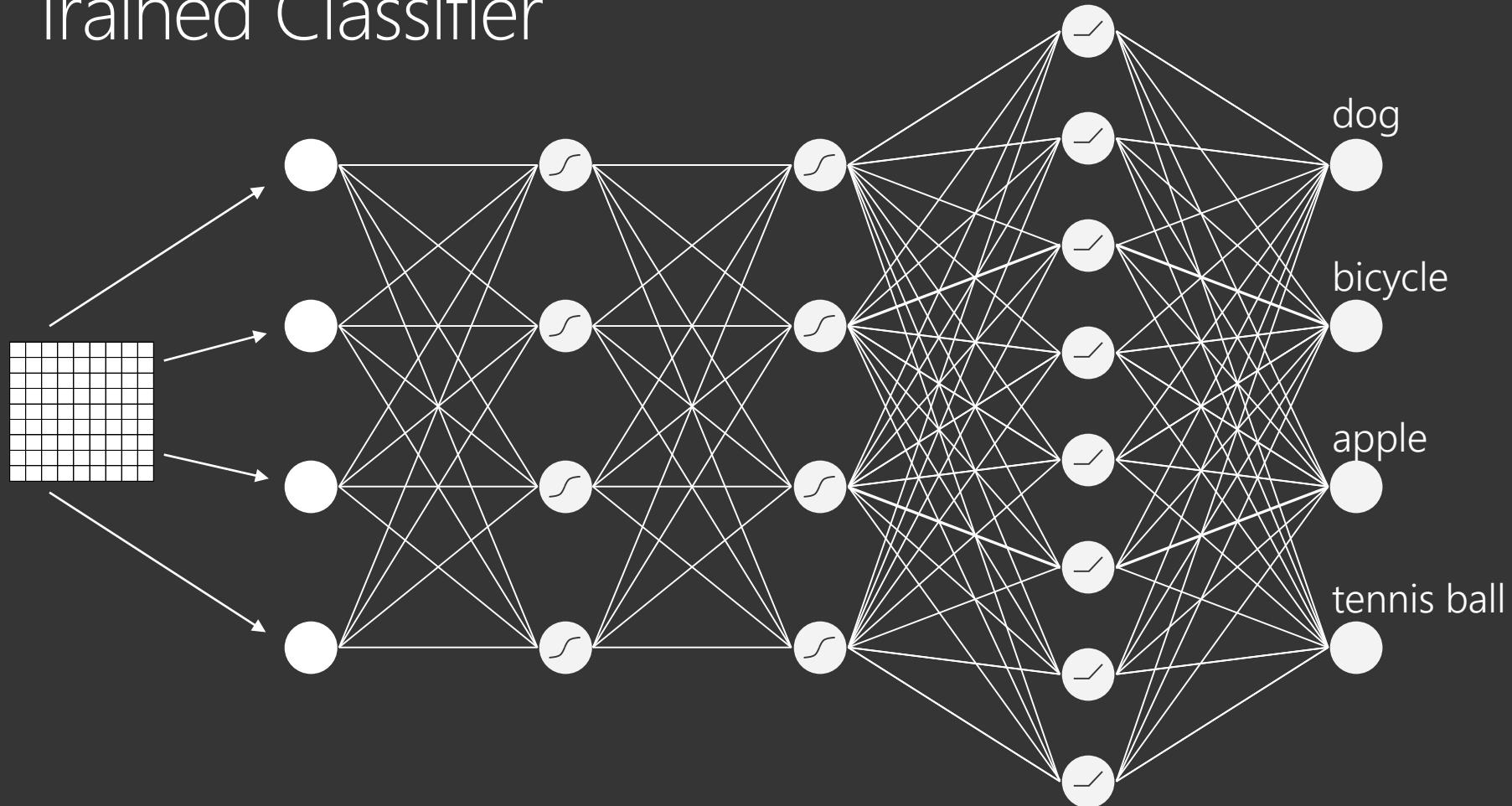
TOD 09:20:07:15
GPS 41.642029-100.128409

