

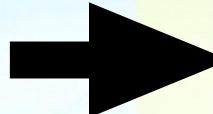


Business Process Automation with VBA and Python

Mr. Eddie Chow / 10 January 2026



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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



Lecturer Biography

<https://www.linkedin.com/in/eddie-chow-a3860464/>



- Founder of InnoVi, Co-founder of 4 companies, covering from property, retail, education and ESG
- 19+ Years' programming experience, including 7 Years' IT Management Experience
- 7 years' teaching experience in tertiary education
- 10+ years' coaching or mentoring experience on large project development..
- Development experience on blockchain, computer vision, machine learning/deep learning
- Researcher in Cutting-edge AI Research, particular in area in Computer vision
- AI Tech Speaker, AI Mentor
- Personal Website : eddiecityu.github.io





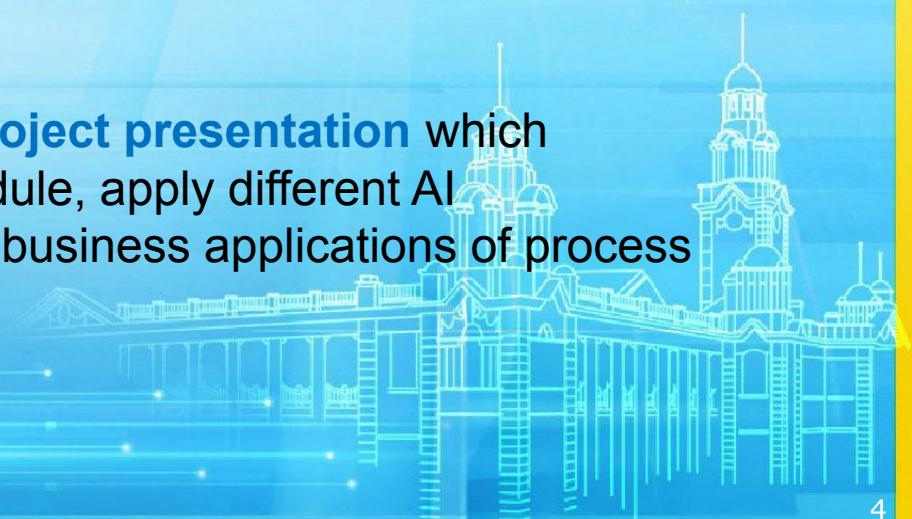
Assessment

- **Continuous Assessment**

In-class discussions and computer assignments which include the usage of different applications & methodologies

- **Final Assessment**

20-mins (3 persons) group project presentation which integrate knowledge in this module, apply different AI methodologies and software to business applications of process automation





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



Intended Learning Outcomes

1. describe the contemporary trends of process automation and explain the opportunities and challenges of business process automation;
2. outline key steps in process automation project management and illustrate the significance of each step;
3. apply computational tools to implement process automation;
4. discuss the development of process automation and practical cases for business.

Assessment

Memory Test?

- NO Midterm / Final exams

Essays?

- NO research paper
- NO project report

Practical Work!

- 2 in-class coding exercises
- 1 Group Project



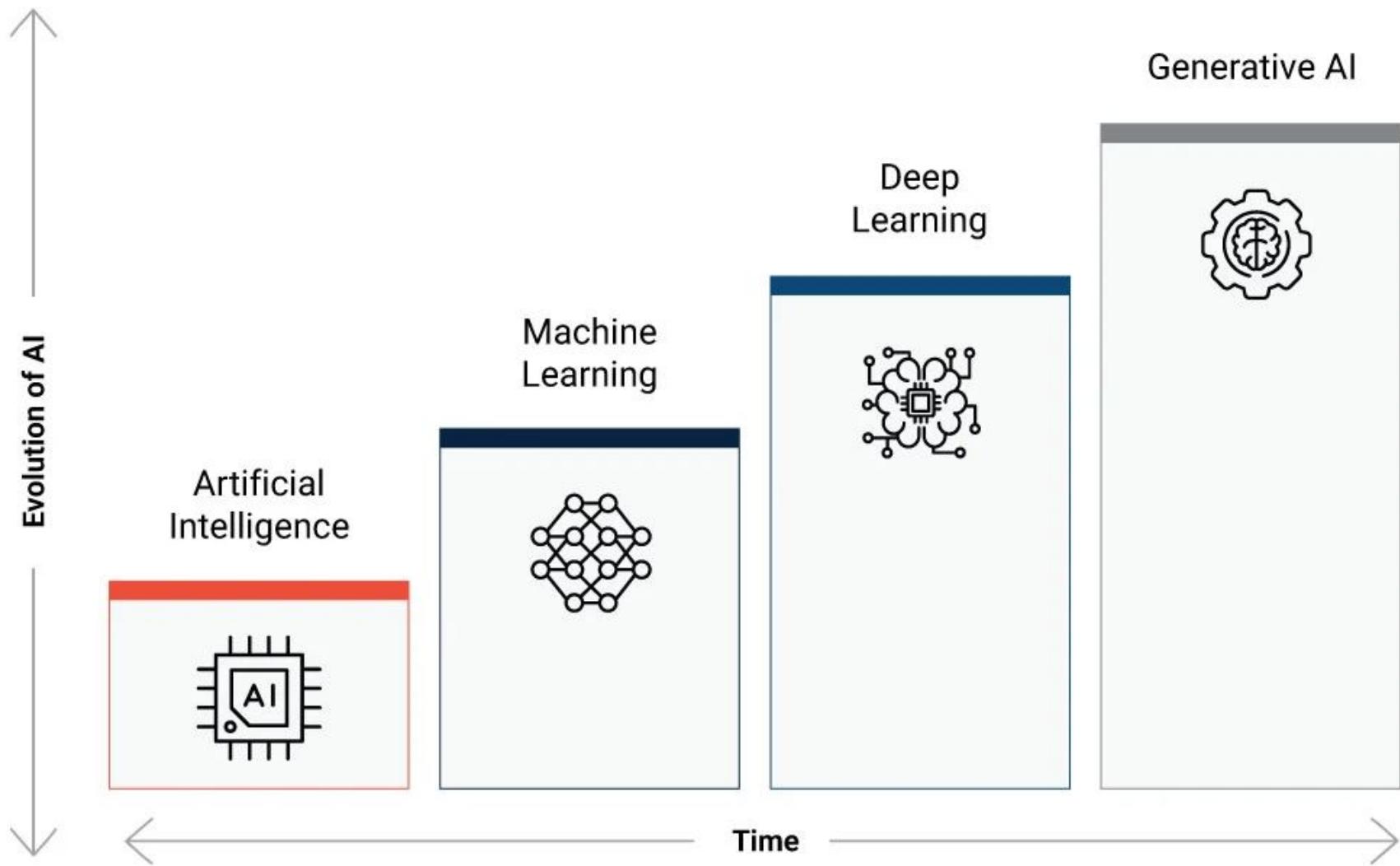
Taking
Exams

Building
Solutions

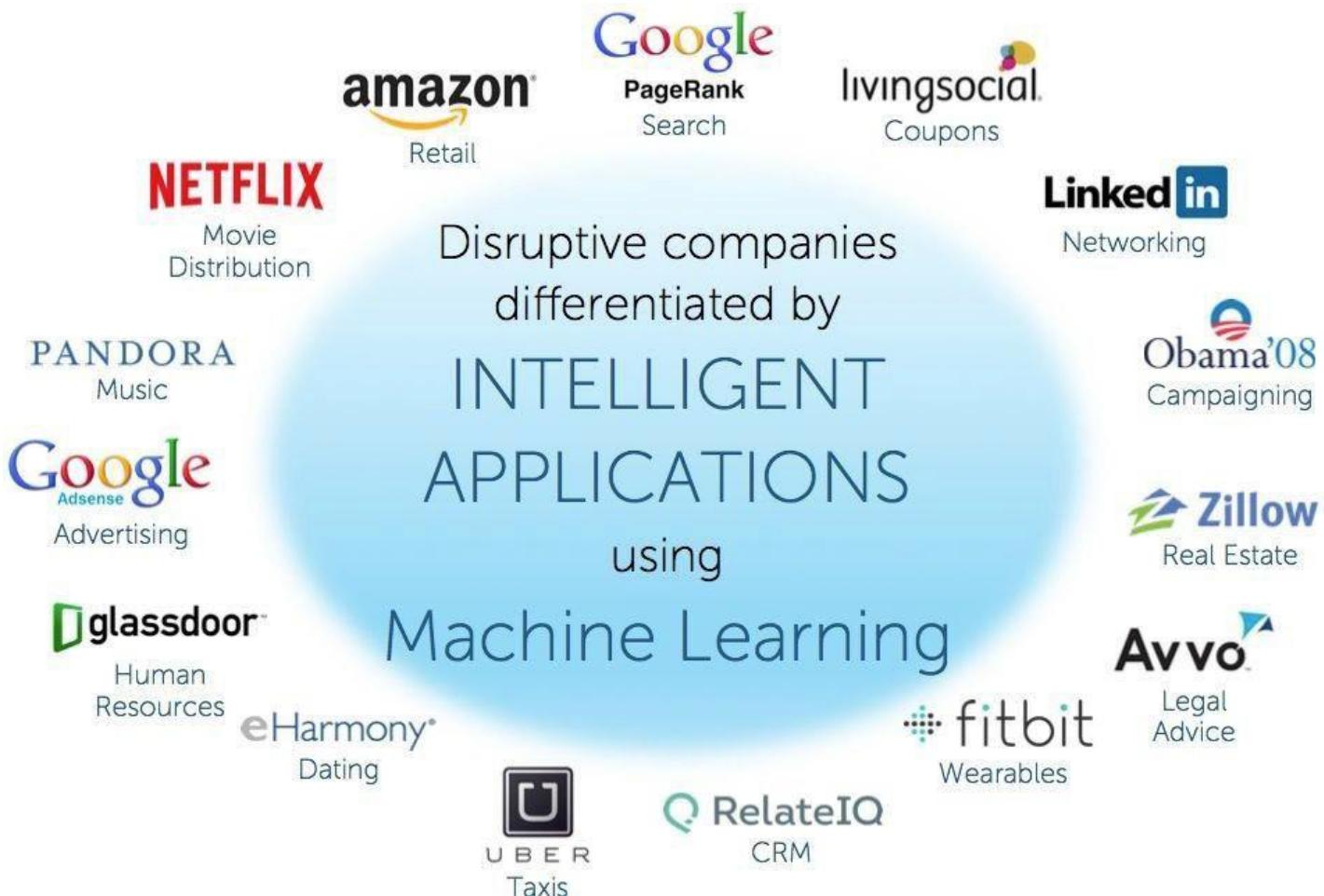
Lecture 1 - Business Process Automation with VBA and Python



Overall Artificial Intelligence Journey



The new disruptors



Machine Learning Business Use Case

Face Recognition Algorithm



Cases : Facial recognition for customer analytics



Face Detection

Reliably detect human faces in a photo, along with their coordinates and sizes.



Emotions, Gender, Age

Recognize people's facial expressions and detects primary and secondary emotions. Also detects age and gender

<https://findface.pro/en/solutions/face-recognition-for-customer-analytics.html>

Shifting mindsets of customers: From Products To Relationships



Products
1970s



Customer
Centric



Relationship
Centric Today

These companies applied analytics to stay 1 step ahead of the competition



AI Features in Retail

- Chatbots, Virtual Assistants
- Facial Recognition
- Demographic Segmentation
- Facial Personality Analytics
- AI-enabled Customer Analytics
- Real-time insights
- Personalization
- Inventory Management
- Visual Recognition
- Customer Purchase Prediction
- Trend Prediction
- Purchasing Recommendation
- Ideal Price Point Recommendation
- Predict the trends in Fashion, e-commerce, etc
- Predictive Analysis
- Predictive Personalization

Business Case Studies: Artificial Intelligence

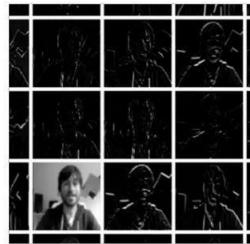
Artificial Intelligence

Common Use Cases:

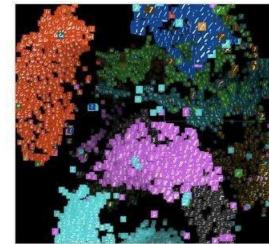
Object Detection
Speech Recognition
Natural Language Processing
Translation between languages
Creativity - Style Transfer
Art Restoration



TEACHABLE MACHINE



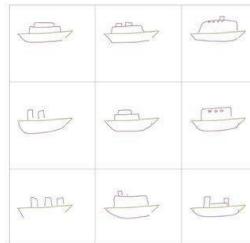
WHAT NEURAL NETWORKS SEE



VISUALIZING HIGH-DIMENSIONAL SPACE



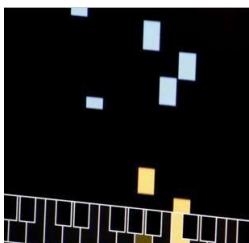
QUICK, DRAW!



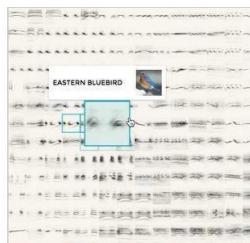
SKETCH-RNN DEMOS



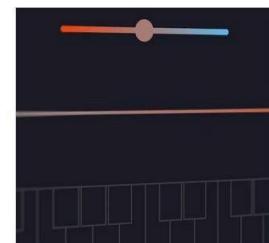
HANDWRITING WITH A NEURAL NET



AI DUET



BIRD SOUNDS



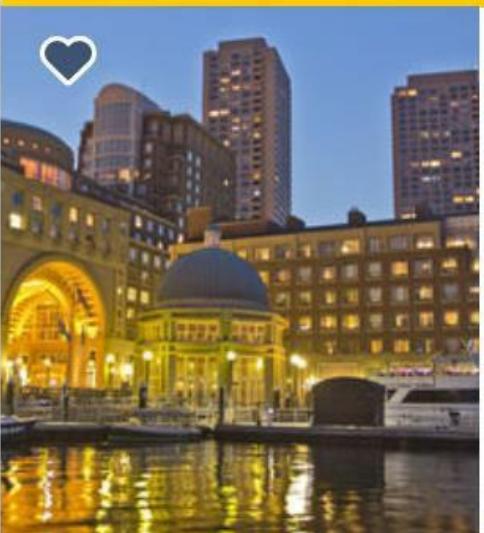
NSYNTH: SOUND MAKER

NLP in real life

- Machine Translation
 - Google Translate translates language from one language to another.
- Text Simplification
 - Rewordify simplifies the meaning of sentences.
- Sentiment Analysis
 - Hater News gives us the sentiment of the user.
- Text Summarization
 - Smmry or Reddit's autotldr gives a summary of sentences.
- Auto-Predict
 - Google Search predicts user search results.
- Auto-Correct
 - Google Keyboard and Grammarly correct words otherwise spelled wrong.
- Speech Recognition
 - Google WebSpeech or Vocalware.
- Question Answering
 - IBM Watson's answers to a query.
- Natural Language Generation
 - Generation of text from image or video data

Machine Learning Business Use Case

Hotel Recommendation Engine



A photograph of the Boston Harbor Hotel at night, showing its illuminated facade and a dome-shaped structure reflected in the water. A small heart icon is in the top left corner of the image.

Boston Harbor Hotel

★★★★★

Downtown Boston

Come Experience our 5 Star Luxury Hotel.

Iconic Waterfront Hotel with a Convenient Location to Everything Boston Has to Offer. Every Room Boasts City or Harbor Views.

1-866-286-0843 • Expedia Rate

👁 Viewed

4.8/5 Exceptional!
(1,132 reviews)

\$693-\$581

nightly price
Sponsored

[Get member price](#)

People who looked at the Boston Harbor Hotel also viewed these:



Four Seasons Hotel Boston

★★★★★

\$645



The Ritz-Carlton, Boston

★★★★★

\$595

Introduction to Business Process Automation

What is Business Automation?

From ChatGPT...

