



Business Process Automation with VBA and Python

Mr. Eddie Chow / 14 December 2024





Table Of Contents

Introduction to business process automation

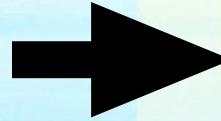
Business Process automation with VBA

Business process automation with Python

Introduction to project management for business process automation

Development and implementation of business process automation

Final Group Presentation





What is Process Automation, RPA, IPA?

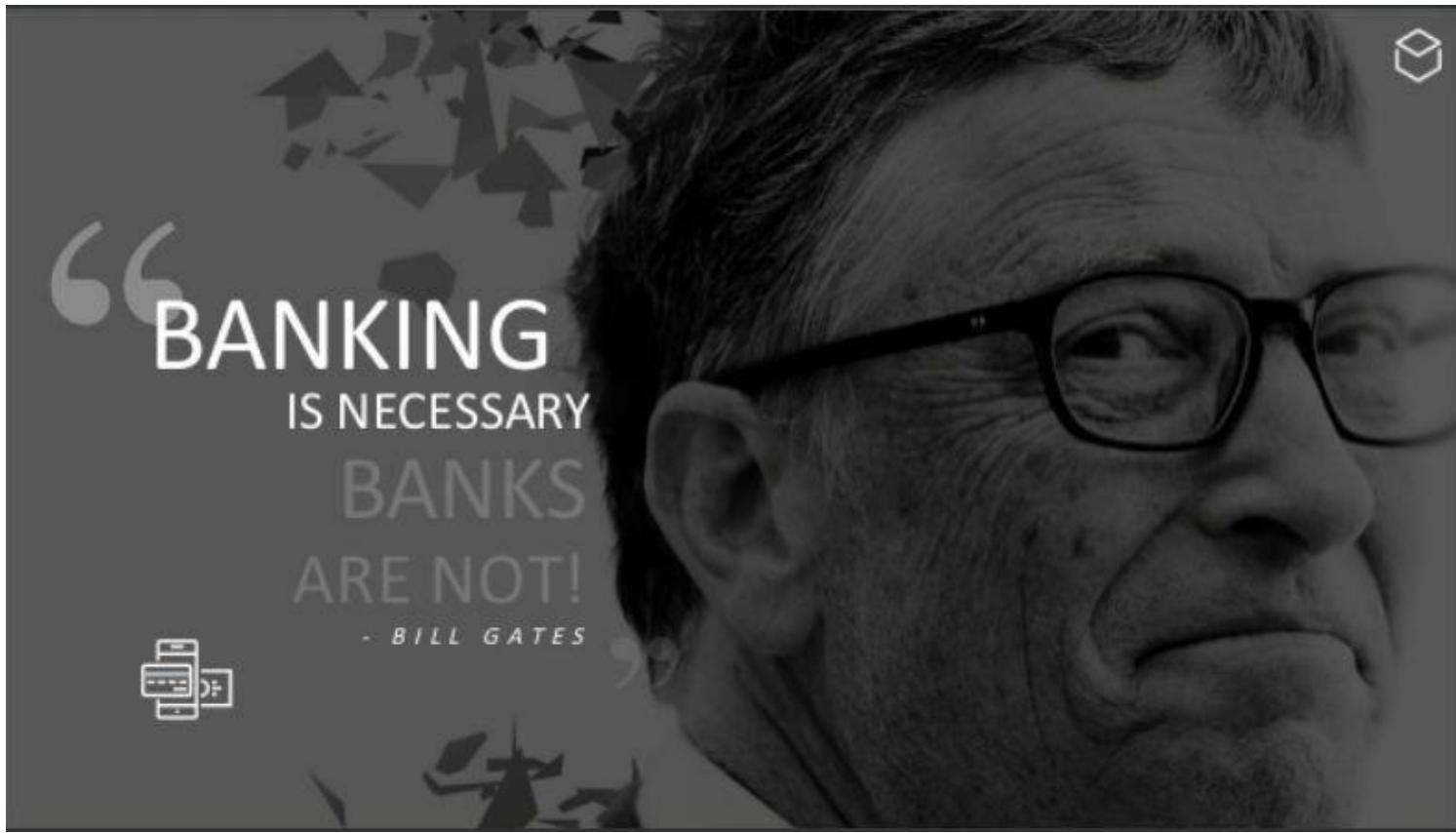
Overview of the technological building blocks related to process automation

Contemporary tools for process automation

Challenges and opportunities of business process automation

Business implications of process automation

Worldwide Open Banking Movement

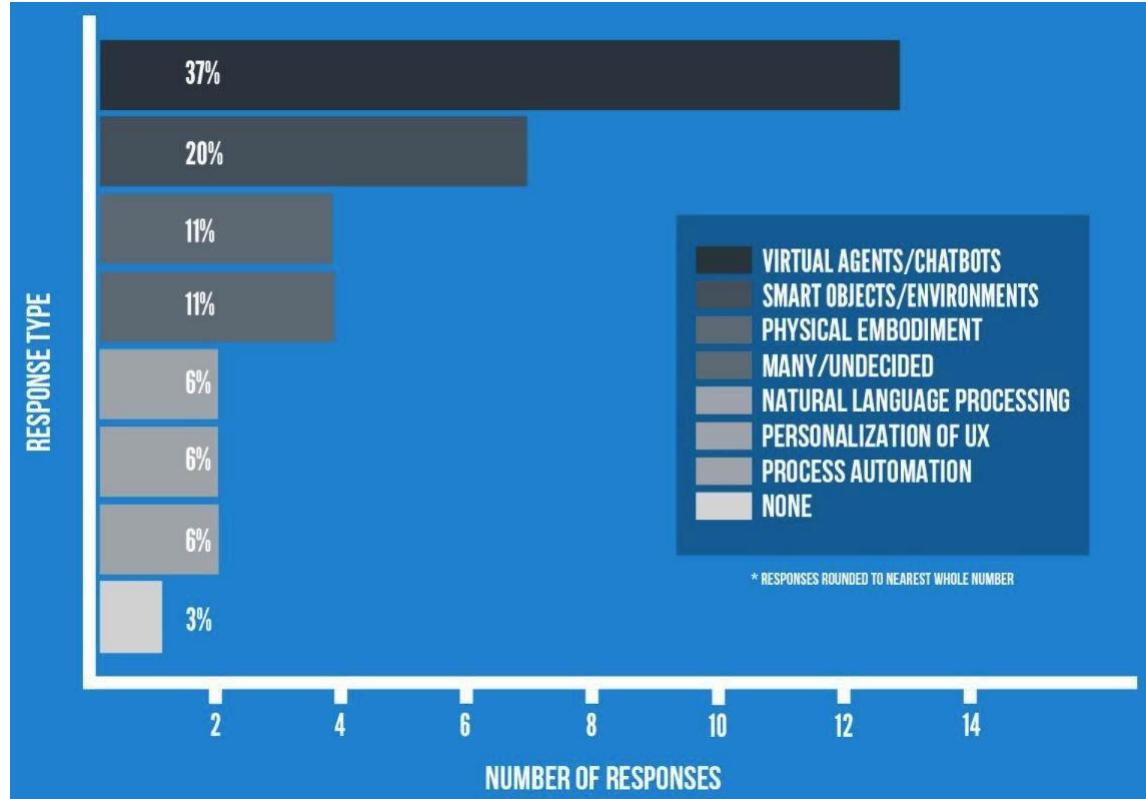


Worldwide Open Banking Movement



<https://www.slideshare.net/CAinc/case-study-open-banking-apis-and-digital-transformationthe-banco-original-story>

Application of AI In Banking: A Case Study



<https://www.techere.com/ai-in-banking-analysis/> October 24, 2017 by Kumba Sennaar

Application of AI In Banking: A Case Study JPMorgan Chase Bank



<https://www.techmgmt.com/ai-in-banking-analysis/> October 24, 2017 by Kumba Sennaar

Application of AI In Banking: A Case Study Wells Fargo Bank Startup Accelerator

WELLS
FARGO

Startup
Accelerator



Edquity offers the first-of-its-kind college financial planning app for high school and college students, supporting students as a "to-and-through" platform through each and every financial decision on the road to college graduation...

More +

Visit: www.edquity.co



Hurdlr is a rapidly growing startup whose API and mobile apps provide financial, tax, and performance insights for "The 1099 Economy," including consumers, freelancers, independent contractors, and self-employed small business owners.

More +

Visit:
www.hurdlr.com



Redrock Biometrics developed the first practical palm-print based authentication software, PalmID. Made possible through several patented algorithmic breakthroughs, PalmID is more accurate than fingerprint authentication, as palms are more unique.

More +

Visit:
redrockbiometrics.com

Inspiring Your Future

Business Education @ HKUSPACE

<https://accelerator.wellsfargo.com/>

HKUSPACE

Application of AI In Banking: A Case Study Wells Fargo Bank Startup Accelerator Alumni



Startup
Accelerator

1,100 applications
from over 50
countries since its
inception in 2014



<https://accelerator.wellsfargo.com/>

Application of AI In Banking: A Case Study



https://twitter.com/_/status/790943639933366274

Chatbot enabled mobile banking has seen steady growth from 12 million customers in 2012 to nearly 22 million in 2016

The screenshot shows a mobile banking application interface for 'erica'. At the top, it says 'Based on your typical monthly spending, you have an additional \$150 you could be putting toward your Cash Rewards Visa. This could save you up to \$300 per year.' Below this, there's a section titled 'Additional Payment' with a slider scale from '\$0' to '\$1540', currently set at '\$150/mn'. Under 'Payment Details', it shows 'Current \$250', 'New \$400', and 'Annual Savings \$300'. At the bottom, it says 'Next Scheduled Payment: Nov 17' with a calendar icon.

Erica - Chatbot is designed to be accessible to clients 24/7 and perform “day-to-day transactions” in addition to anticipating the unique financial needs of each customer and helping them reach their financial goals by providing smart recommendations

<https://www.cnbc.com/2016/10/24/bank-of-america-launches-ai-chatbot-erica--heres-what-it-does.html>

<https://www.bofaml.com/en-us/content/technology-innovation-summit-2017.html>

Application of AI In Banking: A Case Study Citibank: Citi Ventures



Conducts large-scale analyses to identify, eradicate and include online and in-person banking in real-time. Using “machine-based learning” to evaluate “big data” to prevent fraud and monitor potential threats to customers in commerce



Motivates customers to participate in third-party services that can improve financial health

<https://feedzai.com/>

Application of AI In Banking: A Case Study

Bank of New York Mellon Bank: Software Automation Using Robots



Helped build/deploy 220 software robots to handle repetitive tasks, such as “data requests from external auditors” and “funds transfer bots” which help “correct formatting and data mistakes in requests for dollar funds transfers.”



- 100 percent accuracy in account-closure validations across five systems
- 88 percent improvement in processing time
- 66 percent improvement in trade entry turnaround time
- ¼-second robotic reconciliation of a failed trade vs. 5-10 minutes by a human

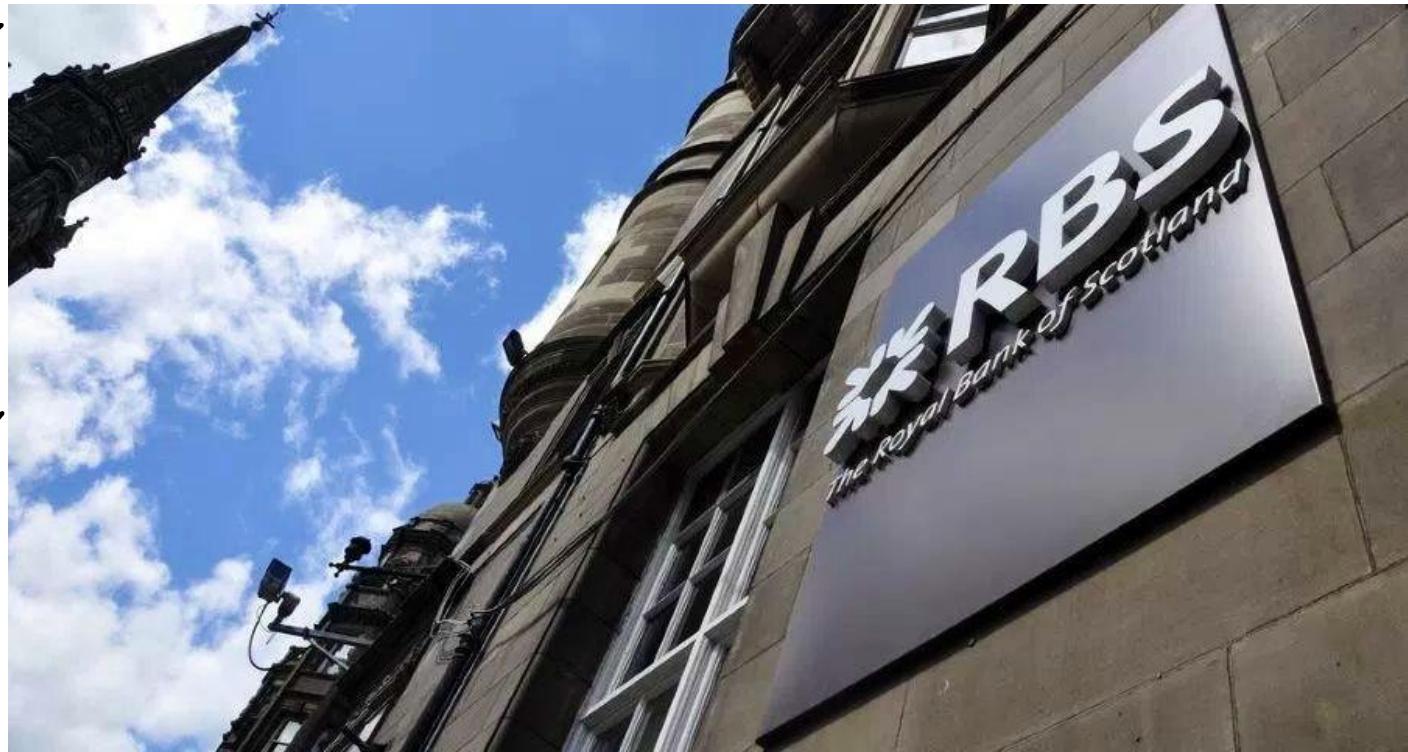
“funds transfer bots” alone is responsible for \$300,000 in annual savings

<https://www.blueprism.com/news/automation/bny-mellon-became-pioneer-software-robots>

Application of AI In Banking: A Case Study Royal Bank of Scotland: Chabots

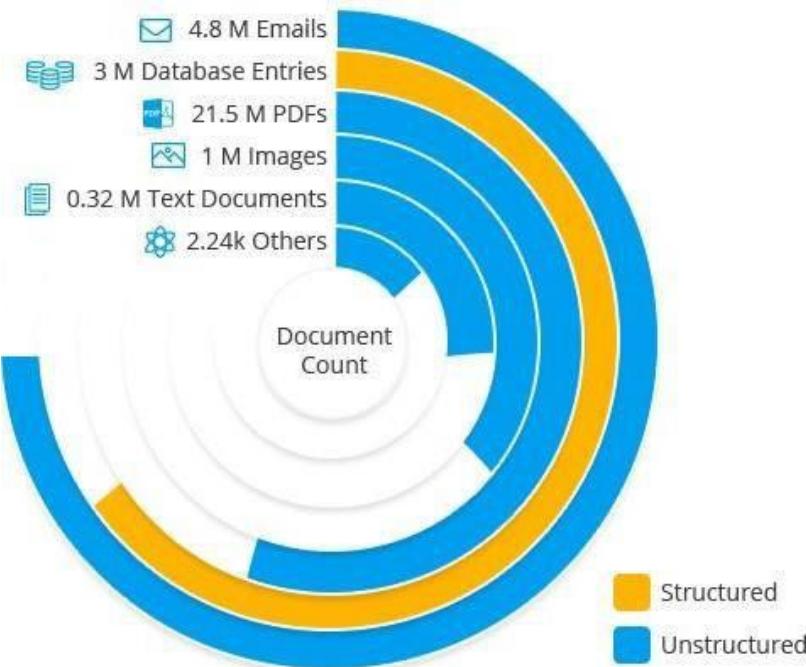
Luvo chatbot pilot is accessible to 50,000 Bank of Scotland iOS mobile customers

answer common queries, such as unknown account transactions, how to make payments and what to do about lost or stolen cards



<https://www.rbs.com/rbs/news/2016/03/rbs-installs-advanced-human-ai-to-help-staff-answer-customer-que.html>

Predictive Analytics Case Study: Mossack Fonseca ‘Panama Papers’ Leak



Hackers stole 40 years worth of client information and gave it to a German newspaper who then shared it with the ICIJ.

Sit with your group mates and research The Panama Papers Leak using the URLs given below;

<https://www.sparrho.com/p/hiding-billions-in-massive-datasets/295324/>
<http://bit.ly/2ydCENP>

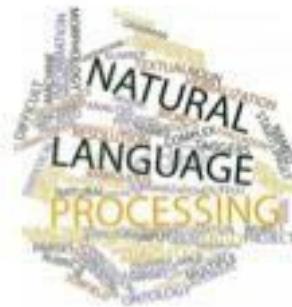
Answer the following questions

- What data science tools were used to create the complex relationships?
Source: <http://www.softwebsolutions.com/resources/the-pandora-project-a-case-about-the-data.html>

Hottest Application of Predictive Analytics?



Fraud/Spam Detection



NLP



Speech Recognition

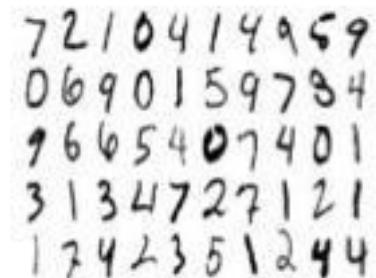


Image Recognition

Business Applications of
Predictive Modeling at Scale -
KDD 2016 Tutorial

Partners choose Microsoft for Data & AI

Accelerate time to value
with best in class platform & services



Pretrained AI
Services



Global Data
Services



Comprehensive
Platform

Innovate with AI everywhere –
in the cloud, at edge and on-premises



Cloud



Edge



On-premises

Use any language, any development
tool and any framework



python™



PYTORCH



ONNX



R



TensorFlow™



Spark

Benefit from industry-leading security, privacy,
compliance, transparency, and AI ethics standards

>90% of Fortune 500 companies
use Microsoft Cloud

AI “Accelerators” – Cognitive Services

AI “Accelerators”

Solution specific
AI services
and patterns

Azure Bot Service
[Cognitive Services](#)

Vision	Speech	Language	Knowledge								
 What is in the image or video? Intelligent Image insights  <table border="1"><tr><td>Category</td><td>People; 5 faces</td></tr><tr><td>Adult/Racy?</td><td>False/False</td></tr><tr><td>Dominant colors</td><td>□ ■ ■</td></tr><tr><td>Accent color</td><td></td></tr></table> Computer Vision	Category	People; 5 faces	Adult/Racy?	False/False	Dominant colors	□ ■ ■	Accent color		 Give me directions to the nearest local branch Speech to text  	 Play today's customer call recording Natural Language Processing <div style="border: 1px solid gray; padding: 5px;">Intent: PlayCall Content: Customer# DateTime.date: today</div>  Now Playing 11/29/2016 Customer Call	 QnA Pair of this site? Automatic extraction of questions and answers <div style="border: 1px solid gray; padding: 5px;">What are your hours today?</div> <div style="border: 1px solid gray; padding: 5px;">Today we are open from 7:00 AM to 10:00 PM.</div> <div style="border: 1px solid gray; padding: 5px;">Do you have vegetarian options?</div> <div style="border: 1px solid gray; padding: 5px;">Yes, we have vegetarian options available.</div> QnA Maker
Category	People; 5 faces										
Adult/Racy?	False/False										
Dominant colors	□ ■ ■										
Accent color											

AI “Accelerators” – Cognitive Services



Example: Industry leading neural text to speech

Azure AI is built with a focus on customer centricity. We don't pretend to beat champions at games or design toys to attract attention. We build technology to help customers leverage AI to create life-changing experiences. If you've paid proper attention to this talk, you know how to leverage Azure AI to drive more ACR. But wait, there's more to come.



