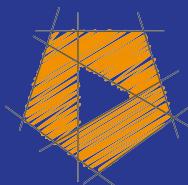


# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# January 2021 Updates

# Microsoft Azure AI Fundamentals

“foundational knowledge of machine learning (ML) and artificial intelligence (AI) concepts and related Microsoft Azure services”

# Microsoft Azure AI Fundamentals

- Candidates with non-technical backgrounds
- Candidates with a technical background who have a need to validate their foundational level knowledge around AI and ML

# Microsoft Azure AI Fundamentals

- Describe AI workloads and considerations
- Describe fundamental principles of machine learning on Azure
- Describe features of computer vision workloads on Azure
- Describe features of Natural Language Processing (NLP) workloads on Azure
- Describe features of conversational AI workloads on Azure

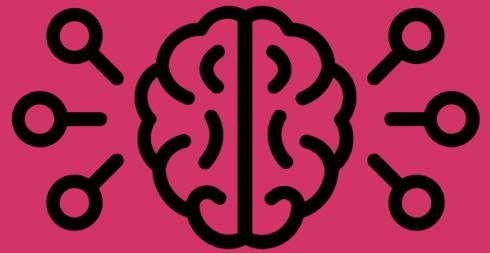


You'll be prepared  
to take and pass  
the AI-900 exam



Created by Adrien Coquet  
from Noun Project

But you don't have  
to, if you just want  
to learn AI concepts



Created by Adrien Coquet  
from Noun Project

# Easy to add AI capabilities to your own applications



Created by Alvida Biersack  
from Noun Project

# What Azure AI Services Exist?

Vision Services

Speech Services

Language Services

Decision Services



Created by Timofei Rostilov  
from Noun Project



# Exam AI-900: Microsoft Azure AI Fundamentals

In response to the coronavirus (COVID-19) situation, Microsoft is implementing several temporary changes to our training and certification program. [Learn more.](#)

The content of this exam will be updated on January 27, 2021. Please download the skills measured document below to see what will be changing.

Candidates for this exam should have foundational knowledge of machine learning (ML) and artificial intelligence (AI) concepts and related Microsoft Azure services.

This exam is an opportunity to demonstrate knowledge of common ML and AI workloads and how to implement them on Azure.

This exam is intended for candidates with both technical and non-technical backgrounds. Data science and software engineering experience are not required; however, some general programming knowledge or experience would be beneficial.

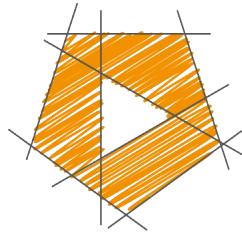
Azure AI Fundamentals can be used to prepare for other Azure role-based certifications like Azure Data Scientist Associate or Azure AI Engineer Associate, but it's not a prerequisite for any of them.

Part of the requirements for: [Microsoft Certified: Azure AI Fundamentals](#)

Related exams: none

Important: [See details](#)

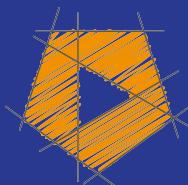
[Go to Certification Dashboard](#)



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# What Do We Mean By “AI”?

The term “Artificial Intelligence” has been used to describe many things

# Oxford Dictionary

artificial intelligence (noun)

/ ,ärdə'fɪSHəl in'teləjəns/

*"the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages."*



Incorporating  
human intelligence  
into machines

# Artificial General Intelligence

That robot or computer in the movies that can teach itself a new task.

Common in science fiction. Does not currently exist in real life.

We're not talking about that type of AI.



# Narrow Artificial Intelligence

Computer systems which use human intelligence but have very strong limitations in what they can do.

Siri, Cortana and Google Assistant are examples of Narrow AI.

“What is the weather today?”

“When is my next appointment?”

“Call Carol.”

# Machine Learning

The study of computer algorithms that improve automatically through experience.

**Unsupervised learning** - ability to find patterns in data without human help

**Supervised learning** - humans label the data and gives general guidance

This course covers ML.

# Natural Language Processing

Allows a machine to read and understand human language.

Machine translation, question answering, sentiment analysis, etc.

This course covers NLP.

# Perception

The ability to use input from sensors - images, audio, lidar, sonar, radar, touch etc.

Covers things like facial recognition, speech recognition and object recognition.

Also covered in this course.



AI is “everywhere”.







OII

Hi, everyone. My name is Stephen Chang. I work for CollaborativeAI. We're trying to bring autonomous sustainable travel at scale. I work as a business strategist. We're building new kinds of transportation that rely on AI and advanced robotics



# Elevate human connections in real time

Augment your workforce with the AI coaching system for the contact center

[Tour the product](#)[Get started](#)

CONSUMER

# Cadillac Fairview suspends use of facial recognition cameras at Calgary malls

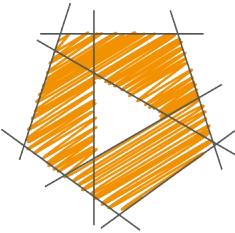


By **Kaylen Small** • Global News

Posted August 5, 2018 4:22 pm



Directories in Chinook Centre are suspending use of facial recognition software. **Blake Lough / Global News**



**SoftwareArchitect**  
.ca



AI-900 is a high-level exam

# What is an ML Model?

Machine learning  
(ML) allows  
computers to use  
data to forecast the  
future...

... without  
specifically being  
programmed.

In ML, a model is a  
program that can  
be used to  
recognize a pattern  
in data



A model can be  
used to **predict**  
future behaviors



A model can be  
used to categorize  
something as one  
thing or another



A model can be used to recognize people, objects and landmarks using unseen images



A model can be  
used to understand  
the context of  
natural human text  
or speech



You train a model  
using “training  
data”

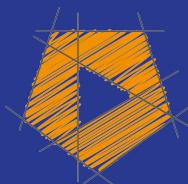


You evaluate a  
model using “test  
data” to measure  
how accurate is it

Once a model has  
been deployed, it  
can recognize  
patterns in data it  
has never seen  
before

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# Describe AI Workloads and Considerations (15-20%)

## **Describe Artificial Intelligence workloads and considerations (15-20%)**

### **Identify features of common AI workloads**

- identify prediction/forecasting workloads
- identify features of anomaly detection workloads
- identify computer vision workloads
- identify natural language processing or knowledge mining workloads
- identify conversational AI workloads

### **Identify guiding principles for responsible AI**

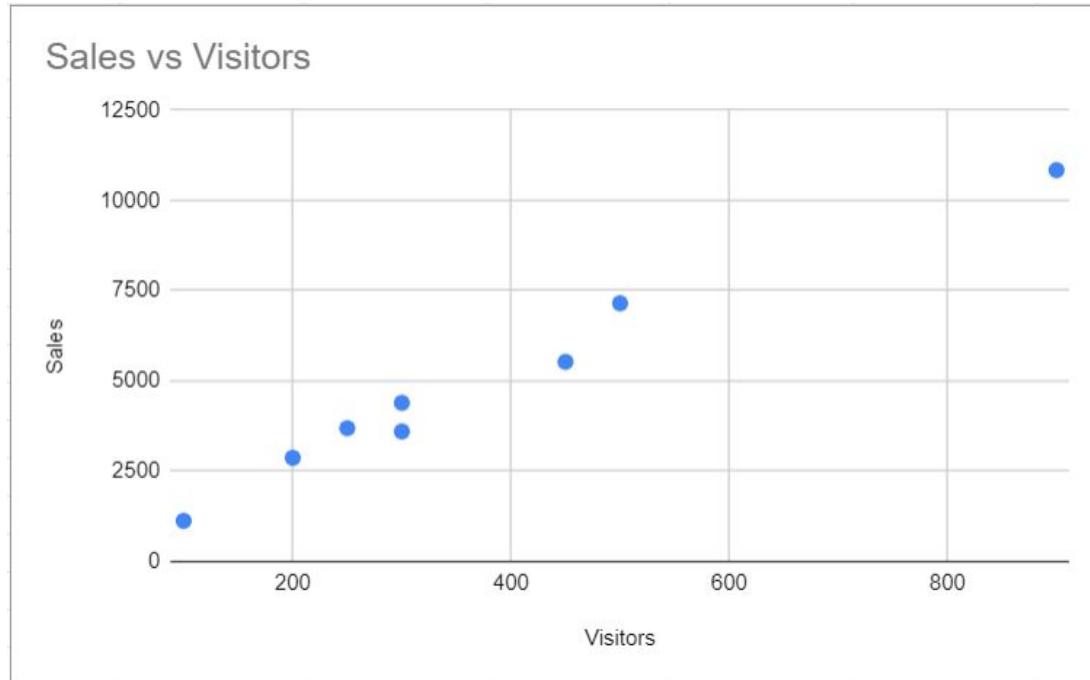
- describe considerations for *fairness* in an AI solution
- describe considerations for *reliability and safety* in an AI solution
- describe considerations for *privacy and security* in an AI solution
- describe considerations for *inclusiveness* in an AI solution
- describe considerations for *transparency* in an AI solution
- describe considerations for *accountability* in an AI solution

# Common AI Workloads

# 1. Prediction and Demand Forecasting

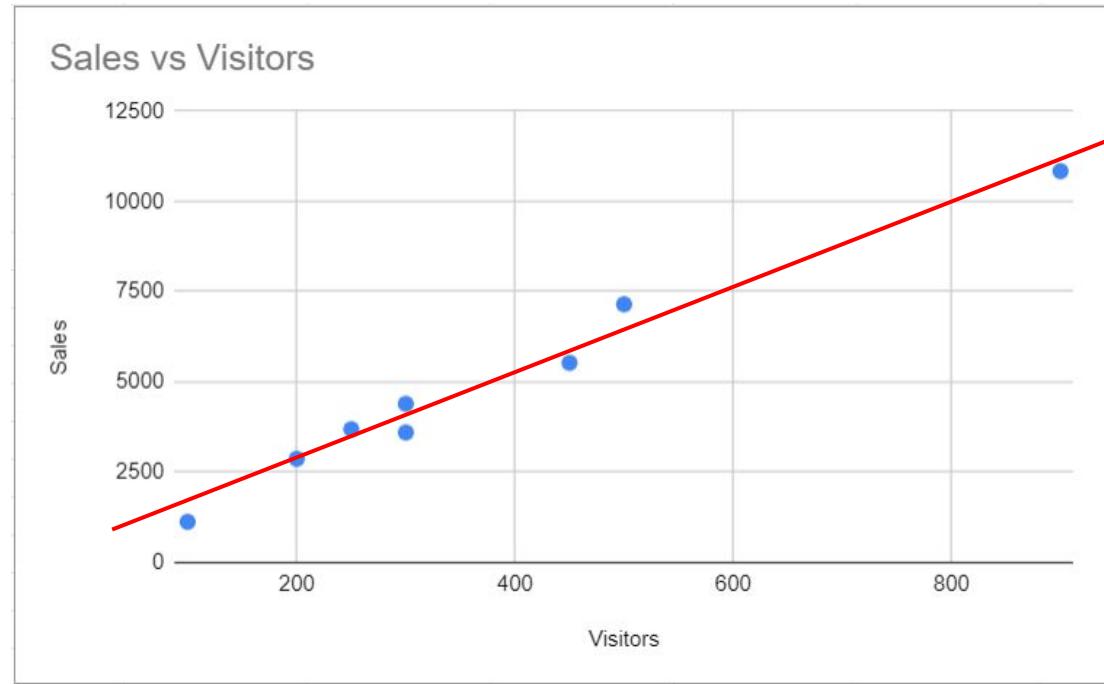
<u>Visitors</u>	<u>Sales</u>
100	1125
200	2871
300	3600
500	7150
450	5529
300	4393
900	10837.5
250	3691.5
786	?
362	?
121	?

# Prediction and Demand Forecasting



# Prediction and Demand Forecasting

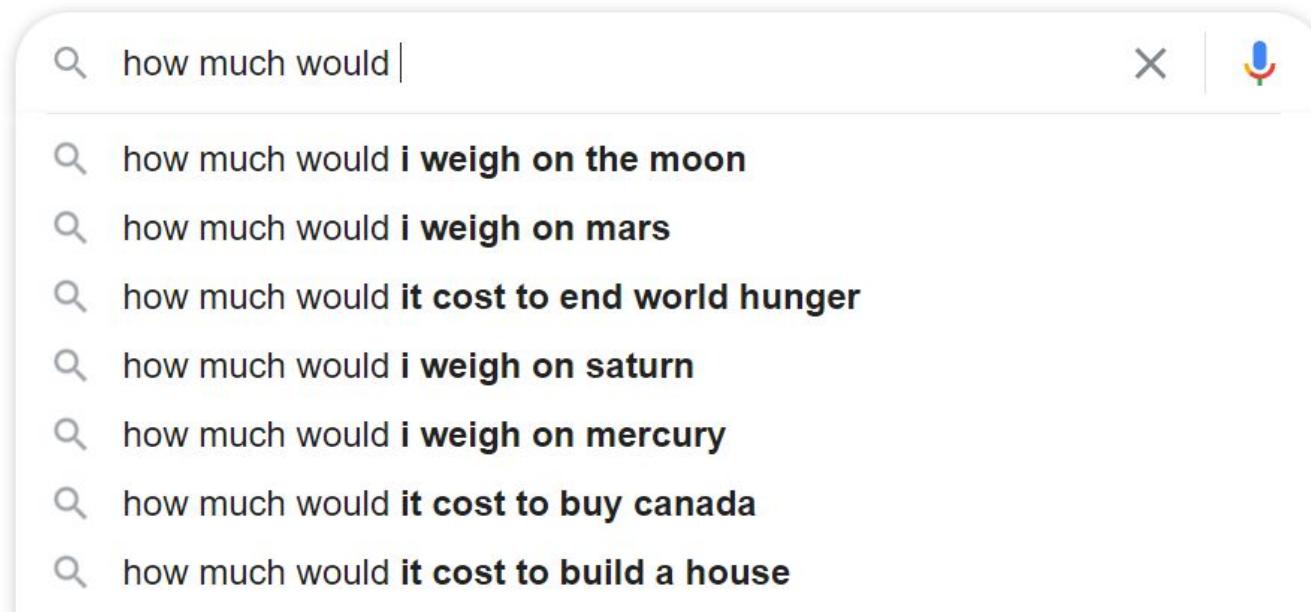
Visitors	Sales
100	1125
200	2871
300	3600
500	7150
450	5529
300	4393
900	10837.5
250	3691.5
786	?
362	?
121	?