JA

What is business automation? asking for a friend :)

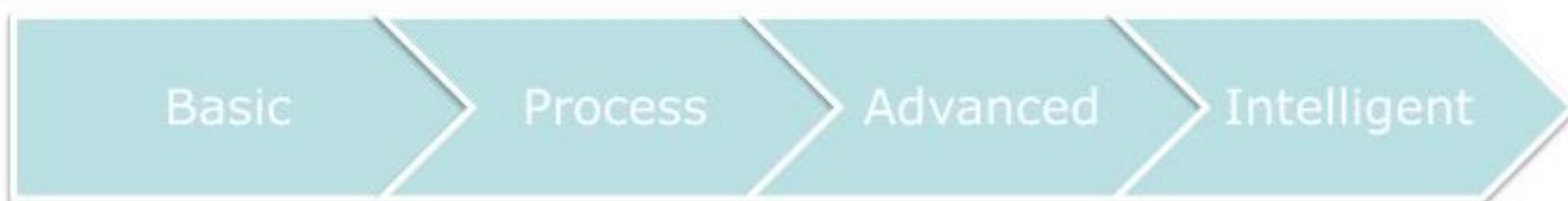


Business automation refers to the process of using technology to automate repetitive or routine tasks and processes within a business, such as data entry, invoicing, and inventory management. It can also involve the integration of various software applications and systems to streamline workflows and improve overall efficiency.

Introduction to Business Process Automation

Types of Business Automation

1. Basic Automation
2. Process Automation
3. Advanced Automation
4. Intelligent Automation



1. *The Basics of Business Automation.* (2021, May 12). The Basics of Business Automation | IBM.
<https://www.ibm.com/cloud/blog/basics-of-business-automation>

Introduction to Business Process Automation

Types of Business Automation – Basic Automation

- **Target →** Simple / Repetitive tasks
- **Why**
 - Eliminate human errors
 - Accelerate pace of transactional work
- **Example →** Robotic Process Automation (RPA)*



* To be covered in the next section

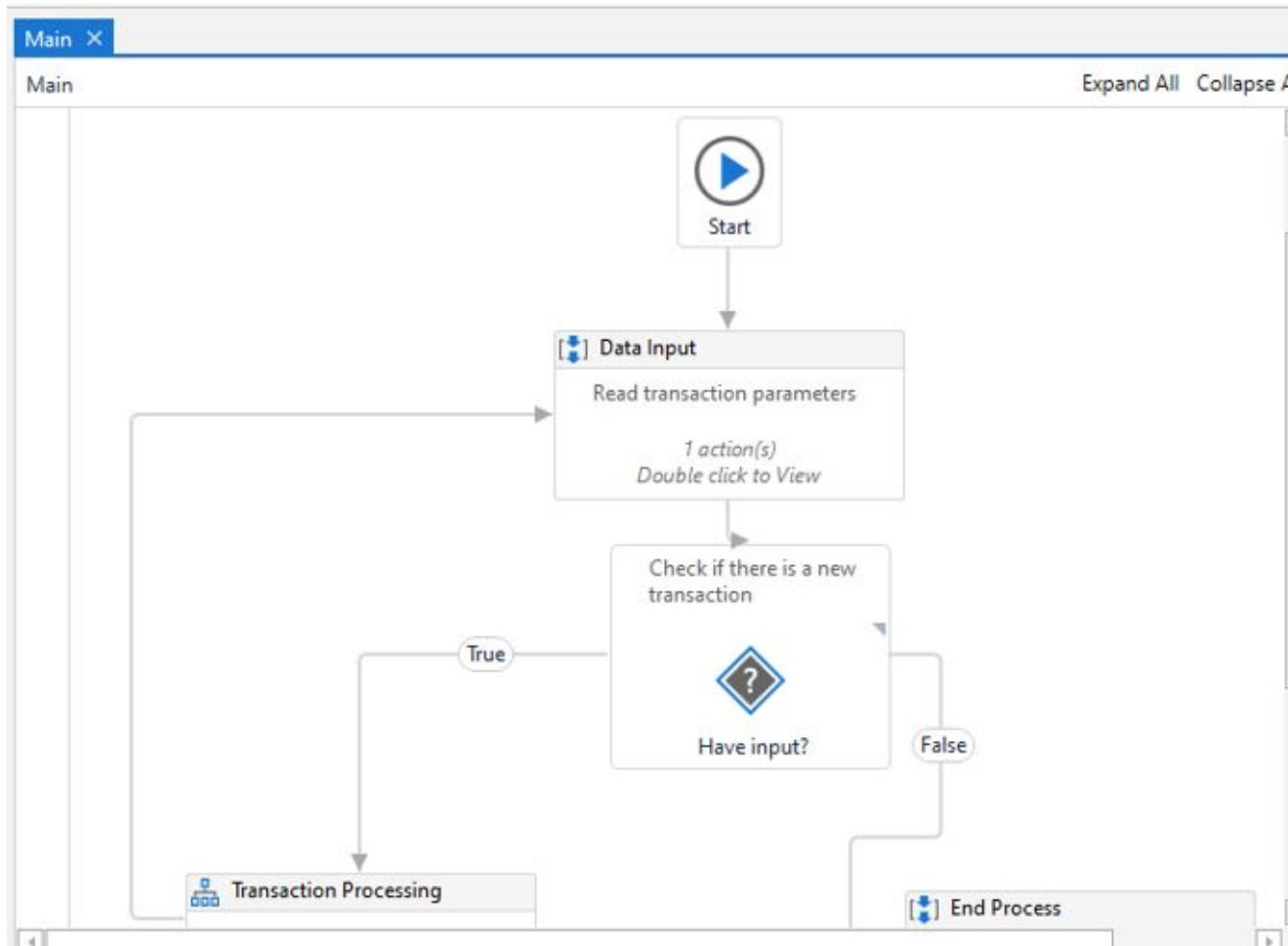
Introduction to Business Process Automation

Types of Business Automation – Process Automation

- **Target →** Process requiring dedicated solutions
- **Why**
 - Increase productivity and efficiency
- **Example →** Process Mining, workflow automation



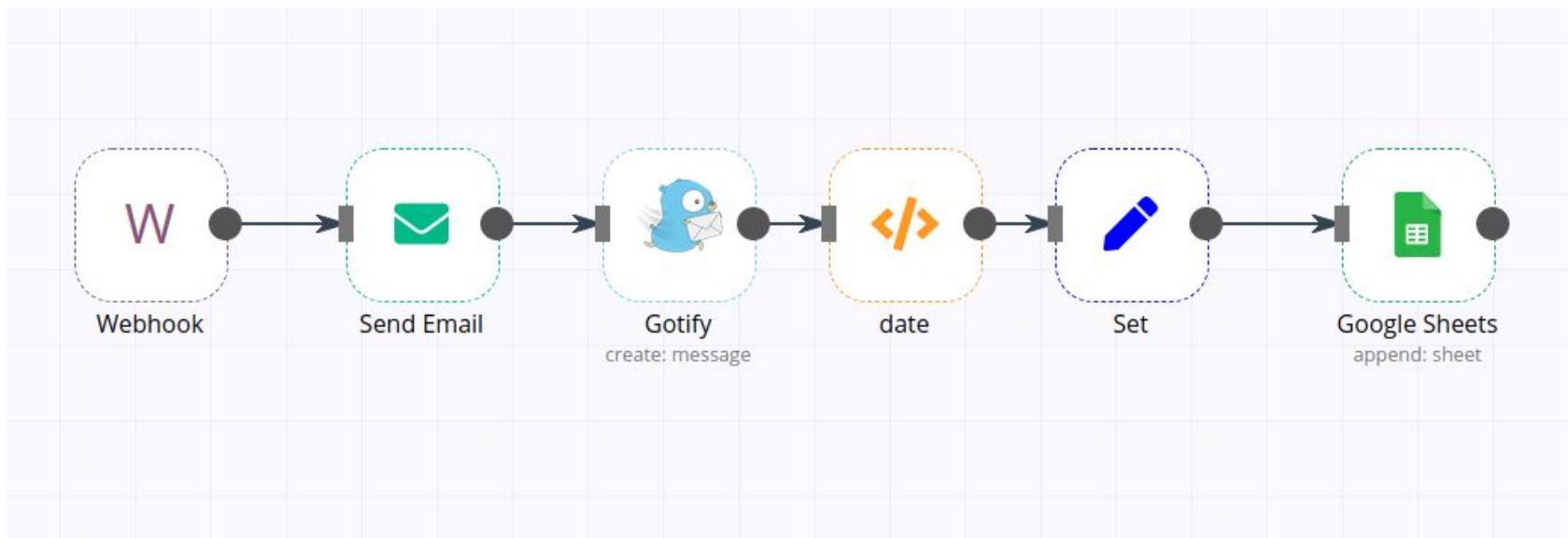
Process Automation Software Example 1 : UiPath



<https://www.uipath.com/rpa/robotic-process-automation>

Process Automation Software Example 2 : n8n

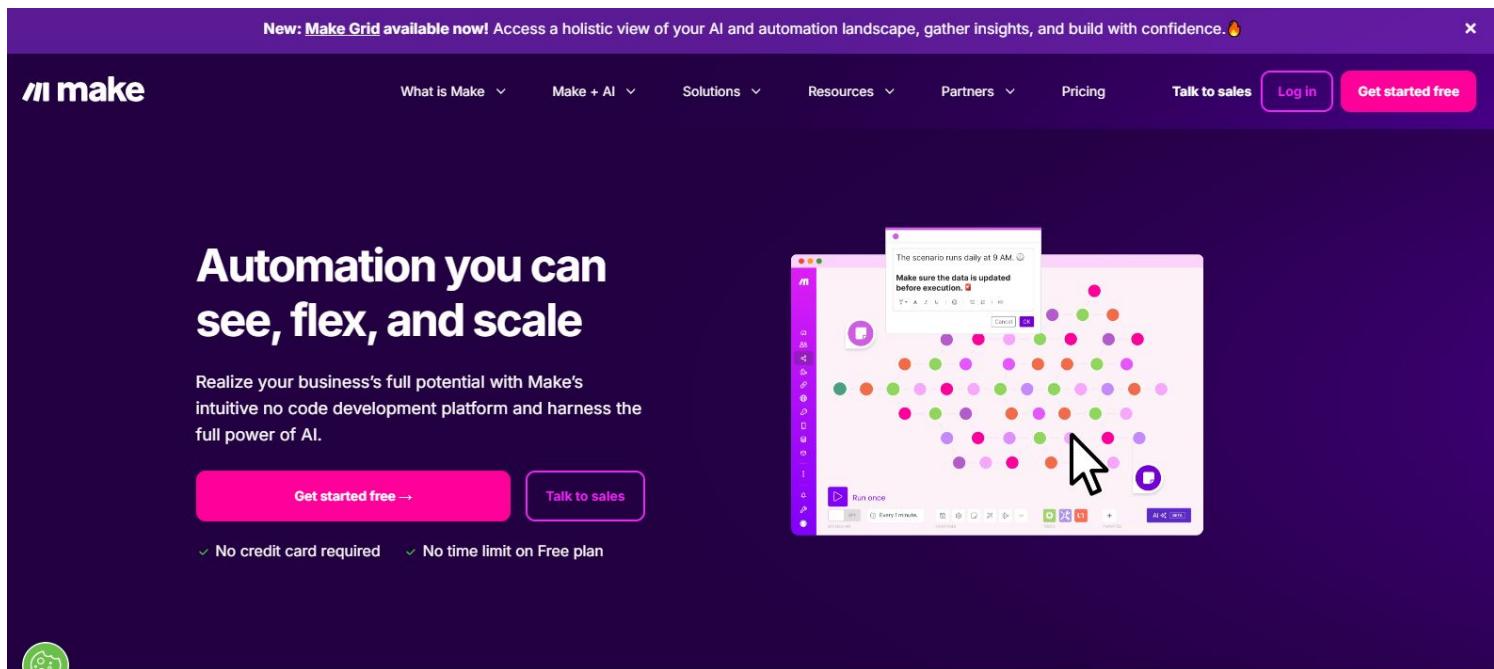
Simple enough to ship in hours, sophisticated enough to scale. n8n lets you automate business processes without limits on your logic.



<https://n8n.io/features/>

Practical Exercise - Process Automation (Make.com)

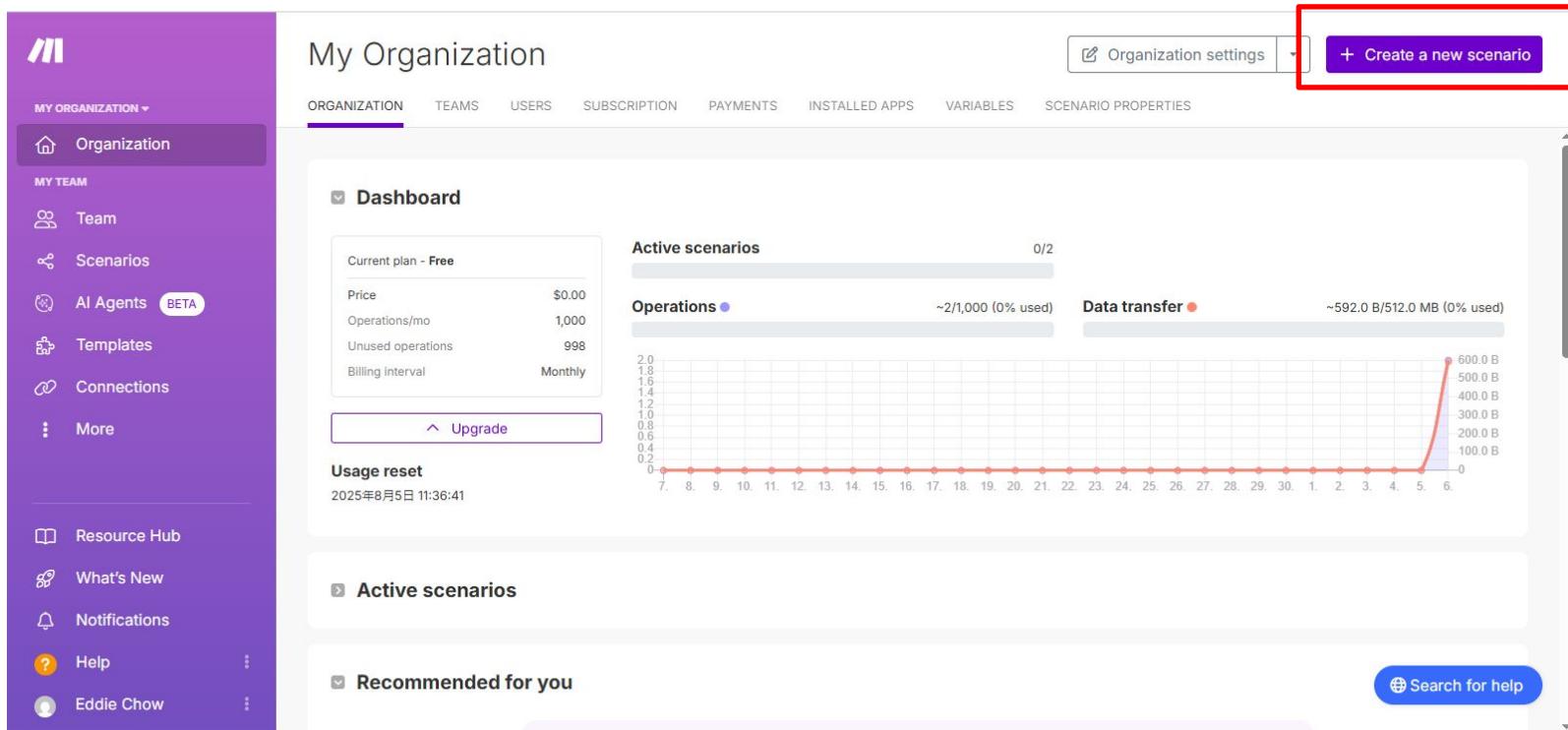
Go to <https://www.make.com/en>



Click “Get started free” or enter <https://www.make.com/en/login>

Practical Exercise - Process Automation (Make.com)