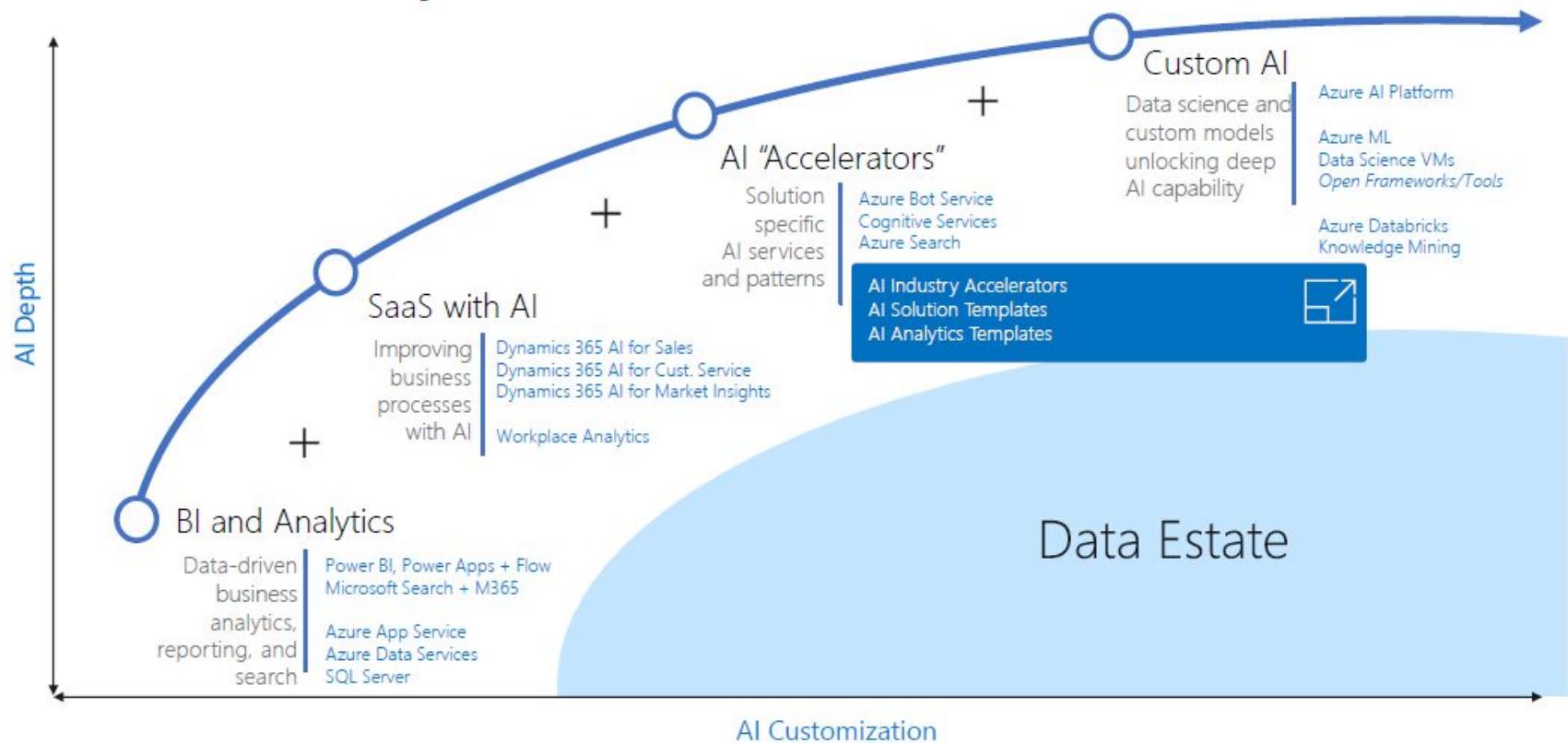
Sample 1



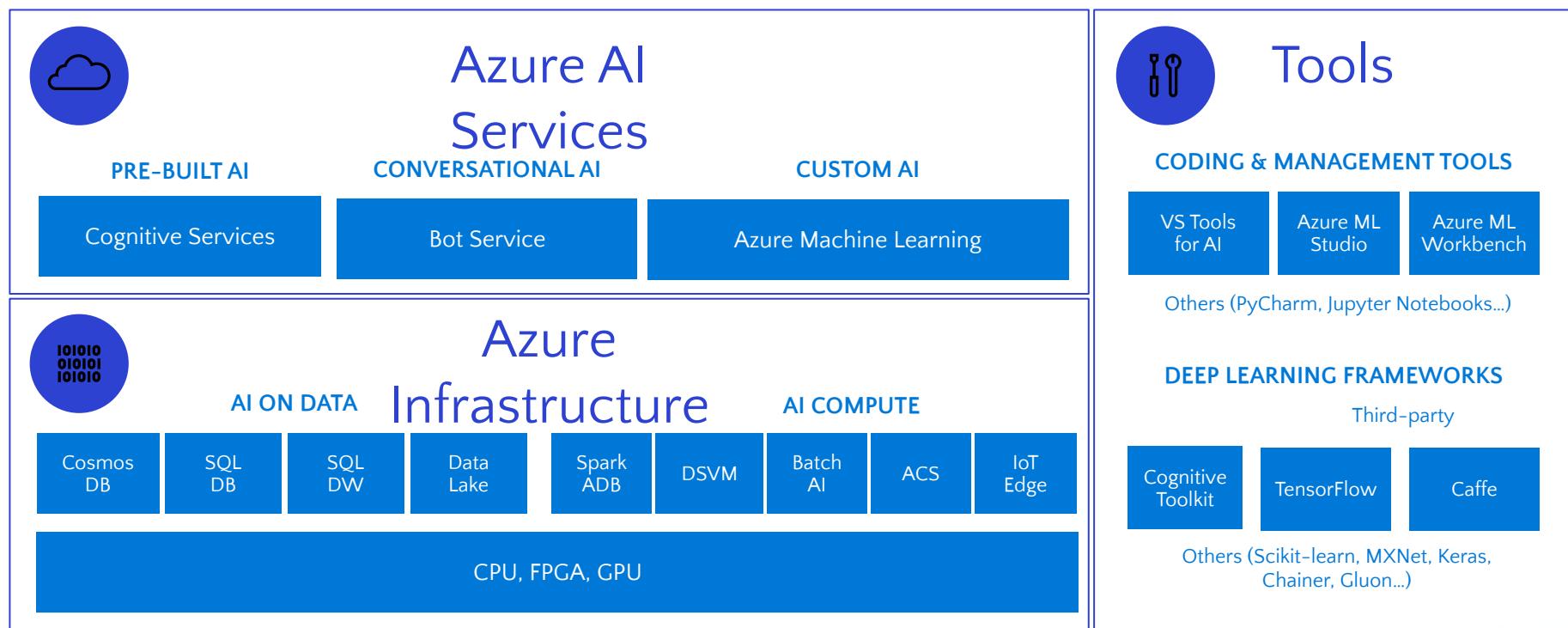
Sample 2

› Get started today: <http://aka.ms/NeuralTTSPreview>

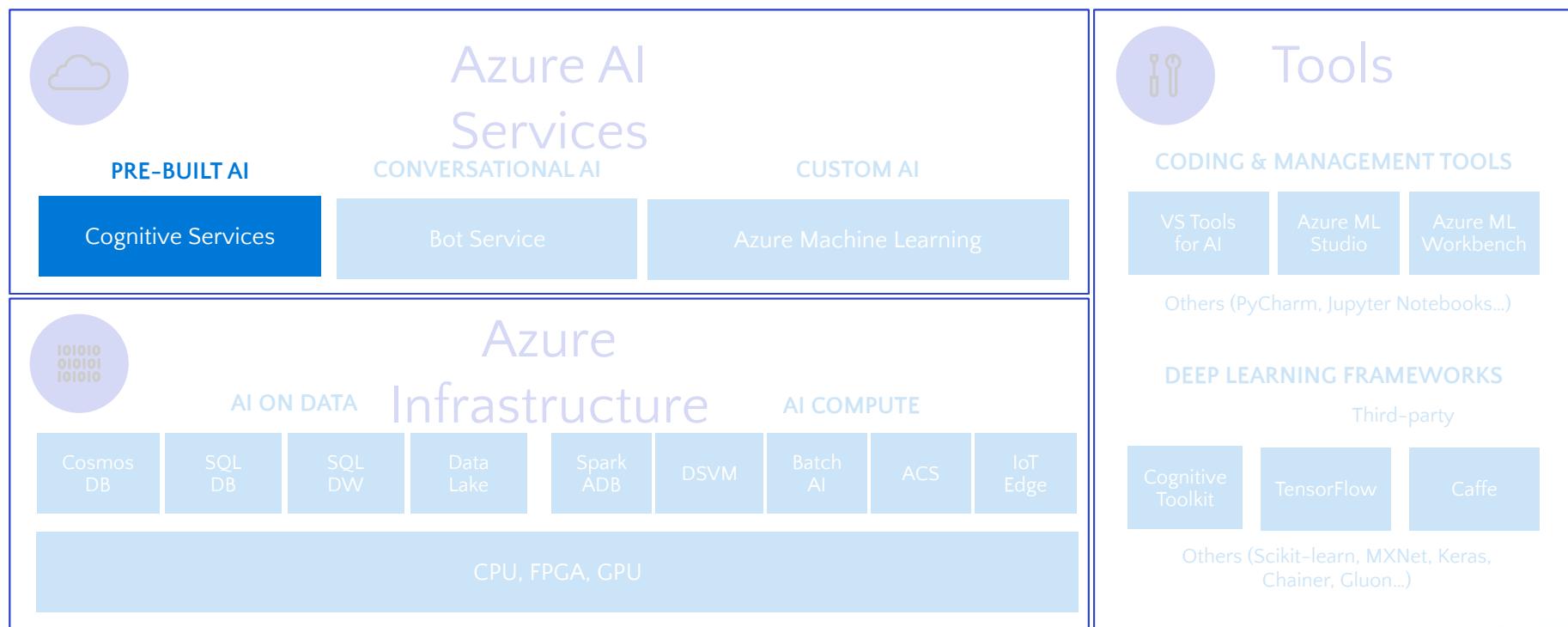
The AI Journey – Where to Start



Microsoft AI Platform



Microsoft AI Platform

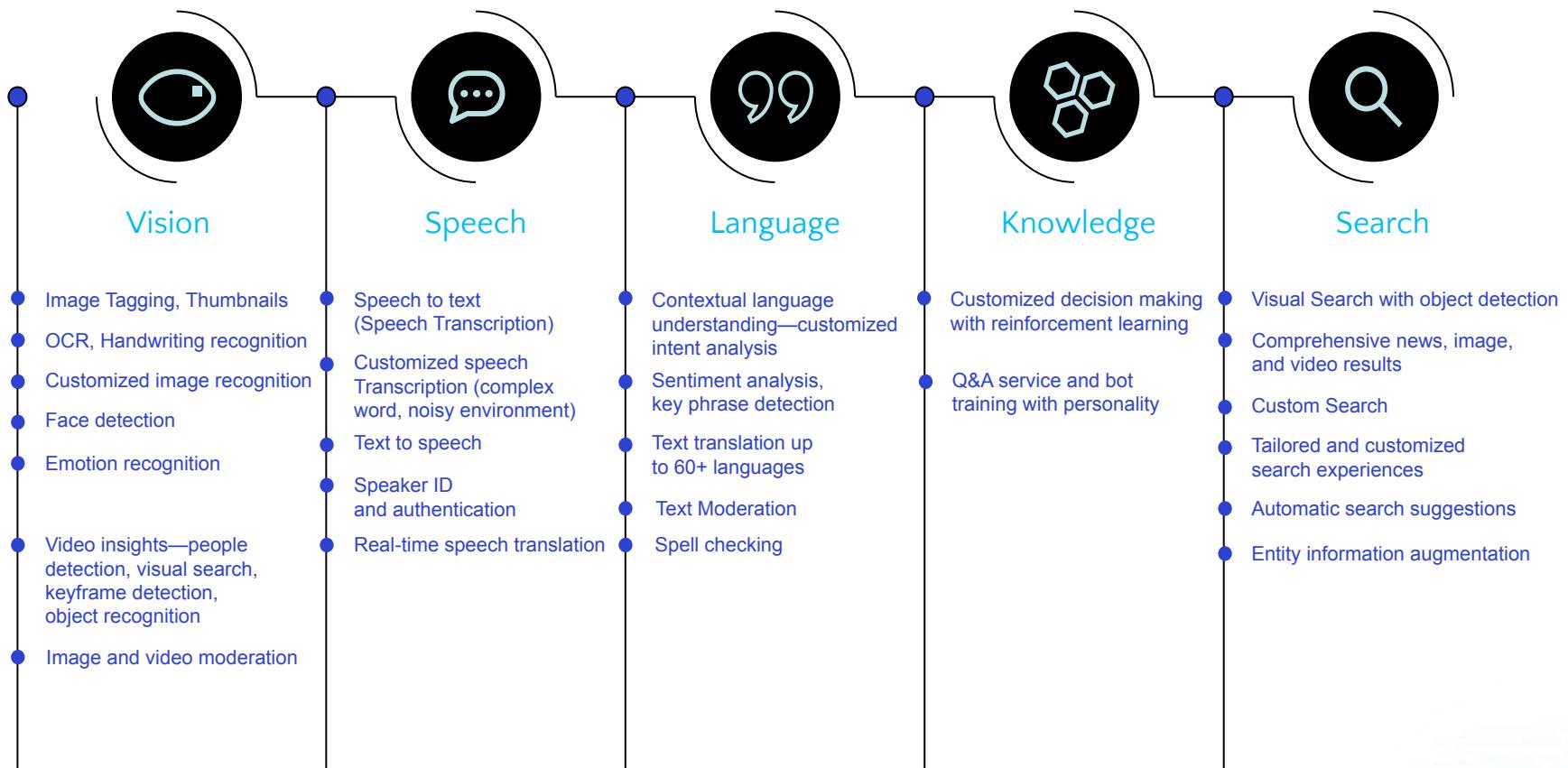


Azure Cognitive Services

A set of **simple APIs** that harness **Machine Learning**
so you can add AI (without needing a deep understanding of AI)



Azure Cognitive Services



Comments from customers

- You lost the details of my product return and refuse to replace it!
- Your website search function is terrible.
- Ich musste die Handschuhe zurückgeben, die ich gekauft hatte. Der Austausch hat lange gedauert.
- Ich liebe deine Website, sie ist wunderschön.
- Este martillo está etiquetado como un juguete.
- 我不喜欢这把螺丝刀。
- 両刃を売っていますか。

Computer Vision



FEATURE	VALUE
NAME:	
Description	{ "tags": ["indoor", "table", "sitting", "black", "pair", "laying", "white", "remote", "sink"], "captions": [{ "text": "a pair of black headphones on a table", "confidence": 0.307312727 }] }
Tags	[{ "name": "indoor", "confidence": 0.9374284 }, { "name": "tool", "confidence": 0.9374284 }, { "name": "brush", "confidence": 0.4960692 }, { "name": "design", "confidence": 0.4172834 }, { "name": "key", "confidence": 0.29472214 }, { "name": "artisan", "confidence": 0.136394173 }, { "name": "knife", "confidence": 0.1352209 }]

Custom AI – Knowledge Mining

Custom AI

Data science and
custom models
unlocking deep
AI capability

[Azure AI Platform](#)

Azure ML

[Knowledge Mining](#)

Domain specific pretrained models

To simplify solution development



Familiar Data Science tools

To simplify model development



Popular frameworks

To build advanced deep learning solutions



Productive services

To empower data science and development teams



Powerful infrastructure

To accelerate deep learning



From the Intelligent Cloud to the Intelligent Edge

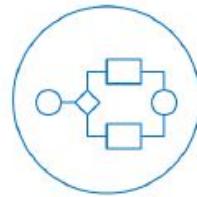


Custom AI – Azure ML

Custom AI
Data science and
custom models
unlocking deep
AI capability

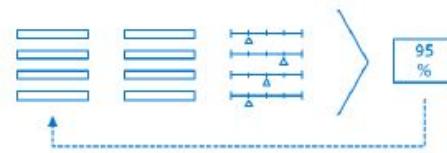
Azure AI Platform
[Azure ML](#)
Knowledge Mining