DEBRIS



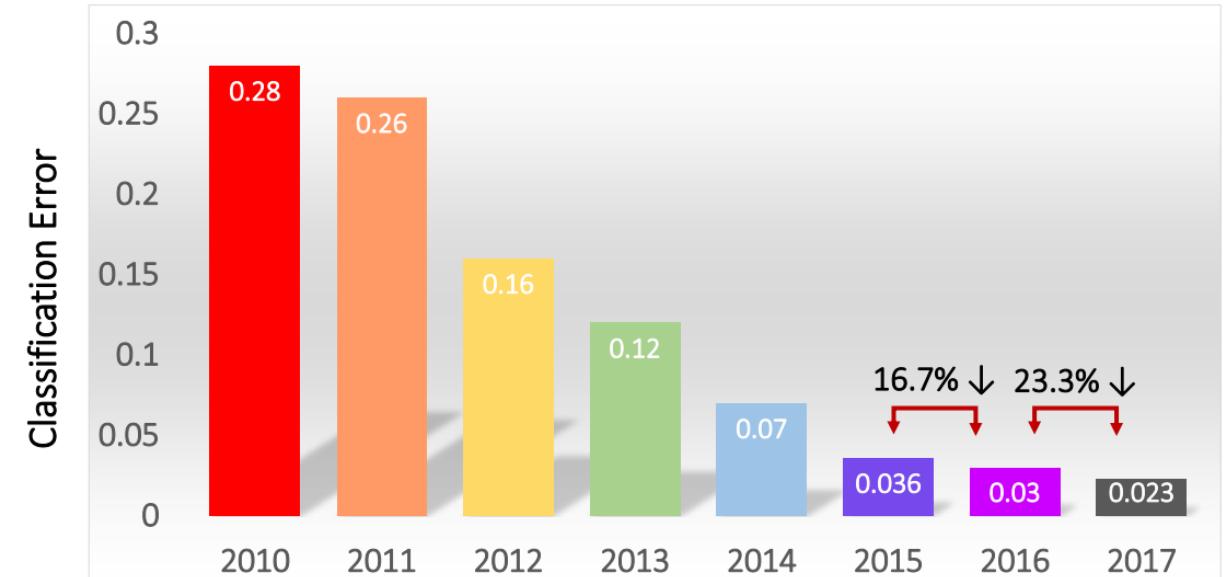


Trained Classifier



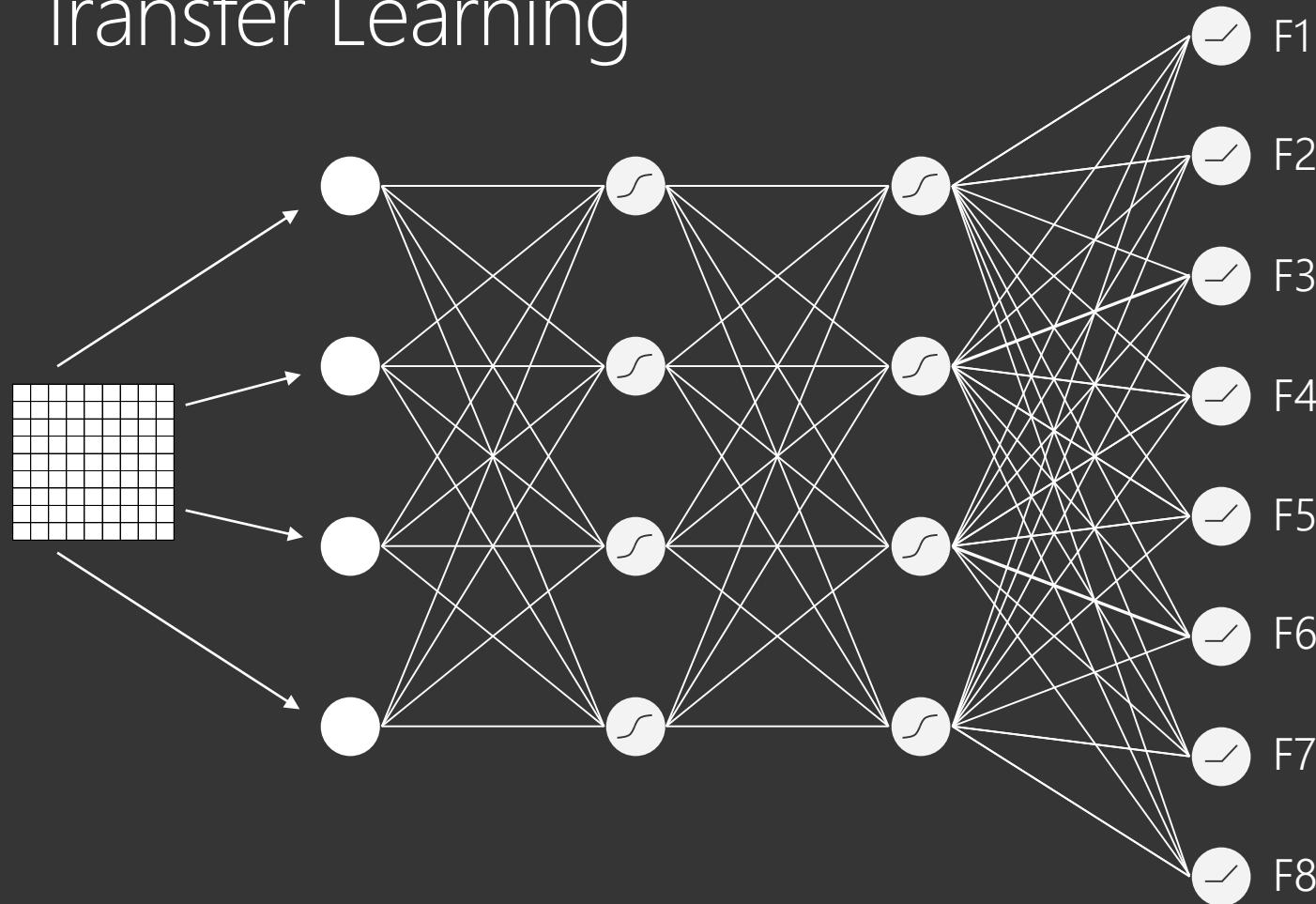
ImageNet Challenge Winners

Classification Results (CLS)