Sign in with Google



The screenshot shows the Make.com dashboard under the 'My Organization' tab. The left sidebar has a purple header 'MY ORGANIZATION' with options like 'Organization' (selected), 'Team', 'Scenarios', 'AI Agents (BETA)', 'Templates', 'Connections', 'More', 'Resource Hub', 'What's New', 'Notifications', 'Help', and 'Eddie Chow'. The main dashboard has a 'Dashboard' section with a 'Current plan - Free' summary table:

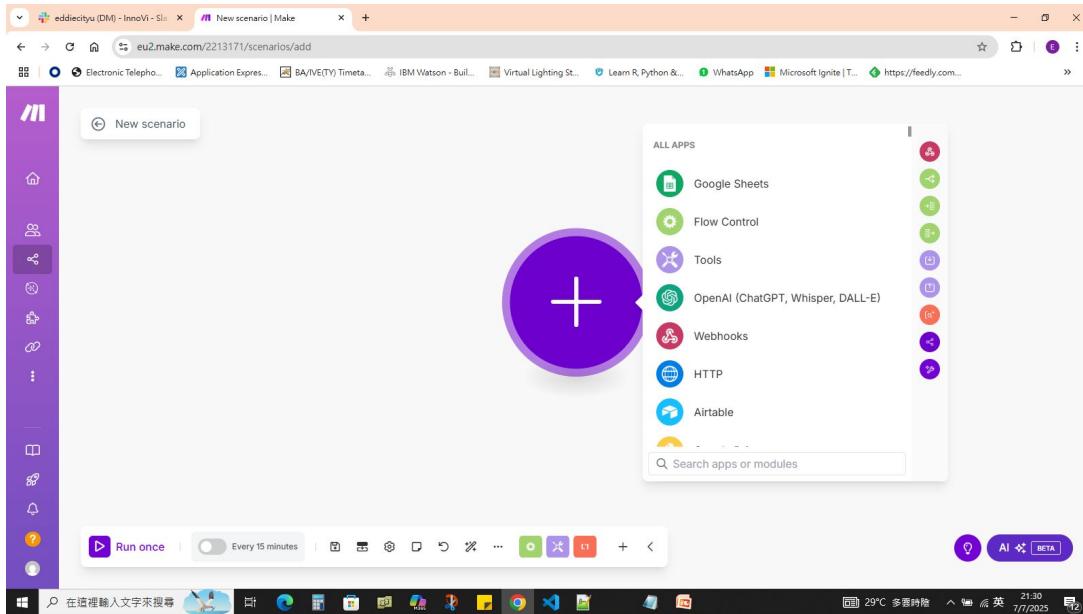
	Current plan - Free
Price	\$0.00
Operations/mo	1,000
Unused operations	998
Billing interval	Monthly

Below this is an 'Upgrade' button. To the right is a chart titled 'Usage reset' showing data transfer over time, with a sharp spike at the end of the month. The chart area includes sections for 'Active scenarios', 'Operations', and 'Data transfer'. At the top right of the dashboard is a purple button labeled '+ Create a new scenario', which is highlighted with a red box.

Click “Create a new scenario”

Practical Exercise - Process Automation (Make.com)

An interface with module is displayed



Create Module “Weather” -> Click “Get daily weather forecast”

Practical Exercise - Process Automation (Make.com)

Enter Days “9 days from today” and City “Hong Kong”
-> Click “Save”

Right-Click and select “Run this module only”

The screenshot shows the Make.com platform interface. On the left, there's a sidebar with various icons. In the center, there's a module titled "Weather" with the sub-instruction "Get current weather". A context menu is open over this module, listing options: "Settings", "Run this module only" (which is highlighted in blue), "Add a module", "Add error handler", "Rename", "Clone", "Copy module", "Copy a note", and "Delete module". Below the module, there are two tabs: "Run once" and "Every 15 minutes". At the bottom, there are several small icons for file operations like copy, paste, and delete, along with buttons for "AI", "META", and a plus sign.

On the right, there's a detailed view of the "Weather" module's configuration. It shows the "Initialization" and "Operation 1" steps. Under "Operation 1", there's an "INPUT" section with a "Bundle 1" collection containing "City: Hong Kong" and "Days: (empty)". There's also a note: "I want to enter a location by: name". The "OUTPUT" section shows a "Bundle 1" collection with "Date: 2025年7月16日 12:00", "Temperature: (Collection)", "Atmosphere pressure: 997", "Air humidity: 80", "Cloudiness: 100", "Wind: (Collection)", "Rain: 7.92", "Status: Rain", "Code: 500", and "Description: light rain". Below this, there are "Commit" and "Finalization" buttons.

You can view an output file in JSON format

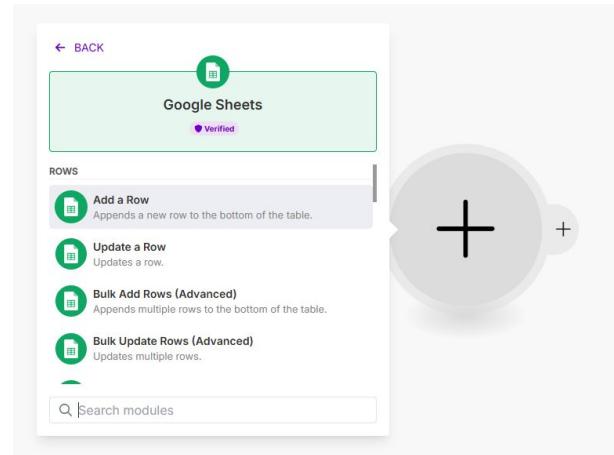
Practical Exercise - Process Automation (Make.com)

Open drive.google.com -> create an google sheet named "Weather Data"

Create an header as follow:

Date	Temperature	Air humidity	Wind	Rain
------	-------------	--------------	------	------

Return to make interface, in the right side of Weather icon, Click “Add another module” -> create “Google Sheets” -> Select “Add a Row”



Automation for updating weather data in google sheet

In Spreadsheet ID, click button “Click here to choose file”

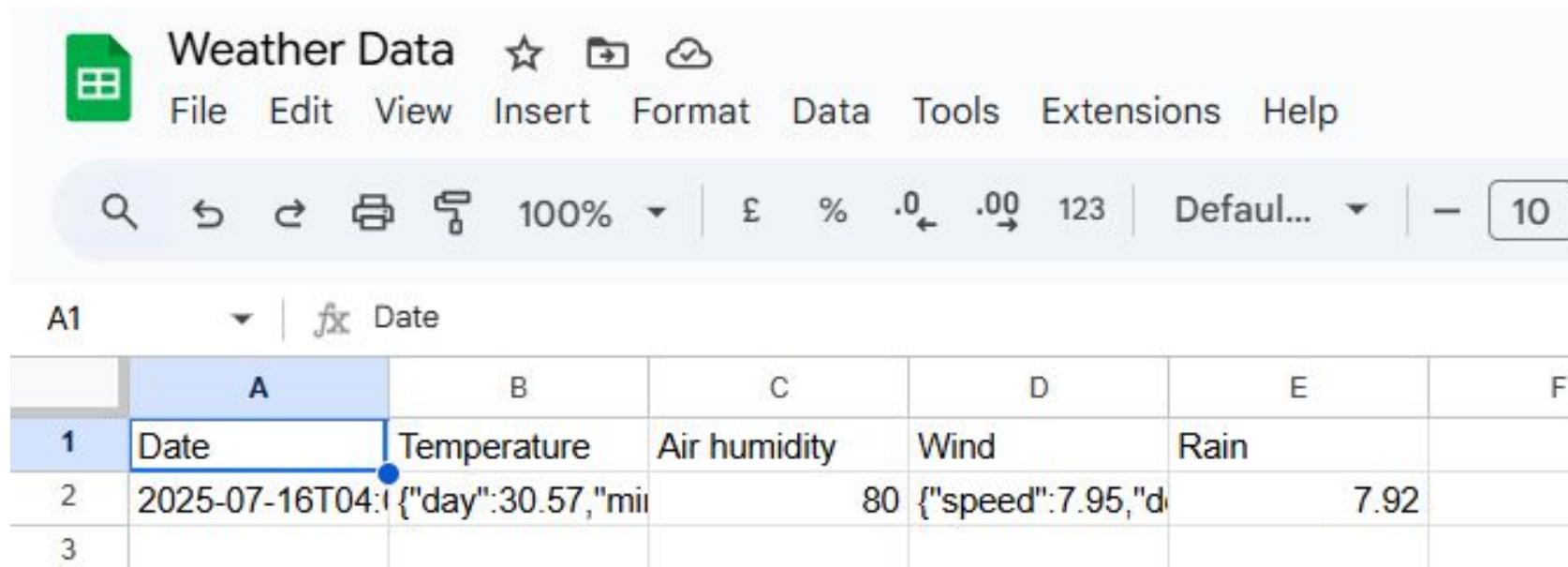
1. Select “Weather Data” -> Enter Sheet Name “Sheet1”
2. Click Date (A), select “3. Date” and other 4 columns
3. Click “Save”



In the button, click “Run once”

Automation for updating weather data in google sheet

Open the google sheet named “Weather Data”, the data is inserted in the second row as following:



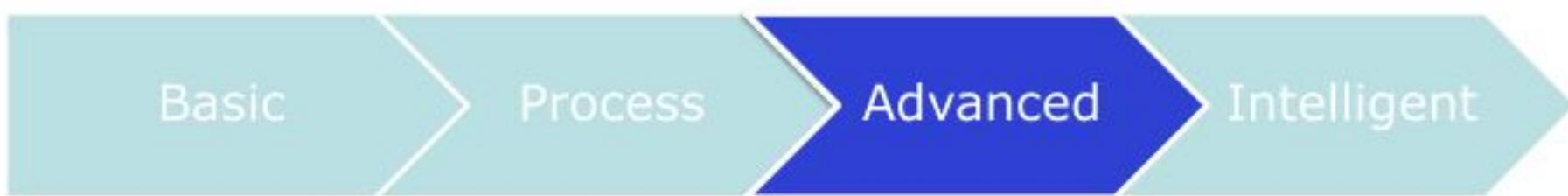
The screenshot shows a Google Sheets interface with the title "Weather Data". The menu bar includes File, Edit, View, Insert, Format, Data, Tools, Extensions, and Help. The toolbar below has icons for search, refresh, print, and zoom (100%), along with currency and number format buttons. The active cell is A1, which contains the text "Date". The second row (row 2) contains the following data:

	A	B	C	D	E	F
1	Date	Temperature	Air humidity	Wind	Rain	
2	2025-07-16T04:1{"day":30.57,"mi		80 {"speed":7.95,"d		7.92	
3						

Introduction to Business Process Automation

Types of Business Automation – Advanced Automation

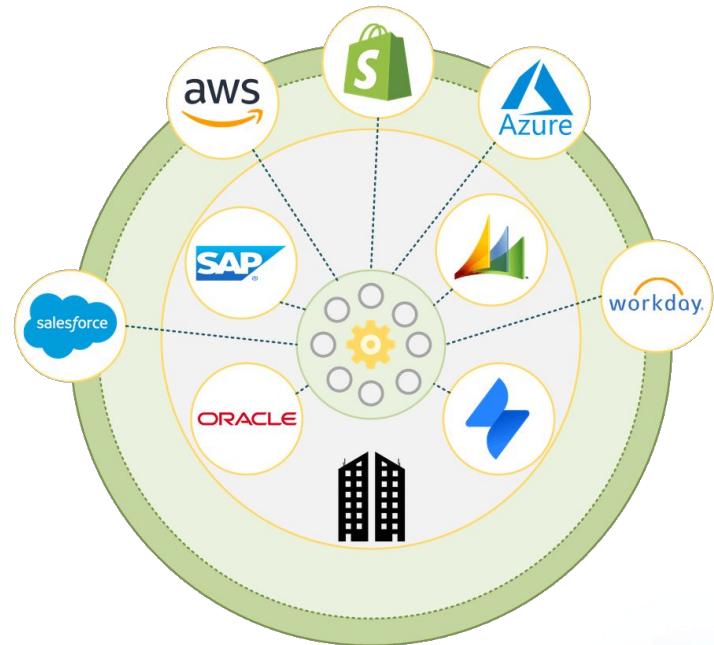
- **Target →** Complex process: Multiple systems + Human
- **Why**
 - Handles unstructured data / methods of access
- **Example →** Machine learning, natural language processing



Advanced Automation : System Integration



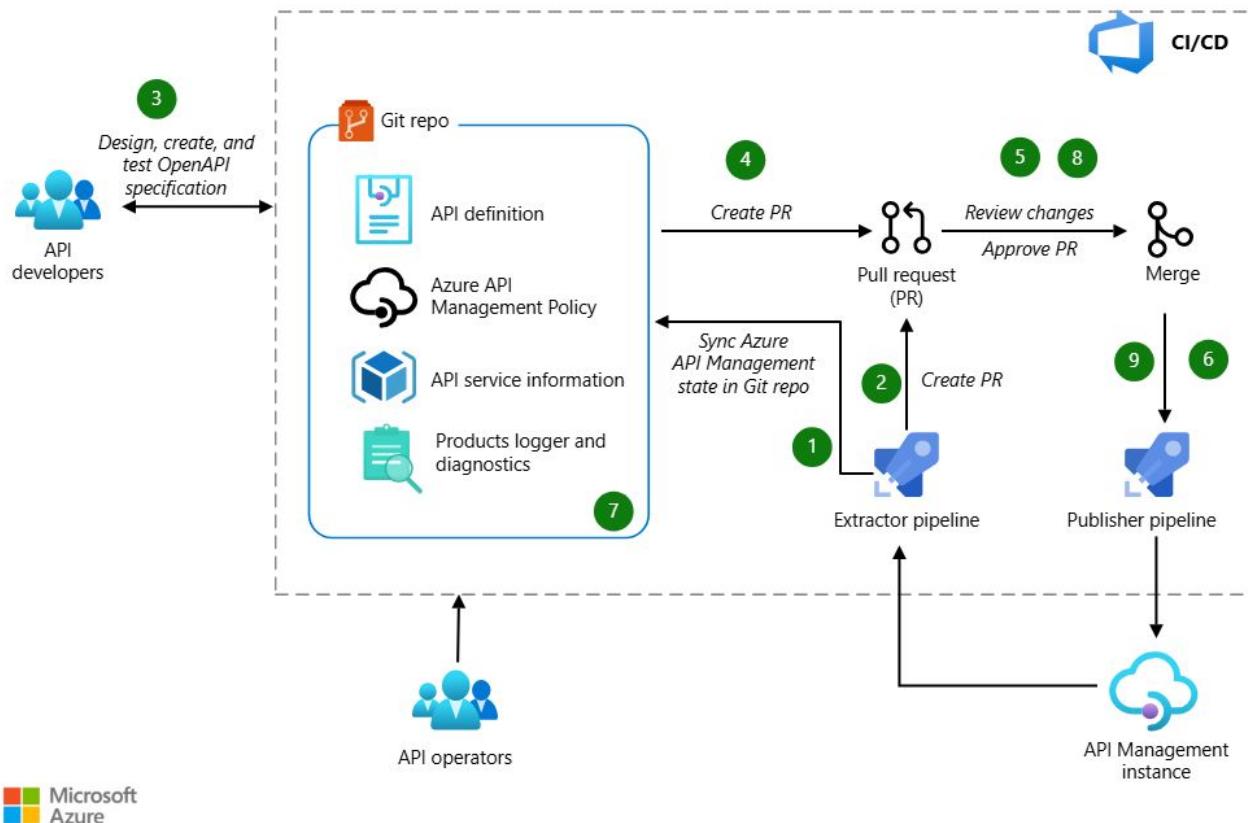
<https://fitsmallbusiness.com/crm-integration/>



<https://iwconnect.com/making-multiple-systems-work-as-one-through-integration/>

Advanced Automation : System Integration

<https://learn.microsoft.com/en-us/azure/architecture/example-scenario/devops/automated-api-deployments-apiops>



Advanced Automation Software Example 1 : Microsoft Power Automate

Link - microsoft.com/en/power-platform/products/power-automate

The screenshot shows the Microsoft Power Automate interface. On the left, a flow is displayed with two steps: 'Recurrence' (with a plus sign icon) and 'Post message in a chat or channel'. To the right of the flow is a 'Copilot' window. The window features a 'Welcome to Copilot in Power Automate' message, an 'Ask a question or describe how you want to change this flow' input field (which is currently empty), and a note at the bottom stating 'Make sure AI-generated content is accurate and appropriate before using.' A red box highlights the input field.