Machine learning DevOps



Azure DevOps integration for CI/CD

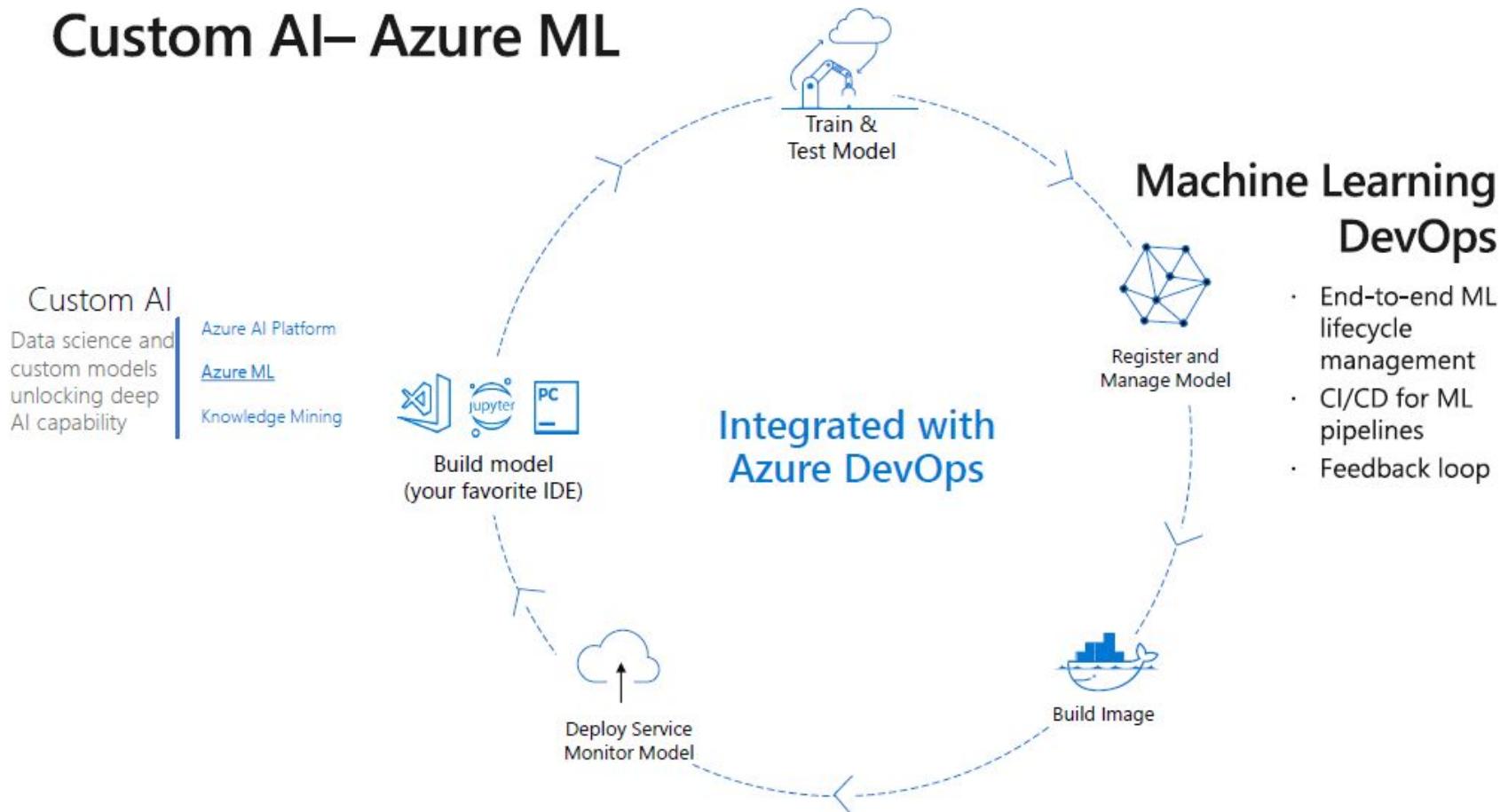
Automated machine learning



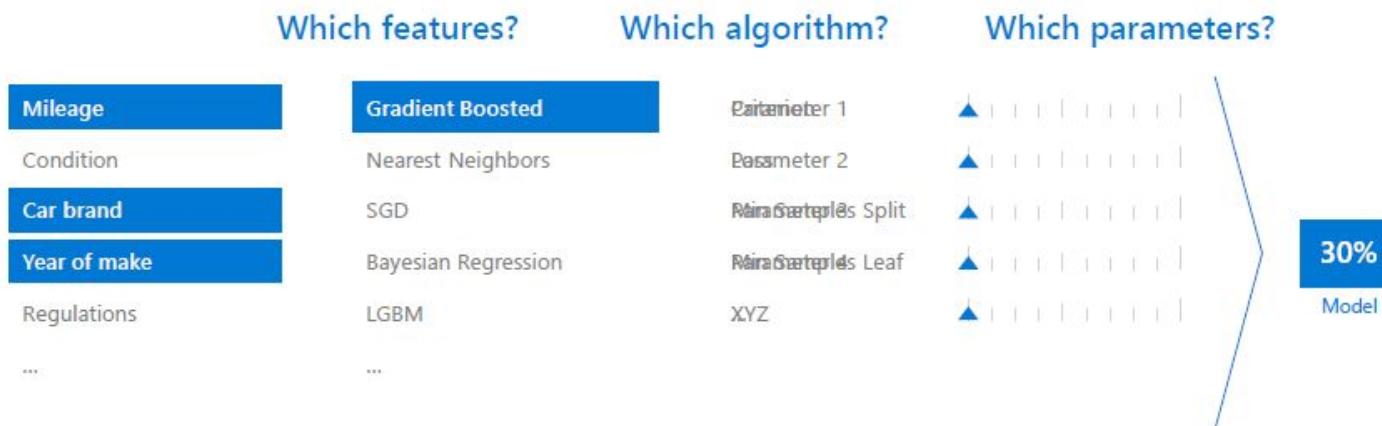
Accelerated model building

Custom AI – Azure ML

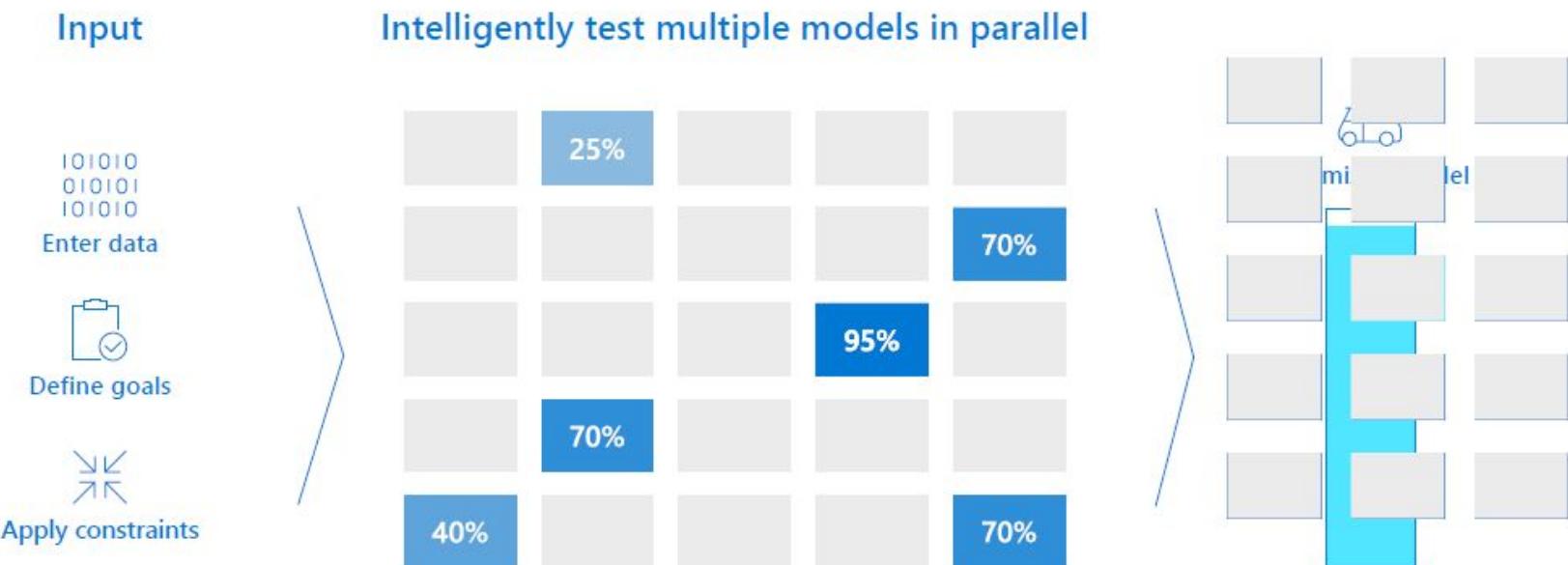
Custom AI– Azure ML



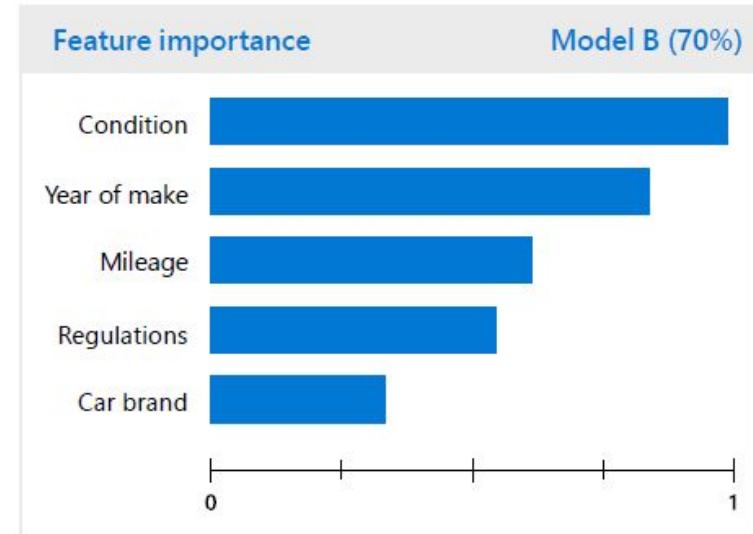
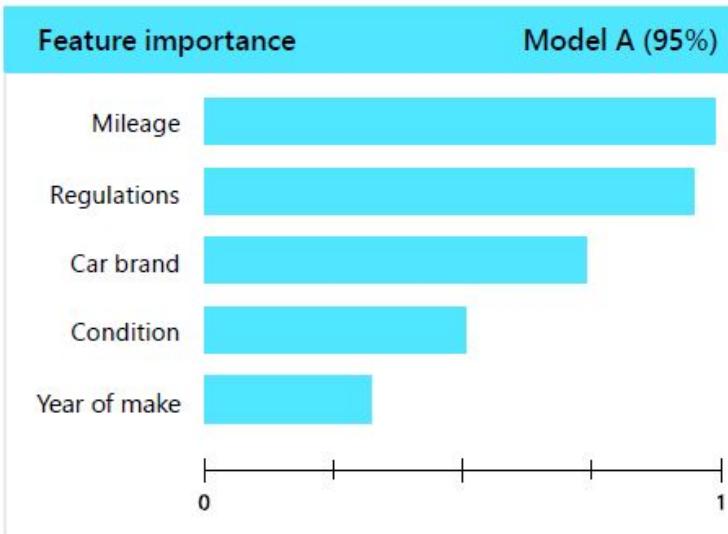
Model Creation is typically a time consuming process



Azure Machine Learning accelerates model development with automated machine learning



Azure Machine Learning accelerates model section with model explainability



Bots Case Story – 1000+ Companies Engaging us

Scenario	Retail	Finance	Insurance	Telecoms	Government	Automotive	Manufacturing	Healthcare	Media	Events
Customer service	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Customer retail	✓	✓	✓	✓				✓	✓	
Audio/speech analysis	✓	✓	✓	✓	✓				✓	
Translation		✓	✓							
Surveillance		✓			✓					
Knowledge extraction		✓	✓	✓				✓		
Video/photo analysis		✓			✓					✓
Product identification	✓							✓	✓	
Digital assistant						✓				
Footfall analysis	✓						✓			✓
HD maps and object detection							✓			

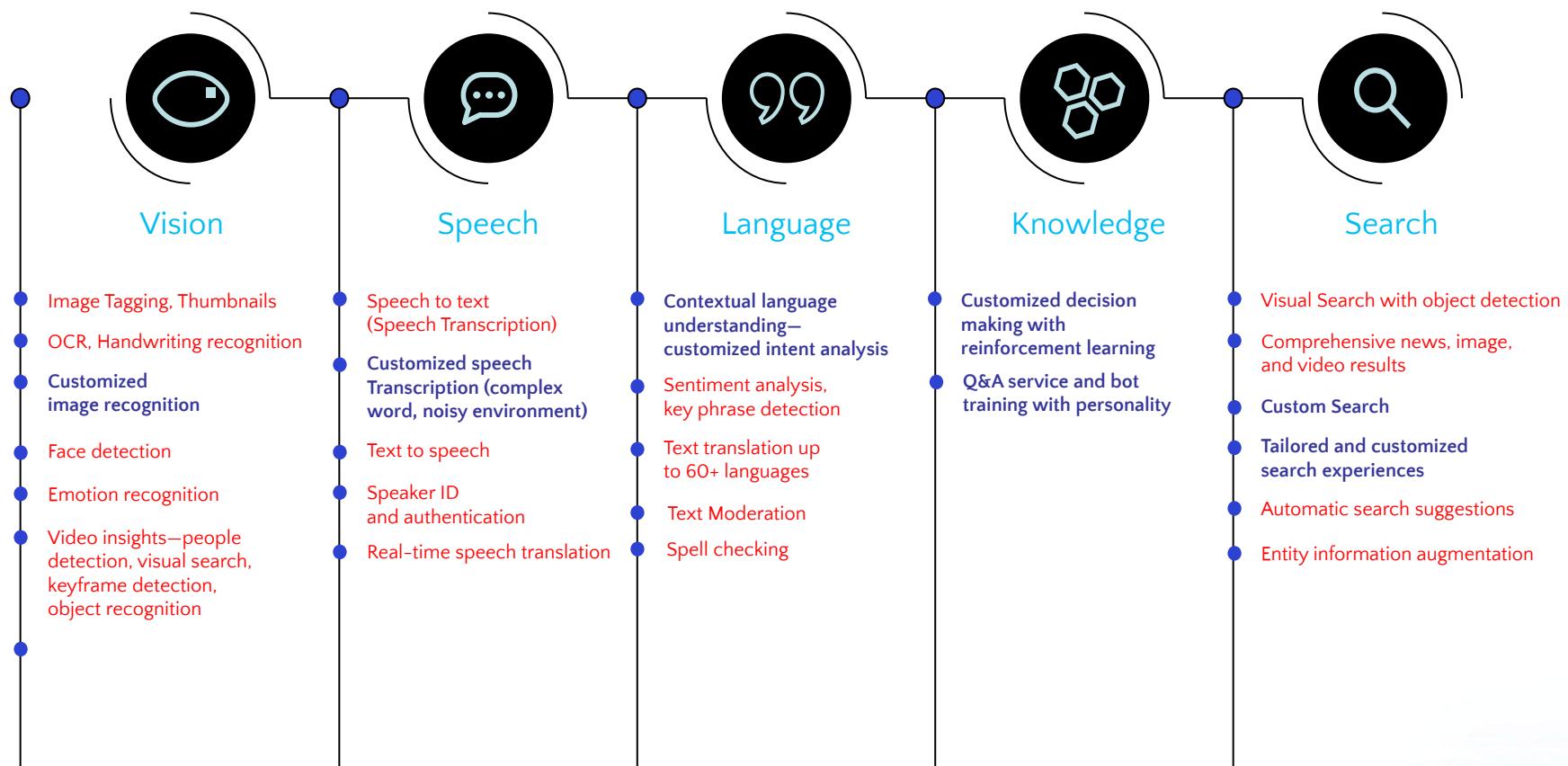
Bot Highlights – Improvements Everywhere



New Channels – Improvement Everywhere



Azure Cognitive Services



Microsoft Learning - AI

<https://www.microsoft.com/en-us/ai/ai-school>

Conversational AI

Add intelligent chat to your apps and channels with AI-powered bots that incorporate features like natural language processing, intent recognition, and more.



Create bots with Azure Bot Service

Bots allow customers to interact with applications in a conversational way using text, graphics, or speech. From a simple question and answer dialog, to sophisticated pattern matching and state tracking, learn how to build a chat bot with QnA Maker and LUIS.

[Start the course >](#)

Create interactive conversational bots for Microsoft Teams

Learn how to create bots for custom Microsoft Teams apps, allowing users to interact with your web service through text, interactive cards, and task modules. Bots can be a few simple commands, or complex virtual assistants powered by AI and natural language.

[Start the course >](#)

Building bots with REST

Most Bot Framework bots are built using the Bot Framework SDK, which organizes your bot and handles all conversations for you. An alternative to the SDK is to send messages directly to the bot using a REST API. You can send and receive messages with users on any channel.

[Learn about building bots >](#)

Azure Cognitive Services

<https://docs.microsoft.com/en-us/learn/certifications/roles/ai-engineer>

AI Engineer certification path

The ai engineer certification path is organized into 3 levels: Fundamentals, Associate and Expert.

View by:

Azure AI Engineer ▾

An optional start for those new to Azure



FUNDAMENTALS CERTIFICATION

[Microsoft Certified: Azure Fundamentals](#)

Complete an associate certification



ASSOCIATE CERTIFICATION

[Microsoft Certified: Azure AI Engineer Associate](#)

AI Engineer certifications

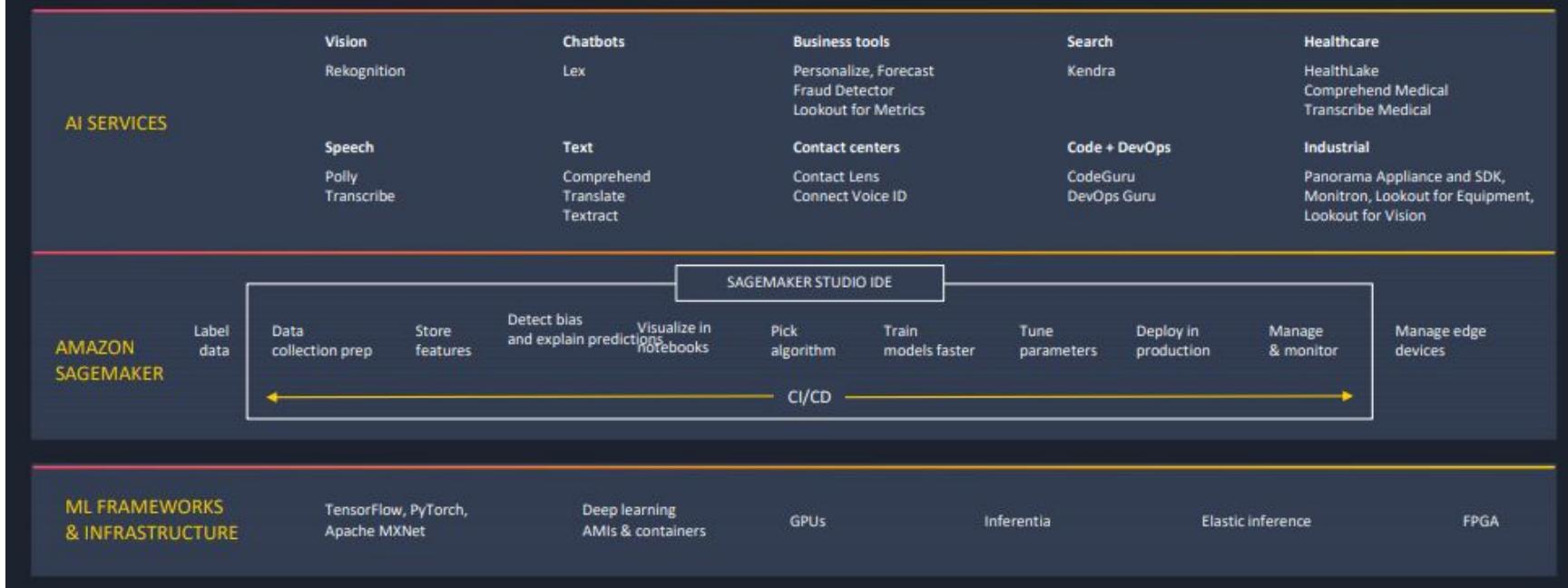
Explore ai engineer certifications most sought after by employers



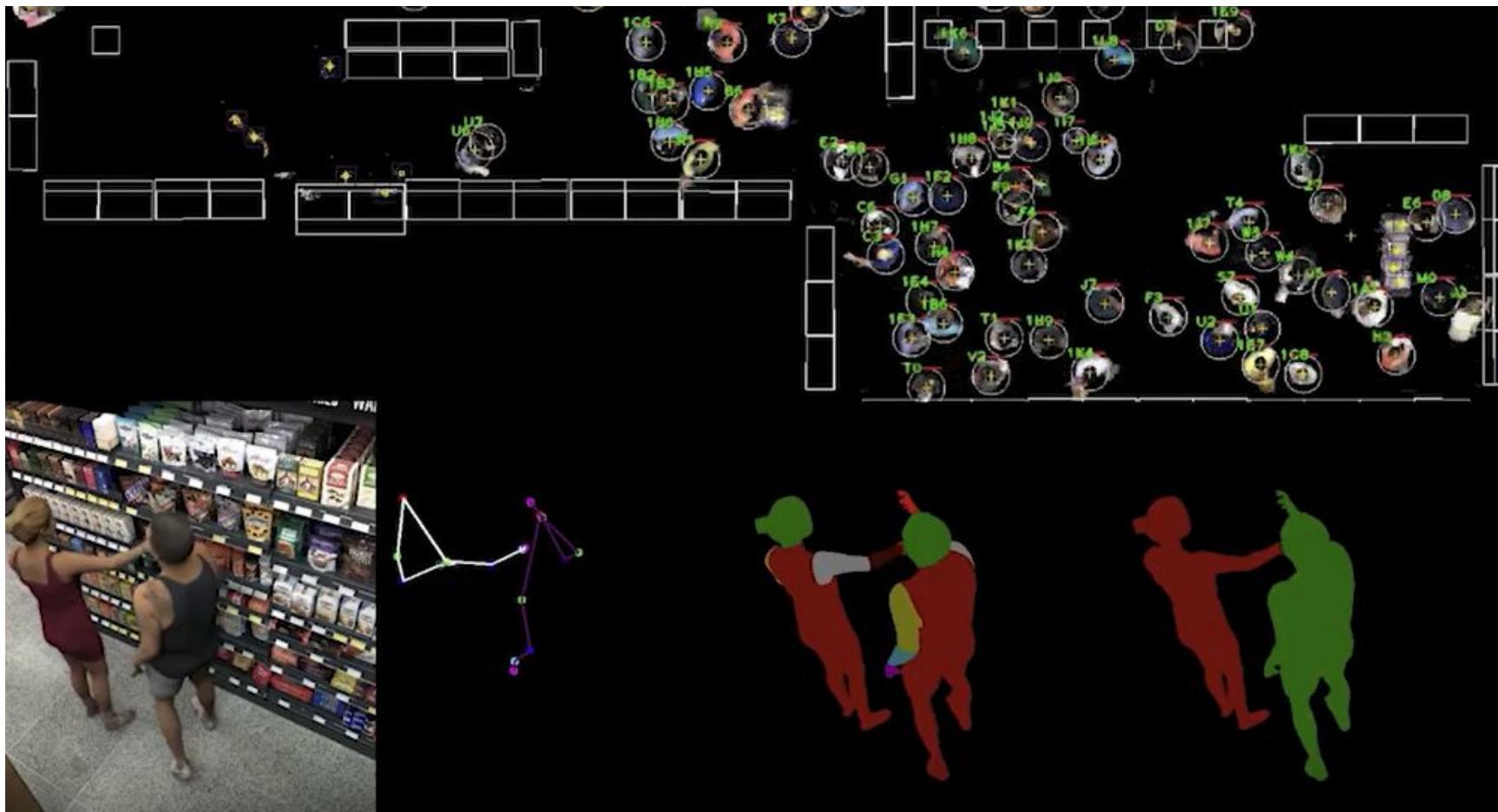
[Microsoft Certified: Azure AI Engineer Associate](#)

The AWS ML Stack

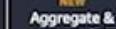
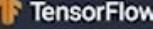
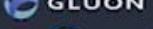
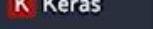
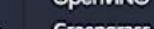
Broadest and most complete set of machine learning capabilities



AWS AI and ML Cases Study



AWS AI and ML Services

AI SERVICES		HEALTH AI		INDUSTRIAL AI				ANOMALY DETECTION		CODE AND DEVOPS									
 NEW	Amazon HealthLake	 Amazon Transcribe Medical	 Amazon Comprehend Medical	 NEW	AWS Panorama + Appliance	 NEW	Amazon Monitron	 NEW	Amazon Lookout for Equipment	 NEW	Amazon Lookout for Vision								
 VISION	 SPEECH	 NEW	 TEXT	 NEW	 SEARCH	 CHATBOTS	 PERSONALIZATION	 FORECASTING	 FRAUD	 CONTACT CENTERS									
 Amazon Rekognition	 Amazon Polly	 Amazon Transcribe Medical	 Amazon Comprehend Medical	 Amazon Translate	 Amazon Textract	 Amazon Kendra	 Amazon Lex	 Amazon Personalize	 Amazon Forecast	 Amazon Fraud Detector	 Contact Lens								
 Voice ID For Amazon Connect																			
ML SERVICES																			
 Label data	 NEW	Aggregate & prepare data	 NEW	Store & share features	Auto ML	Spark/R	 NEW	Detect bias	 Visualize in notebooks	 Pick algorithm	 Train models	 Tune parameters	 NEW	Debug & profile	 Deploy in production	 Manage & monitor	 NEW	CI/CD	Human review
SAGEMAKER STUDIO IDE																			
 TensorFlow	 mxnet	 PyTorch	 Intel RL Coach	 GLUON	 Keras	 DeepLearning Library	 Deep Learning AMIs & Containers	 GPUs & CPUs	 Elastic Inference	 Trainium	 Inferentia	 OpenVINO Greengrass							

AWS AI and ML Cases Study

Sales Services ▾ Search for services, features, marketplace products, and docs [Option+S] Isengard/Administrator/olivierk-isengard@olivierk N. Virginia Support ▾

Amazon Rekognition Custom Labels New Use Custom Labels Demos Object and scene detection Image moderation Facial analysis Celebrity recognition Face comparison Text in image PPE detection New Video Demos Video analysis Metrics Metrics Additional Resources Getting started guide Download SDKs Developer resources Pricing

Read feature documentation to learn more Issues or questions? Use feedback button on bottom-left.