# Using Machine Learning to Predict

- Give the machine all the relevant data you know
- Tell it for which field you want to predict
- It develops a model which it uses to make a prediction

# Common Predictions



Because you watched New Girl



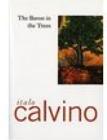
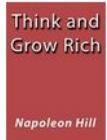
### TV Mysteries



### Irreverent TV Shows



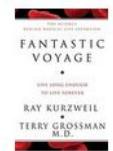
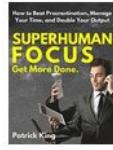
# Recommended for you, Thomas



Literature & Fiction  
62 ITEMS



Exercise & Fitness Equipment  
8 ITEMS



Health, Fitness & Dieting Books  
37 ITEMS



Tableware  
12 ITEMS



Prime Video – Unlimited Streaming for Prime Members  
12 ITEMS



Coffee, Tea & Espresso  
98 ITEMS



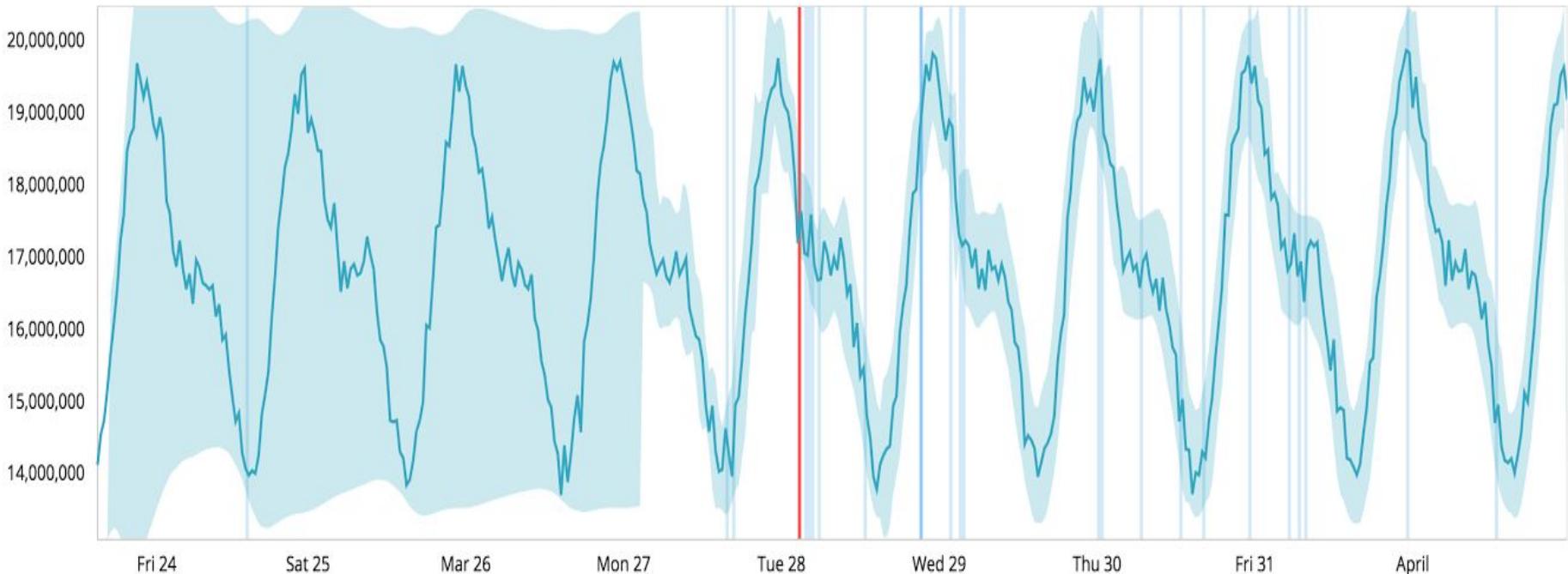
Biographies & Memoirs  
17 ITEMS



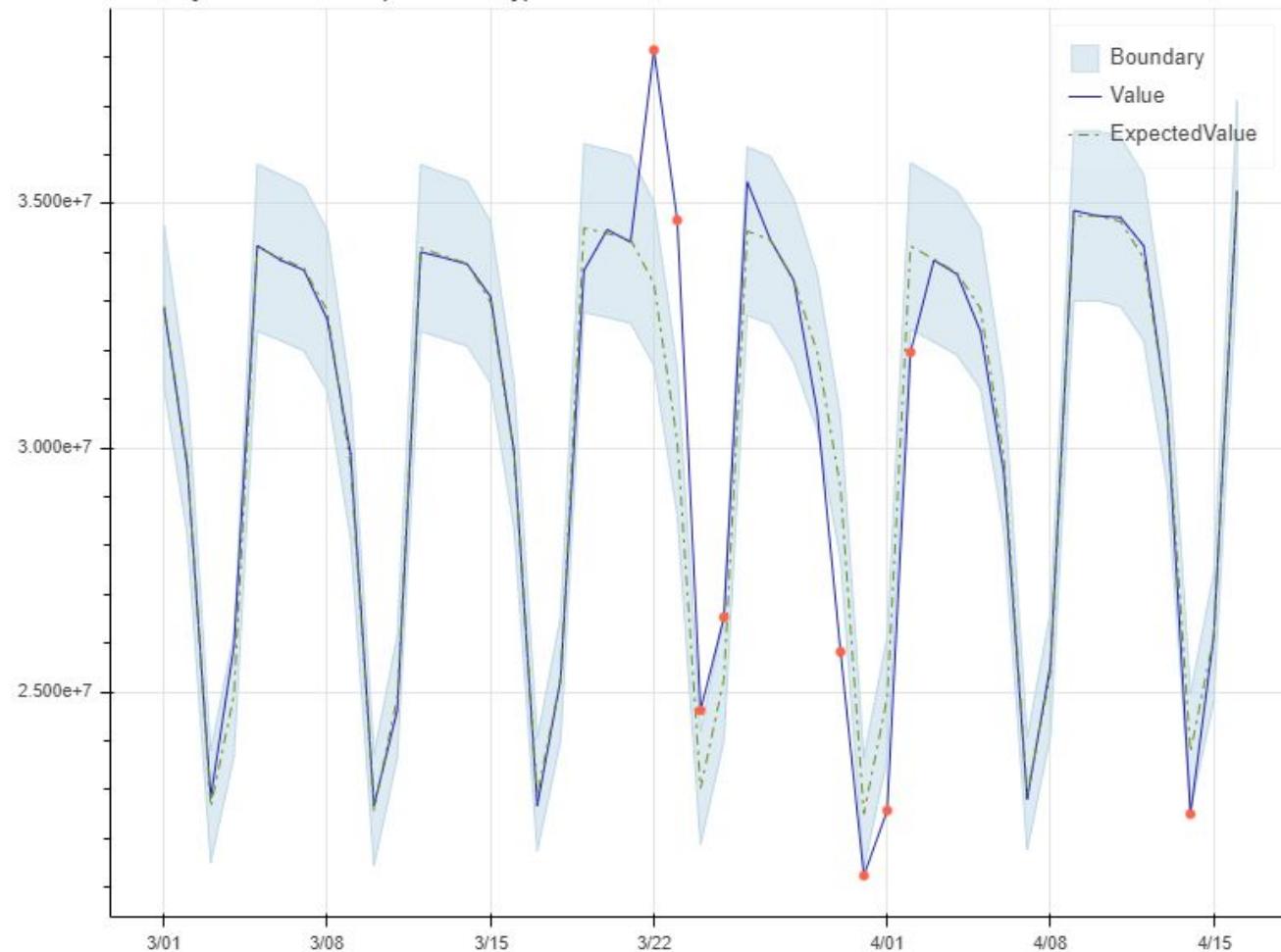
Engineering Books  
7 ITEMS

## 2. Anomaly Detection

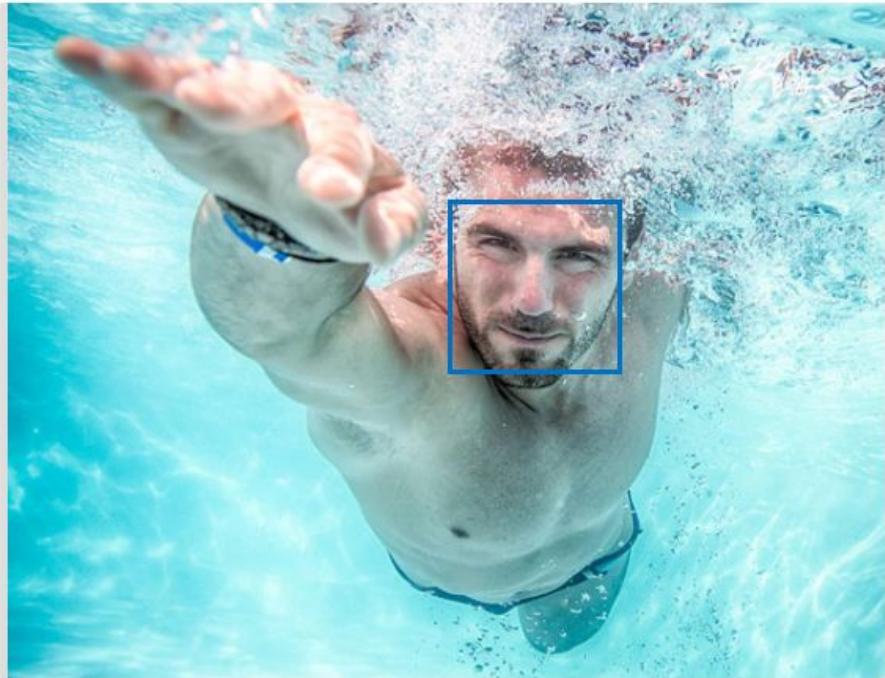




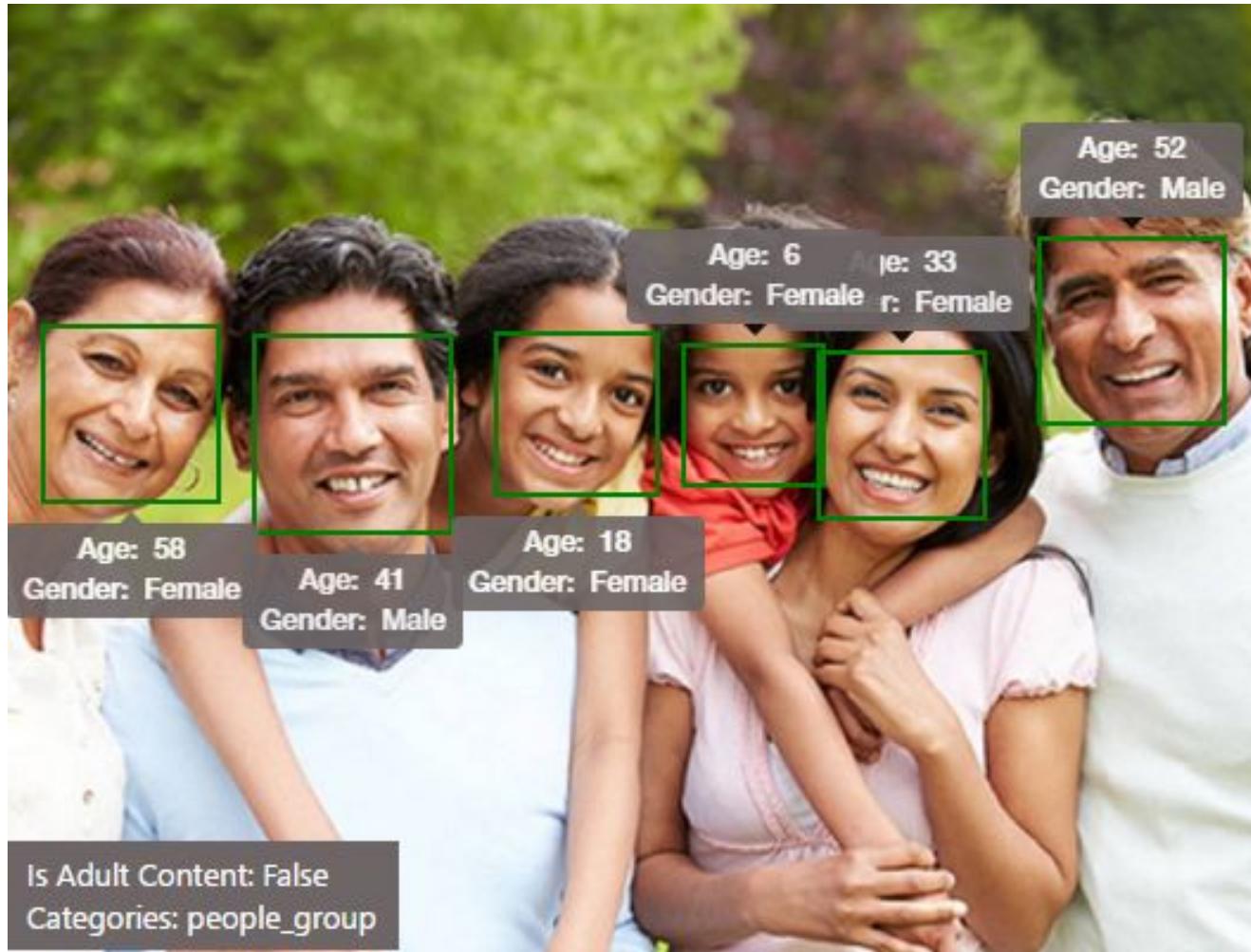
### Anomaly Detector Result (95 Sensitivity)