<https://learn.microsoft.com/en-us/power-automate/create-cloud-flow-using-copilot#create-a-cloud-flow-using-copilot>

Introduction to Business Process Automation

Types of Business Automation - Intelligent Automation

- **Target →** Processes requiring AI/customized decisions
- **Why**
 - Smarter interactions, personalization
- **Example →** Voice-based interfaces



Introduction to Business Process Automation

Types of Business Automation - Checkpoint

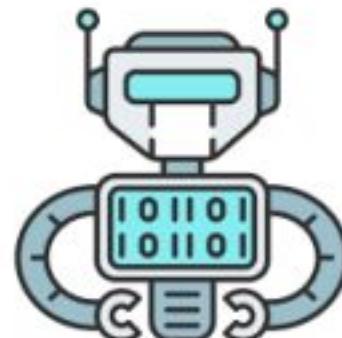
1. Daily email template to enter Market commentary
2. HR time off workflow
3. Online supermarket order processing
4. Voice-automated credit card hotline



Introduction to Business Process Automation

Robotic Process Automation (RPA) - Introduction

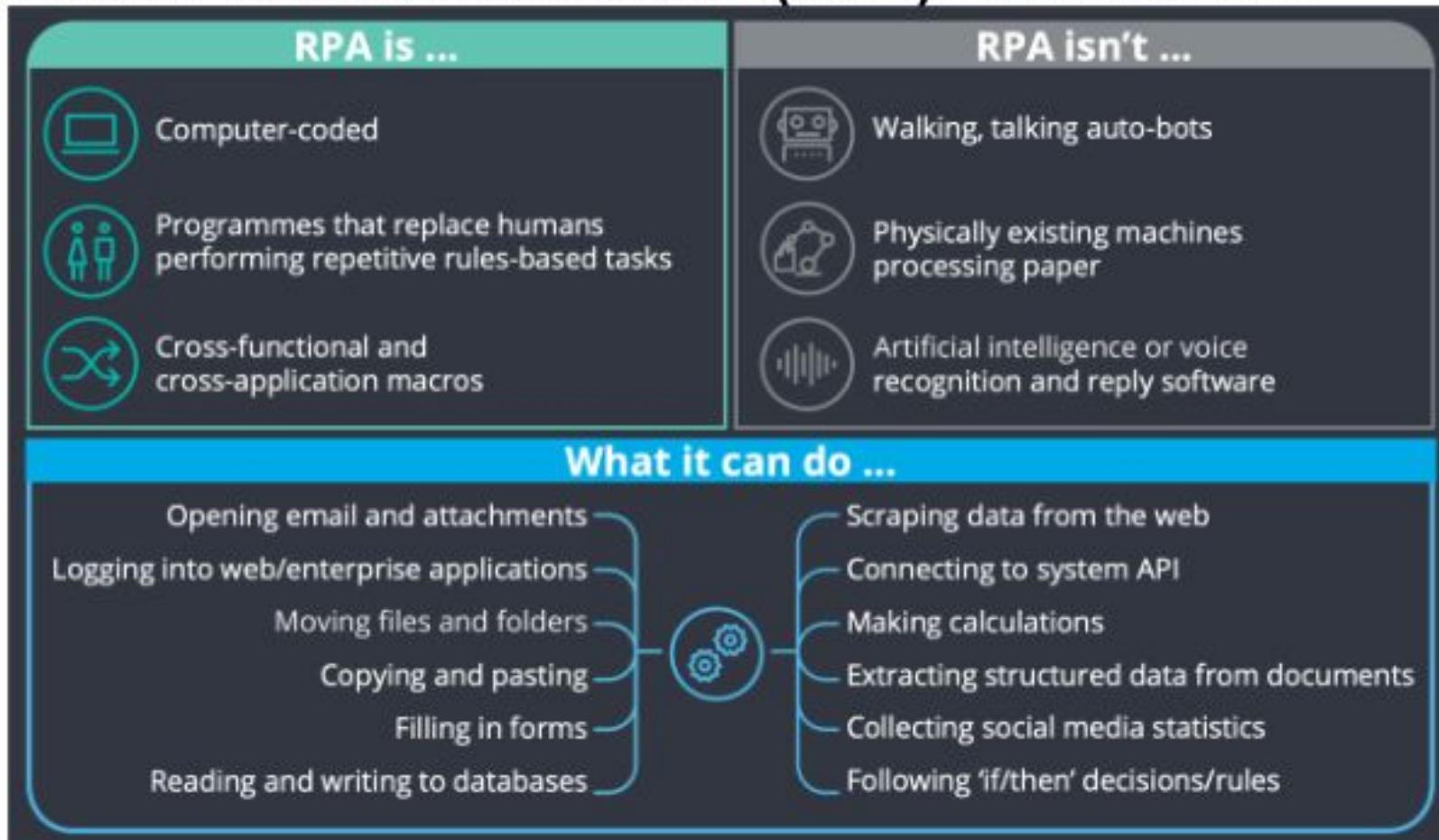
- Rule-based software
- Automating high-volume activities
- Free up human workers (for more meaningful tasks)



1. *What is Robotic Process Automation (RPA)?* | IBM. What Is Robotic Process Automation (RPA)? | IBM. <https://www.ibm.com/topics/rpa>

Introduction to Business Process Automation

Robotic Process Automation (RPA) - Introduction



1. Deloitte. (2018). *The robots are ready. Are you?*

<https://www2.deloitte.com/content/dam/Deloitte/tr/Documents/technology/deloitte-robots-are-ready.pdf>

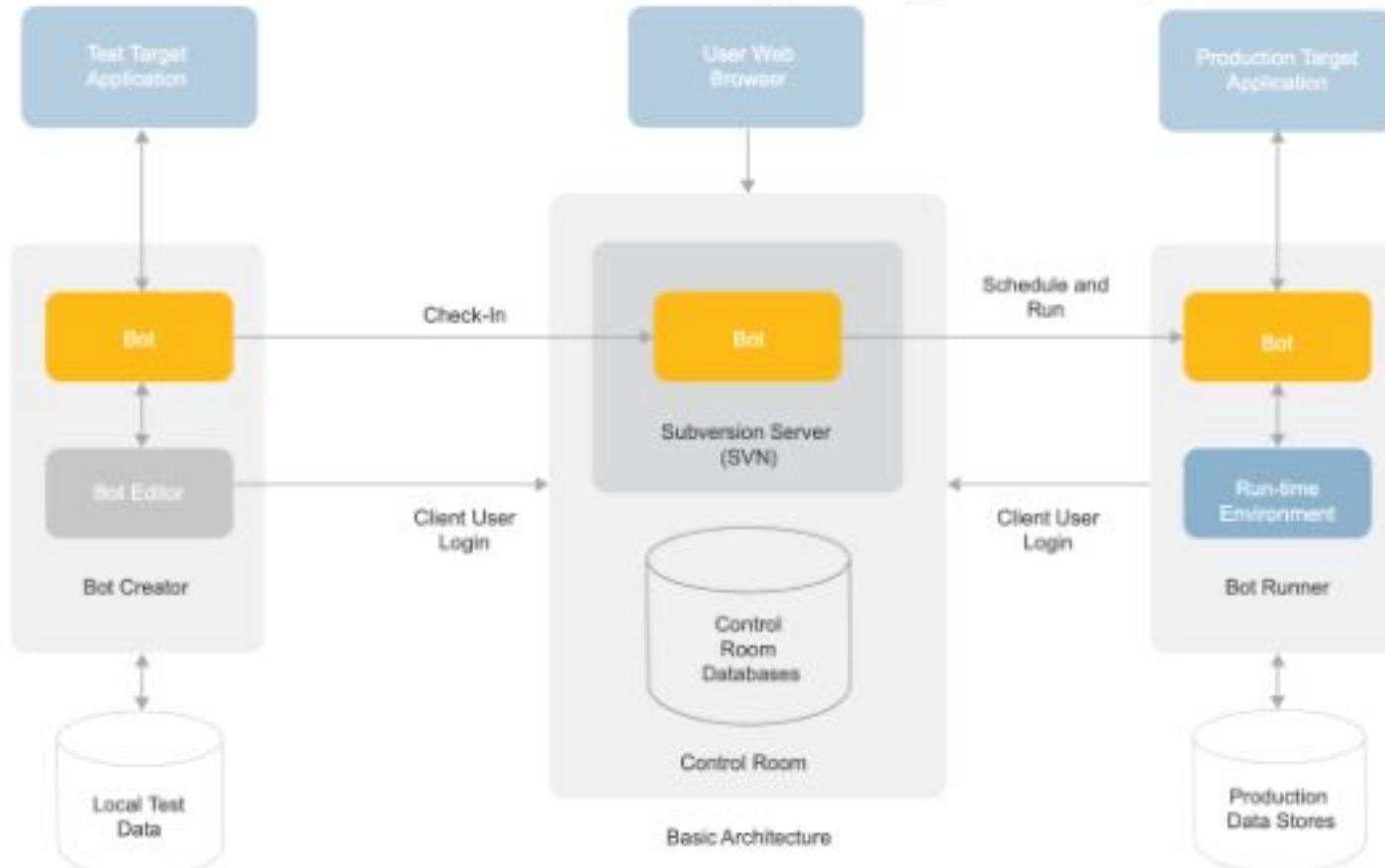
Robotic Process Automation (RPA) - Components

- **Bot modeling**
 - Bot Creator → development/ testing
 - Bot Runner → execution of tested codes in production
- **Control Room**
 - Deployment / Scheduler
 - Audit trails
 - Performance Analytics
 - Role-based access control



Introduction to Business Process Automation

Robotic Process Automation (RPA) - Components



1. Automation Anywhere. *Enterprise-class Security for Robotic Process Automation.*
https://www.automationanywhere.com/sites/default/files/internal-assets/uberflip/security-whitepaper_en.pdf

Introduction to Business Process Automation

Intelligent Process Automation (IPA)

- Using Artificial Intelligence (AI), e.g.,
 - Machine Learning (ML)
 - Natural Language Processing (NLP)
- Enhancing cognitive ability of the automation



Introduction to Business Process Automation

Intelligent Process Automation (IPA)

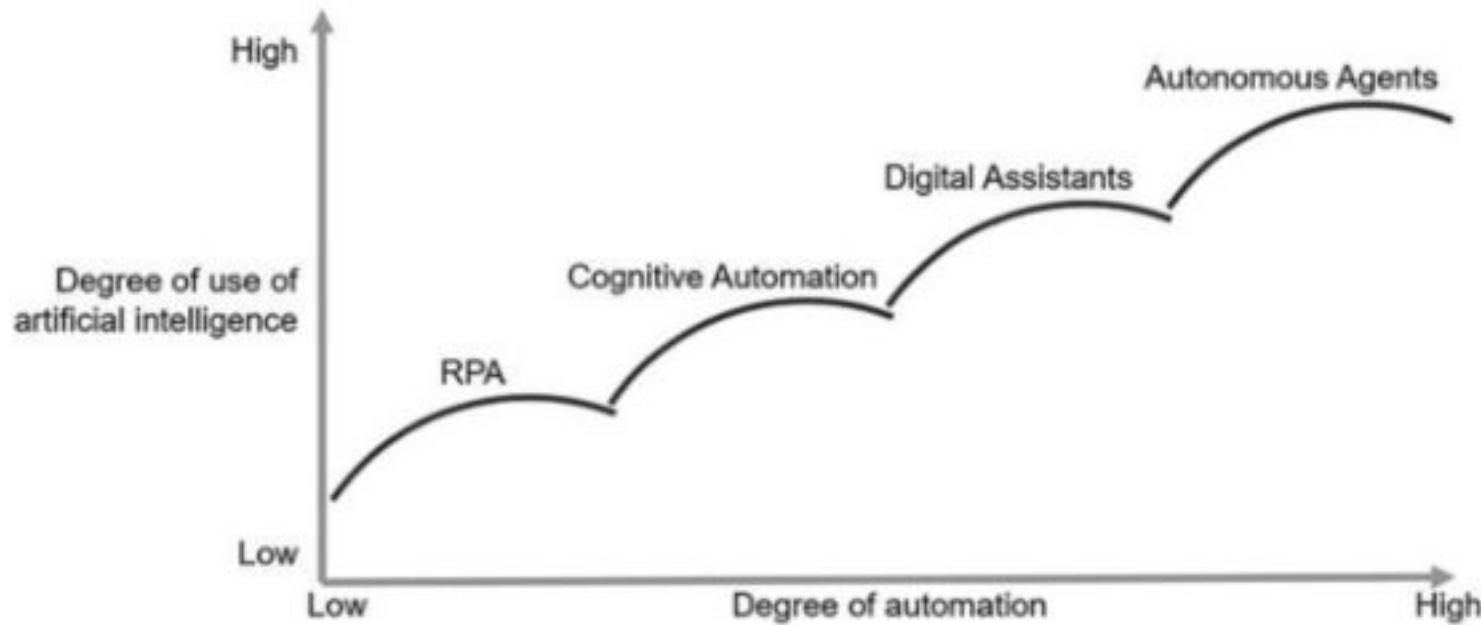
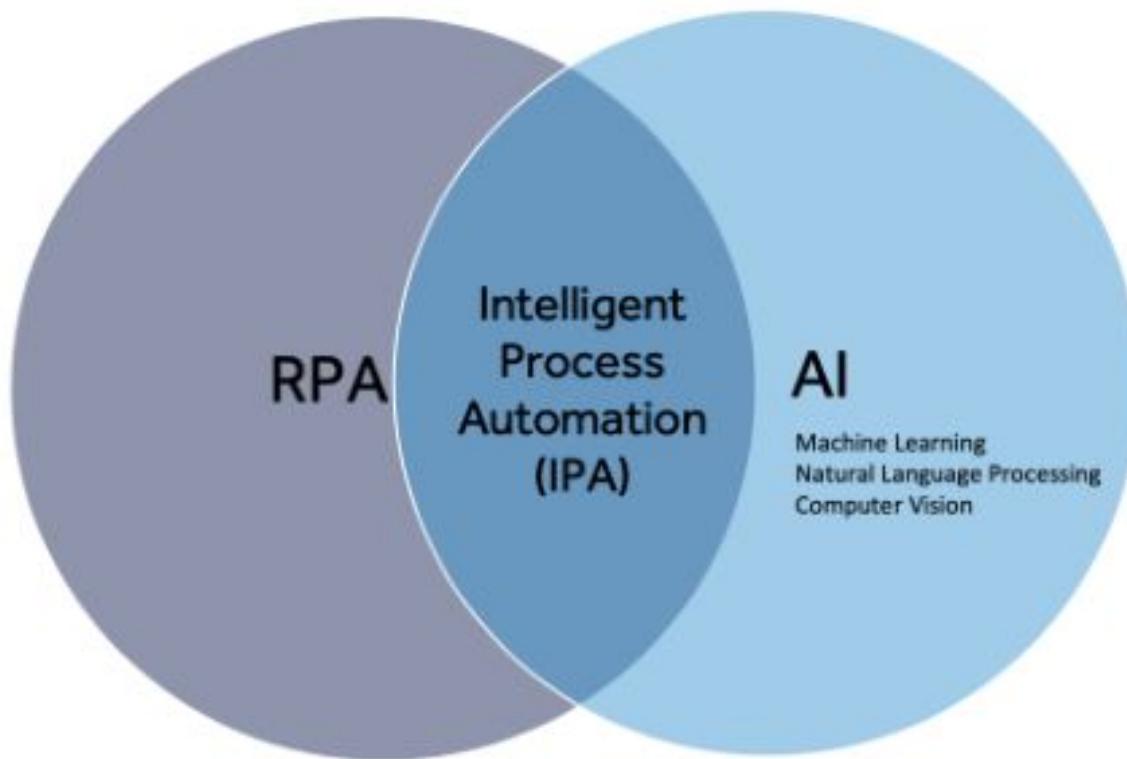


Fig. 2.2 Classification of RPA according to the degree of automation and the use of artificial intelligence (based on Ostrowicz 2018, p. 4)

1. Smeets, M., Erhard, R., & Kaußler, T. (2021, July 30). *Robotic Process Automation (RPA) in the Financial Sector: Technology - Implementation - Success for Decision Makers and Users*. Springer. <https://doi.org/10.1007/978-3-658-32974-7>

Introduction to Business Process Automation

Intelligent Process Automation (IPA)



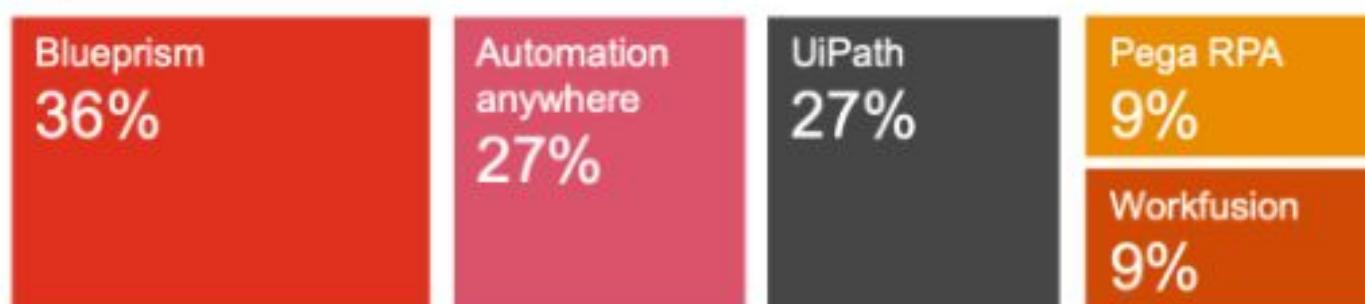
1. Kosmopoulos, C. (2021, May 11). *What is Intelligent Process Automation (IPA)?* | Blueprint. What Is Intelligent Process Automation (IPA)? | Blueprint. <https://www.blueprintsys.com/blog/rpa/what-is-intelligent-process-automation-ipa>

Introduction to Business Process Automation

Tools for Automation - Overview

Which tool is being used ?