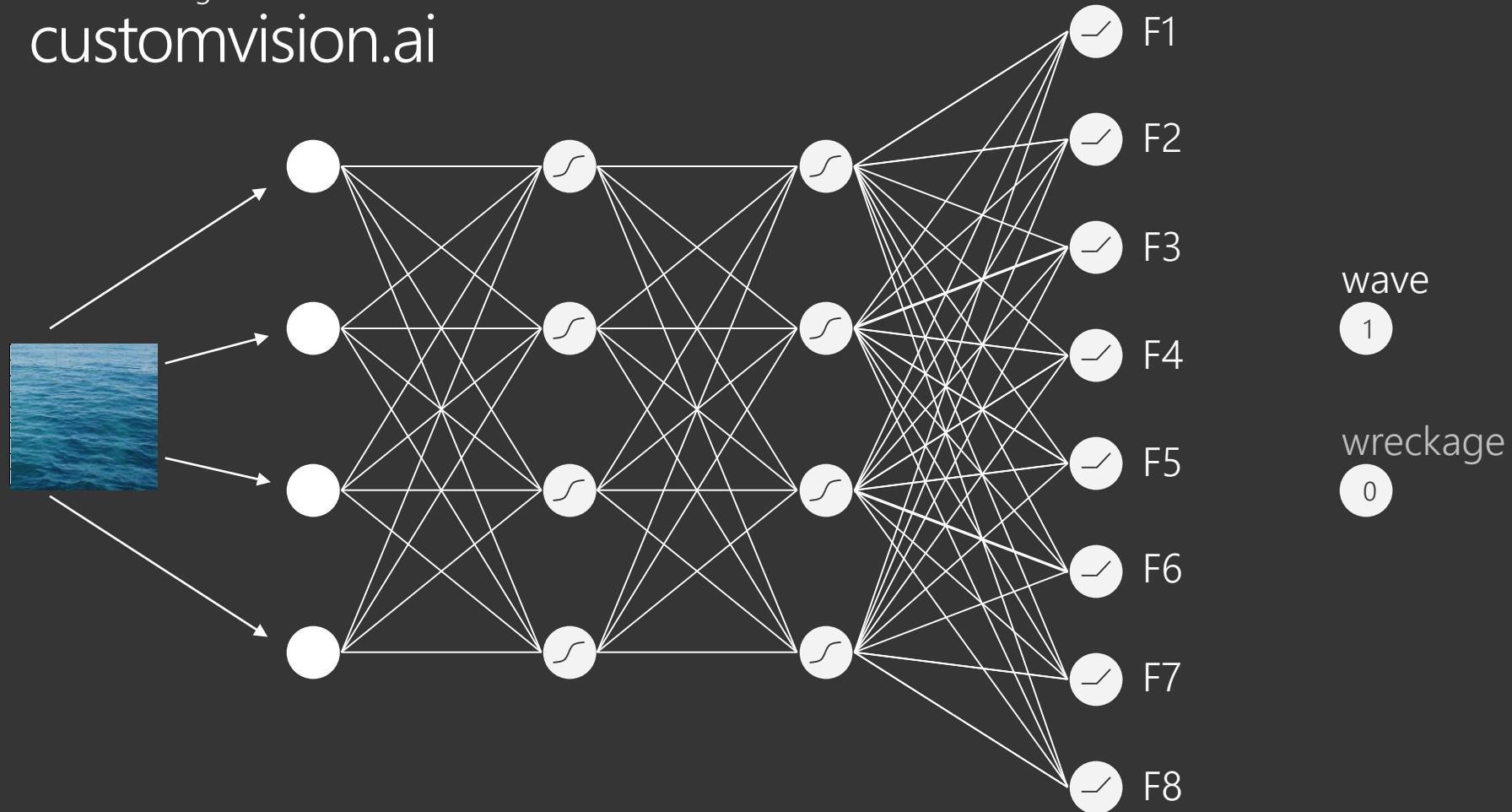
Park et al, ILSVRC 2017

Transfer Learning



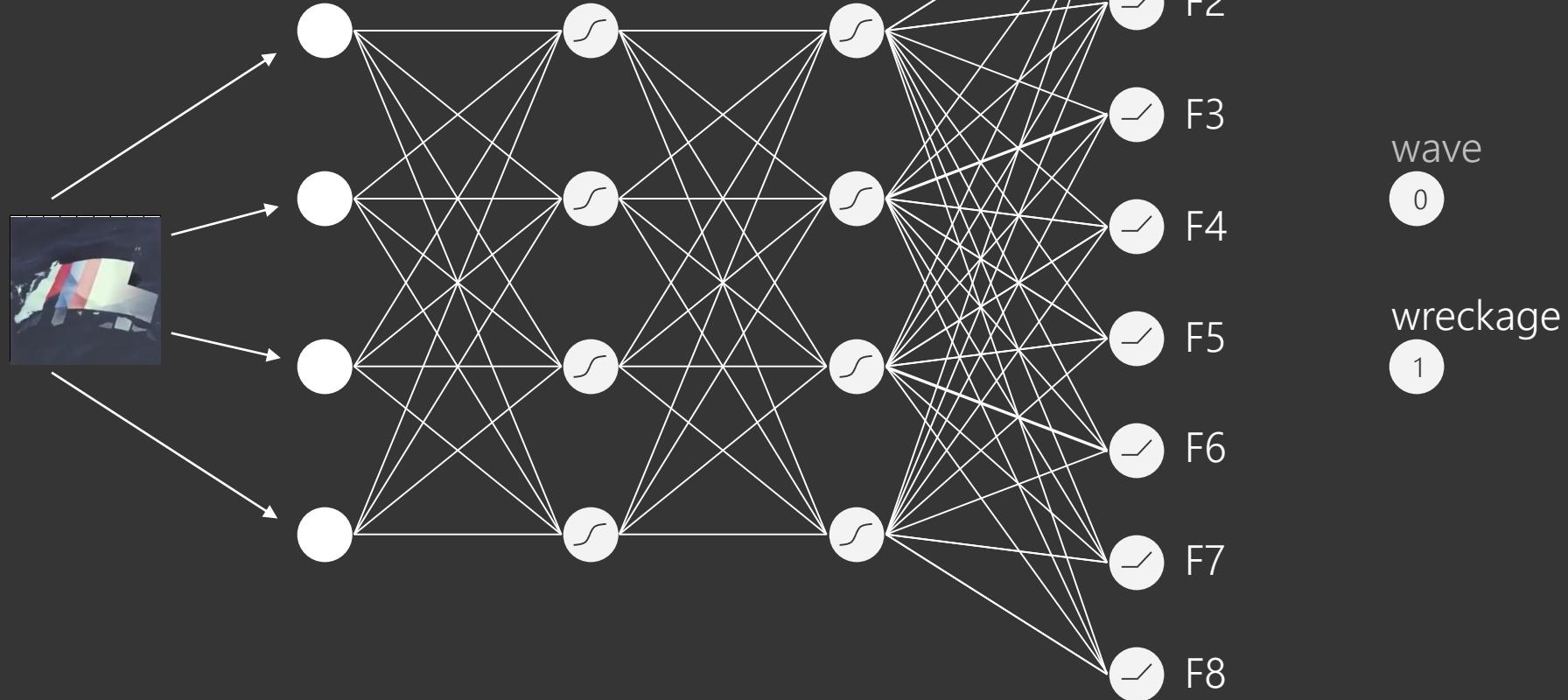
Transfer Learning

customvision.ai



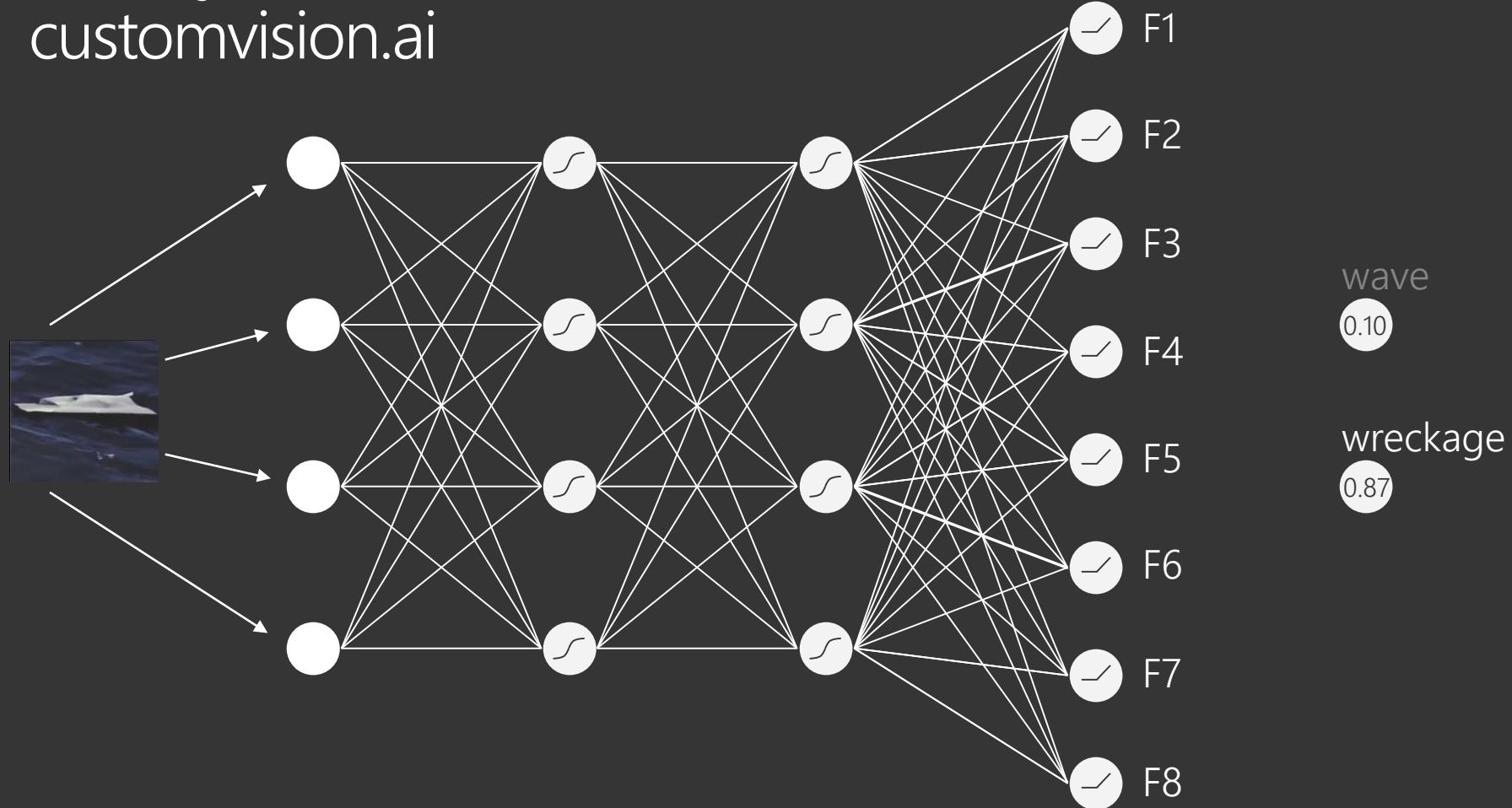
Transfer Learning

customvision.ai



Transfer Learning

customvision.ai



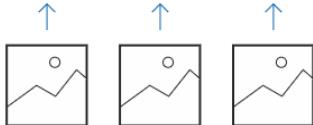
Microsoft Cognitive Services

Custom Vision



Visual Intelligence Made Easy

Easily customize your own state-of-the-art computer vision models that fit perfectly with your unique use case. Just bring a few examples of labeled images and let Custom Vision do the hard work.



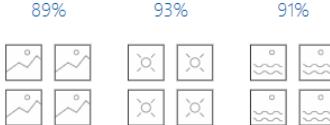
Upload Images

Bring your own labeled images, or use Custom Vision to quickly add tags to any unlabeled images.



Train

Use your labeled images to teach Custom Vision the concepts you care about.



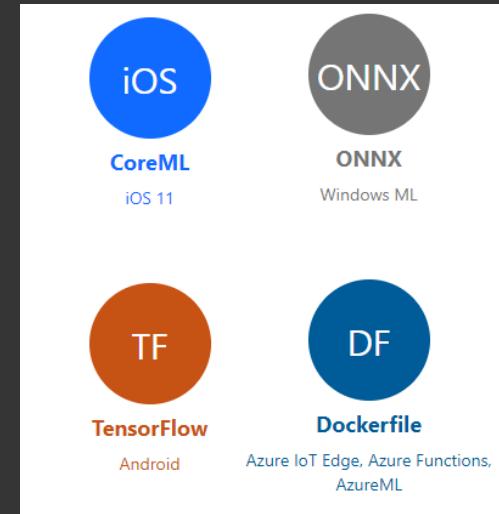
Evaluate

Use simple REST API calls to quickly tag images with your new custom computer vision model.

Building Apps w/ Custom Vision

Offline classification

- Export to CoreML, Tensorflow, ONNX or Dockerfile
- Fast, no internet roundtrip required



Online classification

- REST API
- More powerful models
- Use from any language

If you have an image URL:

```
https://southcentralus.api.cognitive.microsoft.com/customvision/v2.0/Prediction/c1:  
Set Prediction-Key Header to : [REDACTED]  