# 3. Computer Vision



FEATURE	VALUE
NAME:	
Description	{ "tags": [ "water", "swimming", "sport", "pool", "person", "man", "frisbee", "ocean", "blue", "bird", "riding", "top", "standing", "wave", "young", "body", "large", "game", "glass", "pond", "playing", "board", "catch", "clear", "boat", "white" ], "captions": [ { "text": "a man swimming in a pool of water", "confidence": 0.8909298 } ] }
Tags	[ { "name": "water", "confidence": 0.9997857 }, { "name": "swimming", "confidence": 0.955619633 }, { "name": "sport", "confidence": 0.953807831 }, { "name": "pool", "confidence": 0.9515978 }, { "name": "person", "confidence": 0.889862537 }, { "name": "water sport", "confidence": 0.664259 } ]
Image format	"Jpeg"



## 4. Natural Language Processing (NLP)

- What time are you open until today?
- When do you close?
- What time do you close today?
- What are your hours of operation today?
- Until which time can I come there to pick up my order?

# Knowledge Mining - Cognitive Search

Ingest content from Blob storage, Tables, SQL Database, and Cosmos DB

PDFs, Images, Word Documents, Powerpoints, Audio

Uses AI tools such as image classification, face recognition, language detection, key phrase extraction to create a searchable index

## 5. Conversational AI - Chat Bots

**User:** Do you have any of the Levi's 501 Jeans in stock?

**Chatbot:** In what size?

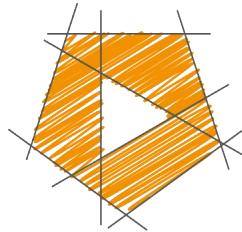
**User:** Size 34 please

**Chatbot:** Yes, we have those. Do you want me to hold one aside for you?

**User:** Yes.

**Chatbot:** What is your name?

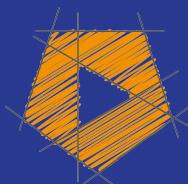
...



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# Guiding Principles in AI



The prevalence of  
AI causes some  
ethical and moral  
challenges



Unintended  
consequences of  
leaving important  
decisions to a  
computer

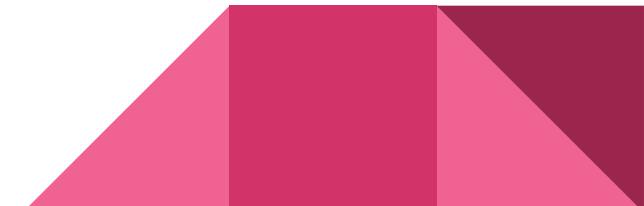
# Unintended Consequences:

Decisions that are wrong

Decisions that are illegal (or at least, go against your own values)

Decisions that cannot be explained by anybody

Decisions that are harmful to society at large



# Unintended Consequences

# Why facial recognition's racial bias problem is so hard to crack

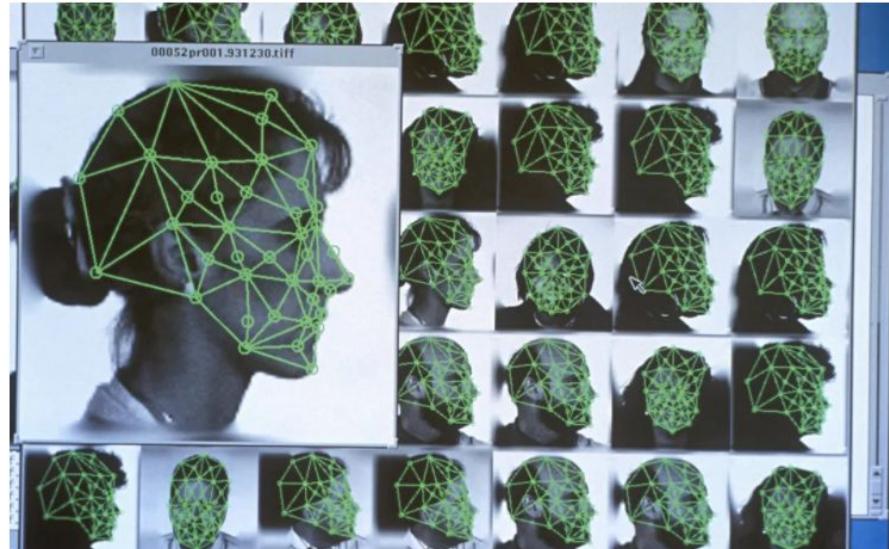
Good luck if you're a woman or a darker-skinned person.



Queenie Wong March 27, 2019 5:00 a.m. PT



26



RETAIL OCTOBER 10, 2018 / 7:04 PM / UPDATED 2 YEARS AGO

# Amazon scraps secret AI recruiting tool that showed bias against women

By Jeffrey Dastin

8 MIN READ



SAN FRANCISCO (Reuters) - Amazon.com Inc's AMZN.O machine-learning specialists uncovered a big problem: their new recruiting engine did not like women.



NEWS · 24 OCTOBER 2019 · UPDATE 26 OCTOBER 2019

# Millions of black people affected by racial bias in health-care algorithms

Study reveals rampant racism in decision-making software used by US hospitals – and highlights ways to correct it.

[Heidi Ledford](#)[!\[\]\(e359e0093fc096d3c72dff8bc7aef438\_img.jpg\) PDF version](#)

## RELATED ARTICLES

A fairer way forward for AI in health care



Bias detectives: the



# Do Calgary police face recognition software, body-worn cameras violate your privacy?



By **Jayne Doll & Mia Sosiak** • Global News

Posted November 5, 2014 8:20 pm · Updated November 5, 2014 8:33 pm



-A A+

Calgary police say their body-worn cameras and new face recognition software won't violate the privacy of citizens, despite concerns raised by Alberta's privacy watchdog.

"Police agencies have broad authority under the FOIP act to collect, use and disclose personal information for law enforcement purposes," said Jill Clayton, Alberta's Information and Privacy Commissioner.

"But I have questions regarding how CPS is implementing these technologies, and specifically what steps have been taken to ensure privacy and security risks have been identified and addressed," she added.

# What If...

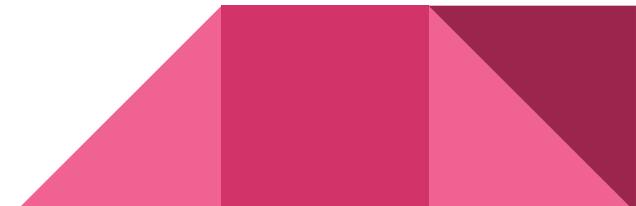
1. The traffic control dept installs sensors in every intersection to count cars
2. The road works dept chooses cameras instead of road sensors because it's cheaper to install and maintain
3. An IT intern uses AI to record the license plates, time and intersection of every car the camera sees as an interesting experiment and leaves it running
4. The police request those records to find a robbery suspect

# What If...

1. The traffic control dept installs sensors in every intersection to count cars
2. The road works dept chooses cameras instead of road sensors because it's cheaper to install and maintain
3. An IT intern uses AI to record the license plates, time and intersection of every car the camera sees as an interesting experiment and leaves it running
4. ~~The police request those records to find a robbery suspect~~
5. A hacker secretly has access to those records and posts them to the Internet for anyone to use

# Six Principles Should Guide AI Development

- Fairness
- Reliability and safety
- Privacy and security
- Inclusiveness
- Transparency
- Accountability



# Principle of Fairness

“AI systems should treat everyone fairly  
and avoid affecting similarly situated groups of people  
in different ways.”



# Principle of Fairness

Imagine a hospital emergency room AI system  
that prioritized patients in the order of their FICO credit score...  
the more money you have, the faster you see a doctor.

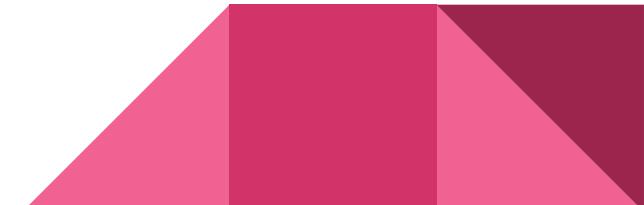
# Principle of Fairness

Imagine a bank loan AI system  
that gave more money to people named Michael  
and less money to people named Alice.



# Principle of Reliability and Safety

“To build trust, it's critical that AI systems operate reliably, safely, and consistently under normal circumstances and in unexpected conditions.”

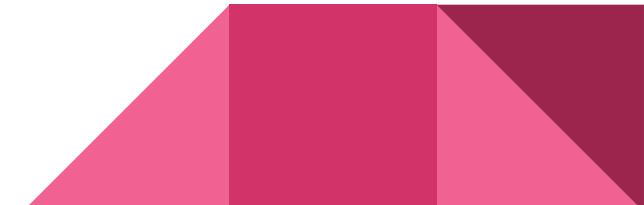


# Principle of Reliability and Safety

It's so easy to program for the “sunny day”.

The data is never bad. No fields have blanks. No fields have accented characters.  
All connected systems are functional.

There is no one trying to intentionally break the system.



Apr 1, 2019, 07:06am EDT | 132,718 views

# Hackers Use Little Stickers To Trick Tesla Autopilot Into The Wrong Lane



**Thomas Brewster** Forbes Staff

Cybersecurity

*Associate editor at Forbes, covering cybercrime, privacy, security and surveillance.*



f  
Twitter



# Principle of Reliability and Safety

How does the self-driving car operate at night?  
In a rainstorm? In a snowstorm?

How does the military unmanned drone operate when the GPS is down?

How does the self-driving car operate when an object is approaching from the side  
instead of the front or back?

# Principle of Privacy and Security

Many countries and regions in the world are developing new standards and laws to try to protect the data of its citizens. Laws are always slower than technology.

**\$2 off**

Coppertone  
Water Babies  
sunscreen item  
Excludes trial size



**75¢ off**

2- to 5-pk.  
Gerber Onesies



**75¢ off**

Johnson's  
baby toiletry or  
Desitin item  
Excludes trial size and  
Johnson's Buddies item



**\$1 off**

265-ct. Q-tips baby vanity pack  
cotton swabs



**\$1 off**

Boudreax's  
baby care item  
Excludes trial size



**\$8 off**

With purchase of two 1.37-lb. or larger  
Similac powder infant formulas



**\$1 off**

Jurt's Bees  
Baby Bee  
toiletry item  
Excludes trial size



**\$1 off**

California Baby  
• 6.5-oz. natural bug  
repellent spray or  
• 2.9-oz. SPF 30+  
sunscreen lotion or  
• 8-oz. SPF 30+  
sunblock stick



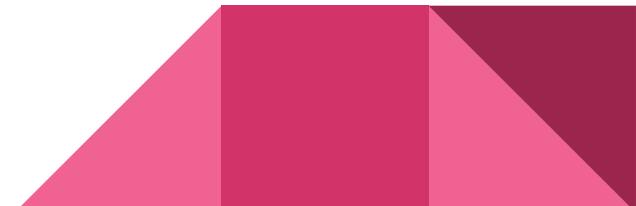
**30¢ off**

Ella's Kitchen organic baby food item



# Six Principles Should Guide AI Development

- Fairness
- Reliability and safety
- Privacy and security
- Inclusiveness
- Transparency
- Accountability



# Principle of Inclusiveness

“At Microsoft, we firmly believe  
**everyone should benefit from intelligent technology,**  
meaning it must incorporate and address a broad range  
of human needs and experiences.”



# Principle of Inclusiveness

How does a voice assistant work for someone who has a speech impediment?

How does a fitness tracker work for someone with a mobility disability?

How does “video-only” product instructions help someone who is blind?



# Principle of Transparency

“When AI systems are used to help inform decisions that have tremendous impacts on people's lives, it is critical that people understand how those decisions were made.”



# Principle of Transparency

When someone is rejected by an AI system for a job, life insurance or a bank loan, why were they rejected? If you are unable to tell them why, the system lacks transparency and you can't tell if it's operating properly. It could be unfair, and you won't know it.

# Principle of Accountability

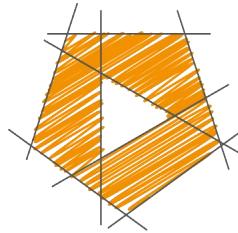
“The people who design and deploy AI systems  
must be accountable  
for how their systems operate.”