As some companies use more than one tool, the percentages in this graphic total to more than 100%

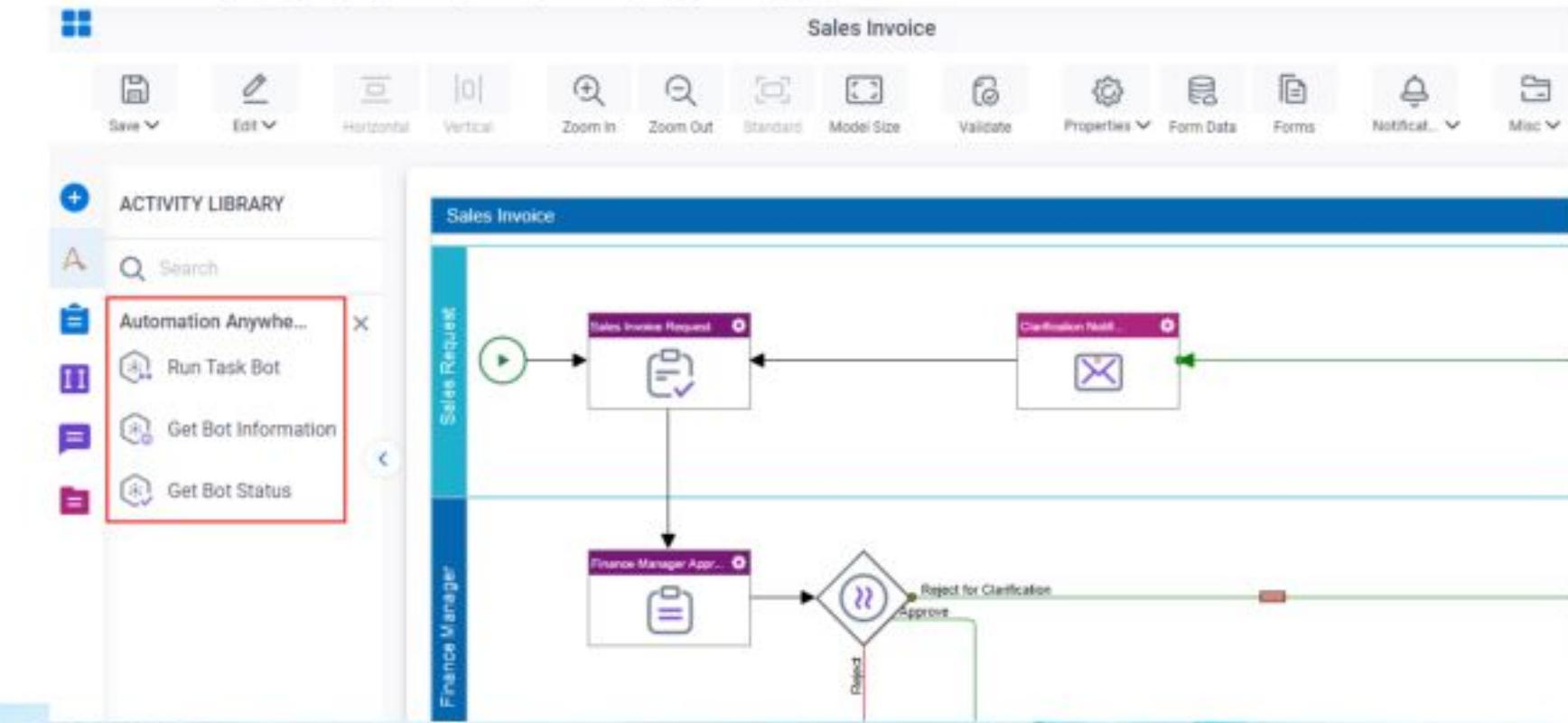


1. 2019 actuarial robotic process automation (RPA) survey report. PwC.
<https://www.pwc.com/gx/en/industries/financial-services/publications/pwc-2019-actuarial-robotic-process-automation-survey-report.html>

Introduction to Business Process Automation

Tools for Automation - Types

- **Low-code platforms**
 - Automation Anywhere, XCEPTOR, Microsoft Power Automate



Introduction to Business Process Automation

Tools for Automation - Types

- In-house Solutions

- Excel VBA, Java, Python, Web

Microsoft®
Excel VBA



Most in-demand functional areas

- Compliance
- Operational Risk
- Fund Accounting
- Corporate Accounting
- Actuarial
- Finance Operations
- IT Audit

In-demand technical skills and experience

- IFRS 17 Reporting and Accounting Policy
- RBC and Capital Reporting
- IT skills (Python, C+ BASIC, C, C++, COBOL, Java, R, Tableau, SQL, VBA, and Macro)
- Operational Risk, Information and IT Risk, Risk Transformation, Risk Analytics, Internal Control Framework



1. Robert Half. 2024 Salary Guide HK.
<https://content.roberthalfonline.com/SG24/SG24-PDF/2024-Salary-Guide-HK.pdf>

Introduction to Business Process Automation

Tools for Automation – Getting a taste

- **Visualping** (<https://visualping.io/>)
 - Websites monitoring



<https://hkuspace.hku.hk/prog/cert-for-module-business-process-automation-with-vba>

Certificate for Module (Business Process Automation with VBA ...)

(2) Mr Jackie Liu. Mr. Jackie Liu is veteran quantitative strategist currently working in one of the top global investment banks. With over 10 years of ...

 hku.hk
<https://hkuspace.hku.hk/prog/cert-for-module-business-process-automation-with-vba>

Certificate for Module (Business Process Automation with VBA ...)

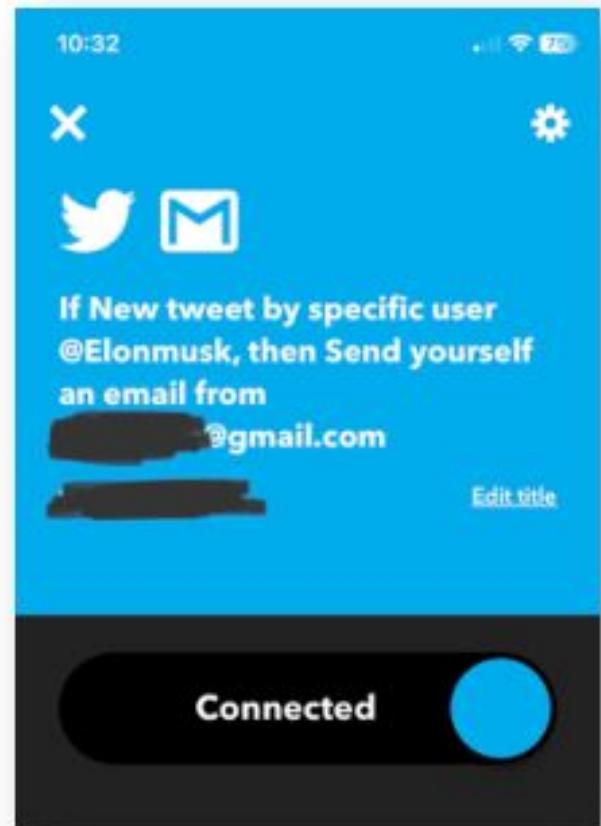
(2) Mr Jackie Liu. Mr. Jackie Liu is veteran quantitative strategist currently working in one of the top global investment banks. With over 10 years of ...

Introduction to Business Process Automation

Tools for Automation – Getting a taste

- **IFTTT (<https://ifttt.com/>)**

- Web + App interfaces
- Service-based triggers and actions



Introduction to Business Process Automation

Tools for Automation – Considerations

- Cost

- One-time cost

- Initial effort of adaptation
 - Implementation and rollout

- Running cost

- License, e.g., Power Automate: \$Millions/year¹
 - Infrastructure, e.g., Cloud storage
 - Training, e.g., Automation Anywhere, 10+ hours²
 - Support, e.g., bot re-configuration

Cost		
Production	Gold	Maint.
60 🎁	240 🎁	1 🎁

1. RPA Pricing: Comparison of Leading RPA Vendors' Fees in 2023. <https://research.aimultiple.com/rpa-pricing/>

2. RPA Course Learning Trails | Automation Anywhere University. <https://university.automationanywhere.com/training/rpa-learning-trails/>

Tools for Automation – Considerations

- **Flexibility**
 - Specialized vs Generalized, e.g., XCEPTOR → Tax
- **Scalability**
 - Desktop vs Enterprise, e.g., Excel VBA
 - Version Control, e.g., Use of repository
- **Time to delivery**
 - “Perfect” solution does not exist



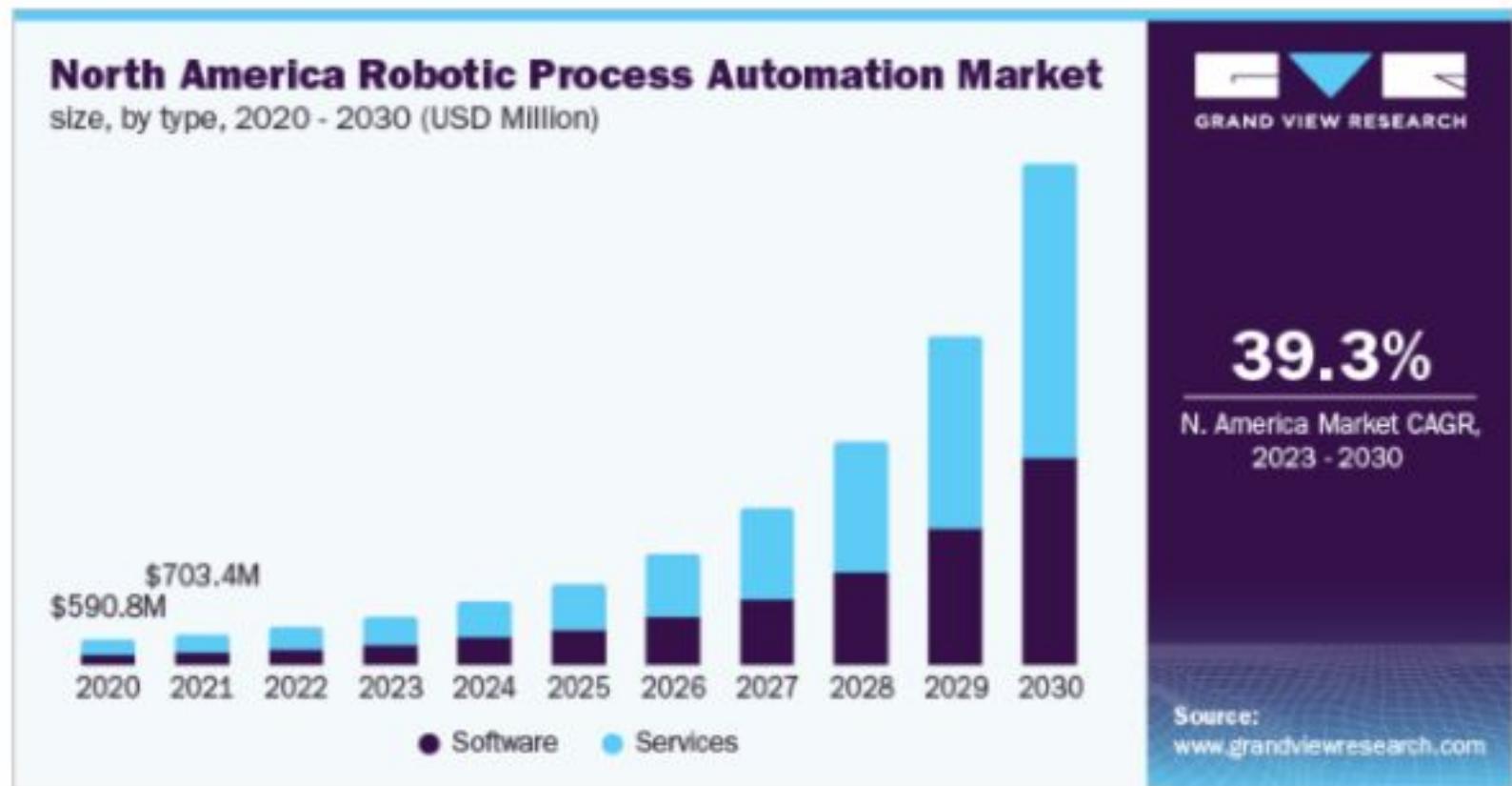
GitHub



1. Smeets, M., Erhard, R., & Kaußler, T. (2021, July 30). *Robotic Process Automation (RPA) in the Financial Sector: Technology - Implementation - Success for Decision Makers and Users*. Springer. <https://doi.org/10.1007/978-3-658-32974-7>

Introduction to Business Process Automation

Opportunities of BPA – The Money



1. *Robotic Process Automation Market Size & Share Report 2030.* Robotic Process Automation Market Size & Share Report 2030.
<https://www.grandviewresearch.com/industry-analysis/robotic-process-automation-rpa-market>

Introduction to Business Process Automation

Opportunities of BPA – Sectors

Industries	% of RPA Solutions
Banking, Financial Services & Insurance	51 %
Business Process Outsourcing (BPO)	14 %
Manufacturing – Consumer Packaged Goods (CPG)	7 %
Professional, Legal & Accountancy Services	7 %
Retail Trade	7 %
Technology (IT, Internet, SAAS)	7 %
Utilities	7 %

1. Top 15 RPA Use Cases & Examples in Banking in 2023. <https://research.aimultiple.com/banking-rpa/>

Opportunities of BPA – Sectors

- **Healthcare**
 - Monitoring, drug dispensing
- **Retail**
 - Auto-checkout, smart shelf, inventory management
- **Marketing**
 - Lead generation
 - social media management
- **Finance**
 - Fraud detection, Credit management, Regtech



Introduction to Business Process Automation

Opportunities of BPA – Regtech

- Follow the money

 CNN

Wells Fargo ordered to pay \$3.7 billion for 'illegal activity' including unjust foreclosures and vehicle repossession

The CFPB said the more than \$2 billion in customer refunds Wells Fargo has been ordered to pay includes more than \$1.3 billion to consumers hurt...