Summarization results Persons with required equipment (ids): [] Persons without required equipment (ids): [] Persons indeterminate (ids): [0]

Per-person results Person ID: 0/D

Person detected	99.9 %
Face detected	99.9 %
Face cover detected	99.9 %
Face cover on nose : false	50.2 %
Head detected	100 %

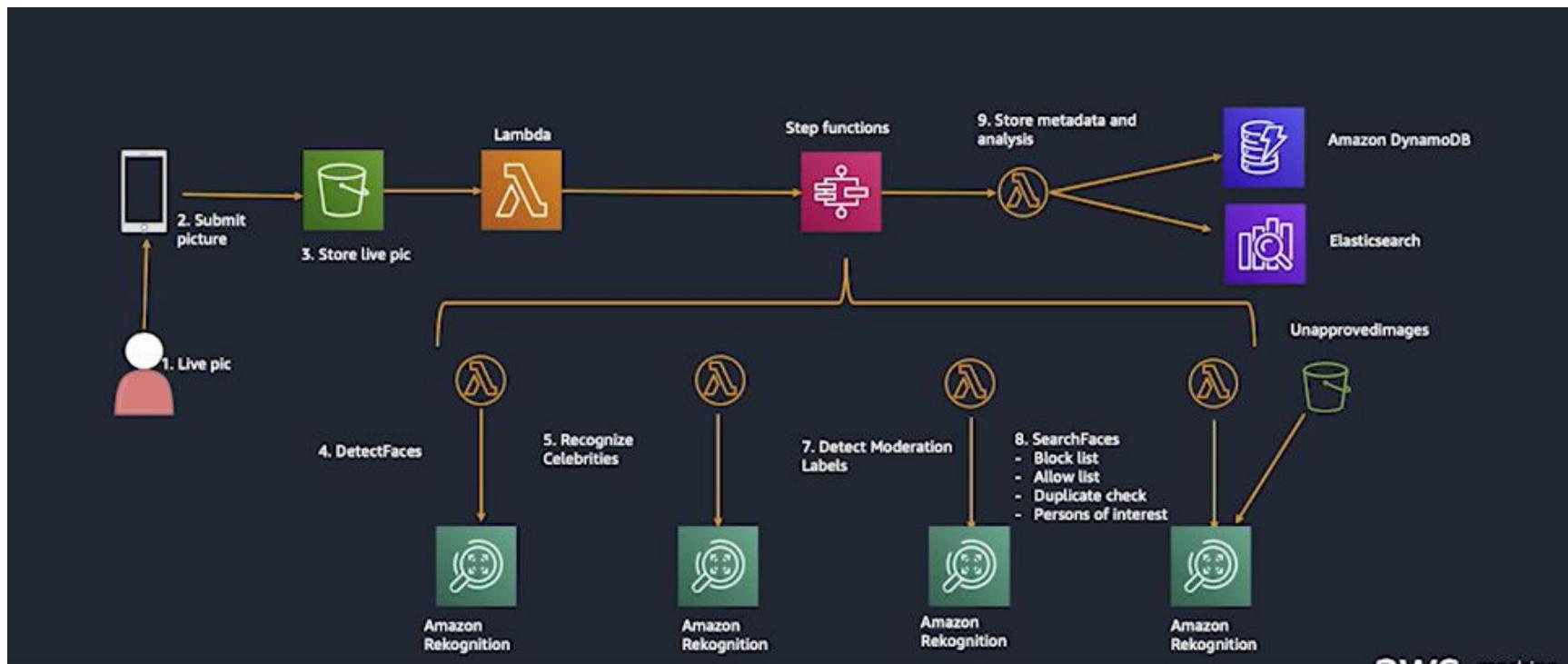
Summarization inputs Provide the following Required PPE and Required minimum confidence threshold inputs to get an identifier summary of persons with required PPE, without required PPE, and indeterminate.
Required PPE: Face cover Hand cover Head cover
Required minimum confidence: 80%

Choose a sample image Use your own image Image must be jpg or png format and no larger than 1MB. Your image will be deleted.
 or drag and drop
 Go

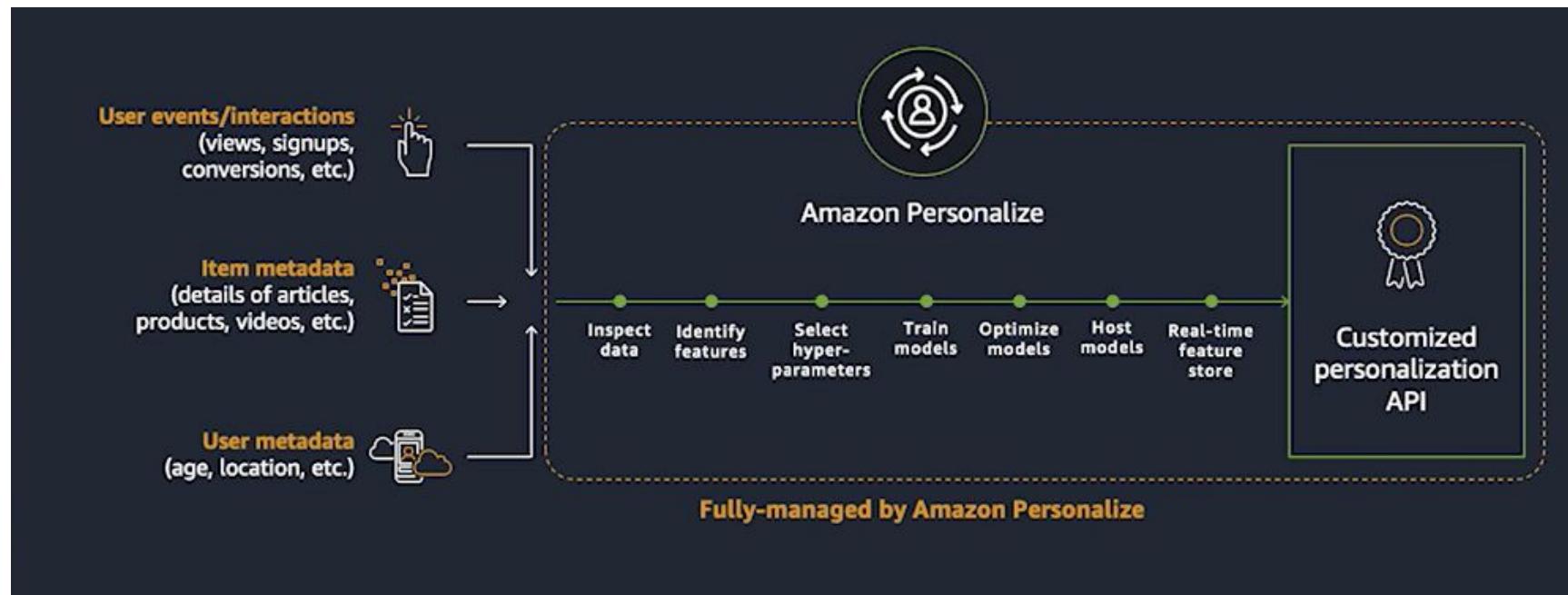


An orange arrow points from the text "Face cover on nose : false" in the results table to the green box highlighting the mask area in the main image.

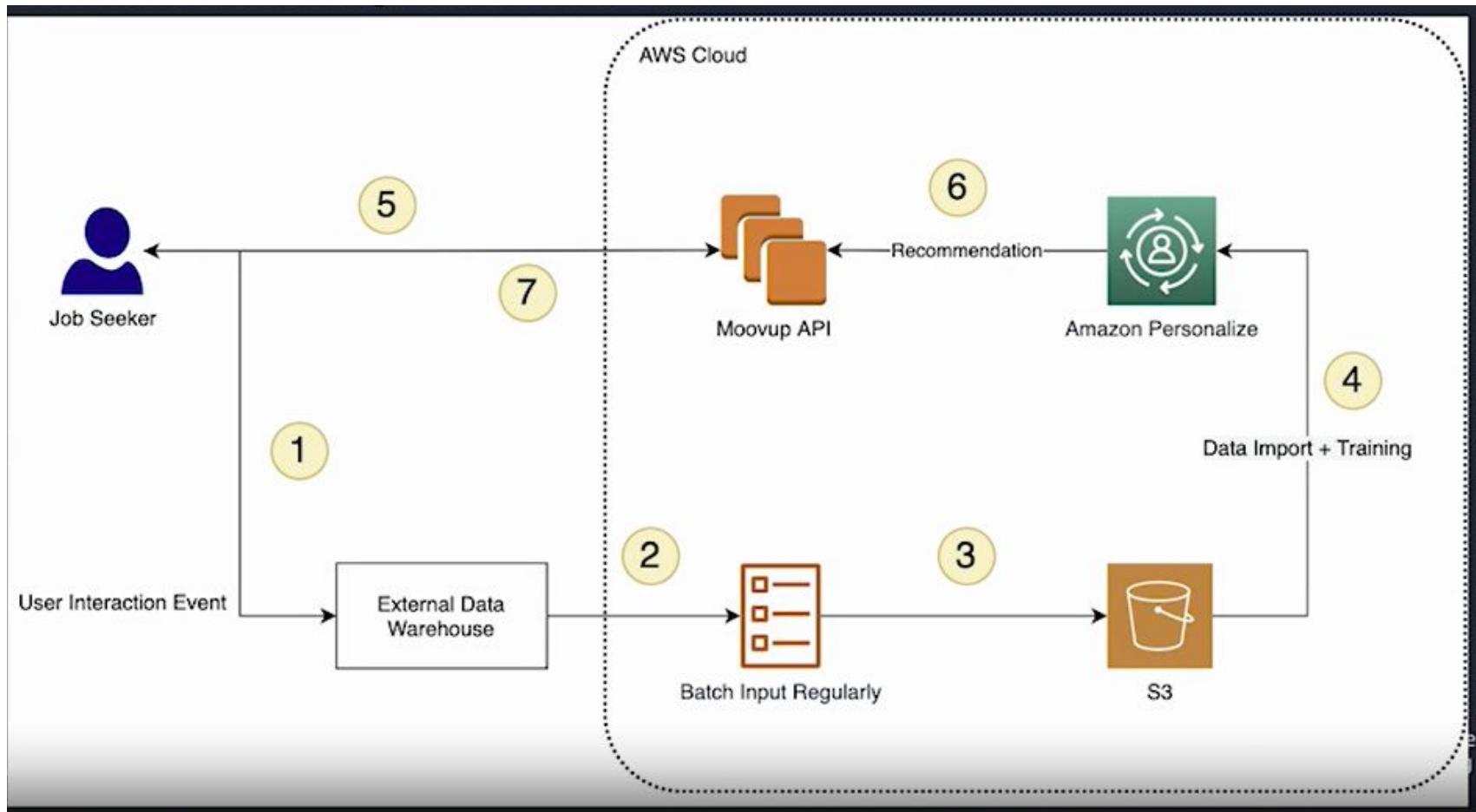
AWS Solution



HOW IT Works – Amazon Personalise



Recommendation System Architecture



Amazon Learning - AI

<https://aws.amazon.com/events/events-content/?awsf.filter-language=language%23english&awsf.filter-topic=event-topic%23ai-ml>

EMB037  [NEW LAUNCH] Understand ML model predictions... Machine learning (ML) models may generate predictions that are not fair, whether because of biased data, a model that contains bias, or bias that emerges over time as real-world conditions change. Likewise, closed-box ML models are opaque, making it	LEVEL 200  [NEW LAUNCH] MLOps for edge devices with ... In this session, learn about Amazon SageMaker Edge Manager, a new capability of SageMaker that helps developers operate machine learning (ML) models on a fleet of edge devices, helping solve challenges with constraints and maintenance of ML	LEVEL 200  [NEW LAUNCH!] Accelerate data preparation with... Preparing training data can be tedious. Amazon SageMaker Data Wrangler provides a faster, visual way to aggregate and prepare data for machine learning. In this session, learn how to use SageMaker Data Wrangler to connect to data sources and use
re:Invent 20-Dec	re:Invent 20-Dec	re:Invent 20-Dec

Case Study

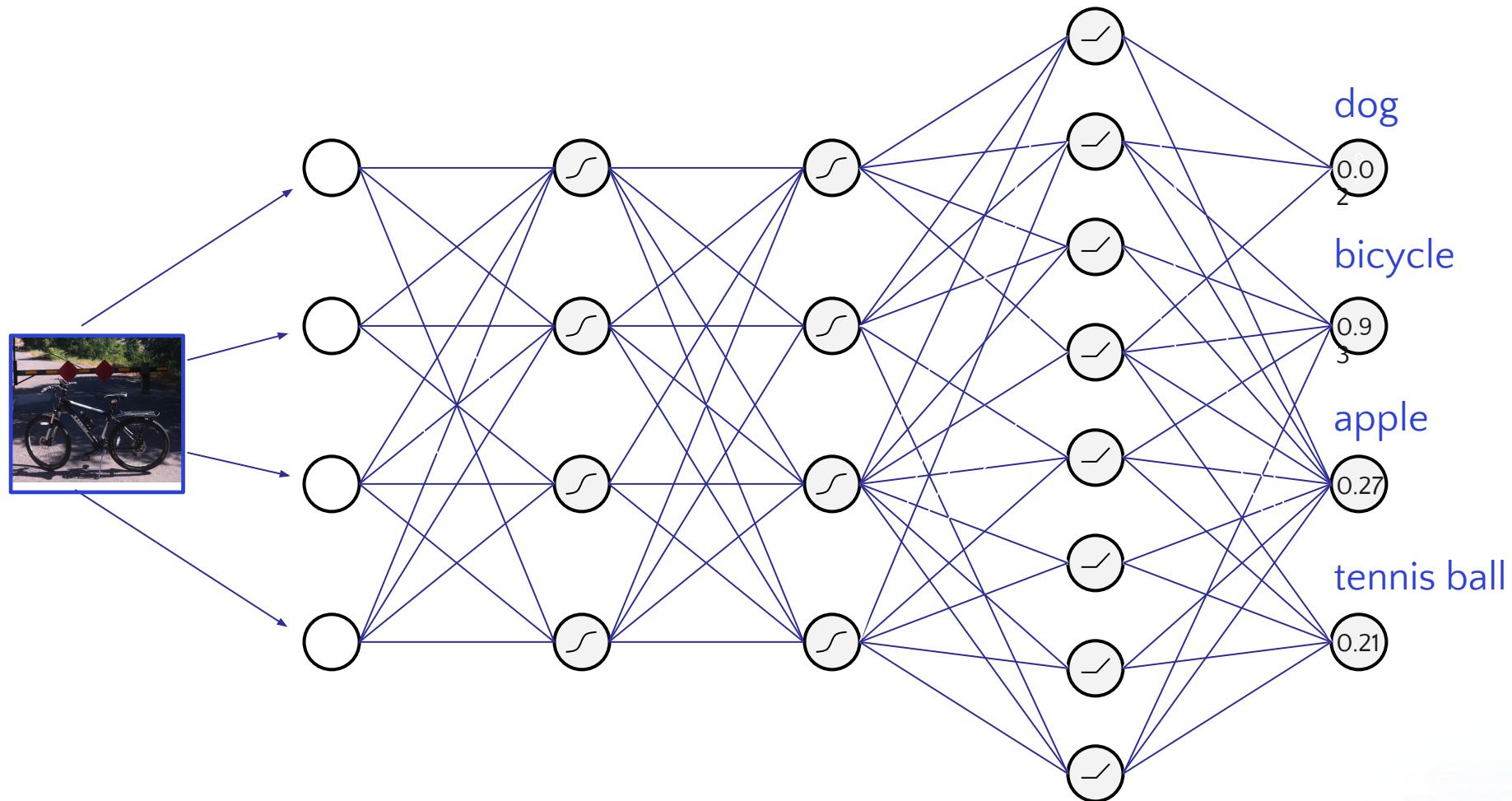
Opening Keynote - Building a smarter and more effective business using AIML on AWS (English Session)

<https://hktw-resources.awscloud.com/ai-machine-learning-web-day/opening-keynote-building-a-smarter-and-more-effective-business-using-aiml-on-aws>

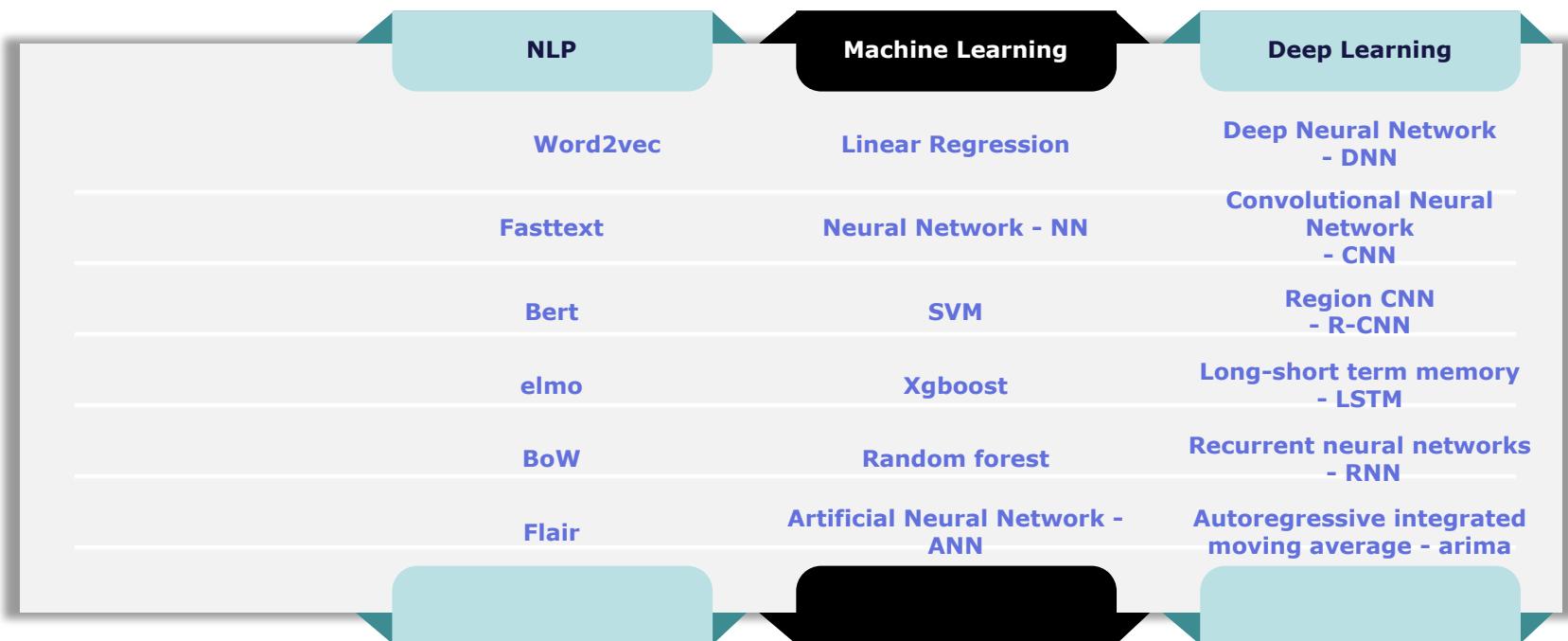
Improving the customer experience of your applications with AWS AI Services (Cantonese session)

<https://hktw-resources.awscloud.com/ai-machine-learning-web-day/improving-the-customer-experience-of-your-applications-with-aws-ai-services>

Trained Convolutional NN

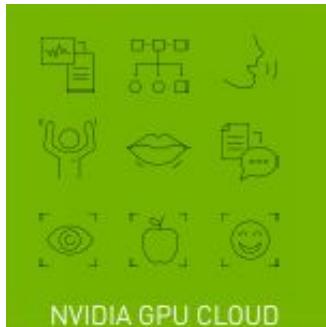


Modelling Techniques



NVIDIA JARVIS – MULTIMODAL CONVERSATIONAL AI SERVICES FRAMEWORK

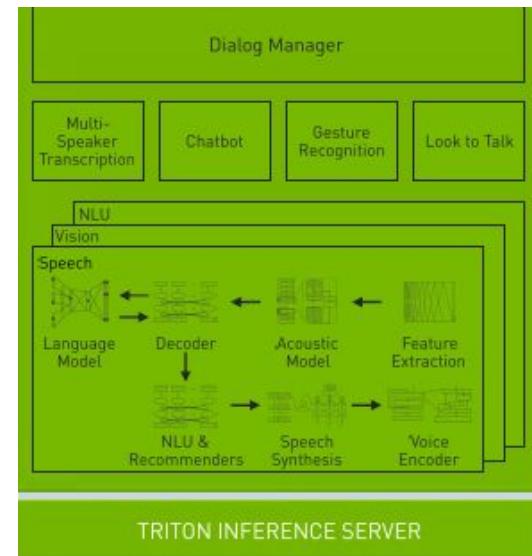
Pre-trained Model



Re-Train



NVIDIA JARVIS



JESSICA: What will you have ready for Wednesday?

DOUGLAS: I expect to have early designs of the packaging.

JESSICA: Great.

CONVERSATIONAL AI IS TRANSFORMING INDUSTRIES



Data Scientist Jobs



FIREBLAZE AI SCHOOL

Data Scientist

Also known as Data Manager,
Statistician

• Tools that need to be mastered •



Python



R Programming



SQL

• Skills that need to be mastered •



Programming



Statistics



Machine Learning



Data Visualization



FIREBLAZE AI SCHOOL

Data Engineers

Also known as Data Architects

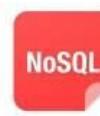
• Tools that need to be mastered •



Python



hadoop



NoSQL

• Skills that need to be mastered •



Programming



Data Mining



Database
architecture

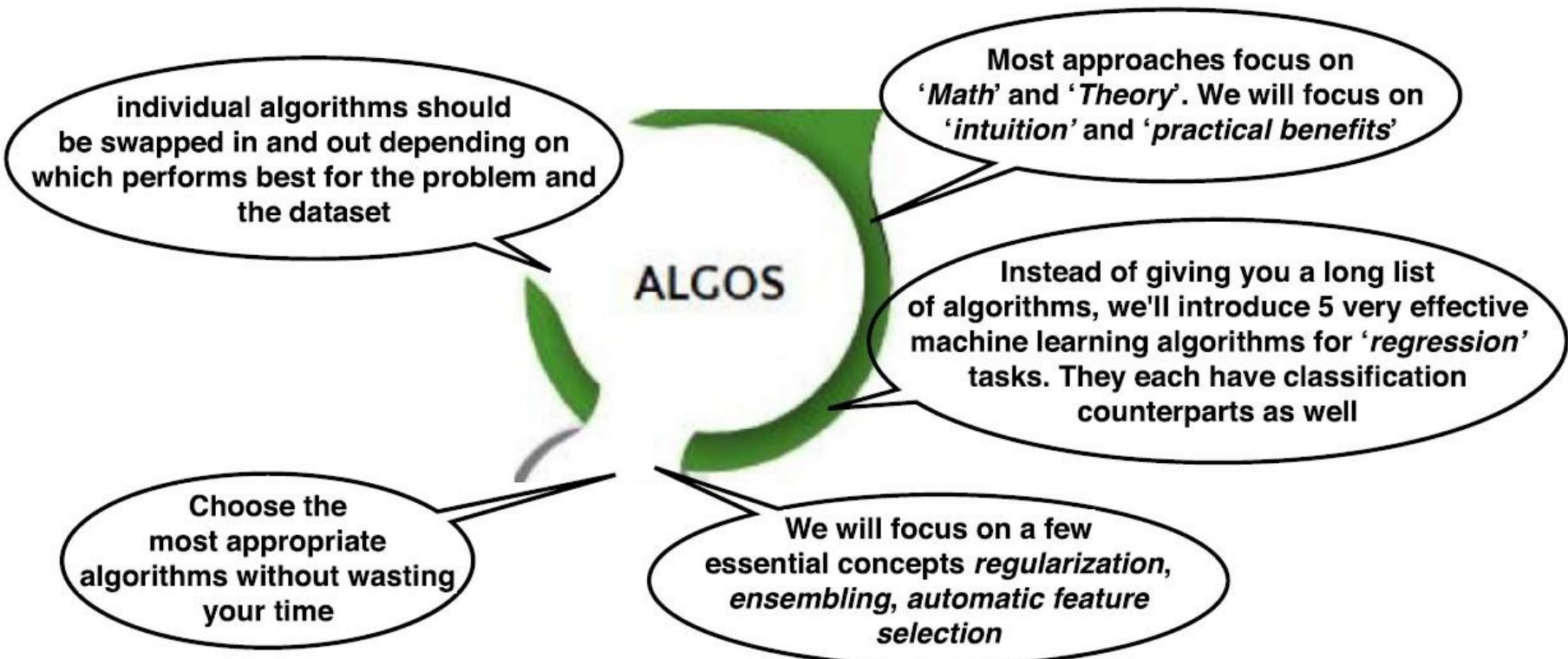


Statistical modeling &
regression analysis

Big Data Tools and Algorithm Exploration

Applied Machine Learning Algorithm Selection

Overview



Source: <https://elitedatascience.com/algorithm-selection>

Big Data Tools and Algorithm Exploration

Applied Machine Learning Algorithm Selection

HKUSPACE

Highly recommend skipping Linear Regression for most machine learning problems

2.0

0.5

0.0

-0.5

-1.0

-1.5

-2.5

-1

Big Data Tools and Algorithm Exploration

Applied Machine Learning Algorithm Selection

Linear Regression models are easy to interpret and understand, but they are deeply flawed and rarely perform well !