# Principle of Accountability

AI systems should not be the “final authority” in any decision that has a major impact on people’s lives - employment, finances, health care, human safety, etc.

There should be regular review of how the AI is operating, and regular improvement of the model.



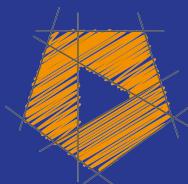
**SoftwareArchitect**  
.ca

# Exam Tips

Really need to understand for which scenario

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>



Describe fundamental principles  
of machine learning on Azure (30-  
35%)

## **Describe fundamental principles of machine learning on Azure (30-35%)**

### **Identify common machine learning types**

- identify *regression* machine learning scenarios
- identify *classification* machine learning scenarios
- identify *clustering* machine learning scenarios

### **Describe core machine learning concepts**

- identify features and labels in a dataset for machine learning
- describe how training and validation datasets are used in machine learning
- describe how machine learning algorithms are used for model training
- select and interpret model evaluation metrics for classification and regression

### **Identify core tasks in creating a machine learning solution**

- describe common features of data ingestion and preparation
- describe common features of feature selection and engineering
- describe common features of model training and evaluation
- describe common features of model deployment and management

### **Describe capabilities of no-code machine learning with Azure Machine Learning:**

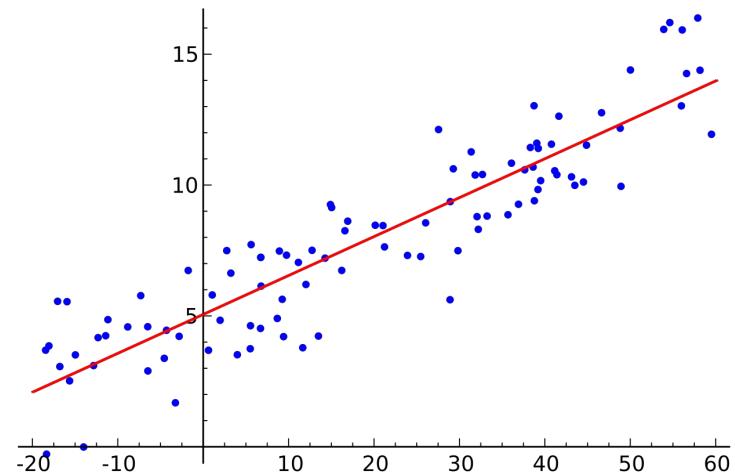
- automated Machine Learning UI
- azure Machine Learning designer

# Common Machine Learning Types

# Regression

A type of supervised learning

The ability to predict the outcome variable given 1 or more predictor variables.



Result is numeric - price, amount, size, etc.



Finds the  
relationship  
between the  
variables

# Classification

A type of supervised learning

Cluster analysis - assign a score to the odds  
of it belonging to a cluster



What type of fruit is this?



Binary classification  
only has two answers,  
0 and 1



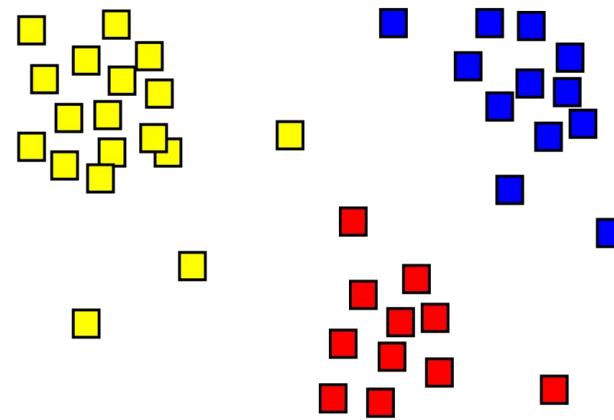
Multi-class  
classifications  
allow for other  
options

# Clustering

A type of unsupervised learning

Find groups of related things among data

What traits do my best customers  
have in common?

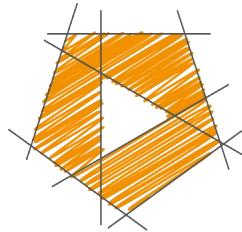


# Which is an Example of Regression?

- A) Which movies to recommend to user Joe Smith (ie. Netflix)?
- B) What make and model of car is in this image?
- C) On a scale of 1-10, how happy is someone who makes \$60,000 per year?
- D) Is this email spam or ham?

# Which is an Example of Regression?

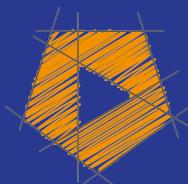
- A) Which movies to recommend to user Joe Smith (ie. Netflix)?
- B) What make and model of car is in this image?
- C) On a scale of 1-10, how happy is someone who makes \$60,000 per year?
- D) Is this email spam or ham?



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# Core Machine Learning Concepts



Feature is an input  
variable



Label is the thing  
we're predicting

# Features and Labels in a Dataset

Given a pile of data, you (data scientist) need to determine which bits are relevant to make decisions on

- Experiment
- Domain knowledge
- Keep in mind the principles of AI

# Examples of Data

- First and last name
- Smoker or non-smoker (feature)
- Date of birth (feature)
- Marital status (feature)
- Gender (feature)
- Annual income (feature?)
- Blood type
- Number of children
- ...
- Life expectancy (label)

# Training the Model

The more input (historical) data you have, the more accurate the results

Don't use ALL of your data to train the model

Divide your available labelled data into training and validation/test datasets

Ie. 1,000,000 rows of data - 500K to train the model, 500K to test the model

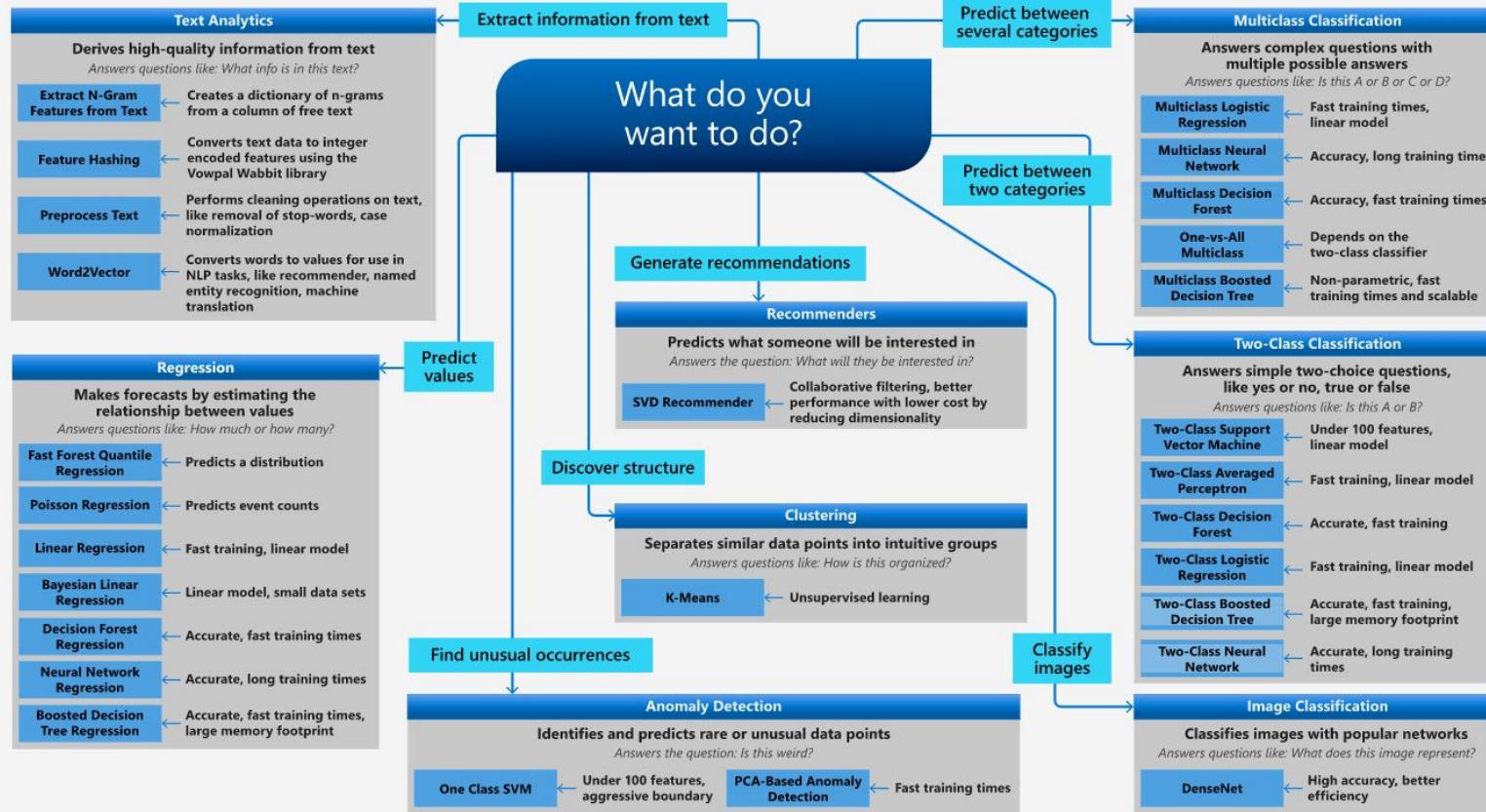


Split the training  
and validation  
datasets randomly



# Microsoft Azure Machine Learning Algorithm Cheat Sheet

This cheat sheet helps you choose the best machine learning algorithm for your predictive analytics solution. Your decision is driven by both the nature of your data and the goal you want to achieve with your data.



Discover structure

## Clustering

**Separates similar data points into intuitive groups**

*Answers questions like: How is this organized?*

K-Means

Unsupervised learning

Cl

# Evaluate the Results - Regression

Use the validation dataset to test the model, and measure how close or far the actual results are from the predicted results

## Mean Square Error

Large differences are much worse than small differences

# Evaluate the Results - Classification

The result is to give a prediction score that the subject is part of the group

“70% confident this is an apple, 30% confident this is a pear”

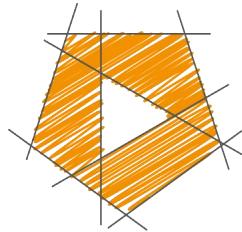
So if an apple is mis-identified as a pear, that's ok as long as it only happens 30% of the time...

# False Positives vs False Negatives

Compare true positives with false positives and true negatives with false negatives when evaluating the model

How important is it to you that it never has a false positive?

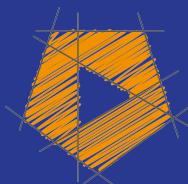
Accuracy vs precision



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# Core Machine Learning Tasks

## Prepare Data



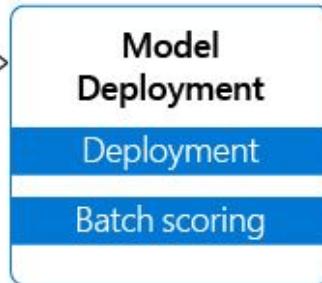
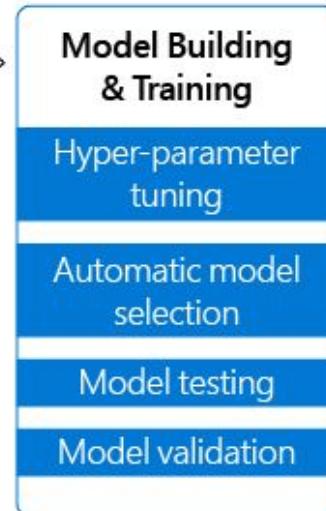
## Build & Train Models