Set Content-Type Header to : application/json  
Set Body to : {"Url": "https://example.com/image.png"}
```

If you have an image file:

```
https://southcentralus.api.cognitive.microsoft.com/customvision/v2.0/Prediction/c1:  
Set Prediction-Key Header to : [REDACTED]  
Set Content-Type Header to : application/octet-stream  
Set Body to : <image file>
```



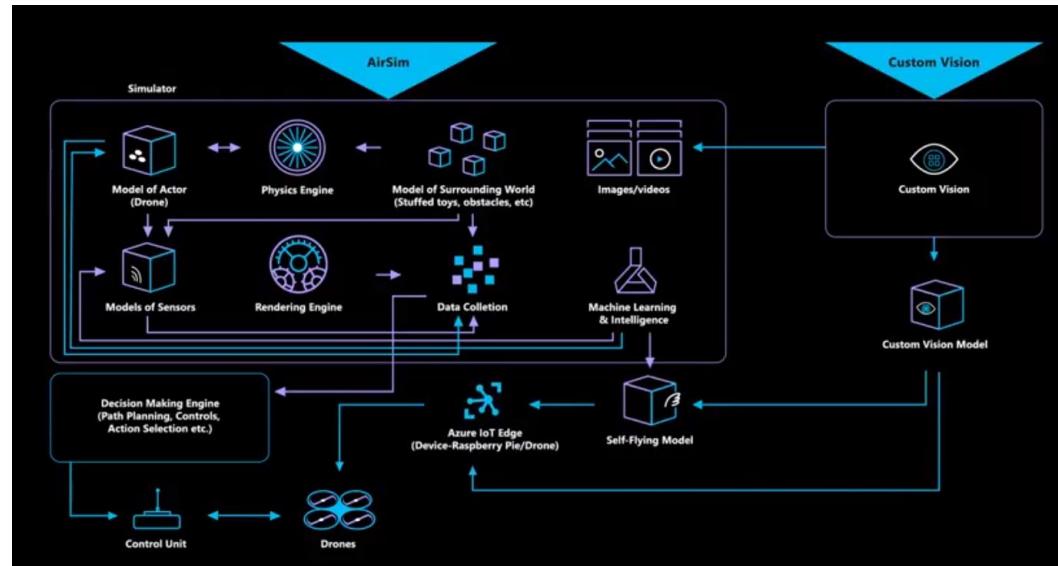
Drones: Search and Rescue training with AirSim

Goal: train AI-powered drones to recognize targets for search-and-rescue.

Train recognizer using real objects in controlled environment with Custom Vision.

Simulate training data for drone control with AirSim (simulator based on Unreal).

<https://github.com/Microsoft/AirSim>



The AI Journey

Pre-Trained AI



Cognitive Services
Developer APIs

Data for inference

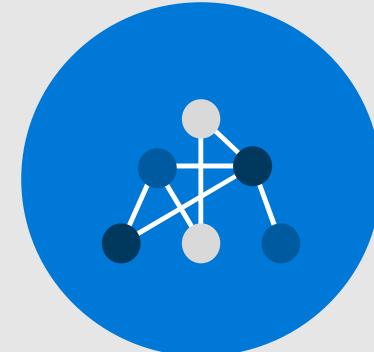
Enhanced AI



Pre-Trained models
Transfer Learning

Some training data

Bespoke AI



Developer Tools
Frameworks

Extensive training data

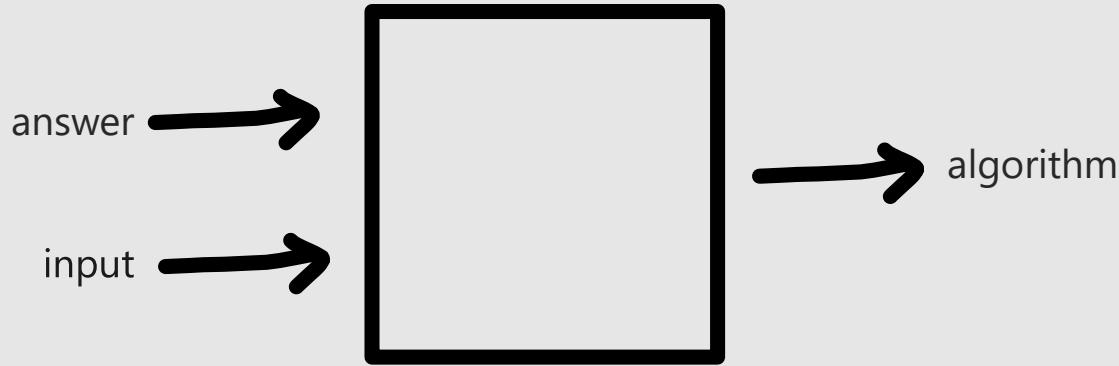
When pre-trained AI doesn't cut it

- Problem: specialized applications
 - New types of data
- Data: AI application lifecycle
 - Re-train to solve problems (data as code)
- Execution: real-world limitations
 - Latency / internet connectivity (on-device)
 - Devices (restrictions/benefits of hosting hardware)