Regression is the supervised learning task for modeling and predicting continuous, numeric variables. Examples include predicting real-estate prices, stock price movements, or student test scores

Regression tasks are characterized by labeled datasets that have a numeric target variable, you have some "ground truth" value for each observation that you can use to supervise your algorithm

Simple linear regression models fit a "straight line", a *hyperplane* depending on the number of features

Simple linear regression are 1 - prone to overfitting with many input features and 2 - cannot easily represent non-linear relationships

Inspiring Your Future

Business Education @ HKUSPACE

Source: <https://elitedatascience.com/algorithm-selection>

HKUSPACE

Big Data Tools and Algorithm Exploration

Applied Machine Learning Algorithm Selection

Each tree is only trained on a random subset of observations (a process called resampling)

Each tree is only allowed to choose from a random subset of features to split on (leading to feature selection)



Random Forests

Random forests train a large number of "strong" decision trees and combine their predictions through bagging

random forests tend to perform very well right out of the box often beat many other models that take up to weeks to develop, and are the perfect "swiss-army-knife" algorithm that almost always gets good results

Source: <https://elitedatascience.com/algorithm-selection>

Big Data Tools and Algorithm Exploration

Model Training

Training sets are used to 'fit and tune' (train) your models

Split your data **before** doing anything else then separately train and test subsets of your dataset

We set up the entire modelling process to maximise performance whilst preventing overfitting

Training Set

Test Set

Train and tune your models (using cross-validation)

Don't touch this until the very end.

Test sets are put aside as "*unseen*" data to evaluate your models, splitting your data, don't touch your test set until you're ready to choose your final model

If the model performs very well on the training data but poorly on the test data, then it's overfit

Split DataSet Into Training/Test Sets

If you evaluate your model on the same data you used to train it, your model could be very overfit. A model should be judged on its ability to predict *new, unseen data*

Source: <https://elitedatascience.com/model-training>

Big Data Tools and Algorithm Exploration

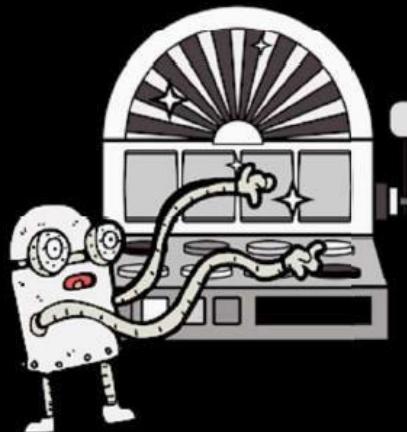
Model Training

Examples of Model parameters include regression coefficients, decision tree split locations

Model parameters are attributes that define *individual models*, and are learned directly from the training data

There are two types of parameters in machine learning algorithms: Model Parameters and hyperparameters

"Don't mind me. Just randomly pressing buttons carefully tuning level parameters."



Hyperparameters: When we talk of tuning models, we specifically mean tuning hyperparameters

Hyperparameters express "higher-level" *structural settings* for algorithms. They are decided before fitting the model because they can't be learned from the data

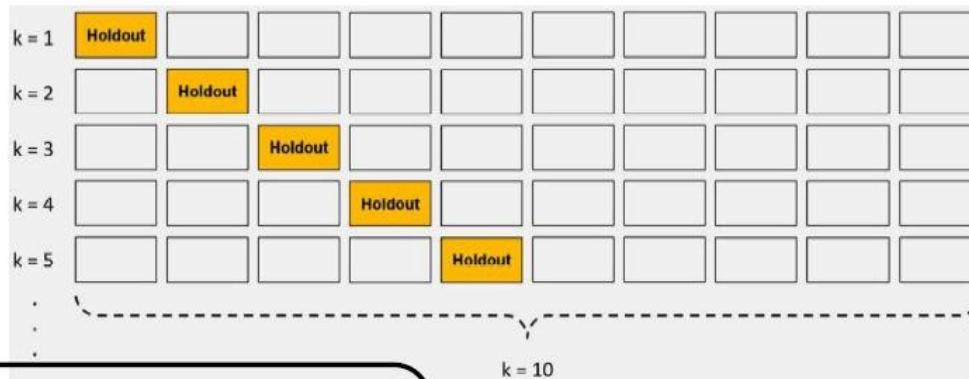
E.g. Hyperparameters "higher-level" *structural settings* are strength of the penalty used in regularized regression and the number of trees to include in a random forest

Source: <https://elitedatascience.com/model-training>

Big Data Tools and Algorithm Exploration

Model Training

1- Split your data into 10 equal parts, or “folds”, 2- Train your model on 9 folds (e.g. the first 9 folds)



10-fold cross-validation, breaks your training data into 10 equal parts (or *folds*), essentially creating 10 miniature train/test splits

Cross-validation is a tuning method for getting a reliable estimate of model performance using only training data

3 - Evaluate it on the 1 remaining "hold-out" fold, Perform steps (2) and (3) 10 times, each time holding out a different fold

Average the performance across all 10 hold-out folds, average performance across the 10 hold-out folds is your final performance estimate, also called your *cross-validated score*

Source: <https://elitedatascience.com/model-training>

Big Data Tools and Algorithm Exploration

Model Training

perform the entire cross-validation loop detailed above on each set of hyperparameter values using a high-level pseudo-code

We've split our dataset into training and test sets, and we've learned about hyperparameters and cross-validation, we're ready fit and tune our models

For each algorithm (i.e. regularized regression, random forest, etc.):

For each set of hyperparameter values to try:
Perform cross-validation using the training set.
Calculate cross-validated score.

At the end of this process, you will have a cross-validated score for each set of hyperparameter values... for each algorithm

Elastic-Net		
Penalty Ratio	Penalty Strength	CV-Score
75/25	0.01	0.63
75/25	0.05	0.64
75/25	0.10	0.67
50/50	0.01	0.62
50/50	0.05	0.63
50/50	0.10	0.66

Source: <https://elitedatascience.com/model-training>

Big Data Tools and Algorithm Exploration

Model Training

Keep the set of hyperparameter values with best cross-validated score.
Re-train the algorithm on the entire training set (without cross-validation)

By now, you'll have 1 "best" model for each algorithm that has been tuned through cross-validation. Most importantly, you've only used the training data so far

Because you've saved your test set as a truly unseen dataset, you can now use it get a reliable estimate of each models' performance. There are a variety of performance metrics you could choose from

For classification tasks, we recommend Area Under ROC Curve (AUROC). *Higher values are better*

For regression tasks, we recommend Mean Squared Error (MSE) or Mean Absolute Error (MAE). (*Lower values are better*)



"I volunteer as tribute"

like the Hunger Games... each algorithm sends its own "representatives" (i.e. model trained on the best set of hyperparameter values) to the final selection

Source: <https://elitedatascience.com/model-training>

Big Data Tools and Algorithm Exploration

Model Training Conclusion

Pick the winning model by asking: Which model had the best performance on the test set? (performance)

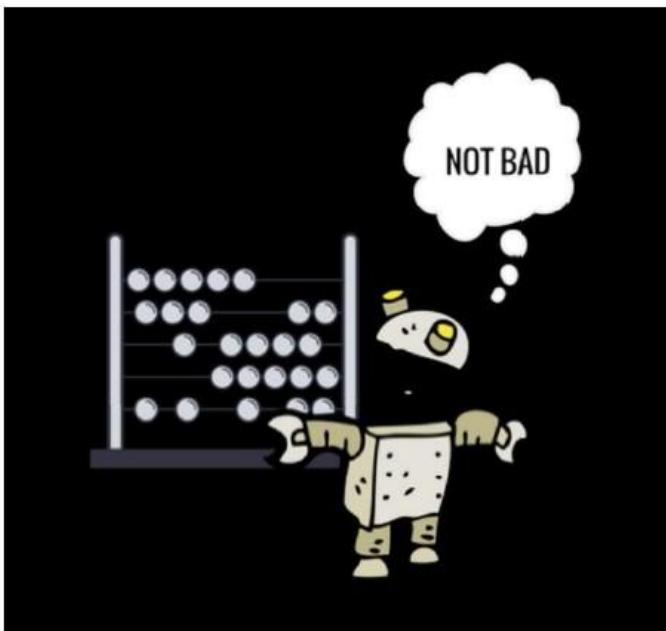
Calculate performance metrics using those predictions and the "ground truth" target variable from the test set

For each of your models, make predictions on your test set

Pick the winning model by asking: Does it perform well across various performance metrics? (robustness)

Pick the winning model by asking: Did it also have (one of) the best cross-validated scores from the training set? (consistency)

Pick the winning model by asking: Does it solve the original business problem? (win condition)

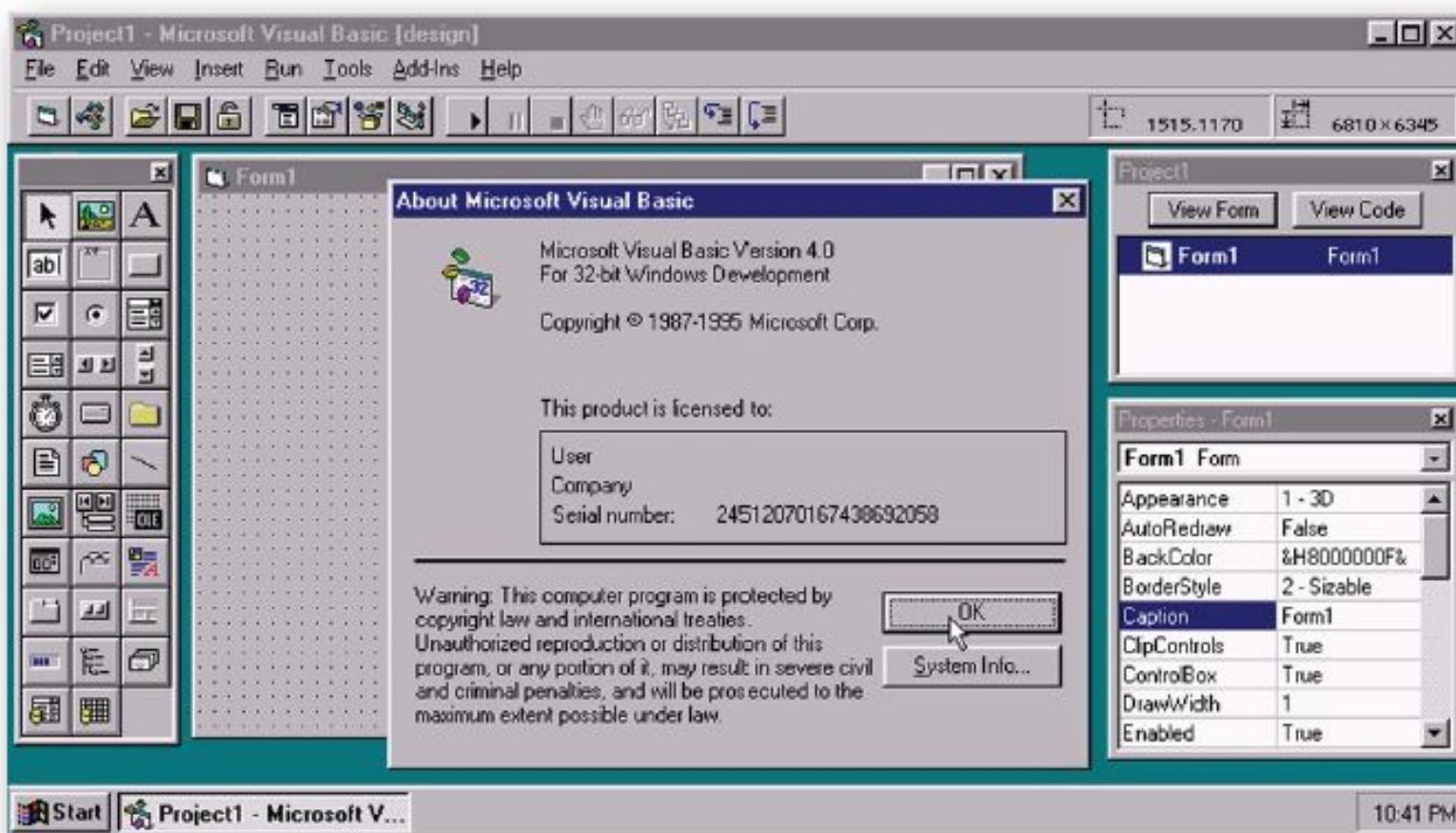


Source: <https://elitedatascience.com/model-training>

Business Process Automation with VBA

VBA - Visual Basic

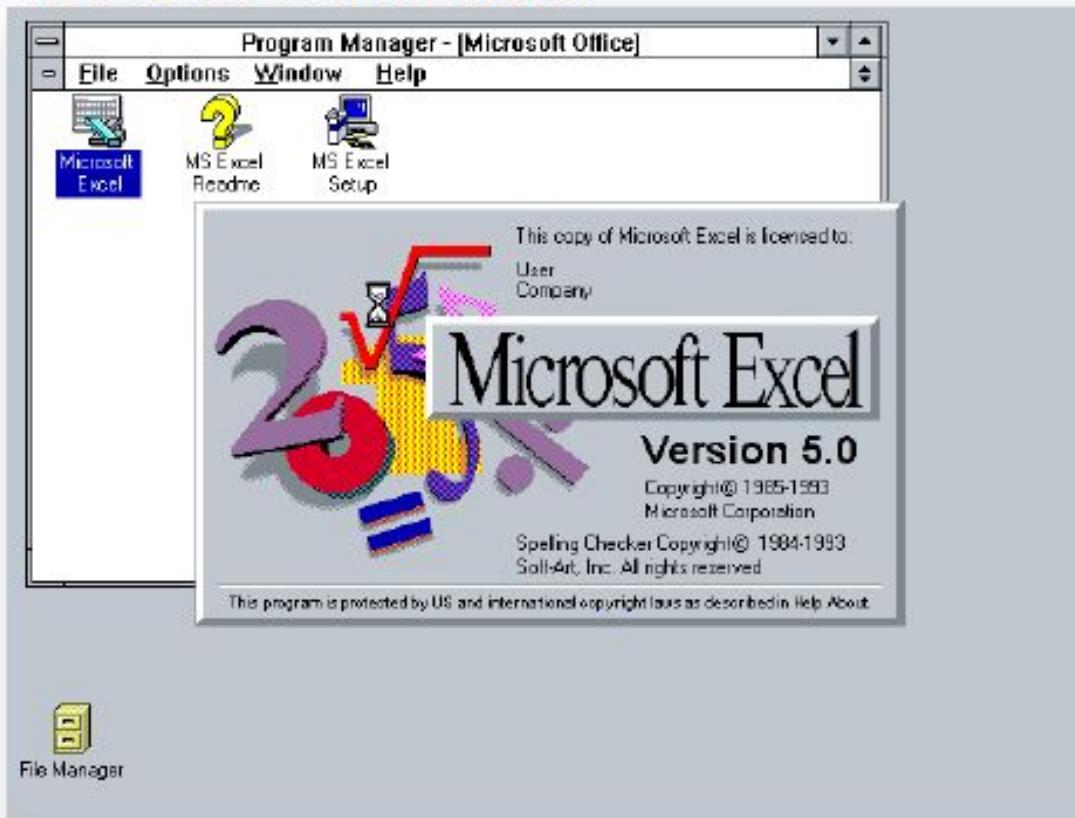
- VB was “The” Microsoft way to write programs



Business Process Automation with VBA

VBA - Visual Basic for Applications

- Introduced to Excel 5.0 in 1993



- Microsoft Excel 5.x. WinWorld. <https://winworldpc.com/product/microsoft-excel/5x>

Business Process Automation with VBA

VBA - Visual Basic for Applications

- Introduced to Excel 5.0 in 1993

The screenshot shows the Microsoft Excel 5.0 interface with the title bar "Microsoft Excel - SAMPLES.XLS". The ribbon tabs include File, Edit, View, Insert, Run, Tools, Window, and Help. The "Run" tab is selected. A toolbar with various icons is visible above the ribbon. The main area displays VBA code:

```
Microsoft Excel - SAMPLES.XLS
File Edit View Insert Run Tools Window Help
Run Start F5 End
Reset Step Into F8 Step Over Shift+F8
Toggle Breakpoint F9 Clear All Breakpoints
----->>>VVISUAL BASIC
To get more information about a keyword, select Microsoft Excel 4.0 help for these procedures
other keyword, select Microsoft Excel 4.0 help for these procedures
are located on the Moving sheet of this workbook.

To ensure explicit declaration of variables, use the "Option Explicit" parameter. This is not necessary, but should be done for clarity and optimum performance.
Option Explicit

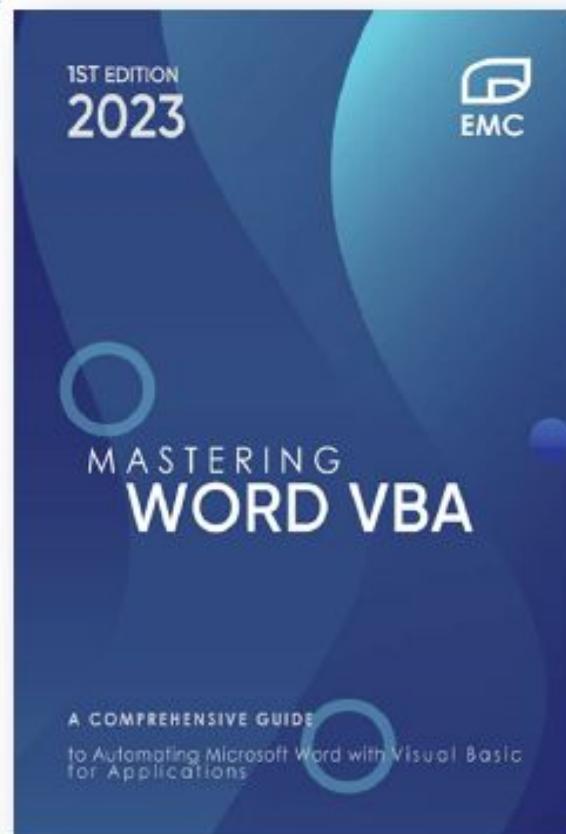
Sub VB_Sort_Database()
    ' Sorts a database or list on the active sheet by values in the first
    ' column, leaving field names in the first row.
    ' Run this macro from any worksheet that contains a list named
    ' Database.
    Range("database").Offset(1, 0).Resize(Range("database").Rows.Count - 1, Range("database").Columns.Count).Select
    Selection.Sort Key1:=ActiveCell, Order1:=xlAscending
End Sub
```

The status bar at the bottom shows "Execute macros, set breakpoints, step through code".

- Microsoft Excel 5.x. WinWorld. <https://winworldpc.com/product/microsoft-excel/5x>

VBA - Visual Basic for Applications

- Gradually extended to Microsoft Office
- VB classic → ended in 2008
- VB.NET → evolution ended in 2020¹
- VBA → still supported (e.g., M365)



1. Team, N. (2020, March 11). *Visual Basic support planned for .NET 5.0*. Visual Basic Blog.
<https://devblogs.microsoft.com/vbteam/visual-basic-support-planned-for-net-5-0/>

Business Process Automation with VBA

VBA – Why?

- Automation
- User interaction
- Widely used in the industry



1. O. (2022, June 8). Getting started with VBA in Office. Getting Started With VBA in Office | Microsoft Learn.
<https://learn.microsoft.com/en-us/office/vba/library-reference/concepts/getting-started-with-vba-in-office>

VBA - Automation

- Macros → Microsoft's response to automation
- Naming:
 - Micro-instruction vs **Macro**-instruction
 - 1 key to perform series of commands / actions



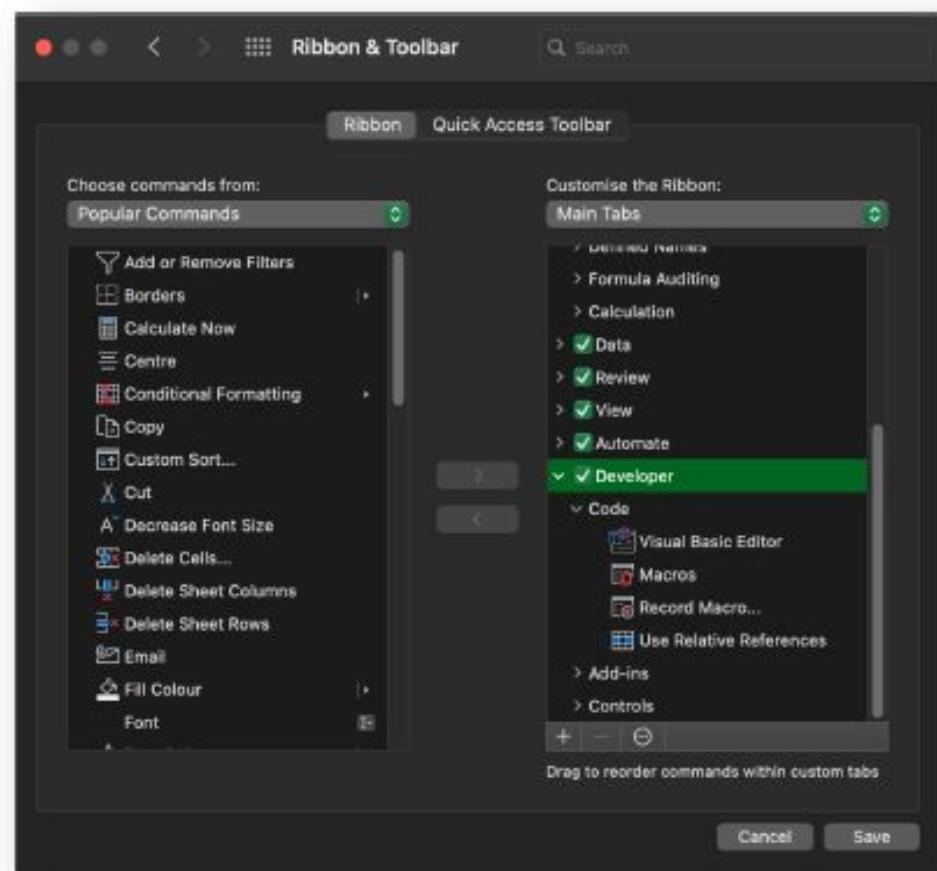
and so much more

1. Why is Excel VBA called "Macros"? Why Is Excel VBA Called "Macros"? <https://www.excelforum.com/the-water-cooler/791161-why-is-excel-vba-called-macros.html>

Business Process Automation with VBA

Macros – Where?