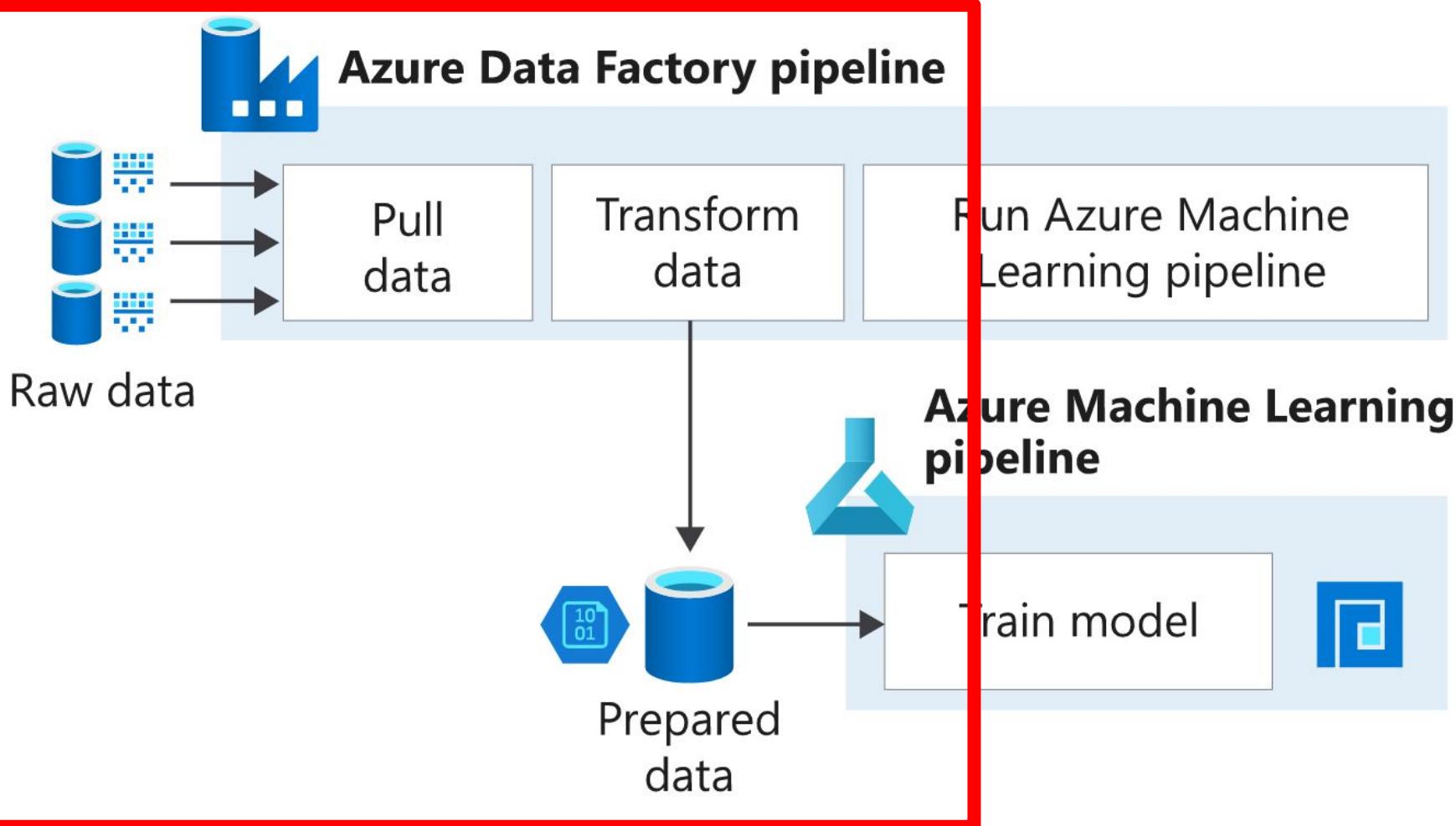
## Deploy & Predict

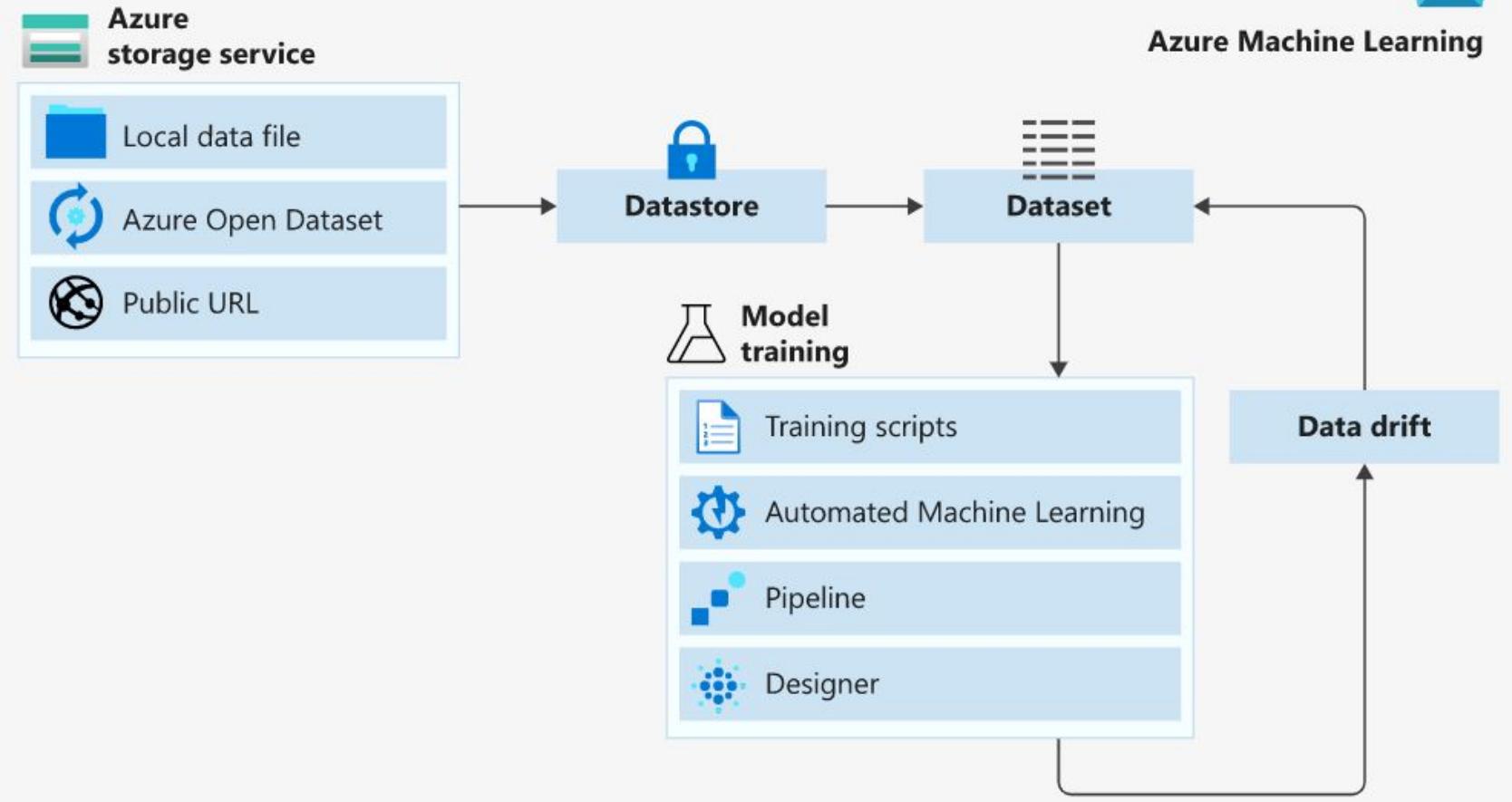


Data storage  
locations



# Data ingestion and preparation





# Steps

1. Load your data into Azure Storage from some other source
2. Clean up the data to remove low quality / bad data
3. Transform the data into useful / standard formats, intelligent defaults
4. Create a datastore in Azure ML to link to the data
5. Create a dataset in Azure ML to work with
  - a. File or table data
6. Register the dataset in your workspace

# Data Ingestion

**Azure Data Factory** - the ELT solution

**Azure ML Python SDK** - scripts and custom code

# Data Processing

**Parquet** and **CSV** file formats

**Pandas** dataframes for data less than 1GB

**Ray, Dask, or Spark** for data more than 1GB

# Feature selection and engineering

# Feature Selection is...

“The process of selecting a subset of relevant features ... for use in model construction.” - Wikipedia

# Feature Selection

Azure ML supports both automated and manual configuration of ML

Feature selection is one of the core concepts and has a huge impact on the performance of the model in ML

You need to identify and remove irrelevant or partially relevant features



# Over-fitting the training data

# Simplify the model



Minimum redundancy,  
maximum relevance

# Curse of dimensionality

# Feature Engineering is...

“The process of using domain knowledge to extract features from raw data via data mining techniques.” - Wikipedia



# Deciding what features to create



Improving existing  
features by  
transforming them



Brainstorming and  
iterating on the best  
features to achieve  
the desired result

# Model training and evaluation





Providing an ML  
algorithm with  
training data to  
learn from



AutoML - try all the  
algorithms to see  
what is the best one



ML Designer - you  
choose the  
algorithm to use

# Model Training is...

The process by which a machine learning algorithm “learns”

Depending on the type of ML (regression, classification, clustering)

Feed it the “training dataset”

Could take hours to process

May or may not be correct until you evaluate it.

# Model evaluation is...

The process by which you estimate the accuracy of the model

You typically use a “test dataset” which is different than the “training dataset”

Compare the prediction made by the model with the actual result that you already know

There are various ways to determine what is a good result and what is a bad result

# Classification Model Metrics

# Classification - Confusion Matrix

		Actual Values	
		Yes	No
Predicted Values	Yes	True Positive	False Positive
	No	False Negative	True Negative

# Classification - Confusion Matrix

		Actual Values	
		1	0
Predicted Values	1	 <b>TRUE POSITIVE</b> You're pregnant	 <b>FALSE POSITIVE</b> You're pregnant <b>TYPE 1 ERROR</b>
	0	 <b>FALSE NEGATIVE</b> You're not pregnant <b>TYPE 2 ERROR</b>	 <b>TRUE NEGATIVE</b> You're not pregnant

# Confusion Matrix

True Positive (TP) - you predicted true, and it's actually true (OK)

True Negative (TN) - you predicted false, and it's actually false (OK)

False Positive (FP) - you predicted true, and it's actually false (oops)

False Negative (FN) - you predicted false, and it's actually true (oops)

# Classification - Confusion Matrix

		Actual Values	
		Yes	No
Predicted Values	Yes	True Positive	False Positive
	No	False Negative	True Negative

# Classification - Recall

$$\text{Recall} = \text{TP} / (\text{TP} + \text{FN})$$

Out of all positive outcomes, how many did you predict correctly?

Should be as high as possible

		Actual Values	
		Yes	No
Predicted Values	Yes	True Positive	False Positive
	No	False Negative	True Negative

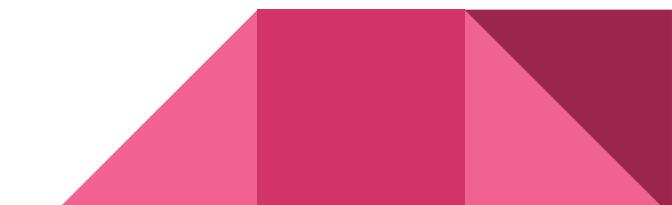
# Classification - Precision

$$\text{Precision} = \text{TP} / (\text{TP} + \text{FP})$$

Out of all positive predictions, how many were actually positive

Should be as high as possible

		Actual Values	
		Yes	No
Predicted Values	Yes	True Positive	False Positive
	No	False Negative	True Negative



# Classification - Accuracy

$$\text{Accuracy} = (\text{TP} + \text{TN}) / \text{Total}$$

How many correct predictions did you get out of the total predictions?

		Actual Values	
		Yes	No
Predicted Values	Yes	True Positive	False Positive
	No	False Negative	True Negative

Should be as high as possible

# Classification - F-Score or F-Measure

F-Score combines Recall and Precision into a single score.

$$\text{F-score} = 2 * \text{recall} * \text{precision} / (\text{recall} + \text{precision})$$

Punishes extreme values

Raw

## Confusion Matrix

	Predicted Label						
	A	B	C	D	E	F	
A	1531	0	0	0	0	0	1500
B	0	702	0	1	0	0	1000
C	0	0	1356	0	0	0	500
D	0	0	6	615	0	4	0
E	0	0	0	0	707	0	0
F	0	0	0	0	0	1508	0

Raw

## Confusion Matrix

	Predicted Label					
	A	B	C	D	E	F
A	1526	0	5	0	0	0
B	2	691	3	0	0	7
C	0	0	1355	0	0	1
D	9	1	146	350	0	119
E	56	45	5	0	465	136
F	0	0	42	0	0	1466

# Regression Metrics

# Calculating Regression Errors

**R2 (R-squared)** = measures the correlation between the observed outcome and predicted outcome; the higher the better

**RMSE (Root Mean Squared Error)** = the average error between observed and predicted; (the square-root of the mean square error); lower is better

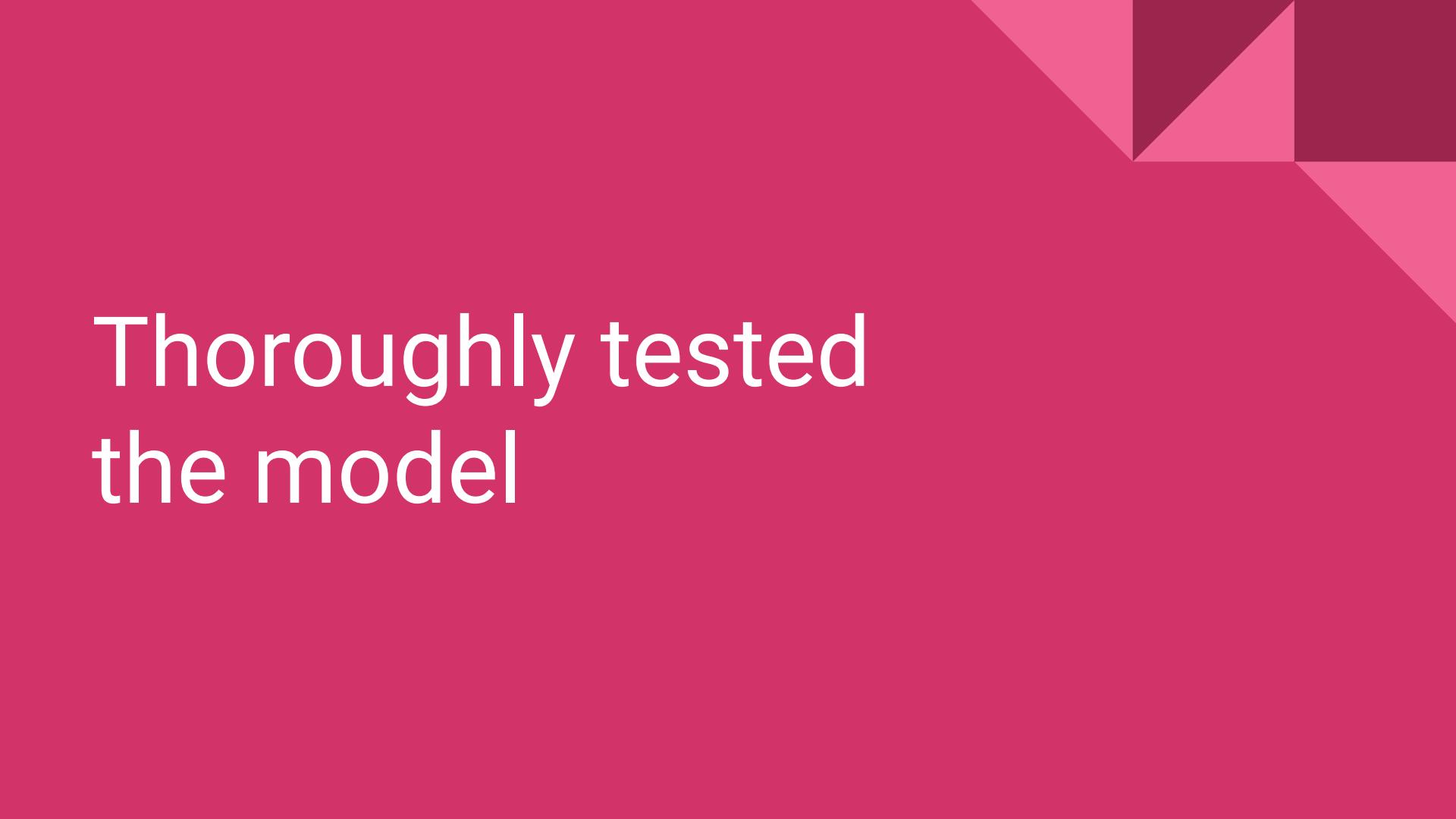
**RSE (Residual Standard Error)** = accounts for the number of predictors in the model; lower is better; not much different than RMSE