20 Dec 2022



 Spiceworks

SEC Penalizes Major Wall Street Firms \$1.97B For Using Unauthorized Messaging Apps

If there are allegations of wrongdoing or misconduct, we must be ... Morgan Stanley recently agreed to a \$35 million fine by the SEC for...

28 Sept 2022



Introduction to Business Process Automation

Opportunities of BPA – Regtech

- Follow the money



1. KPMG. (2019, June). *There's a revolution coming.*

<https://assets.kpmg.com/content/dam/kpmg/cn/pdf/en/2019/06/embracing-the-challenge-of-the-new-regtech-era.pdf>

Introduction to Business Process Automation

Opportunities of BPA – Regtech

- Common themes



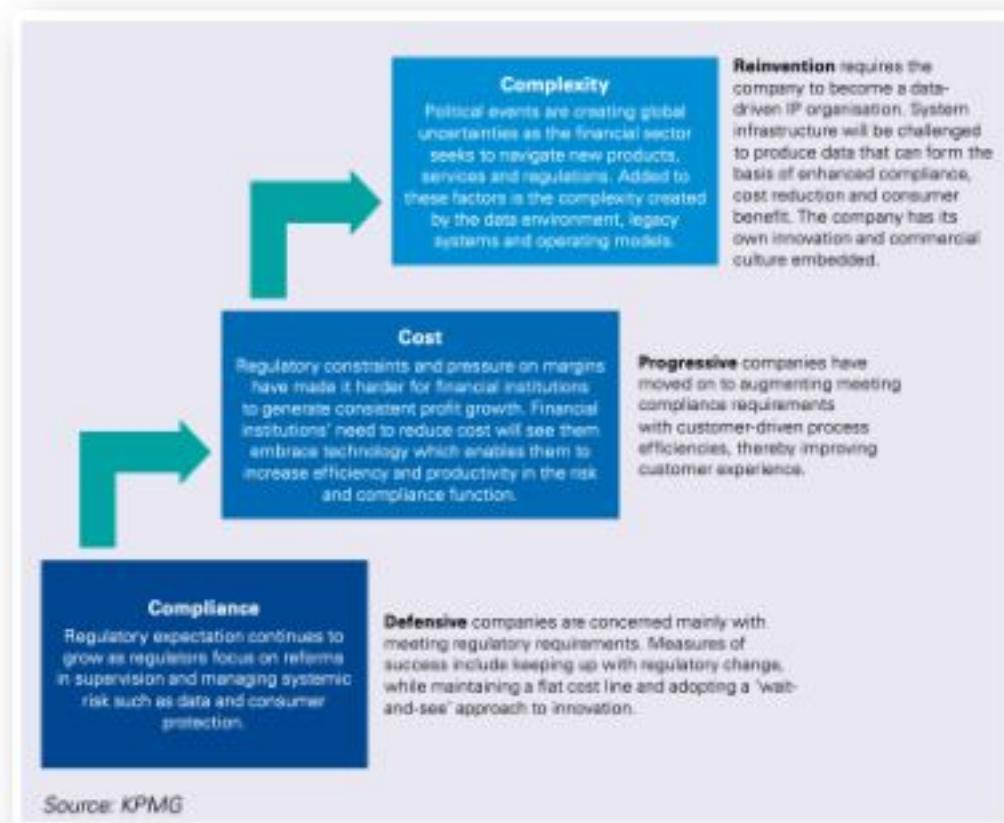
1. KPMG. (2022, November). <https://assets.kpmg.com/content/dam/kpmg/uk/pdf/2022/11/innovate-finance-regtech-industry-and-adoption.pdf>

Introduction to Business Process Automation

Opportunities of BPA – Regtech

Adoption phases:

1. Defensive
2. Progressive
3. Reinvention



1. KPMG. (2019, June). *There's a revolution coming.* <https://assets.kpmg.com/content/dam/kpmg/cn/pdf/en/2019/06/embracing-the-challenge-of-the-new-regtech-era.pdf>

Introduction to Business Process Automation

Opportunities of BPA – Regtech

- HKMA 3-Year Roadmap
 - RPA: automating rule-based processes
 - Network Analysis: Company holdings and exposures

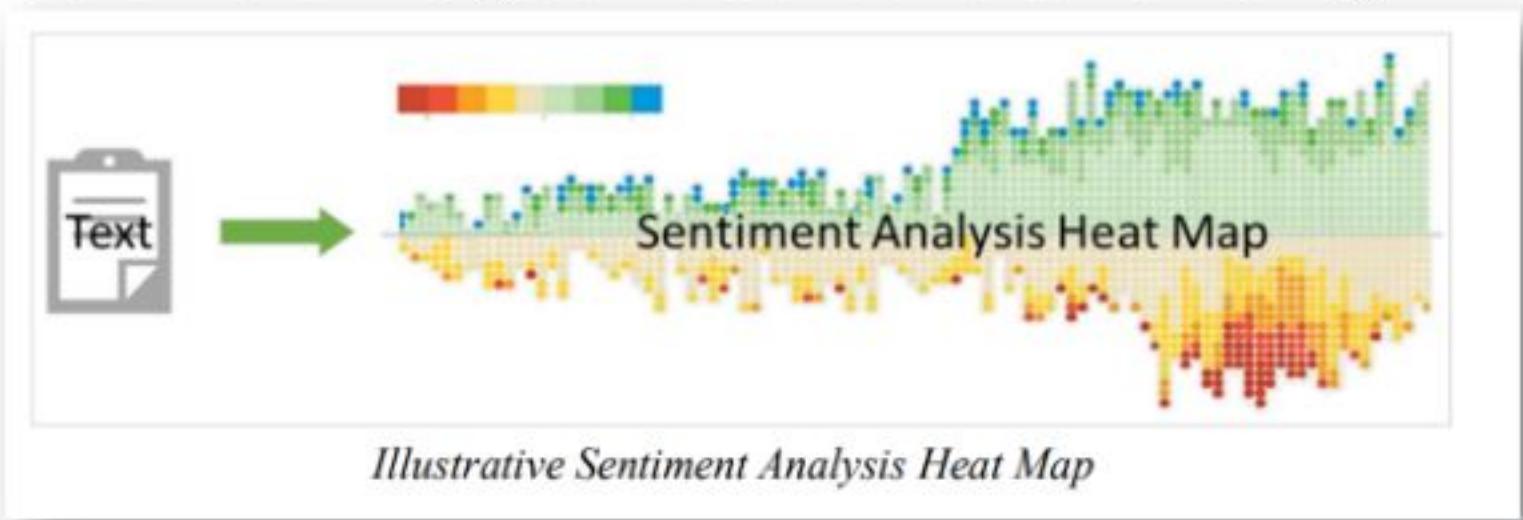


1. HKMA. (2021, June). *Regtech Watch Issue No. 7*.
<https://www.hkma.gov.hk/media/eng/doc/key-information/guidelines-and-circular/2021/20210617e1a1.pdf>

Introduction to Business Process Automation

Opportunities of BPA – Regtech

- **HKMA 3-Year Roadmap**
 - **Speech-to-text (STT)**: Audio to time-stamped text
 - **Sentiment Analysis**: Realtime news monitoring

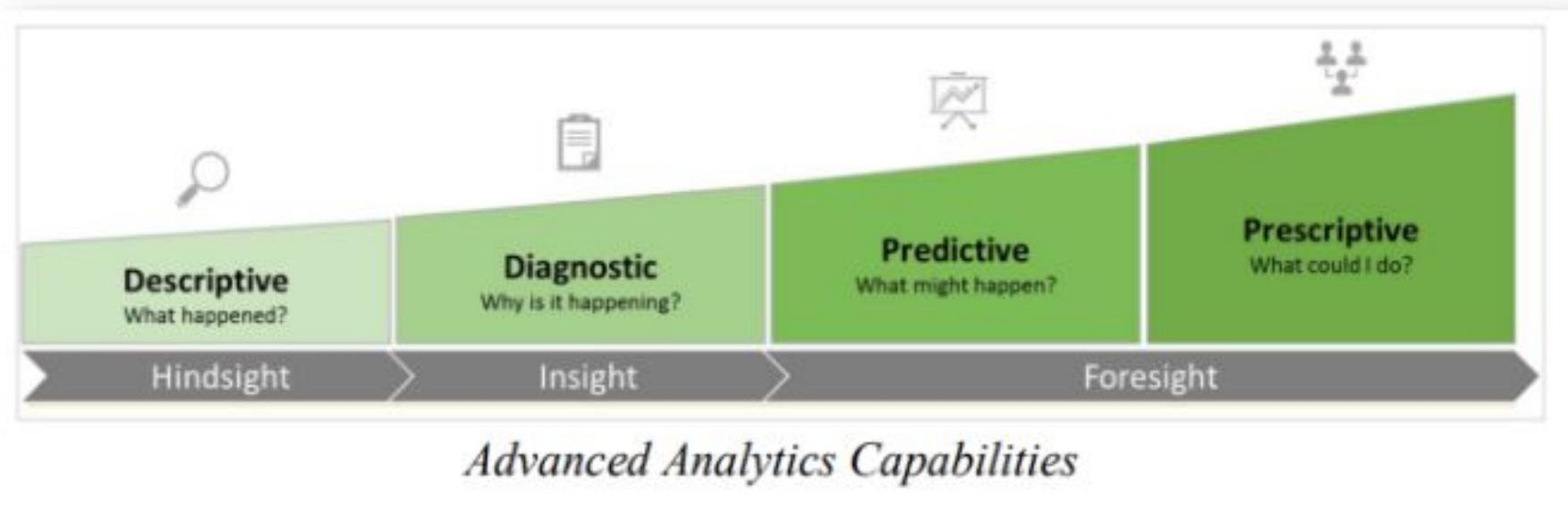


1. HKMA. (2021, June). *Regtech Watch Issue No. 7*.
<https://www.hkma.gov.hk/media/eng/doc/key-information/guidelines-and-circular/2021/20210617e1a1.pdf>

Introduction to Business Process Automation

Opportunities of BPA – Regtech

- Analytics enabled by BPA



1. HKMA. (2021, June). *Regtech Watch Issue No. 7*.
<https://www.hkma.gov.hk/media/eng/doc/key-information/guidelines-and-circular/2021/20210617e1a1.pdf>

Introduction to Business Process Automation

Challenges of BPA – Insight from the banks

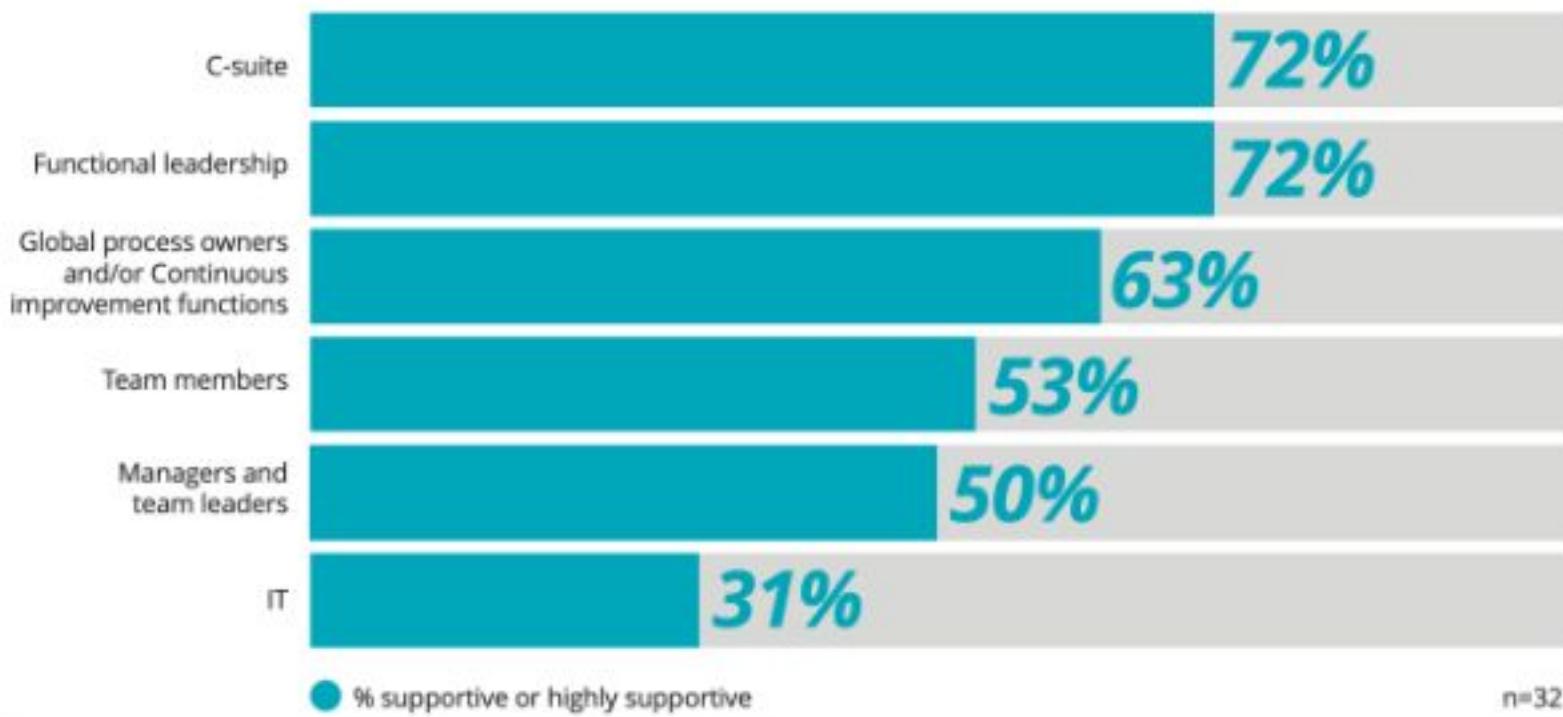


1. KPMG & HKMA. (2020). *Transforming Risk Management and Compliance: Harnessing the Power of Regtech.* <https://www.hkma.gov.hk/media/chi/doc/key-information/press-release/2020/20201102c3a1.pdf>

Introduction to Business Process Automation

Challenges of BPA – Worries from the workers?

Figure 5: How supportive of the RPA implementation were your stakeholder groups?

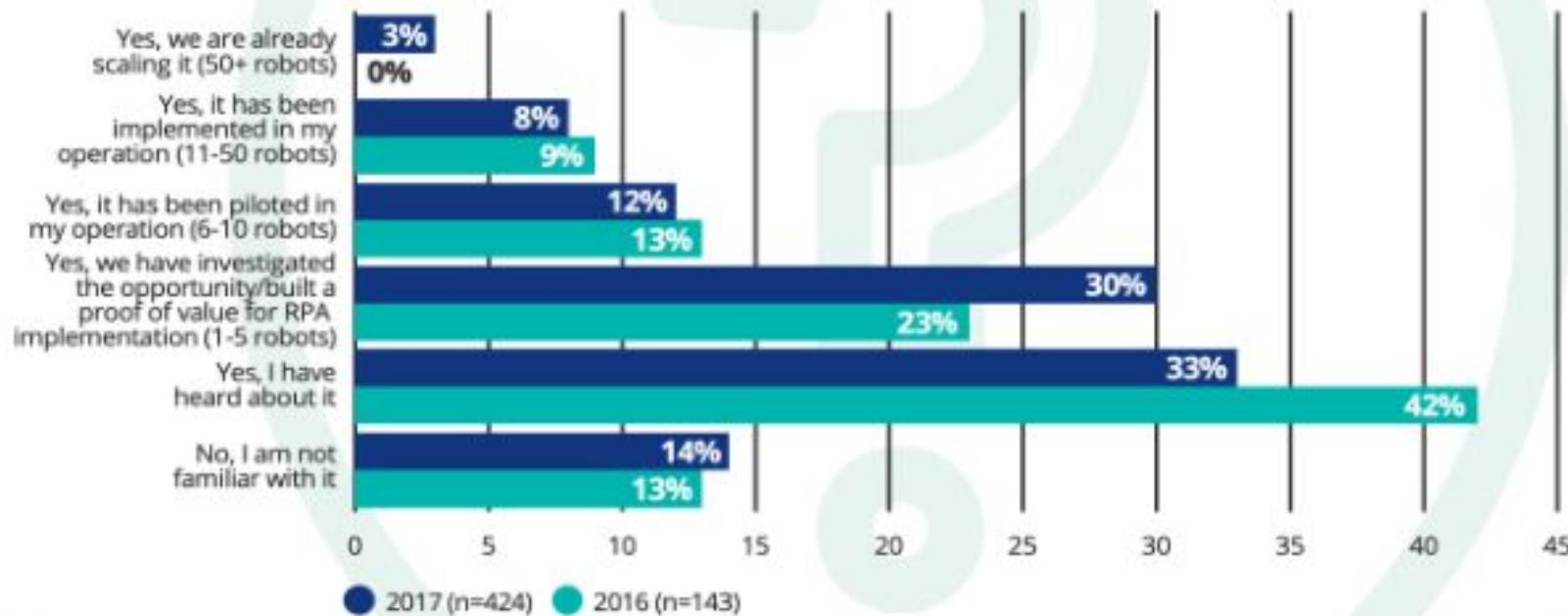


1. Deloitte. (2018). *The robots are ready. Are you?*
<https://www2.deloitte.com/content/dam/Deloitte/tr/Documents/technology/deloitte-robots-are-ready.pdf>

Introduction to Business Process Automation

Challenges of BPA – Hesitant to scale up

Figure 2: Are you familiar with RPA?