- “Developer” tab
 - Hidden by default
 - File
 - ➔ Options
 - ➔ Customize Ribbon
 - Turn on “Developer”

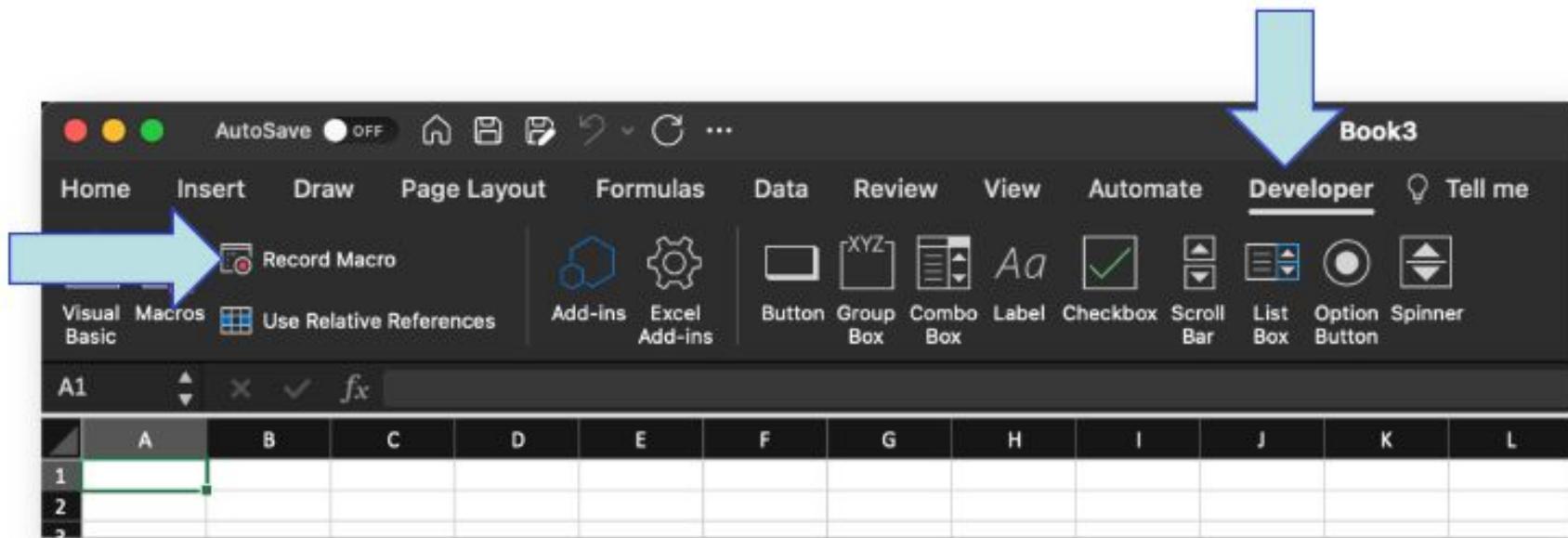


1. Show the Developer tab - Microsoft Support. Show the Developer Tab - Microsoft Support.
<https://support.microsoft.com/en-us/office/show-the-developer-tab-e1192344-5e56-4d45-931b-e5fd9bea2d45>

Business Process Automation with VBA

Practice 1 - Your first macro

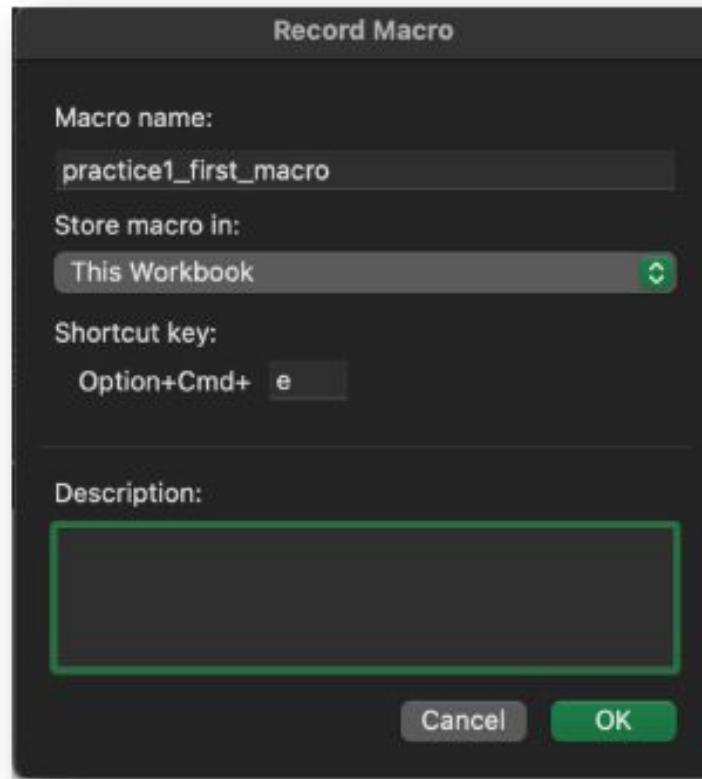
- Click “Record Macro”



Business Process Automation with VBA

Practice 1 - Your first macro

- Type in a name (use “_” instead of spaces)
- Set a shortcut key
- Click OK



Practice 1 - Your first macro

- The recording has started
- Add a new sheet with the “+” at the bottom-left



Practice 1 - Your first macro

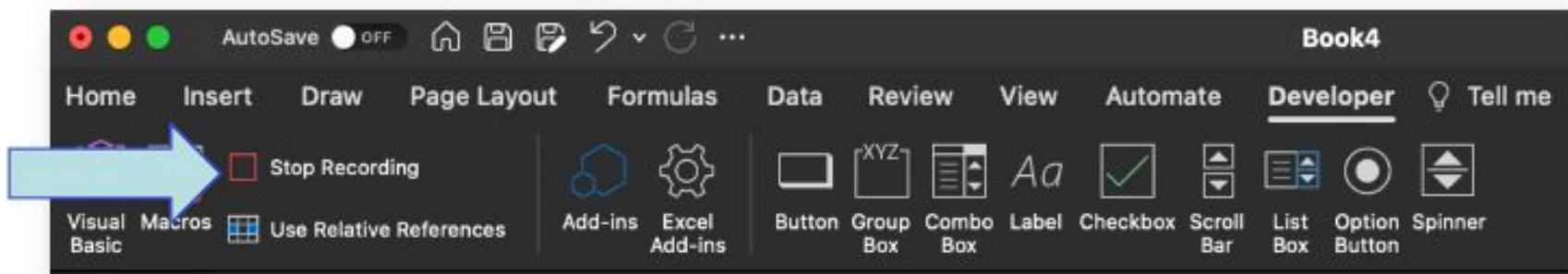
- Go back to “Home” tab
- Select Cells A1 to D1 → Merge
- Enter “Application Form” at the top-left
- Style it: e.g., Font size + Bold + Underline

The screenshot shows a Microsoft Excel interface. The ribbon is visible at the top with tabs: Home, Insert, Draw, Page Layout, Formulas, Data, Review, View, Automate, and Developer. The Home tab is currently selected. The formula bar shows the cell reference A1. The main workspace shows a 4x1 range of cells from A1 to D1. These cells are merged and contain the text "Application Form" in a bold, underlined, black Calibri font, with a font size of 36. The background of the merged cells is yellow. The rest of the grid is white.

Business Process Automation with VBA

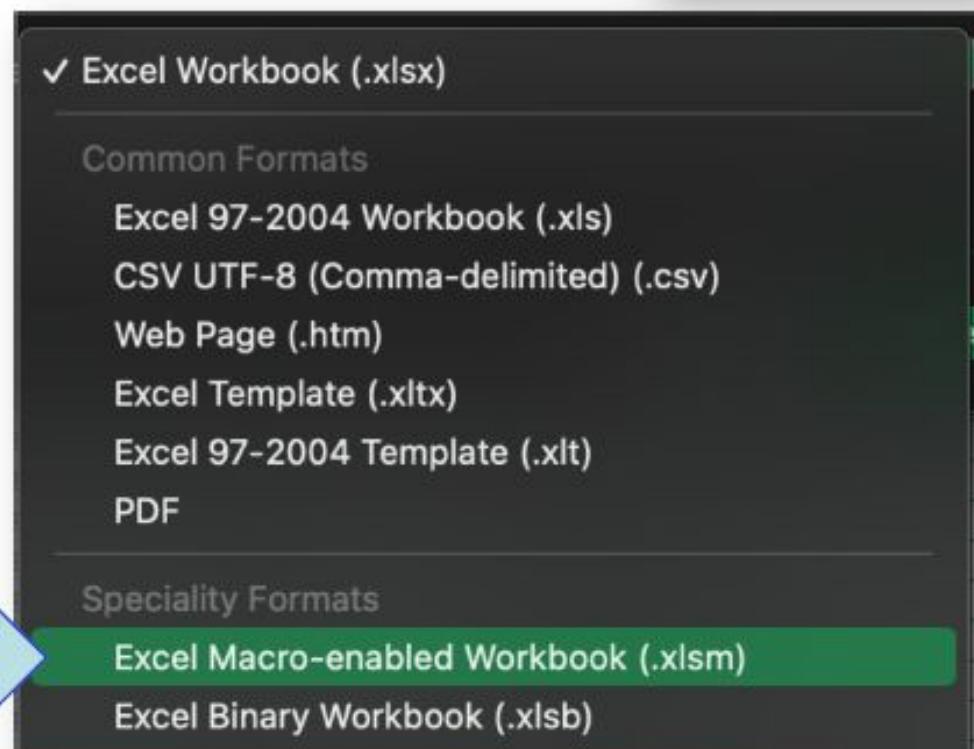
Practice 1 - Your first macro

- Go back to “Developer” tab
- Hit “Stop Recording”



Practice 1 - Your first macro

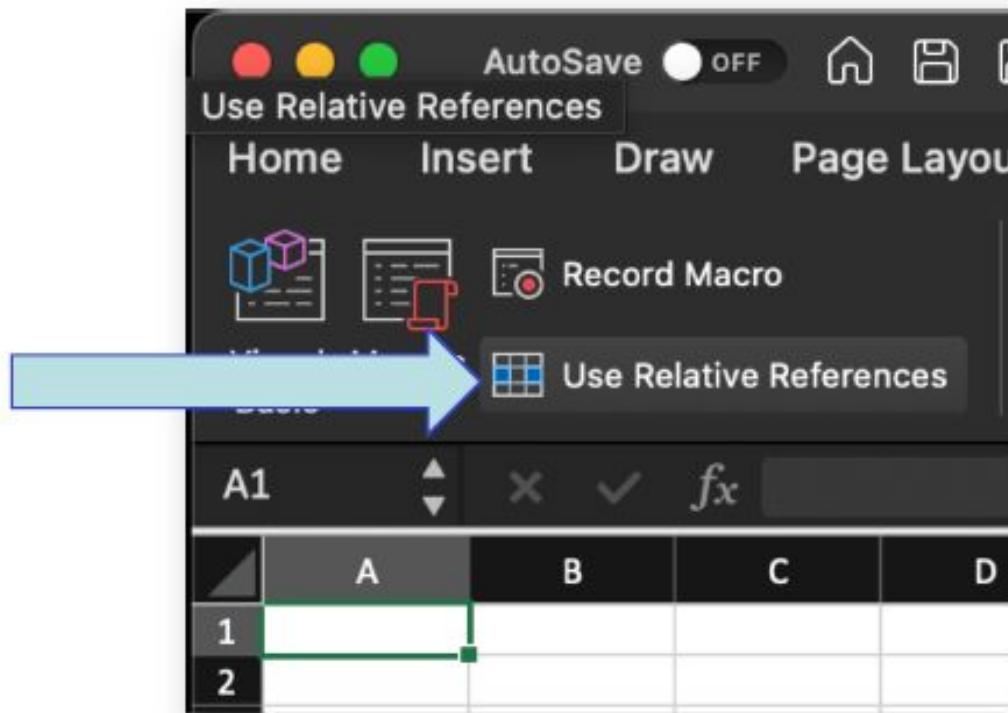
- Save as .xlsm to preserve your macros!



Business Process Automation with VBA

Relative Reference

- Record and execute based on “current selection”
- Click BEFORE “Record Macro”



Business Process Automation with VBA

Practice 2 – Relative References

- Create a new macro to generate below

The image shows two side-by-side screenshots of Microsoft Excel.

Left Screenshot: Record Macro Dialog

- Macro name:** practice2_relative_references
- Store macro in:** This Workbook
- Shortcut key:** Option+Cmd+ r
- Description:** (Empty text area)

Right Screenshot: Excel Worksheet and Macro Recording Interface

- Macro Recording Tools ribbon:** Shows tabs for Visual Basic, Macros, and Basic. The "Use Relative References" button is highlighted.
- Worksheet:** A1:F11 grid. Cell F17 is selected.
- Form:** A data entry form in the bottom right corner with fields for Name, Phone, and Address.

Business Process Automation with VBA

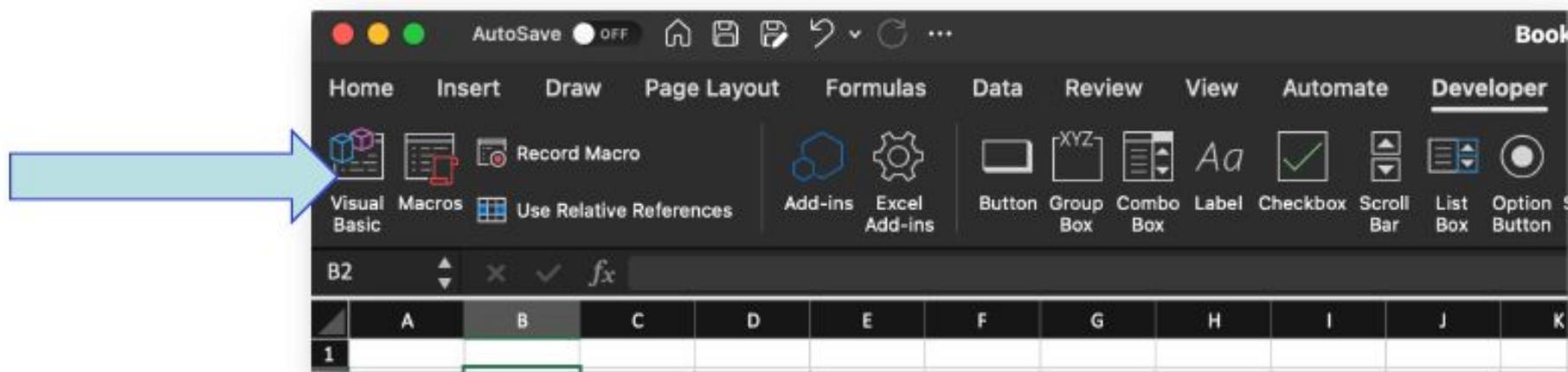
VBA - Why not just use macros?

- Macros → great for repetition
- Need → More flexibility and interactivity
- Solution → Dig into the codes



Entering Visual Basic Mode

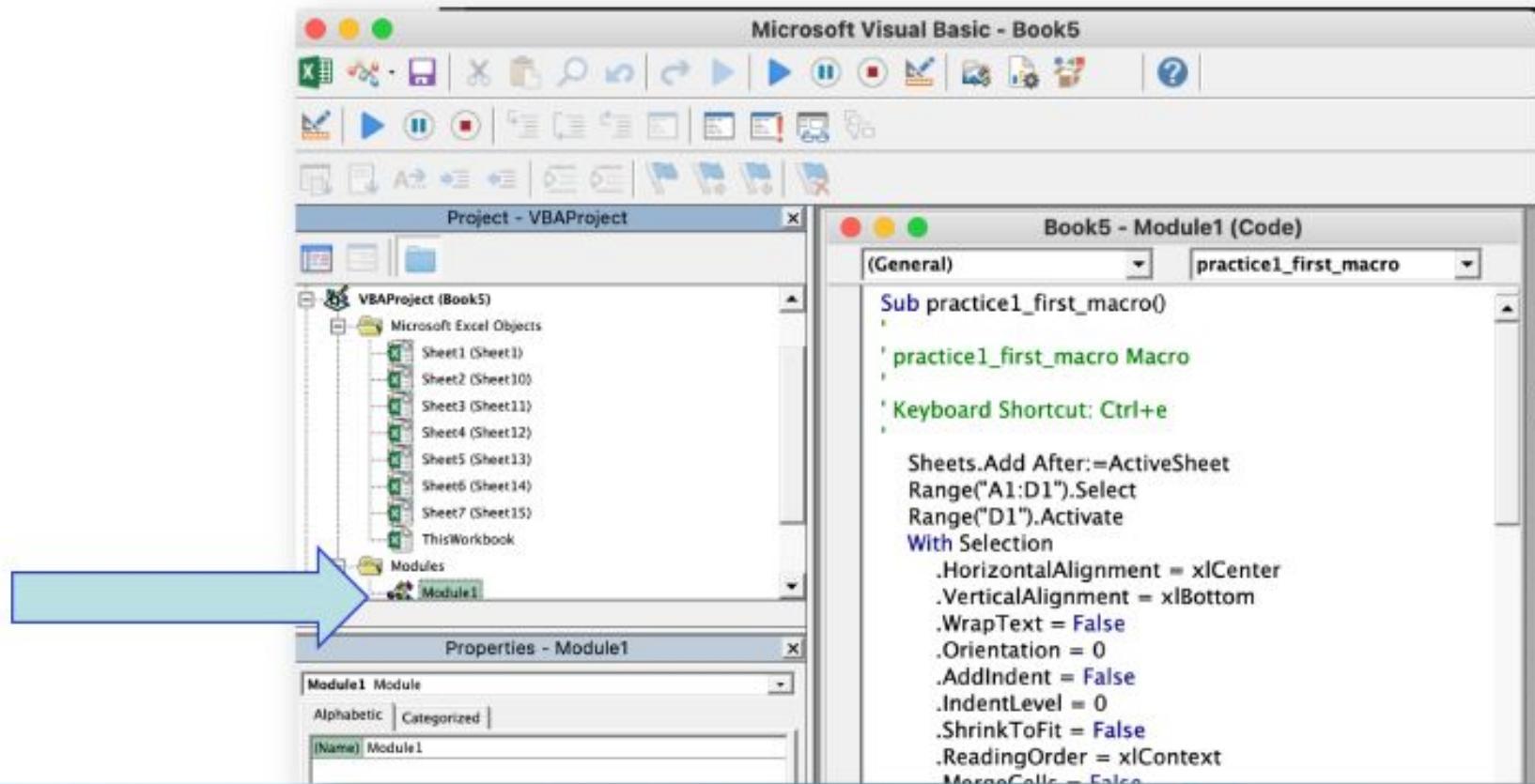
- Developer tab → Visual Basic



Business Process Automation with VBA

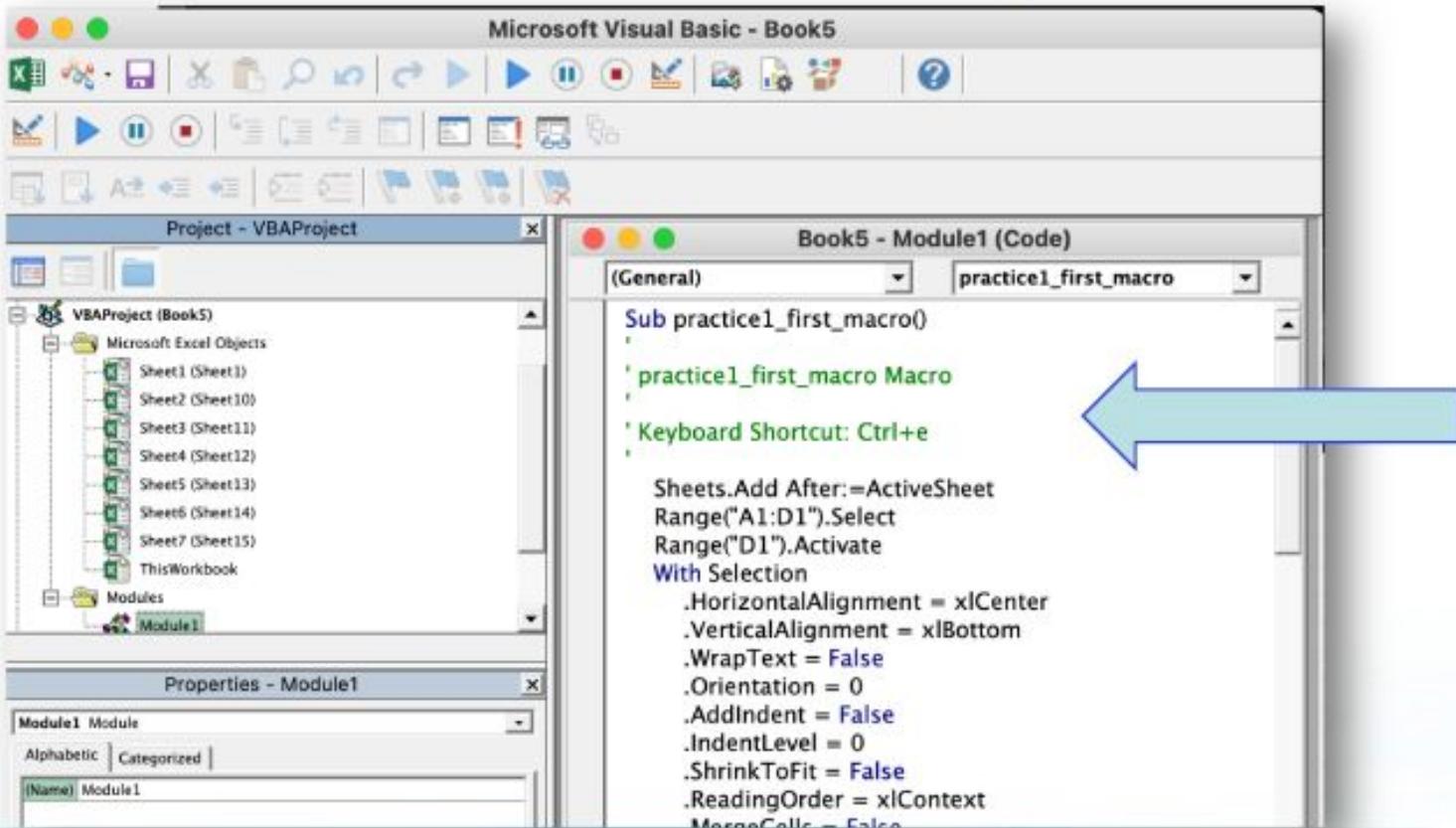
Entering Visual Basic Mode

- Integrated Development Environment (IDE)
- Modules = where codes are usually stored