**MAE (Mean Absolute Error)** = similar to RMSE; less sensitive to large errors than RMSE; lower is better

# Model deployment and management

# Model deployment is...

The process of getting a trained model, that has passed evaluation, into a production-ready state.



Thoroughly tested  
the model



Choose the winning  
“run”

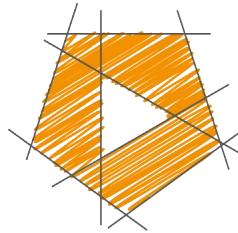
# Configure the model for production use



Publish and deploy  
the model to a  
compute  
environment



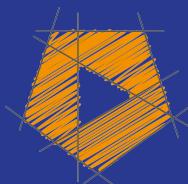
Production URL  
endpoint and  
sometimes a key



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# Capabilities of No-Code ML

# Azure Machine Learning

“Azure Machine Learning is a cloud-based service that helps simplify some of the tasks and reduce the time it takes to prepare data, train a model, and deploy a predictive service.”



# Automated Machine Learning (AutoML)

# AutoML Steps

1. Identify the problem - classification, regression or time-series forecasting
2. Choose the environment - Python SDK or ML Studio
3. Specify the source and format of the labeled data
4. Configure the compute
5. Configure the AutoML parameters
6. Submit a training run
7. Review the results

## Automated machine learning



User inputs



Dataset



Iterations

Training scores



1

Features + Algorithm + Parameters ➔ 50%



2

Features + Algorithm + Parameters ➔ 76%



3

Features + Algorithm + Parameters ➔ 53%



4

Features + Algorithm + Parameters ➔ 95%

...



n

Features + Algorithm + Parameters ➔ 43%

Leaderboard		
Rank	Model	Score
1		95%
2		76%
3		53%

# Video Showing AutoML

# Azure ML Designer



# Another no-code approach to model design



Drag the dataset  
onto the designer  
canvas



# Visualize the data



Exclude columns  
that are not going  
to be useful for  
training



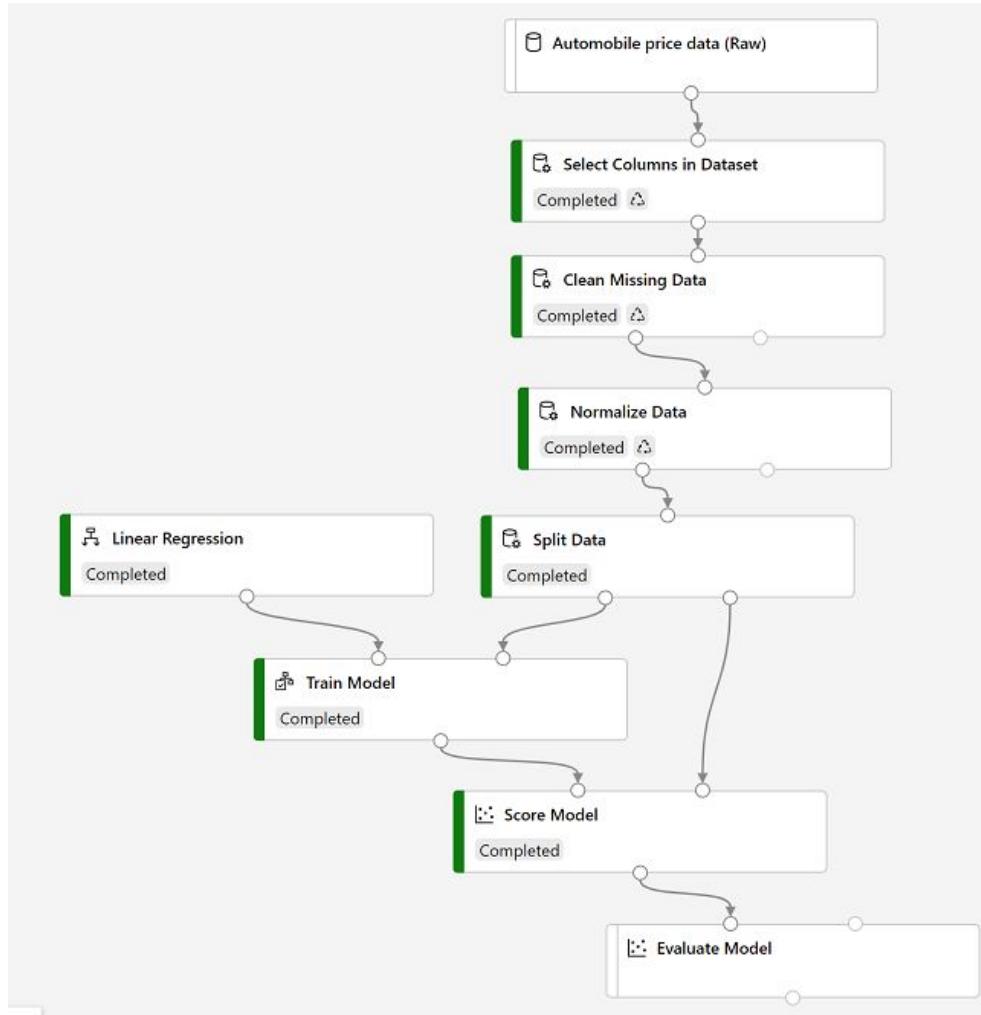
# Clean rows with missing data from training



Normalize the data  
to make it more  
useful through  
transformations



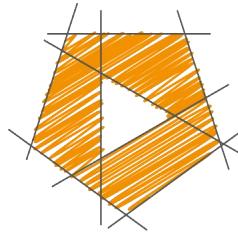
Drag training  
models onto the  
canvas





Training pipeline  
can be converted to  
the inference  
pipeline

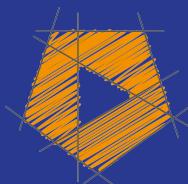




**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>



Describe features of computer  
vision workloads on Azure  
(15-20%)

## **Describe features of computer vision workloads on Azure (15-20%)**

### **Identify common types of computer vision solution:**

- identify features of image classification solutions
- identify features of object detection solutions
- identify features of semantic segmentation solutions
- identify features of optical character recognition solutions
- identify features of facial detection, facial recognition, and facial analysis solutions

### **Identify Azure tools and services for computer vision tasks**

- identify capabilities of the Computer Vision service
- identify capabilities of the Custom Vision service
- identify capabilities of the Face service
- identify capabilities of the Form Recognizer service

# Computer Vision Features

# Image Classification



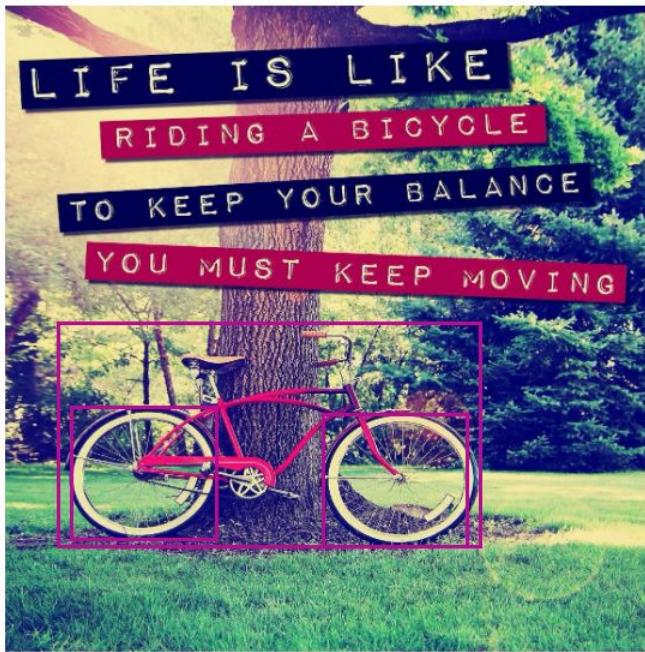
Car

# Object Detection



FEATURE	VALUE
NAME:	
Objects	<pre>{ "rectangle": { "x": 866, "y": 1514, "w": 1359, "h": 1168 }, "object": "Maple", "parent": { "object": "tree", "parent": { "object": "plant", "confidence": 0.808 }, "confidence": 0.641 }, "confidence": 0.627 }</pre>
Tags	<pre>[ { "name": "grass", "confidence": 0.9999995 }, { "name": "outdoor", "confidence": 0.979063153 }, { "name": "autumn", "confidence": 0.9517902 }, { "name": "green", "confidence": 0.84434 }, { "name": "maple", "confidence": 0.836734951 }, { "name": "plant", "confidence": 0.824939132 }, { "name": "fall", "confidence": 0.726369739 }, { "name": "laying", "confidence": 0.714074731 }, { "name": "leaf", "confidence": 0.6680558 }, { "name": "flower", "confidence": 0.642228246 }, { "name": "maple leaf", "confidence": 0.57402 } ]</pre>

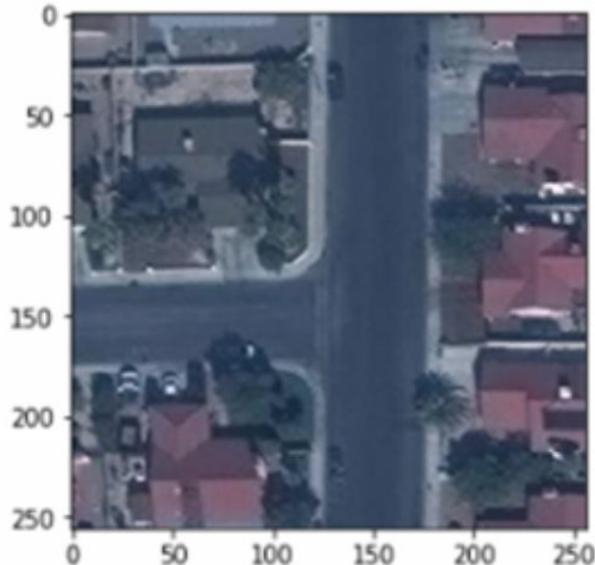
# Object Detection



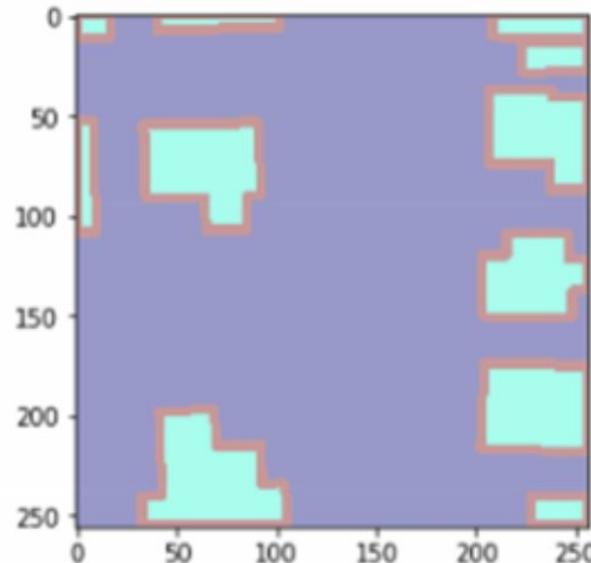
FEATURE NAME:	VALUE
Objects	[ { "rectangle": { "x": 112, "y": 711, "w": 269, "h": 243 }, "object": "Bicycle wheel", "parent": { "object": "Wheel", "confidence": 0.775 }, "confidence": 0.574 }, { "rectangle": { "x": 566, "y": 723, "w": 268, "h": 243 }, "object": "Wheel", "confidence": 0.585 }, { "rectangle": { "x": 96, "y": 568, "w": 759, "h": 409 }, "object": "bicycle", "parent": { "object": "cycle", "confidence": 0.928 }, "parent": { "object": "Land vehicle", "parent": { "object": "Vehicle", "confidence": 0.928 }, "confidence": 0.927 }, "confidence": 0.923 }, { "confidence": 0.91 } ]
Tags	[ { "name": "text", "confidence": 0.9999137 }, { "name": "grass", "confidence": 0.999893069 }, { "name": "outdoor", "confidence": 0.9880197 }, { "name": "bicycle", "confidence": 0.9697467 }, { "name": "bicycle wheel", "confidence": 0.8976265 }, { "name": "sign", "confidence": 0.842304468 }, { "name": "bike", "confidence": 0.842304468 } ]