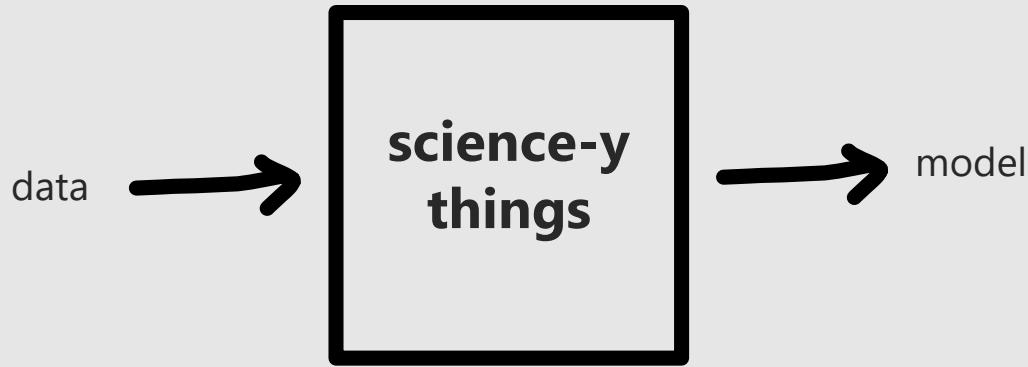
programming



machine learning



machine learning

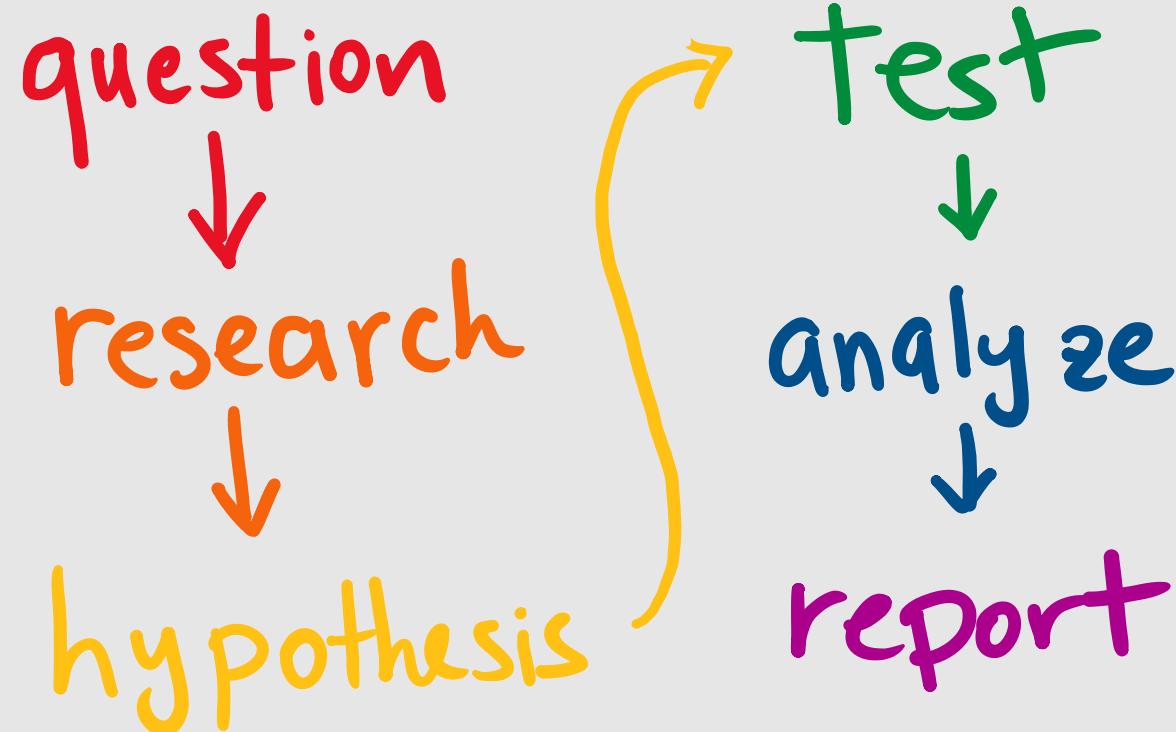




- Tensor: array
- Flow: computation graph
- Arithmetic computation engine
- Unrestricted data size
- GPU support
- Distributed
- Not just for Deep Learning



science



science

question



research



hypothesis



Test



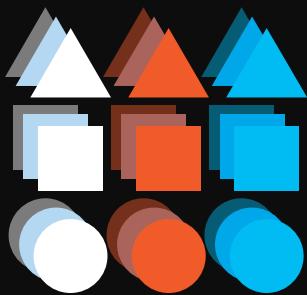
analyze



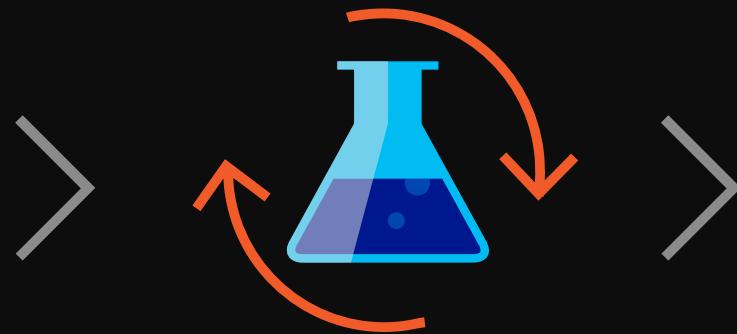
report

Bespoke AI

Creating your own AI applications from scratch



Prepare Data



Build & Train



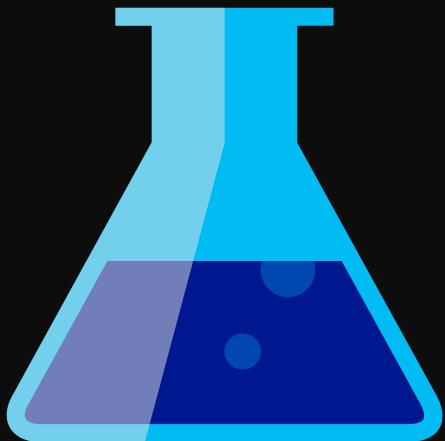
Deploy

working with others



NEW!