1. Deloitte. (2018). *The robots are ready. Are you?*
<https://www2.deloitte.com/content/dam/Deloitte/tr/Documents/technology/deloitte-robots-are-ready.pdf>

Challenges of BPA

- **Shortage**
 - Budget / Resource/ Talent
- **Concerns**
 - Risk of rushing / failing
 - Moral / Structural unemployment

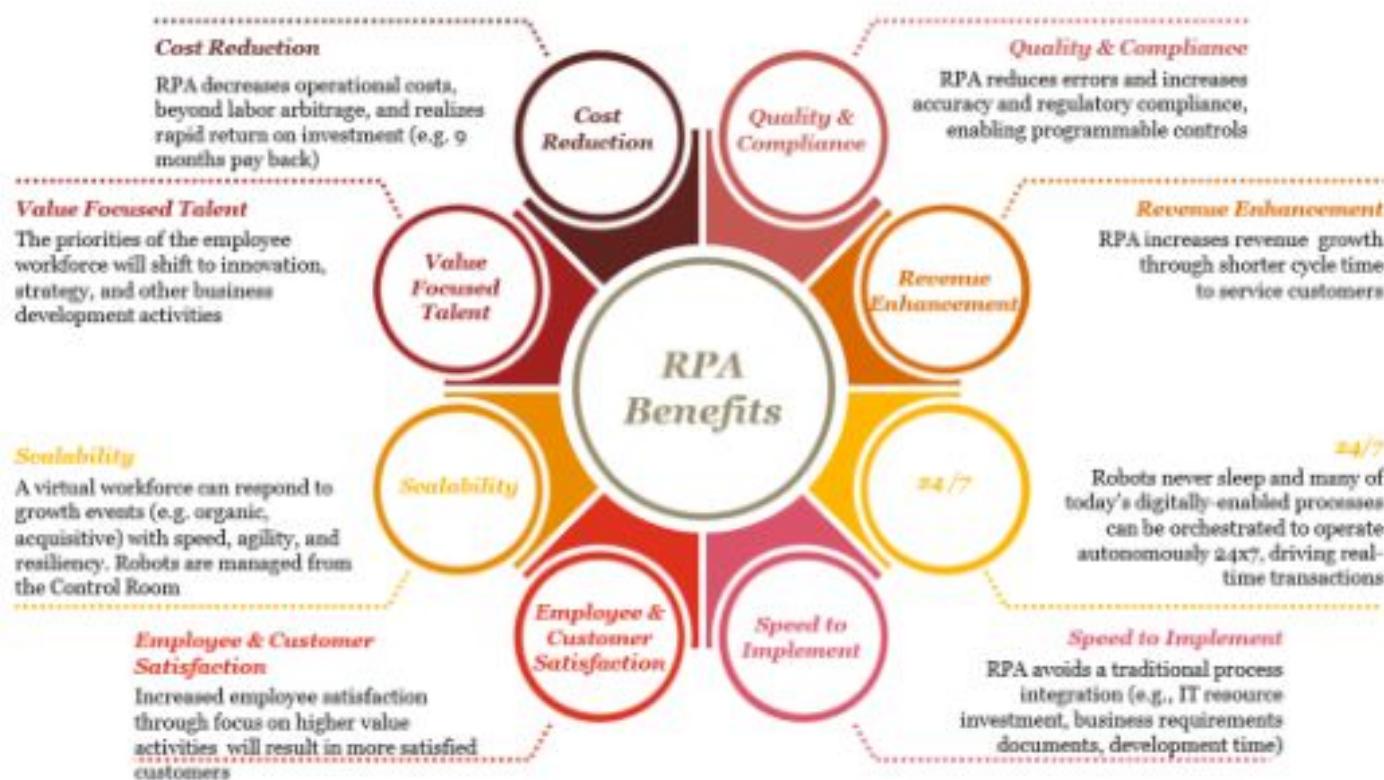


* Success depends on planning
(More on project management later)

Introduction to Business Process Automation

Implications of BPA – The Good

- Cost, Efficiency, Customer Experience



1. PwC Robotics Process Automation Solutions. PwC.

<https://www.pwchk.com/en/services/entrepreneurial-and-private-business/new-technology-digitalisation-and-transformation/process-automation-solutions.html>

Introduction to Business Process Automation

Implications of BPA – The Bad

- Automation complacency / dependency
- Risk of Technical Issues / Downtime

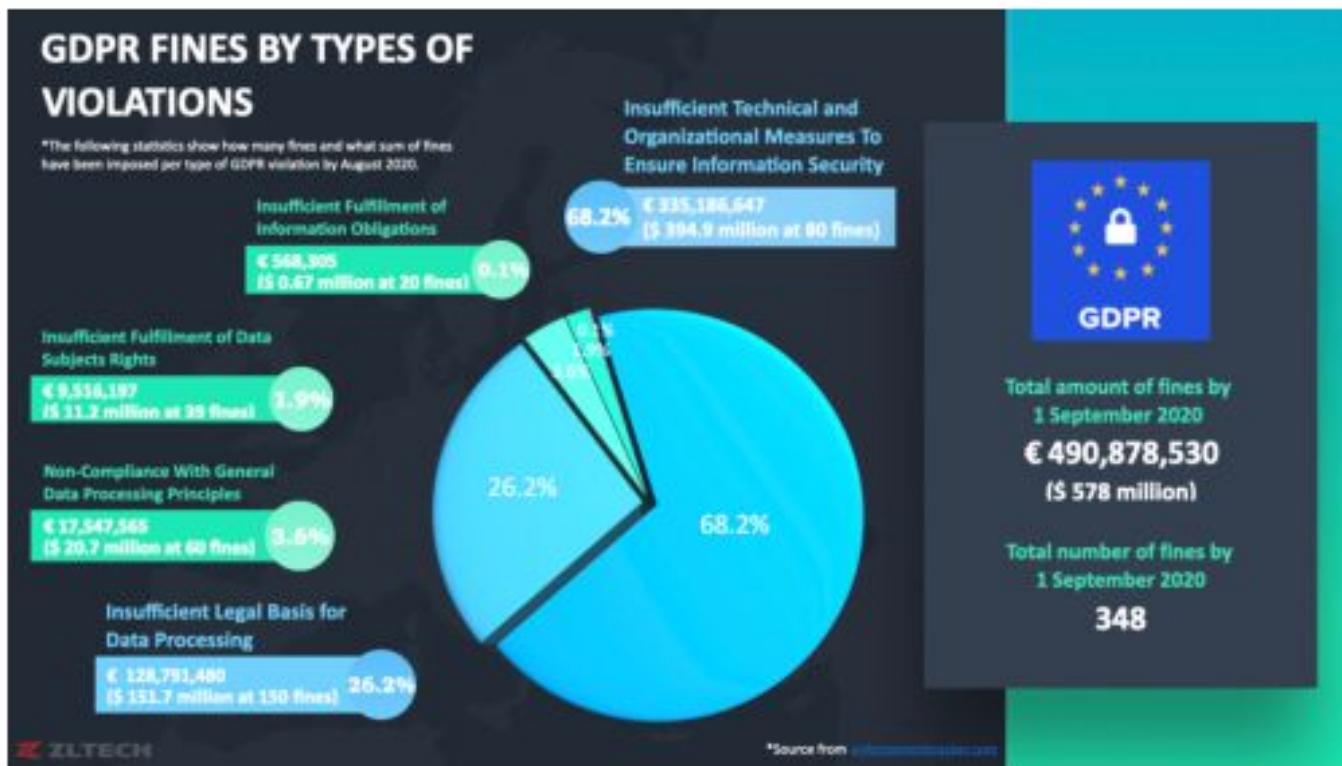


Image: Civil Aviation Safety Authority

Introduction to Business Process Automation

Implications of BPA – The Ugly

- Data Collection and Analysis¹
- Vulnerability to Cyberattacks

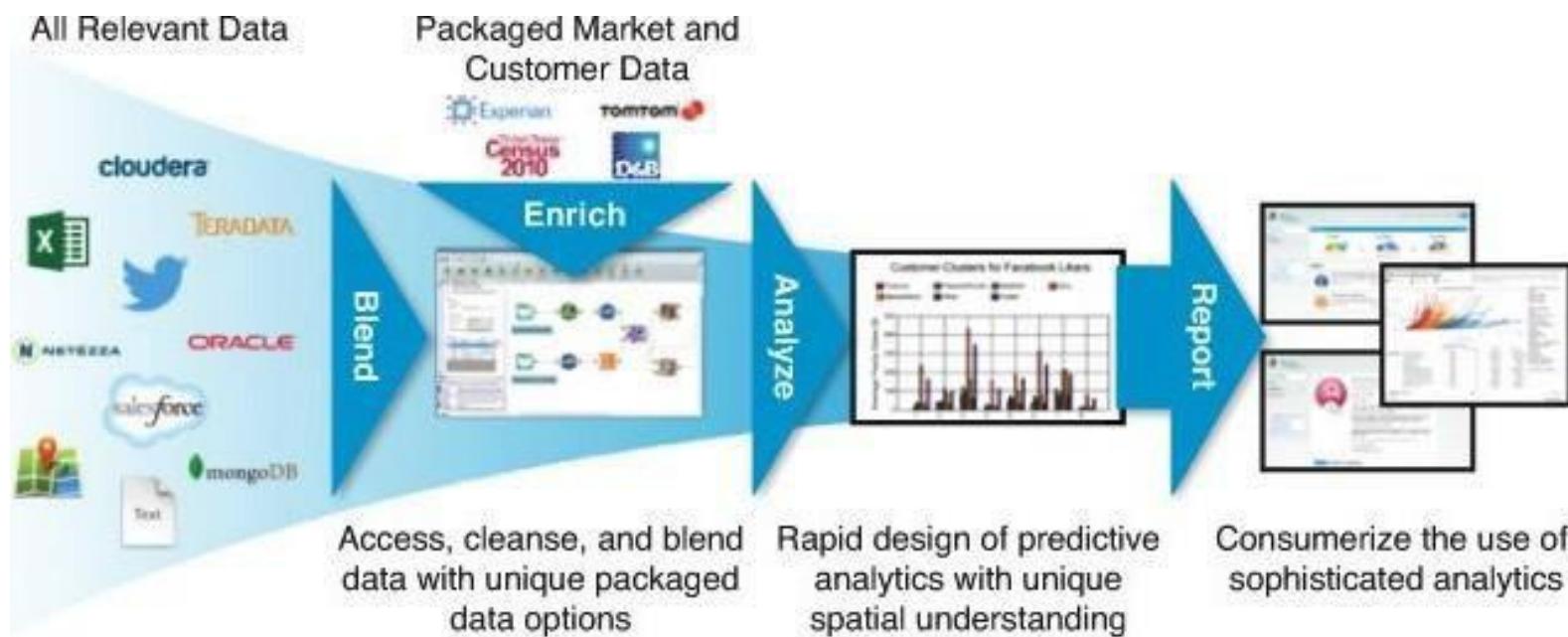


1. Chen, B. (2020, September 9). GDPR Recap: 28 Nations, 348 Fines, Half a Billion Euros. ZL Tech.
<https://www.zltech.com/blog/gdpr-recap-28-nations-348-fines-half-a-billion-euros/>

Modern BI Process - Blend, Enrich, Analyze, and Report

Predictive Analytics: By applying machine learning algorithms to historical project data, organizations can forecast outcomes more accurately and mitigate risks in project delivery

Business Intelligence: Automating the preparation of data for analytics tools allows organizations to gain actionable insights more rapidly, enhancing their decision-making capabilities.

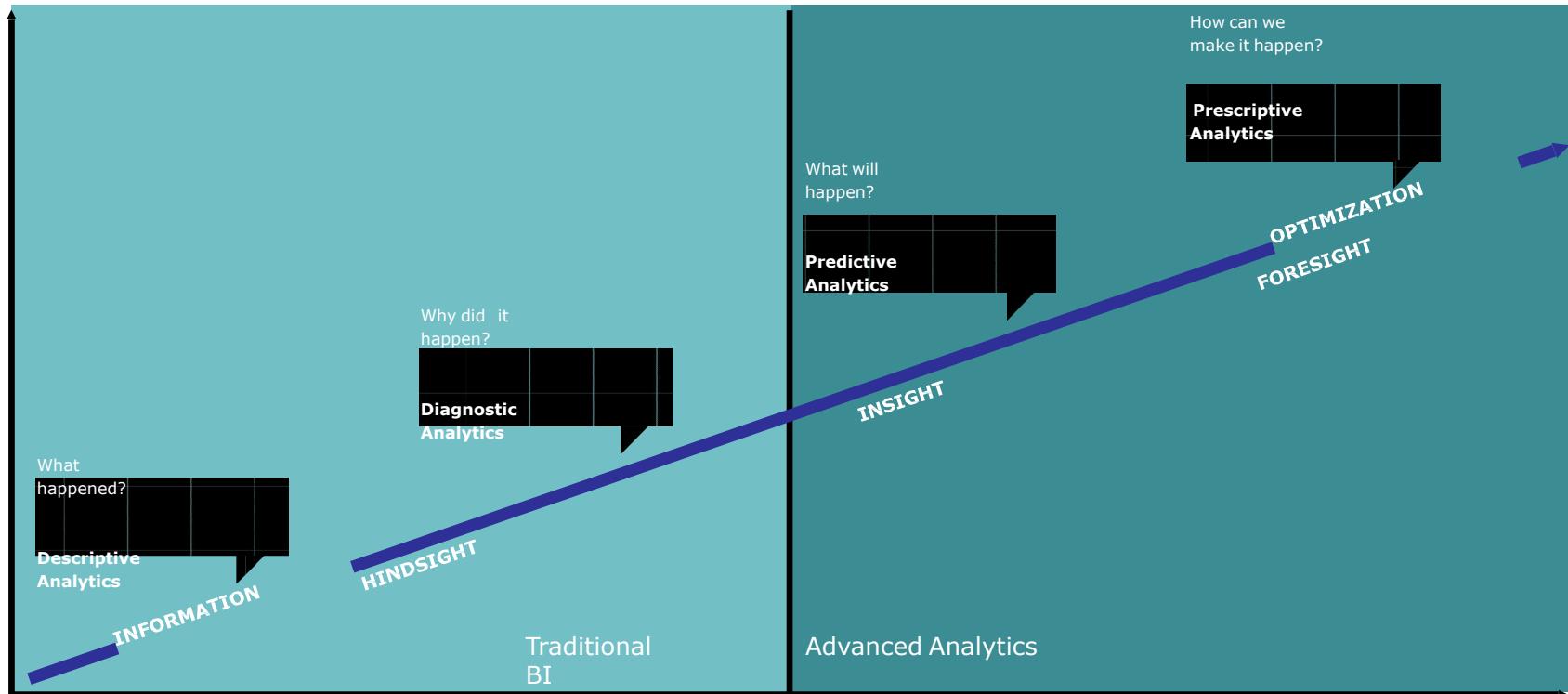


What Is Data Science?