# Semantic Segmentation

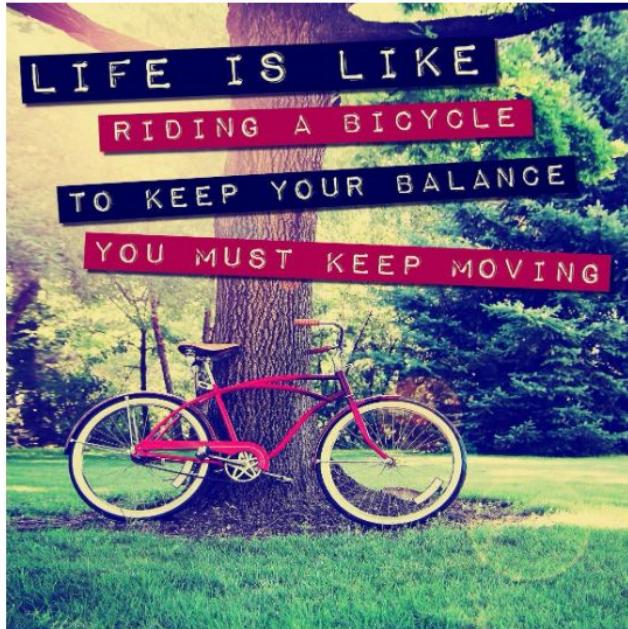
Input image



Label



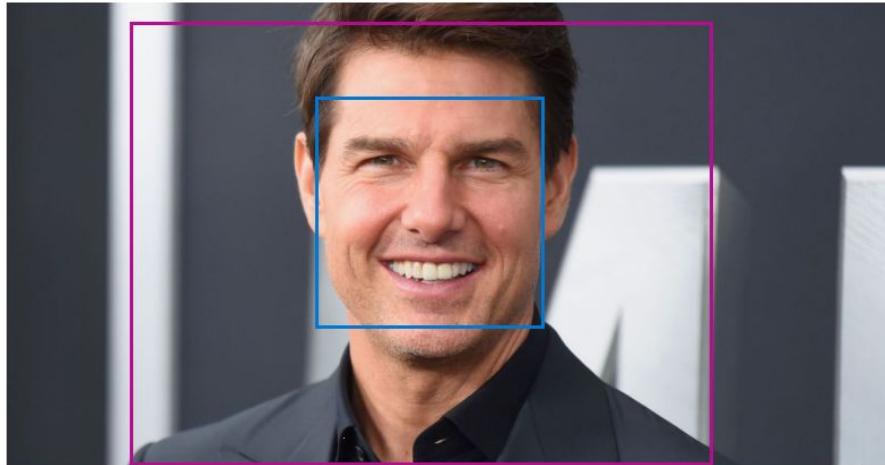
# Optical Character Recognition



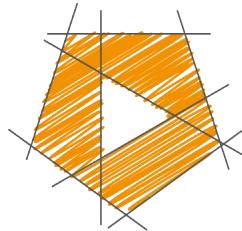
Preview    JSON

LIFE  
IS  
LIKE  
RIDING  
A BICYCLE  
TO  
KEEP  
YOUR BALANCE  
YOU MUST KEEP MOVING

# Facial Detection and Recognition



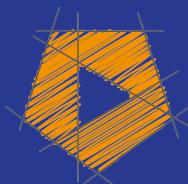
	"confidence": 0.692408264 }, { "name": "forehead", "confidence": 0.6696403 }, { "name": "shirt", "confidence": 0.645371258 }, { "name": "face", "confidence": 0.5145748 }, { "name": "eyebrow", "confidence": 0.5063325 }, { "name": "posing", "confidence": 0.479296565 }, { "name": "male", "confidence": 0.275576472 } ]
Description	{ "tags": [ "person", "man", "necktie", "wearing", "indoor", "suit", "smiling", "looking", "shirt", "camera", "posing", "front", "jacket", "standing", "business", "glasses", "male", "holding", "neck", "young", "blue", "sign" ], "captions": [ { "text": "Tom Cruise wearing a suit and tie smiling and looking at the camera", "confidence": 0.973894 } ] }
Image format	"Jpeg"
Image dimensions	630 x 1200



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>

# Computer Vision Tools



In Azure, you can  
use Computer  
Vision service,  
or you can use  
Cognitive Services

# **Cognitive Services**

includes many  
other services  
under one umbrella



All services require  
a **KEY** and an  
**ENDPOINT**

# Computer Vision Service

Pre-trained ML model

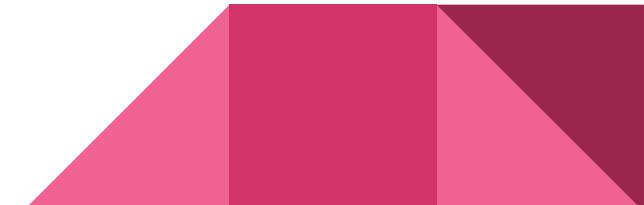
Can recognize over 10,000 objects

Can generate automatic captions for images and tags

Content moderation for adult, racy or gory content

Detect faces

Text recognition



# Custom Vision Service

A model that you can build and train

Classification or object detection

Upload an existing data set of images and classes

Publish the model so that you and others can use it



Custom Vision  
service separates  
out **training** and  
**prediction** into two  
resources

# Face Service

Can recognize a human face in an image

Returns the rectangle coordinates of those 1 or more faces

Can recognize celebrities

Needs to be trained on your own data

CONSUMER

# Cadillac Fairview suspends use of facial recognition cameras at Calgary malls



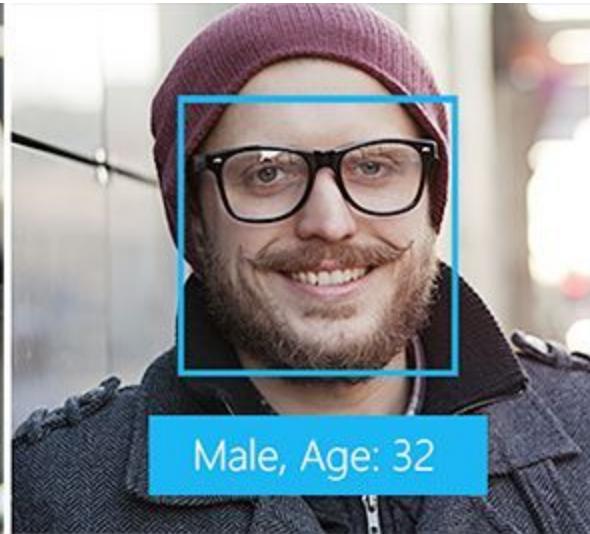
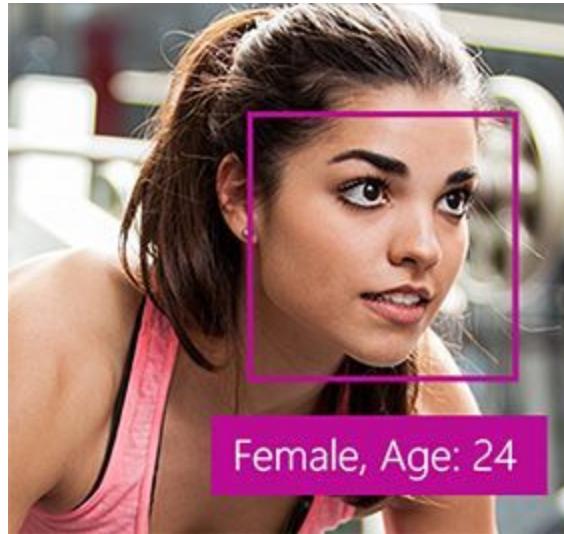
By **Kaylen Small** • Global News

Posted August 5, 2018 4:22 pm



Directories in Chinook Centre are suspending use of facial recognition software. **Blake Lough / Global News**

# Azure Face Service - Face Detection



# Azure Face Service - Face Verification

To compare one face against a known face, to identify if they belong to the same person.

# Azure Face Service - Similar Faces



(a)



(b)



(c)



(d)



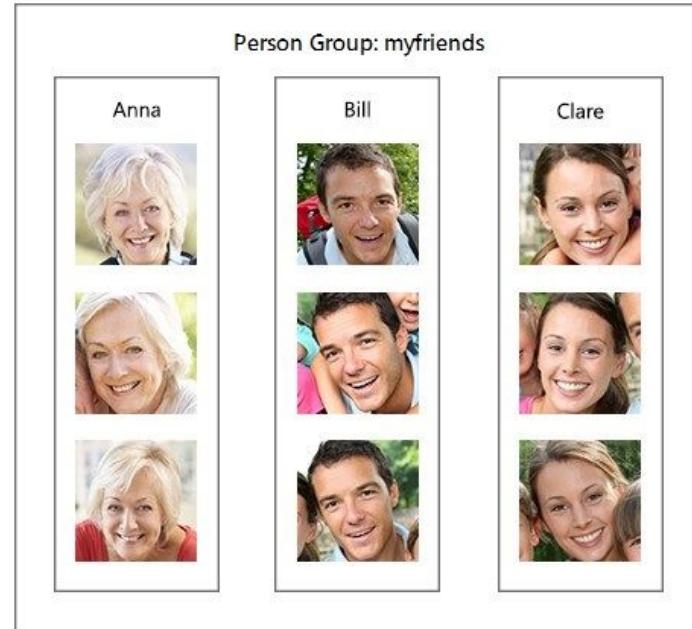
(e)

# Azure Face Service - Face Grouping

Divides a set of unknown faces into groups based on similarity. All faces of each group are likely to belong to the same person.

Also supports differentiating by another factor such as expression.

# Azure Face Service - Identify API



# Form Recognizer Service

The diagram illustrates the process of extracting data from a scanned invoice. On the left, a scanned document titled "CONTOSO LTD. INVOICE" is shown. The document contains various address fields, bill-to and ship-to details, a table of services with their descriptions and unit prices, and a summary table at the bottom. On the right, the extracted JSON data is displayed, showing the recognized elements and their bounding boxes.

INVOICE

CONTOSO LTD.

Contoso Headquarters  
123 456th St  
New York, NY, 10001

Microsoft Corp.  
123 Other St,  
Redmond WA, 98052

INVOICE: INV-100  
INVOICE DATE: 11/15/2019  
DUE DATE: 12/15/2019  
CUSTOMER NAME: MICROSOFT CORPORATION  
SERVICE PERIOD: 10/14/2019 – 11/14/2019  
CUSTOMER ID: 00000000000000000000000000000000

BILL TO:  
Microsoft Finance  
123 Bill St,  
Redmond WA, 98052

SHIP TO:  
Microsoft Delivery  
123 Ship St,  
Redmond WA, 98052

SERVICE ADDRESS:  
Microsoft Services  
123 Service St,  
Redmond WA, 98052

SALESPERSON	P.O. NUMBER	REQUISITIONER	SHIPPED VIA	F.O.B. POINT	TERMS
ROBESON					

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	Consulting service	1	\$100.00

SUBTOTAL  
\$100.00  
SALES TAX  
\$10.00  
TOTAL  
\$110.00  
PREVIOUS UNPAID BALANCE  
\$500.00  
TOTAL DUE  
\$610.00

THANK YOU FOR YOUR BUSINESS!