Azure Machine Learning Services



Build and Deploy Custom ML

Simplify ML with automated machine learning

Identify suitable algorithms and hyper-parameters faster

Increase productivity with DevOps for machine learning

Integrated CI/CD, ML pipelines, model management

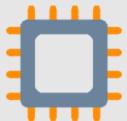
Tool agnostic Python SDK

Use your favorite Python environment and ML framework

the team workspace - logical



Workspace



compute



models



experiments



images



data stores



deployment

the team workspace - physical



workspace



storage



container
registry



key vault



application
insights

Prepare

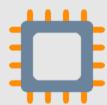


Prepare Data

Experiment



Build model
(your favorite
IDE)



Train & Test
Model



Register and
Manage Model



Build Image



Deploy
Service
Monitor
Model



Experimentation

- Leverage service side capture of run metrics, output logs and models
- Use leaderboards, side by side run comparison and model selection
- Manage training jobs locally, scaled-up or scaled-out
- Run distributed TensorFlow, PyTorch or MPI training jobs
- Conduct a hyperparameter search on traditional ML or DNN
- Use your favorite IDEs, editors, notebooks, and frameworks

USE ANY FRAMEWORK OR LIBRARY



USE ANY TOOL

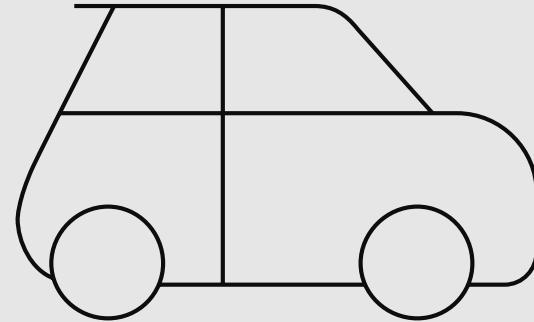


USE THE MOST POPULAR INNOVATIONS



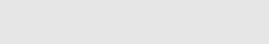
Azure Machine Learning

Automated machine learning



How much is this car worth?

Model creation is typically a time consuming process

Which features?	Which algorithm?	Which parameters?	
Mileage	Gradient Boosted	Parameter 1	
Condition	Nearest Neighbors	Parameter 2	
Car brand	SVM	Parameter 3 Split	
Year of make	Bayesian Regression	Parameter 4 Leaf	
Regulations	LGBM	Others	
...	...		

30%
Model

Model creation is typically a time consuming process

Which features?

Mileage
Condition
Car brand
Year of make
Regulations
...

Which algorithm?

Gradient Boosted
Nearest Neighbors
SVM
Bayesian Regression
LGBM
...

Which parameters?

Neighbors
Weights
Min Samples Split
Min Samples Leaf
Others

30%
Model



Iterate

Model creation is typically a time consuming process

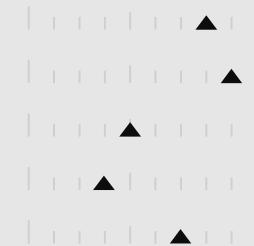
Which features?



Which algorithm?



Which parameters?

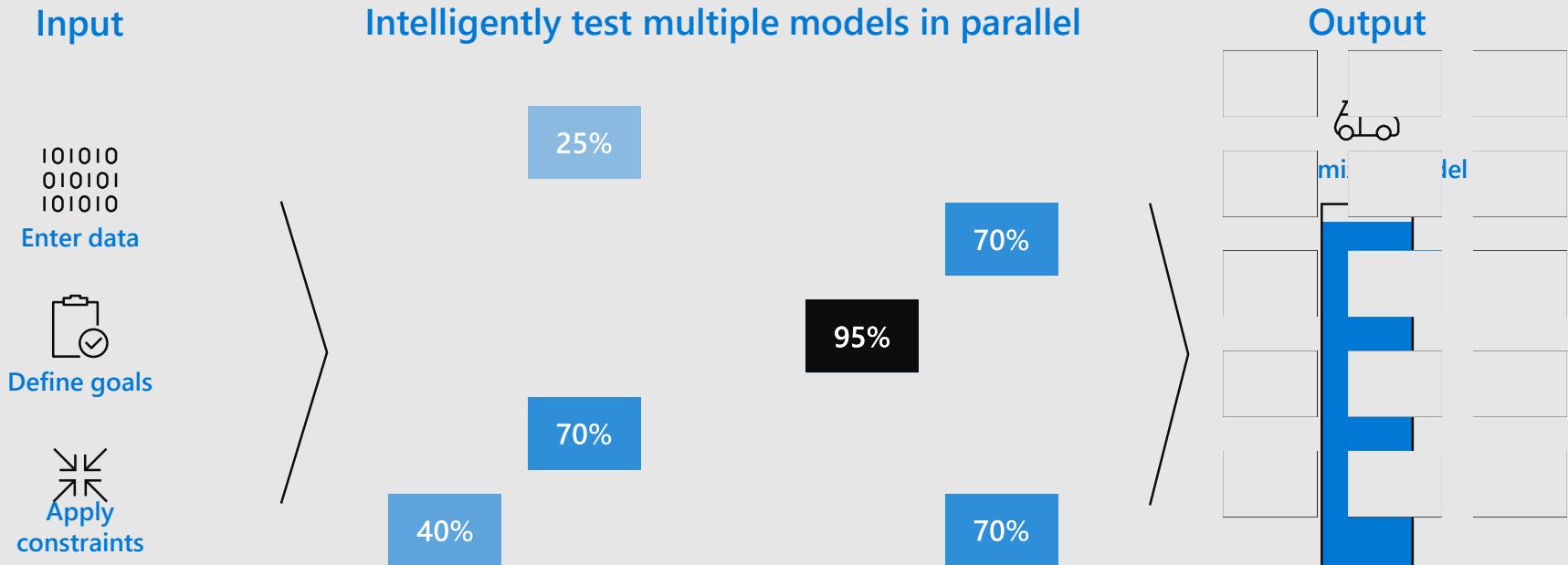


30%

15%

Iterate

Automated Machine Learning accelerates model development



Prepare

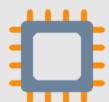


Prepare Data

Experiment



Build model
(your favorite
IDE)