Entering Visual Basic Mode

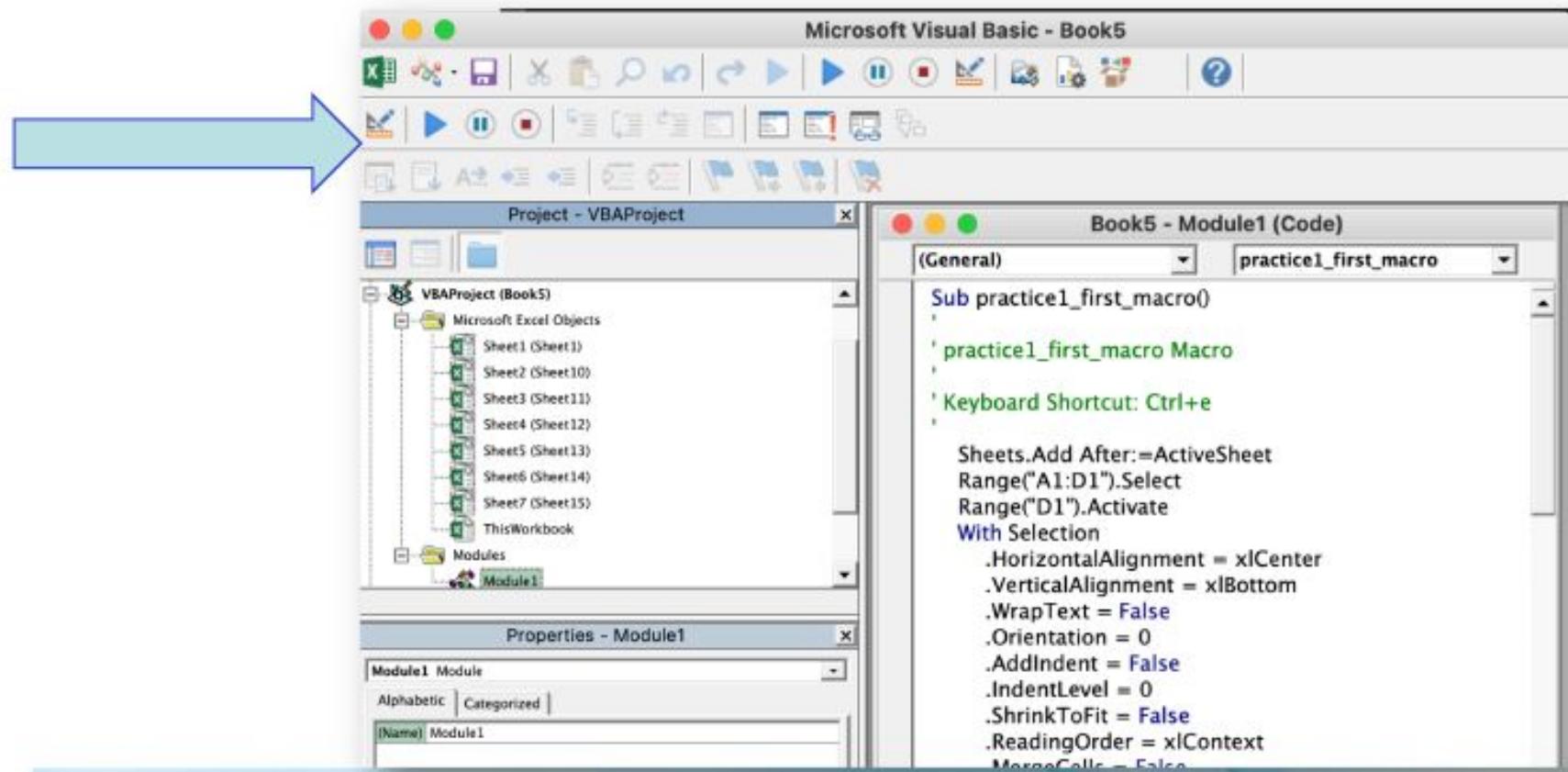
- Main editor on the right
- Modules → 1 or more “Sub” (sub-routines) or “Function”



Business Process Automation with VBA

Entering Visual Basic Mode

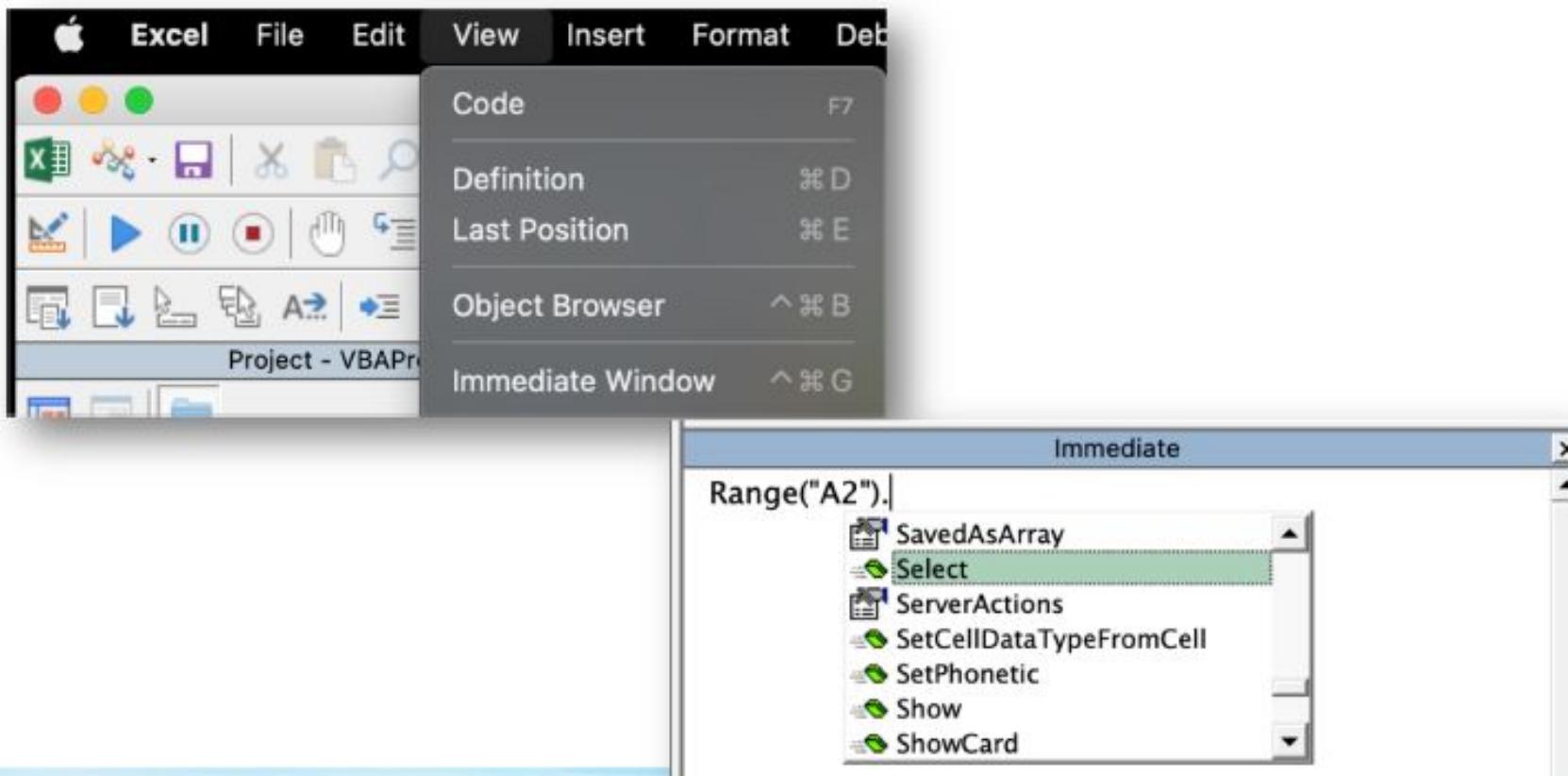
- Debugging toolbar at the top



Business Process Automation with VBA

Immediate Window

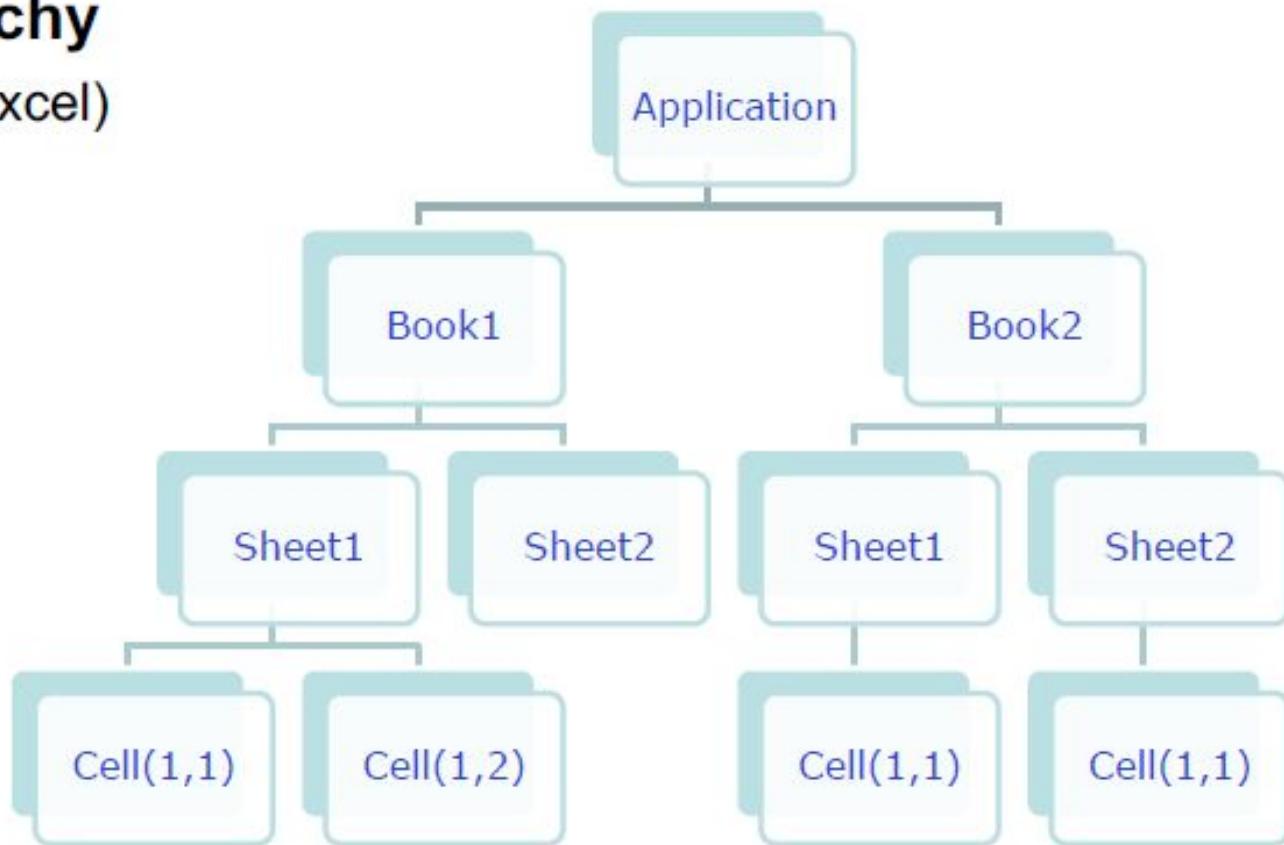
- View → Immediate Window
- Useful for trying out codes (Thanks to Auto-complete)



Business Process Automation with VBA

Object hierarchy

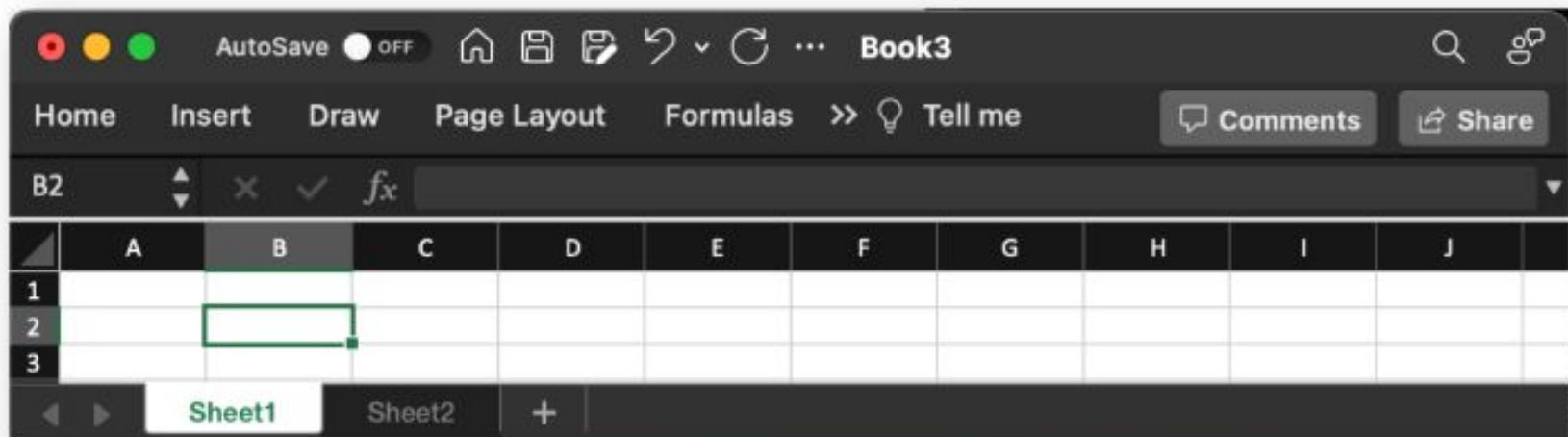
- Application (Excel)
- Workbooks
- Worksheets
- Cells



Business Process Automation with VBA

Object reference – Call something by name

- English: This man / that girl / “Mr. Chan”
- VBA
 - Application → Excel.Application / Outlook.Application / etc
 - Workbooks("Book1")
 - Worksheets("Sheet1") / Worksheets(1)
 - Cells(2,3)
 - Range("B2")



Object reference - Implied naming

- English: Here / Today
- VBA
 - ActiveWorkbook
 - ActiveSheet
 - Selection
 - If you write:
 - Range("A1:D1").Select
 - From that moment onwards:
 - Selection → Same as Range("A1:D1")

* ThisWorkbook

- This = Where the macro is stored
- Active = Changeable by user

Business Process Automation with VBA

Object reference - Offset

- English: Is it that building? No, the one on the right
- VBA
 - Range("B2").Offset(1, 2)
 - Worksheets(ActiveSheet.Index + 1).Select

	A	B	C	D
1				
2		B2		
3	1			
4		2		

Range("B2").Offset(1, 2)



Object reference – Offset

- Region
 - `Selection.CurrentRegion.Select`

B2	A	B	C
1			
2			
3			
4			
5			
6			
7			

- Boundary
 - `Range("A1").End(xlDown).Select`

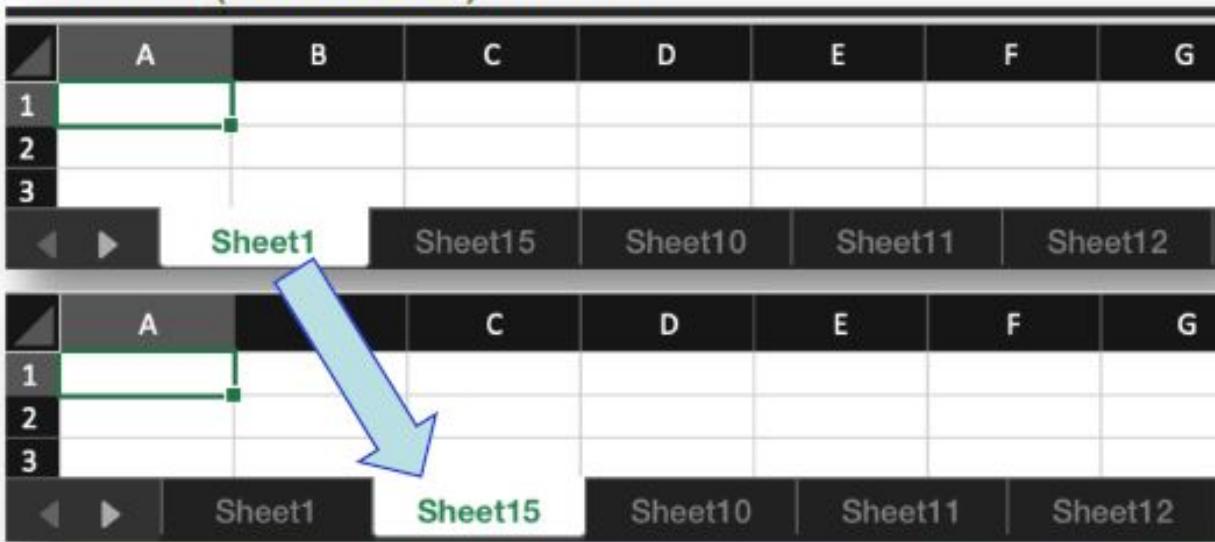
?`Range("A1").End(xlDown).Row`
6

A	1	1
2		2
3		3
4		4
5		5
6		6

Business Process Automation with VBA

Object properties – Actions

- English
 - Jackie runs / That person sings
- VBA (Actions are also known as Methods)
 - ActiveSheet.PrintOut
 - Workbooks("Book5").PrintPreview
 - Worksheets("Sheet15").Select



Business Process Automation with VBA

Object properties – More actions

- VBA – Some methods require parameters



- Copy & Paste
 - Range("B2").Copy Range("B3")
- Export to PDF
 - ActiveSheet.ExportAsFixedFormat Type:=xlTypePDF, Filename:="demo.pdf"

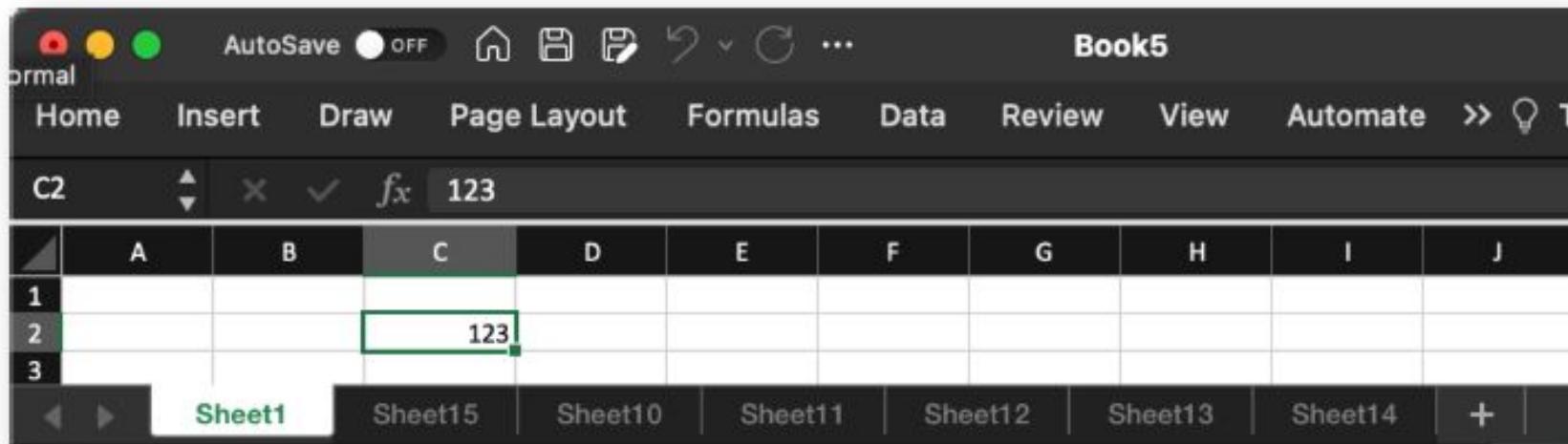
	A	B
1		
2		testing
3		testing
4		

Name	Size	Kind
demo.pdf	13 KB	PDF Document
Book5.xlsm	28 KB	Micros...(xlsm)

Business Process Automation with VBA

Object properties – Value

- English
 - HSBC → Account 123-654321-012 → Value → \$1000
- VBA
 - `Workbooks("Book5").Worksheets("Sheet1").Cells(2,3).Value = 123`



Object properties – Other properties

- VBA
 - Worksheets("Sheet1").Range("B2").Font.Size = 36
 - Worksheets("Sheet1").Range("B2").Font.Color = vbRed

	A	B	C
1			
2			
3		testing	

Object properties – Editing many properties

- “With” statement
 - Reduce redundancy
 - Example from Practice 1

The screenshot shows the Microsoft VBA Editor window titled "Book5.xlsxm - Module1 (Code)". The code editor displays the following VBA code:

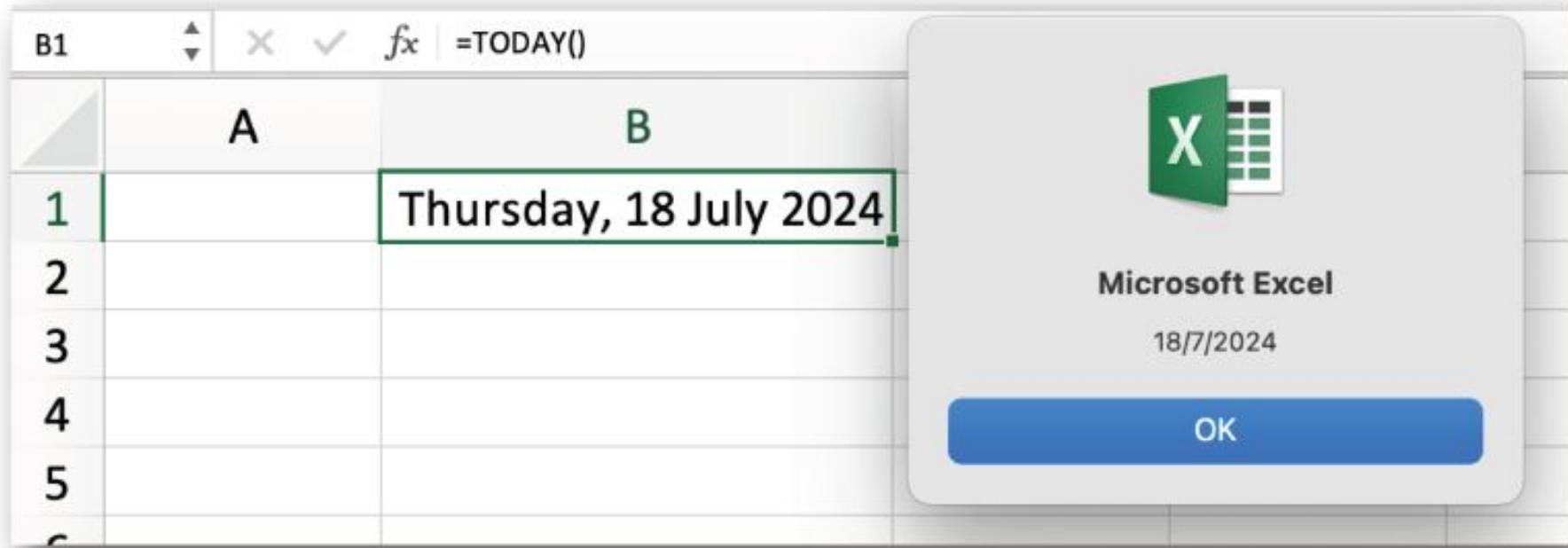
```
ActiveCell.FormulaR1C1 = "Application Form"
Range("A1:D1").Select
With Selection.Font
    .Name = "Calibri"
    .Size = 36
    .Strikethrough = False
    .Superscript = False
    .Subscript = False
    .OutlineFont = False
    .Shadow = False
    .Underline = xlUnderlineStyleNone
    .ThemeColor = xlThemeColorLight1
    .TintAndShade = 0
    .ThemeFont = xlThemeFontMinor
End With
```

The line "With Selection.Font" is highlighted with a blue rectangular selection box.