REMIT TO:  
Contoso Billing  
123 Remit St  
New York, NY, 10001

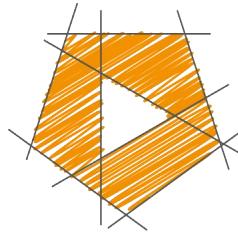
},  
"InvoiceId": {  
 "type": "string",  
 "valueString": "INV-100",  
 "text": "INV-100",  
 "boundingBox": [  
 7.4926,  
 1.4203,  
 7.9938,  
 1.4203,  
 7.9938,  
 1.5198,  
 7.4926,  
 1.5198  
 ],  
 "page": 1,  
 "confidence": 0.999,  
 "elements": [  
 "#/readResults/0/lines/3/words/1"  
 ]  
},  
"VendorAddress": {  
 "type": "string",  
 "valueString": "123 456th St New York, NY, 10001",  
 "text": "123 456th St New York, NY, 10001",  
 "boundingBox": [  
 0.594,  
 1.6077,  
 1.9918  
 ]  
}

# Form Recognizer Service

Ideal for invoices and receipts

Pre-built model or custom model

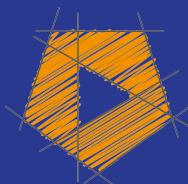
Pre-built model recognizes common receipt formats, English in USA



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>



Describe features of NLP  
workloads on Azure (15-20%)

## **Describe features of Natural Language Processing (NLP) workloads on Azure (15-20%)**

### **Identify features of common NLP Workload Scenarios**

- identify features and uses for key phrase extraction
- identify features and uses for entity recognition
- identify features and uses for sentiment analysis
- identify features and uses for language modeling
- identify features and uses for speech recognition and synthesis
- identify features and uses for translation

### **Identify Azure tools and services for NLP workloads**

- identify capabilities of the Text Analytics service
- identify capabilities of the Language Understanding Intelligence Service (LUIS)
- identify capabilities of the Speech service
- identify capabilities of the Translator Text service

# NLP Workload Scenarios



Understands  
written and spoken  
language

# Key Phrase Extraction

Identifying the main points of a document; context

*"When I was shovelling snow in my driveway earlier today, I cut my finger. It wasn't a deep cut, and I will be ok. But it's a bit painful. Snow isn't fun sometimes."*

- Shovelling snow
- Cut my finger
- I will be ok
- A bit painful
- Snow isn't fun

# Entity Recognition

Identifying “entities” of a document; items categorized by type and subtype

*“When I was shovelling snow in my driveway earlier today, I cut my finger. It wasn’t a deep cut, and I will be ok. But it’s a bit painful. Snow isn’t fun sometimes.”*

Snow, driveway, finger - objects

Earlier today - date

Driveway - location



Can also return  
links to wikipedia  
for relevant entries  
I.e. “snow”

# Sentiment Analysis

Pre-built ML model

Sentiment score from 0 to 1 - 1 being positive sentiment

*"I thought the steak here was awesome and the staff was super friendly."*

Vs

*"The steak was tough and the service was a bit slow. Not a great experience".*

# Language Modeling

Build your own dictionary for terms in your industry

Train the language understanding engine for your own use

# Speech Recognition and Synthesis

Speech recognition - the ability to detect and interpret speech

Speech synthesis - the ability to generate spoken output

Speech-to-text and text-to-speech

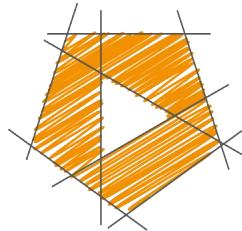
# Translation

Supports over 60 languages

Getting better all the time

Understands semantic context

“Café da manhã” in Portuguese literally translates to “coffee of the morning” in English, but really means “breakfast” - the meal, nothing to do with coffee



**SoftwareArchitect**  
.ca

# NLP Workload Tools

# Text Analytics Service

All of the Azure services that include key phrase extraction, entity detection, and sentiment analysis

It can detect the language of text

Can detect when text has multiple languages and identify the predominant language

Returns **NaN** when it can't determine

# Language Understanding Service (LUIS)

Understanding natural language

Three core concepts:

1. Utterances
2. Entities
3. Intents

# Language Understanding - Utterances

An example of something a user will say:

“What time are you open until?”

“When do you close?”

“What time do you close today?”

“What is the latest you are open until?”

# Language Understanding - Entities

An item to which an utterance refers:

“What time do you close today?”

- **Today** (DateTime)
- **You** (subject)

# Language Understanding - Intents

The purpose or goal expressed by the user

Things your application is able to do

“What time do you close today?”

Goal: **TodayHoursOfOperation**

# Language Understanding - Intents

Sometimes, there is no intent

Questions you don't even want your AI to try to answer.

“What is the meaning of life?”

“How do teach a dog to walk himself?”

# Speech Service

Text to speech

Speech to text

Audio translation

“Custom voice models”

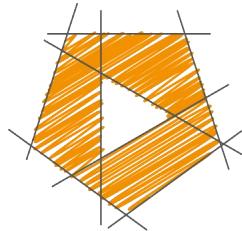


# Translator Text Service

Translate text between 70 languages

Custom models for specific industries / terms

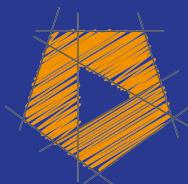
Can detect the language being passed in



**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>



Describe features of  
conversational AI workloads on  
Azure (15-20%)

## **Describe features of conversational AI workloads on Azure (15-20%)**

### **Identify common use cases for conversational AI**

- identify features and uses for webchat bots
- identify features and uses for telephone voice menus
- identify features and uses for personal digital assistants
- identify common characteristics of conversational AI solutions

### **Identify Azure services for conversational AI**

- identify capabilities of the QnA Maker service
- identify capabilities of the Bot Framework



Conversational AI  
allows a human and  
a computer to talk



Typically called  
agents, or bots



Azure Bots can  
operate over the  
web, email, social  
media, and voice

# Do You Know You're Talking to a Bot?

Artificial Intelligence ›

The Bot That Writes

Are These People Real?

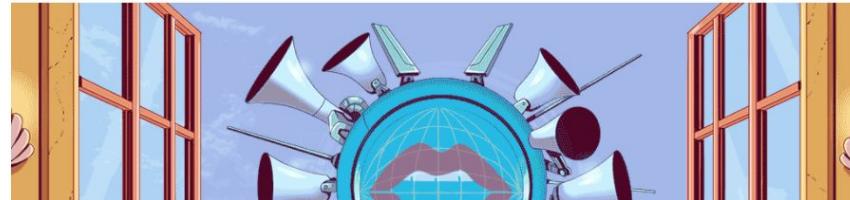
Algorithms Against Suicide

Robots Without Bias

TECH FIX

## Google's Duplex Uses A.I. to Mimic Humans (Sometimes)

In a free service, bots call restaurants and make reservations. The technology is impressive, except for when the caller is actually a person.

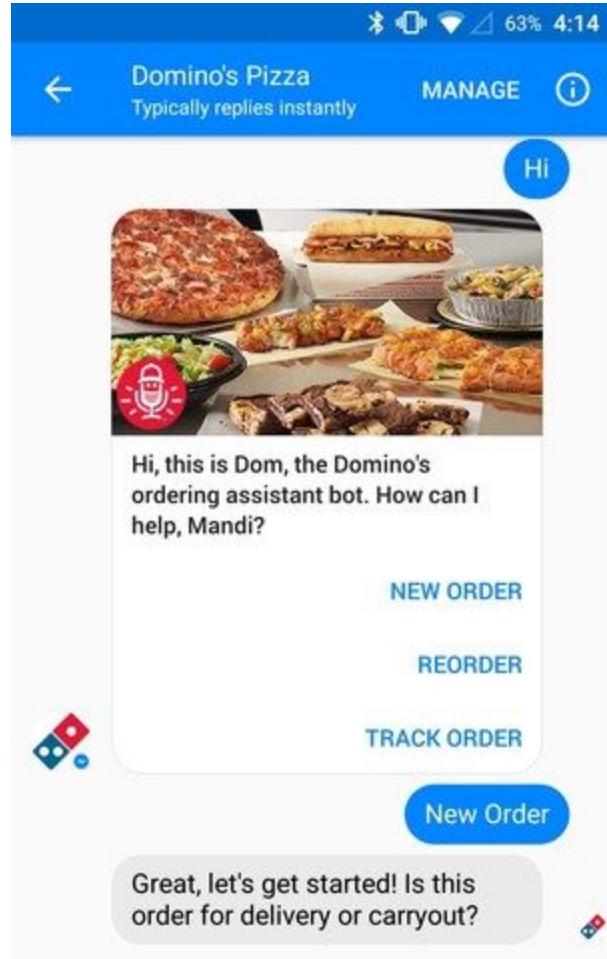


# Conversational AI Use Cases

# Webchat Bots

- Appear on a website or social media app
- Understands and responds to written text
- A limited scope of conversation
- Often friendly tone, called “chit chat”

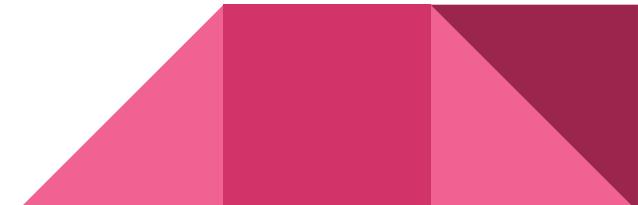




# Telephone Voice Menus

Speech recognition and speech synthesis

Conversational banking

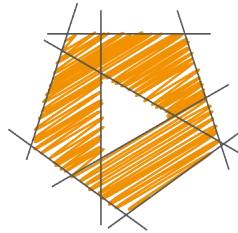


# Personal Digital Assistants

OK Google - when is my next appointment?

Hey Alexa - what time is the movie tonight?

Yo yo, Bing - tell Mom that I'll be home this weekend from college



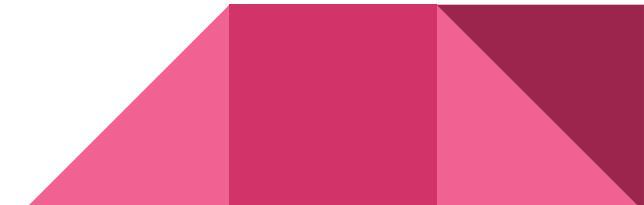
**SoftwareArchitect**  
.ca

# Conversational AI Services

# QnA Maker Service

Automatically build a chat bot based on any semi-structured source

- Your website
- FAQ
- Product manuals
- etc



# Course Taking

## Student Topics

 Getting Started Account/Profile Troubleshooting **Course Taking** Purchase/Refunds Mobile

## Certificates of Completion

[How to Download Your Certificate of Completion](#)[How to Change The Language or Name on Your Certificate of Completion](#)

## Course Settings

[The Free Course Experience](#)[Assignments: Apply Your Knowledge and Improve the Skills You've Learned With Udemy!](#)[Practice Test FAQs](#)[Archiving a Course](#)[How to Leave and Edit a Course Review](#)[Learning With Coding Exercises](#)[» See all 7 articles](#)

## Course Player



hi

User

Hello

Bot

lights won't turn on

User

Check the connection to the wall outlet to make sure it's  
plugged in properly.

Bot at 10:58:38 AM

My smart light app stopped responding

User

Restart the app. If the problem persists, contact support.

Bot at 11:46:00 AM

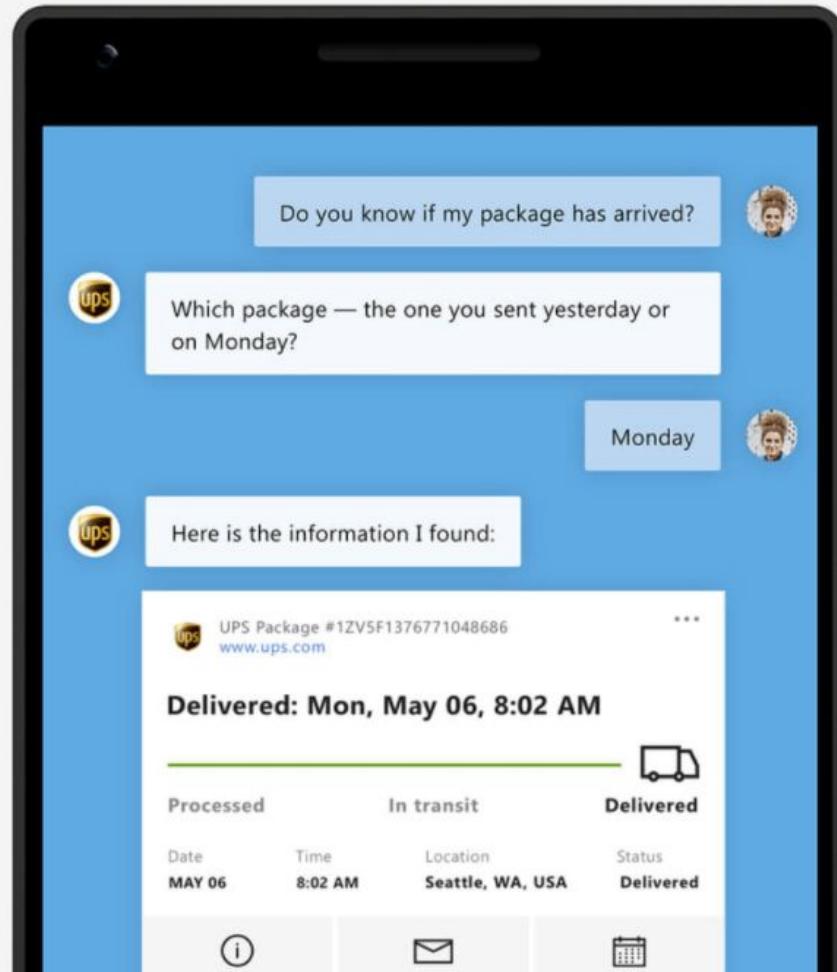
# Azure Bot Service

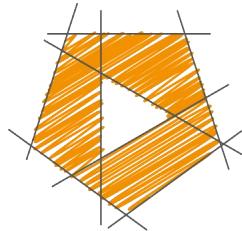
Enterprise-grade chat bots

Start simply and grow in sophistication

Coded chat bots



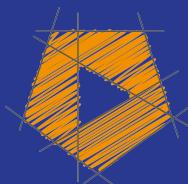




**SoftwareArchitect**  
.ca

# AI-900 Microsoft Azure AI Fundamentals

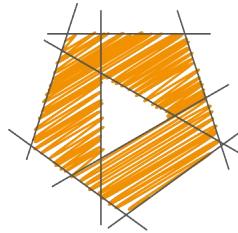
Scott Duffy, Instructor



© 2021 Scott Duffy, softwarearchitect.ca... get the course for these slides at:  
<http://sjd.ca/ai900>



Thank you and best of luck!



**SoftwareArchitect**  
.ca