Train & Test
Model

Register and
Manage Model

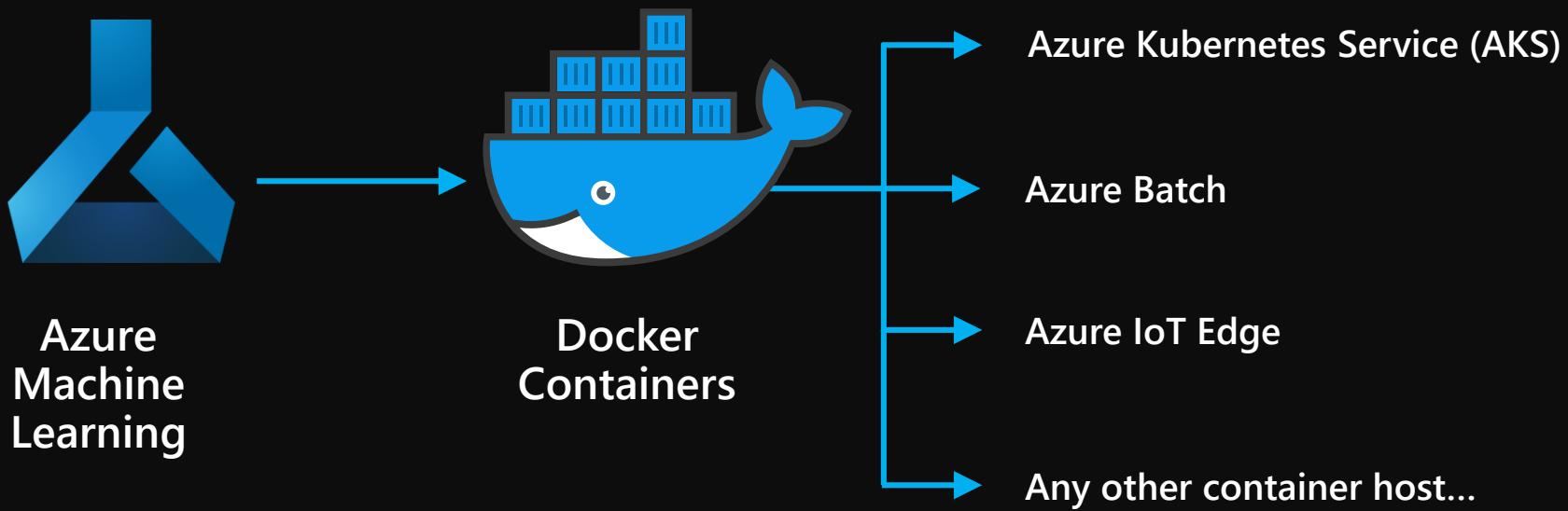
Deploy



Build Image

Deploy
Service
Monitor
Model

Deploying your own AI models



A Computer Vision Application

- A hardware retailer needs to monitor store shelves to make sure they are stocked correctly
 - Are the right products on the shelf?
 - Are they in the right place?
- We have developed a computer vision system to:
 - Observe a store shelf
 - Detect stock objects and their locations
 - Confirm the right products are stocked and in the right places
- How do we deploy it as an application?



/Learn alert

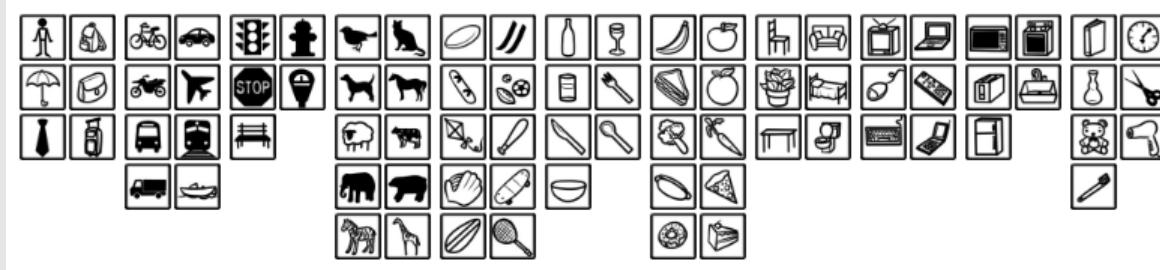
Interactive deep learning with Jupyter,
Docker and PyTorch

<https://aka.ms/AA3dxsc>

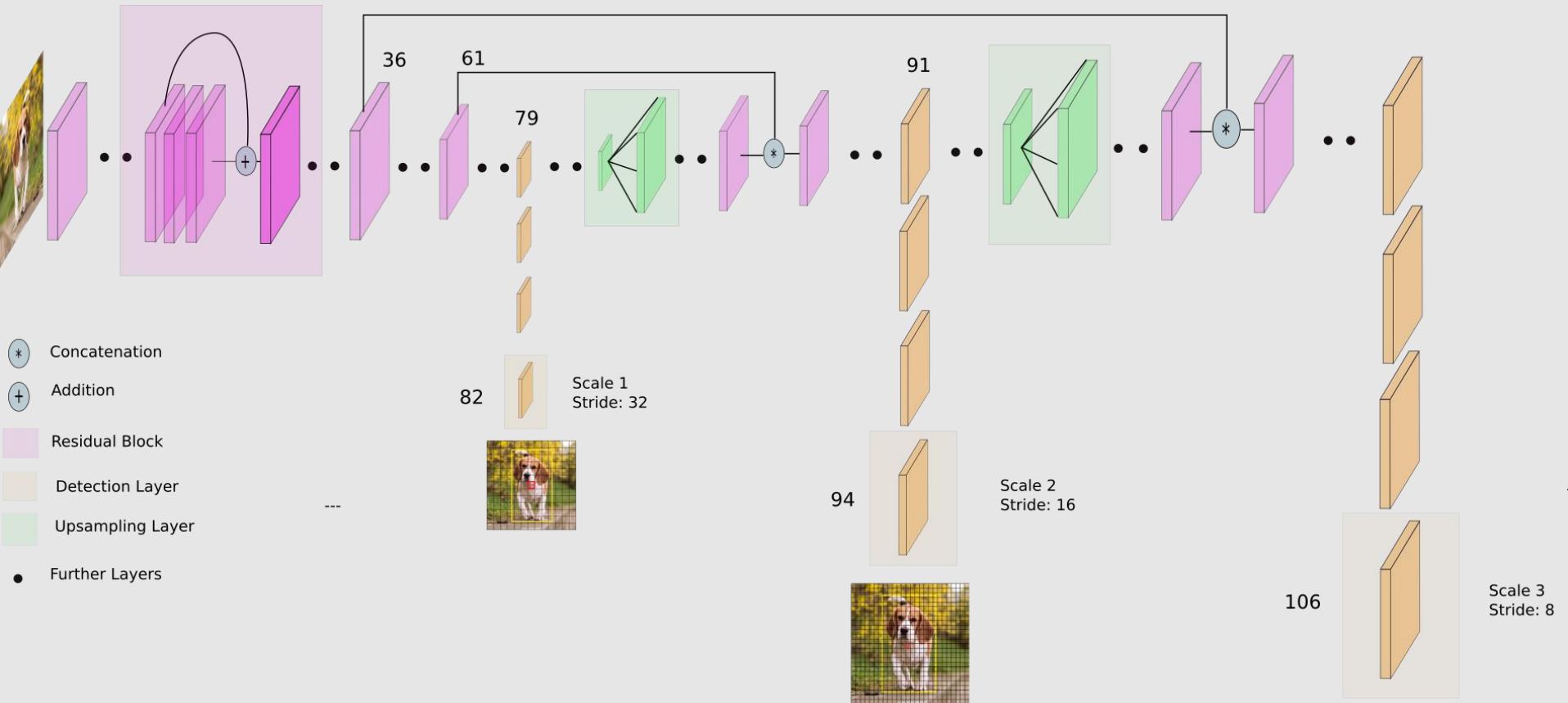
The screenshot shows the Microsoft Learn homepage. At the top, there's a navigation bar with the Microsoft logo, 'Learn', 'Azure', 'Business Applications', 'About', 'Browse All', 'Certifications', 'All Microsoft', and a search bar. Below the navigation is a breadcrumb trail 'Docs / Learn'. On the left, there's a sidebar with a 'WELCOME TO Microsoft Learn' section, 'Introducing a new approach to learning', and a message about earning points, levels, and achievements. It also mentions 'More coming soon!' and features icons for AI, ML, and data. In the center, there's a large 'Introduction to Azure' module card with a 'Start learning for free' button. At the bottom, there are three tabs: 'Learning paths', 'Hands-on learning', and 'Learn for free'. To the right, there's a 'Start a learning path' section with a dropdown menu 'Select your role'. Below that is a 'Learn Azure' section with a link to 'Explore more advanced Azure topics with online courses'. A decorative graphic of interconnected icons representing various Microsoft services like Azure, Power BI, and SharePoint is positioned on the right side.