Business Process Automation with VBA

Object properties – Value check

- Use “MsgBox”
 - `MsgBox(Worksheets("Sheet1").Range("B1").Value)`



Business Process Automation with VBA

Object properties – Value check

- Use “Debug.Print()”

```
Sub HighlightCell()
    If Range("B1").Value > 50 Then
        Range("B1").Interior.Color = vbYellow
    Else
        Range("B1").Interior.Color = vbGreen
    End If
    Debug.Print (Range("B1"))
End Sub
```

40

- Use “?” in the immediate window
 - ?ActiveWorkbook.Sheets.Count
 - ?Range("B2").Formula

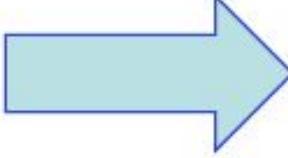
Immediate
?ActiveWorkbook.Sheets.Count
7

?Range("B2").Formula
=TODAY()

Business Process Automation with VBA

Checkpoint – Value swapping

- How to swap (switch) values between 2 cells?



The diagram illustrates the process of swapping values between two cells in a table. It consists of two tables separated by a large blue arrow pointing from left to right.

Initial State (Left):

	A	B
1		
2		ABC
3	DEF	

Final State (Right):

	A	B
1		
2		DEF
3	ABC	

Checkpoint – Value swapping

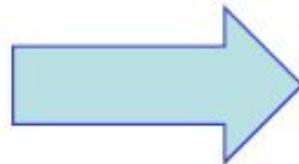
- How to swap (switch) values between 2 cells?
 - 1 solution...

	A	B
1		
2		ABC
3		DEF

	A	B
1		
2		DEF
3		ABC

	A	B
1		
2	ABC	
3	DEF	

1) Copy



	A	B
1		
2	ABC	
3	DEF	ABC

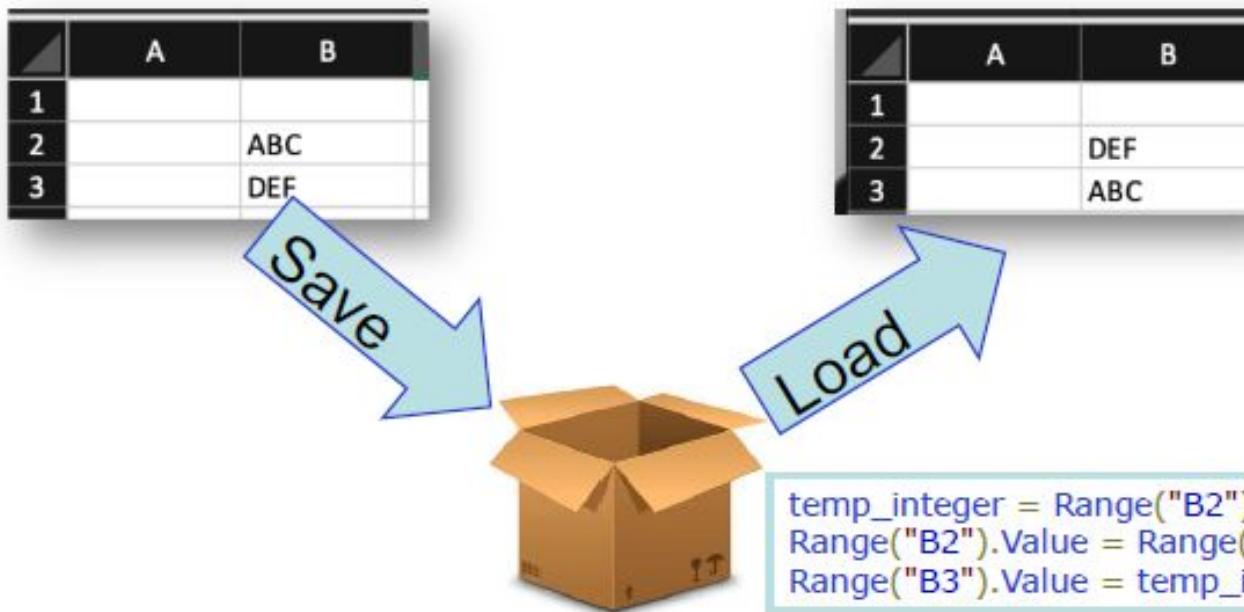
2) Overwrite



3) Clean up

Variables – Motivation

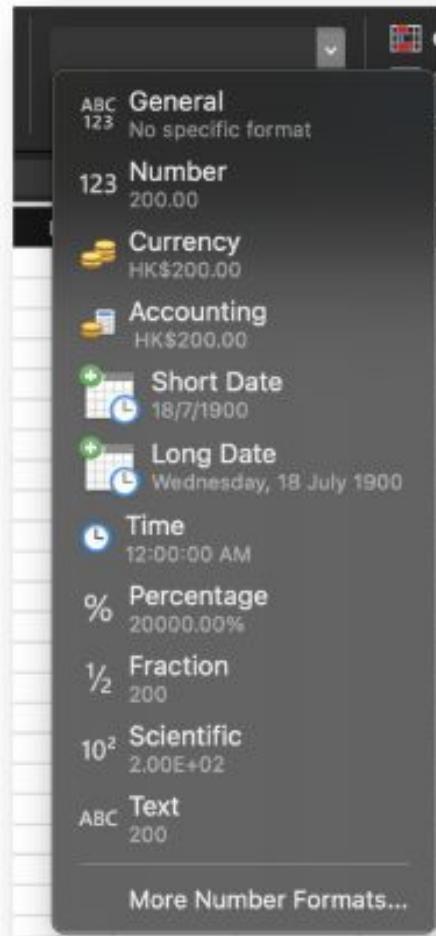
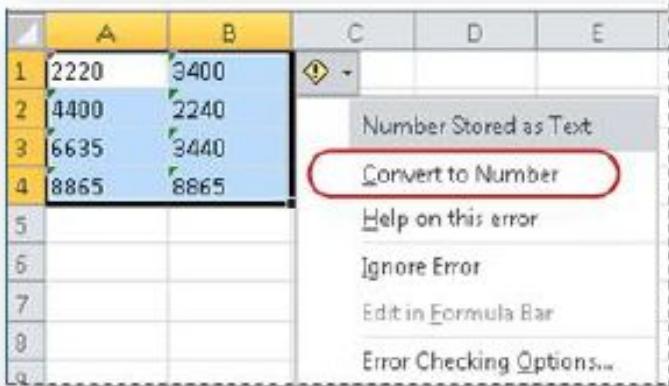
- Storage of values without changing the sheets
- Meaningful references during calculation



Business Process Automation with VBA

Variables – Data Types

- Excel is good at detecting types
 - Numbers / Date / Text
- Though sometimes can still be wrong



1. Fix text-formatted numbers by applying a number format - Microsoft Support. Fix Text-formatted Numbers by Applying a Number Format - Microsoft Support. <https://support.microsoft.com/en-us/office/fix-text-formatted-numbers-by-applying-a-number-format-6599c03a-954d-4d83-b78a-23af2c8845d0>

Variables – Data Types

- Best to define variables with types

Commonly Used VBA Data Types

Data Type	Bytes Used	Range of Values
Integer	2	-32,768 to 32,767
Long	4	-2.147 Billion to 2.147 Billion
Single	4	45 digits (left or right of decimal point)
Double	8	308 digits (left or right of decimal point)
Currency	8	-922 T to 922 T (4 digits after decimal point)
Date	8	1/1/100 to 12/31/9999
Boolean	2	True or False
String	1 per char	Varies according to number of characters
Variant	Varies	Any data type

Variables – Data Types

- Integer
 - Dim year As Integer
 - year = 2024
- Double
 - Dim pi As Double
 - pi = 3.14125
- Smart conversion during calculation



?TypeName("A" & 3)
String

?"A"&3
A 3

?TypeName(2)
Integer

?TypeName(3.3)
Double

?TypeName(2 * 3.4)
Double

?TypeName(5-3)
Integer

Variables – Data Types

- Date
 - Dim today As Date
 - today = DateSerial(2024, 7, 1)
 - today = Date()
- String
 - Dim message As String
 - message = "Welcome!"
- Boolean
 - Range("A1").Font.Bold = True
 - Range("A1").Font.Underline = False



Common functions - Numbers

- IsNumeric() → Check if a text is number

```
?IsNumeric("123")  
True
```

```
?IsNumeric("ABCD")  
False
```

- CInt() / CDbl() → Text to number

```
?CInt("123")  
123
```

```
?CInt("123.45")  
123
```

```
?CDbl("123.45")  
123.45
```

```
?CDbl("123")  
123
```

Common functions - Numbers

- Round() → Rounding to a certain decimal place

```
?Round(5.1234)  
5
```

```
?Round(5.1234, 2)  
5.12
```

- Log() / Exp() → For financial / engineering calculation

```
?exp(2)  
7.38905609893065
```

```
?log(10)  
2.30258509299405
```

```
?log(exp(1))  
1
```

Common functions - Date

- DateSerial → Create a date literal

```
?DateSerial(2024, 12, 25)  
25/12/2024
```

- Date() → Today's date

```
?Date()  
18/7/2024
```

- Year() / Month() / Day() → Extract

```
?Year(DateSerial(2024, 12, 25))  
2024
```

```
?Month(DateSerial(2024, 12, 25))  
12
```

```
?Day(DateSerial(2024, 12, 25))  
25
```

Business Process Automation with VBA

Common functions - Date

- DateDiff – Difference of 2 dates

The screenshot shows the Microsoft Excel environment with the VBA DateDiff Function Template.xlsm file open. The formula bar displays "Run Sub/UserForm (F5)". The code editor window shows a Subroutine named DateDiff_Example1(). It declares two Date variables (Date1, Date2), initializes them with specific dates ("15-01-2018" and "15-01-2019"), calculates the difference using DateDiff("D", Date1, Date2), and displays the result (365) in a message box.

```
Sub DateDiff_Example1()
    Dim Date1 As Date
    Dim Date2 As Date
    Dim Result As Long

    Date1 = "15-01-2018"
    Date2 = "15-01-2019"

    Result = DateDiff("D", Date1, Date2)
    MsgBox Result
End Sub
```

The code editor also contains two additional lines of code:

```
?DateDiff("M", DateSerial(2024, 12, 1), DateSerial(2024, 12, 10))  
0  
  
?DateDiff("M", DateSerial(2024, 11, 30), DateSerial(2024, 12, 1))  
1
```

A yellow arrow points from the word "DateDiff" in the subroutine call to the tooltip definition of the DateDiff function. Another yellow arrow points from the highlighted line of code to the value "365" displayed in the message box.

Common functions - String

- **CDate()** → Text to Date

```
?CDate("2023-03-25")  
25/3/2023
```

```
?CDate("April 1, 2023")  
1/4/2023
```

```
?CDate("25/2")  
25/2/2023
```

- **Format()** → Date to Text

```
?Format(DateSerial(2023, 3, 25), "M")  
3
```

```
?Format(DateSerial(2023, 3, 25), "MM")  
03
```

```
?Format(DateSerial(2023, 3, 25), "MMM")  
Mar
```

```
?Format(DateSerial(2023, 3, 25), "MMMM")  
March
```

```
?Format(DateSerial(2023, 3, 25), "DD-MMM-YYYY")  
25-Mar-2023
```

Common functions - String

- Left() / Right() → Substring

```
?Left("0005.HK", 4)  
0005
```

```
?Right("0005.HK", 2)  
HK
```

- Split() → Tokenizing into a string array

```
?Split("A,B,C", ",")(0)  
A
```

```
?Split("A,B,C", ",")(2)  
C
```

```
?UBound(Split("A,B,C", ","))  
2
```

Common functions - String

- Trim() → Remove empty spaces
 - Note: "" gives 1 quote
- InStr(x, y) → Find y in x
 - Case sensitive

```
?"""" & Trim("Hello! ") & """"  
"Hello!"
```

```
?InStr("Search here", "Search")  
1
```

```
?InStr("Search here", "here")  
8
```

```
?InStr("Search here", "nothing")  
0
```

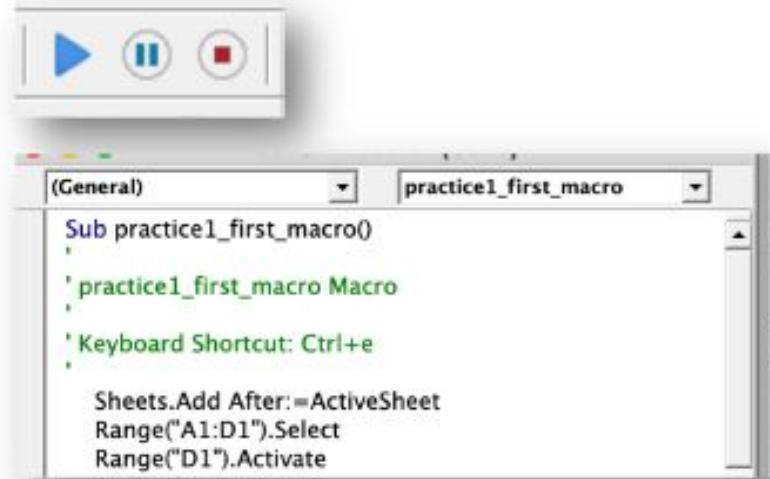
```
?InStr("Search here", "search")  
0
```

```
?Lcase("HeLLo")  
hello
```

```
?InStr(Lcase("Search here"), "search")  
1
```

Sub-routines

- Macros recorded are wrapped with “Sub … End Sub”
- Sub-routines are just reusable codes
- Within the scope of a sub-routine
 - Click the “Play” button to execute



Control flow – If, Then, Else

- Example: speed check

	A	B
1	Speed	40
2		
	A	B
1	Speed	50
2		
	A	B
1	Speed	70
2		

```
Sub HighlightCell()
```

```
    If Range("B1").Value > 50 Then  
        Range("B1").Interior.Color = vbYellow  
    Else  
        Range("B1").Interior.Color = vbGreen  
    End If
```

```
End Sub
```

Control flow – If, Then, Else

- Mark → Grade

<i>Mark</i>	<i>Letter Grade</i>
90+	A+
85-89	A
80-84	A-
77-79	B+
73-76	B
70-72	B-
67-69	C+
63-66	C
60-62	C-
57-59	D+
50-56	D
0-49	F

Control flow – Select, Case

- Range check

```
?GetGrade(90)  
A
```

```
?GetGrade(80)  
B
```

```
Function GetGrade(score As Integer) As String  
    Select Case score  
        Case Is >= 90  
            GetGrade = "A"  
        Case Is >= 80  
            GetGrade = "B"  
        Case Is >= 70  
            GetGrade = "C"  
        Case Is >= 60  
            GetGrade = "D"  
        Case Else  
            GetGrade = "F"  
    End Select  
End Function
```

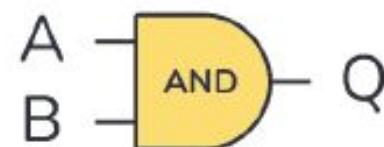
Control flow – Select, Case

- Grade → Marks

```
Dim letter_grade As String  
Dim grade_point As Double  
  
Select Case letter_grade  
Case "A", "A+"  
    grade_point = 4.0  
Case "A-"  
    grade_point = 3.7  
Case "B+"  
    grade_point = 3.3  
...  
Case Else  
    grade_point = 0.0  
End Select
```

Control flow – Conditions

- AND
 - (True AND True) → True
 - e.g., Month validity: $1 \leq \text{month} \text{ AND } \text{month} \leq 12$
- OR
 - (True OR False) → True
 - e.g., Game Area: $\text{gold} > 1000 \text{ OR } \text{level} > 10$
- NOT
 - NOT $x=0$ is same as $x \neq 0$



A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

Loops – Using “For”

- Iterating through the rows
- What is changing?
 - A1 → A2 → A3 → A4...



	A	B	C
1	1		
2	2		
3	3		
4	4		
5	5		
6	6		
7	7		
8	8		
9	9		
10	10		

```
Sub LoopThroughRows()
    For i = 1 To 10
        Range("A" & i).Value = i
    Next i
End Sub
```

Loops – Using “For”

- Iterating through the columns
- Again, track the change: A1 → B1 → C1 → ...
- Option 1: Make use of offset()

	A	B	C	D	E	F	G	H	I	J
1	1	2	3	4	5	6	7	8	9	10
2										

```
Sub LoopThroughColumns()
    For i = 1 To 10
        Range("A1").Offset(0, i - 1).Value = i
    Next i
End Sub
```

Loops – What is happening?

- Temporary variable + “Array”

```
Sub LoopThroughRows()
    For i = 1 To 10
        Range("A" & i).Value = i
    Next i
End Sub
```

```
Sub LoopThroughColumnsWithCells()
    Dim i As Integer: i = 1
    For Each cell In Range("A1:J1").Cells
        cell.Value = i
        i = i + 1
    Next cell
End Sub
```

Loops – What is happening?

- Array = many variables

VBA Arrays

The screenshot shows the Microsoft Visual Basic for Applications (VBA) environment. On the left, an Excel spreadsheet window displays a table with columns A and rows 1 to 5. The value 20 is highlighted in red in cell A1. On the right, the VBA editor window has the title "Microsoft Visual Basic for Applications - VBA Arrays ...". It contains the following code:

```
Sub Array_Example()
    Dim x(1 To 5) As Long, i As Integer
    x(1) = 20
    x(2) = 25
    x(3) = 44
    x(4) = 78
    x(5) = 96
    For i = 1 To 5
        Cells(i, 1).Value = x(i)
    Next i
End Sub
```

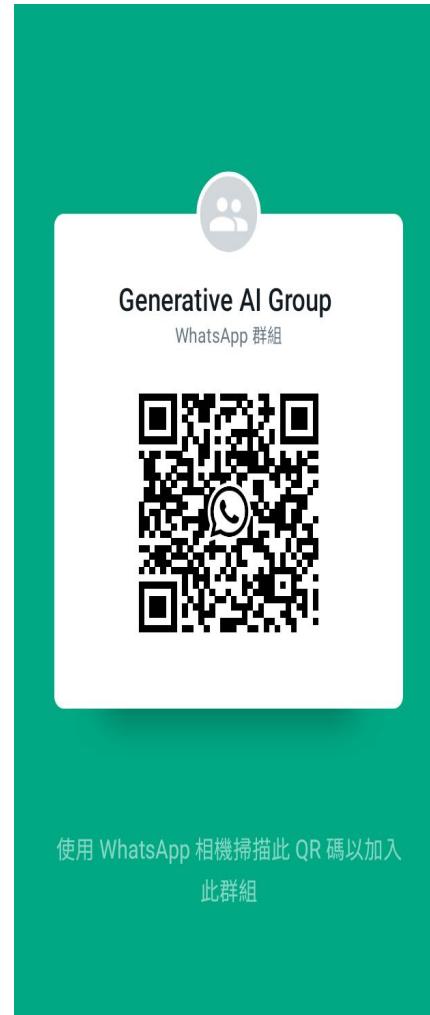
The status bar at the bottom of the VBA editor shows "Run Sub/UserForm (F5) | Code".



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學習體驗調查以匿名方式進行，完成的問卷交由質量數據分析組處理。



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