YOLO: You Only Look Once

- For the shelf vision problem, we used YOLO v3
 - By Joseph Redmon: <https://pjreddie.com/darknet/yolo/>
 - Detects a fixed set of object types and their location in an image
- Trained on the COCO dataset: cocodataset.org



- PyTorch code and data (Erik Linder-Norén):
 - github.com/eriklindernoren/PyTorch-YOLOv3



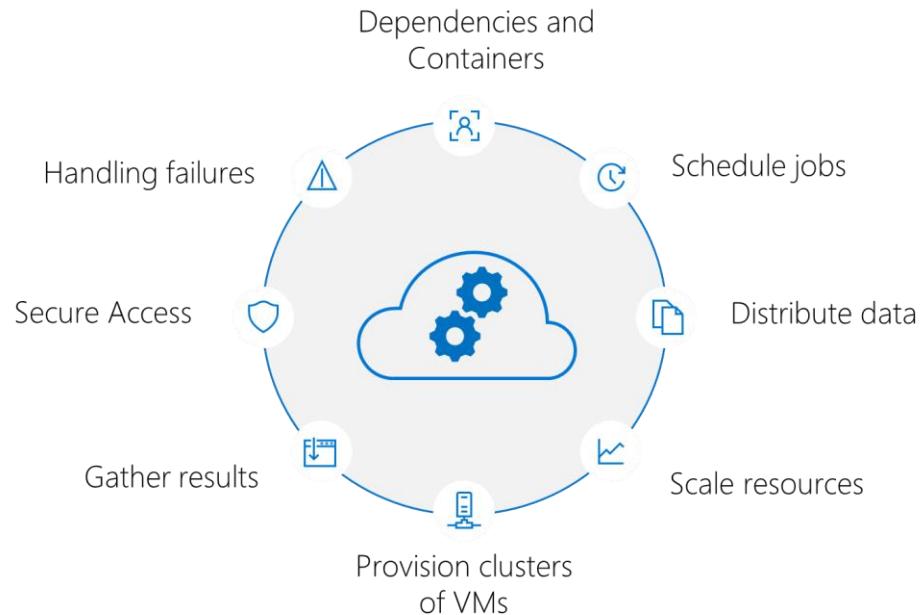
YOLOv3: An Incremental Improvement

Joseph Redmon & Ali Farhadi

pjreddie.com/media/files/papers/YOLOv3.pdf

Training Infrastructure

- Do distributed training at cloud scale using a framework of choice
- Leverage system managed Azure Machine Learning Compute or bring your own compute (VM, Databricks/HDI cluster)
- Manage resources across subscription and share them within a workspace
- Autoscale resources to only pay while running a job
- Use the latest NDv2 series VMs with the NVIDIA V100 GPUs

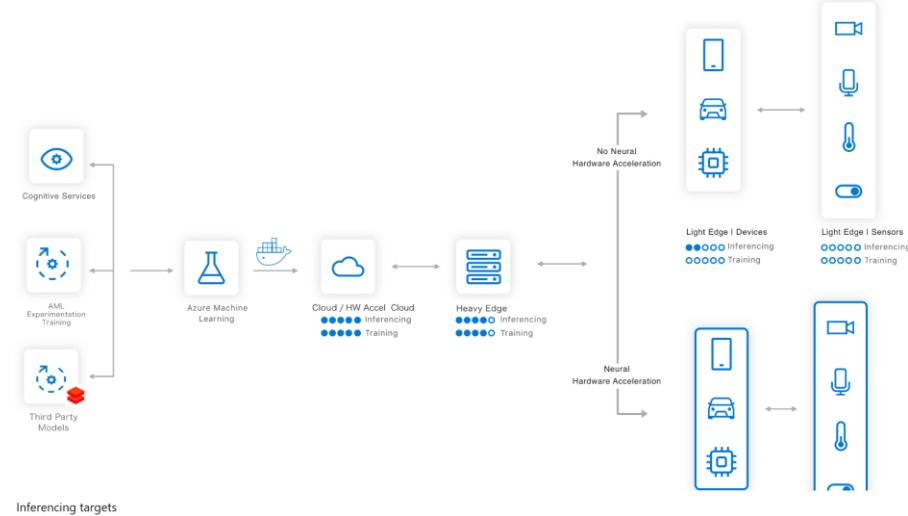


Create images

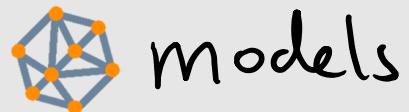


Model management and deployment

- Manage and track model versions with a central model registry
- Deploy models to Azure Kubernetes service with automatic scaling capability
- Container-based hosting for improved time to market
- Deploy models to the cloud, on-premises, to IoT edge and to FPGAs
- Management and monitoring of deployments through Azure AppInsights
- Enable DevOps with full CI/CD integration with VSTS
- Automatically optimize models to take advantage of new hardware accelerators in edge devices

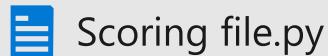


Deploy image



models

+



Scoring file.py

+



Python Environment



images

+



Azure
Kubernetes
Service (AKS)
or



Azure Container
Instance



deployment

Deploy image



Summary

In this session we learned:

- About pre-trained models in Cognitive Services
- How computer vision works
- Transfer learning with Custom Vision
- Building, training and deploying with Azure Machine Learning
- Automatic Machine Learning
- Hyperdrive optimization for deep learning models
- Deploying models to containers

Try Azure ML Services for free

2 Experimentation Users

20 Managed Models

2 Deployed Models (4 cores)

**free with every Azure
subscription**





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aischool.microsoft.com

Thank you!

AIF01 Practical AI for the Working Developer
8AM Friday

github.com/davidsmi/projects/practicalai

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