From Wikipedia:

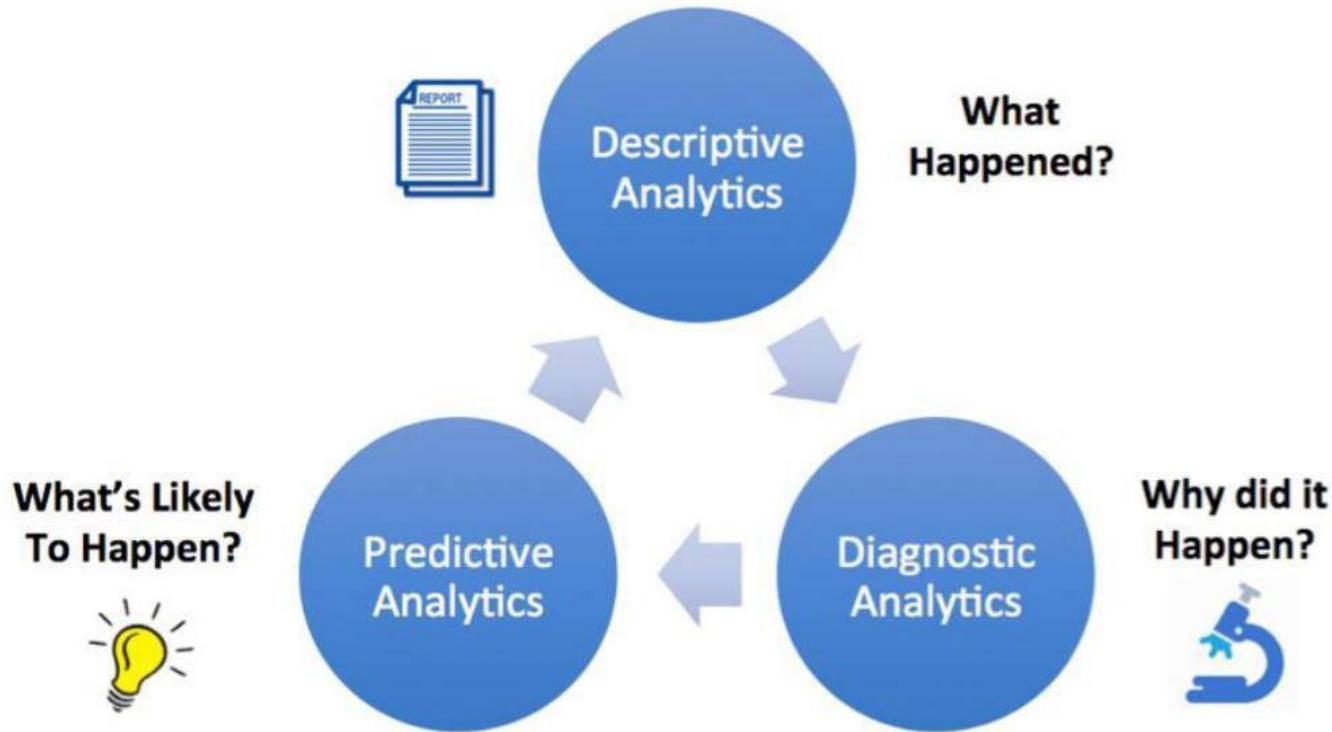
Data science, also known as data-driven science, is an interdisciplinary field about scientific processes and systems to extract knowledge or insights from data in various forms, either structured or unstructured, which is a continuation of some of the data analysis fields such as statistics, machine learning, data mining ,and predictive analytics similar to Knowledge Discovery in Databases (KDD).

How Is Business Intelligence Different From Data Science?



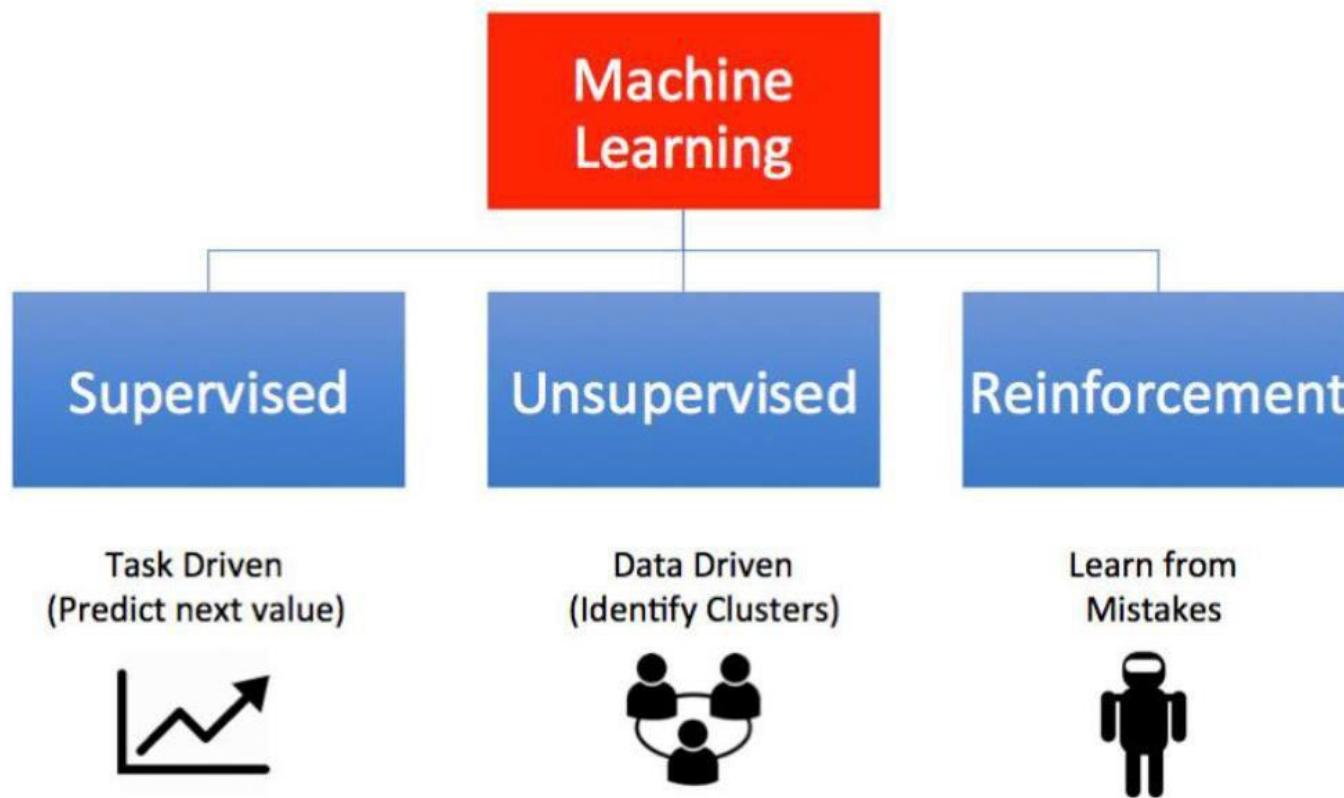
What is Business Analytics & Machine Learning?

Types of Analytics

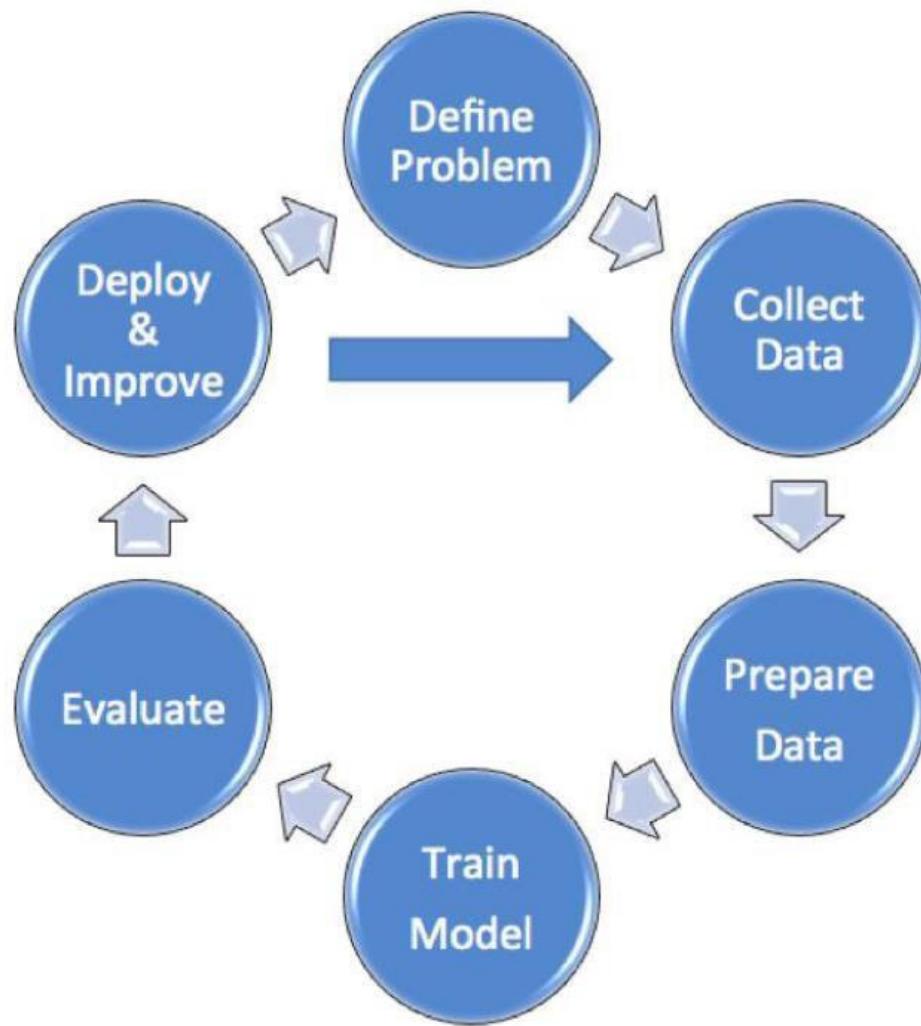


What is Business Analytics & Machine Learning?

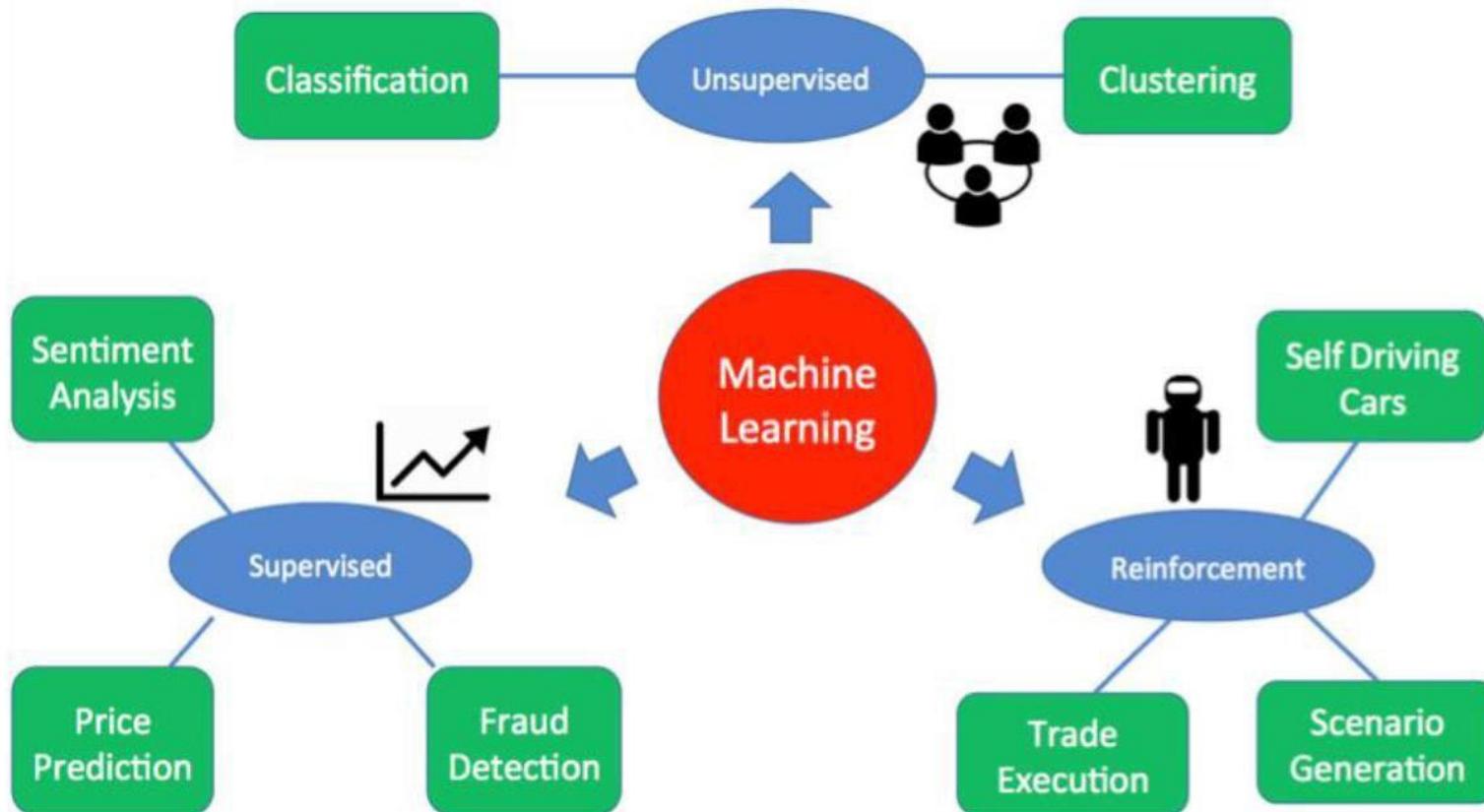
Types of Machine Learning



What is Business Analytics & Machine Learning?



What is Business Analytics & Machine Learning?



How To Do Data Mining: Machine Learning Techniques

Essential Concepts of Machine Learning

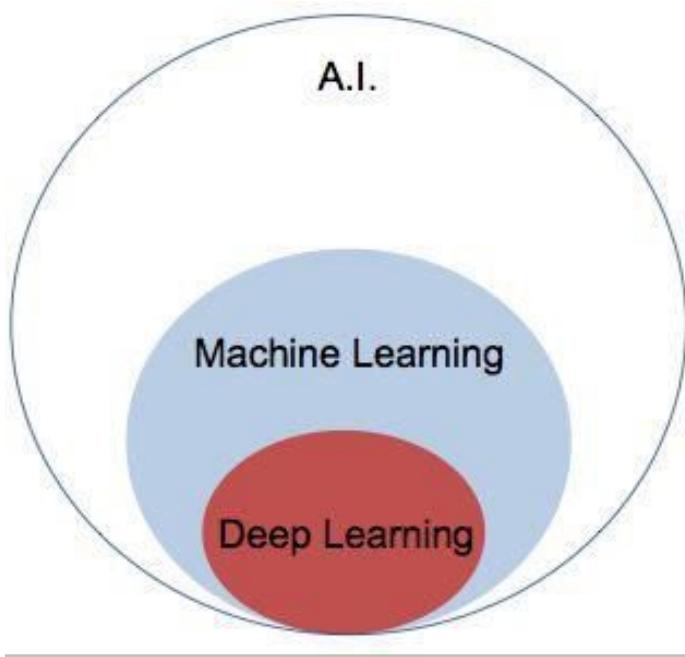
Artificial Intelligence

Machine Learning

Deep Learning

Source: <https://www.becomingadatascientist.com/2017/07/17/introductory-machine-learning-terminology-with-food/>

Clearing The Confusion About Data Science And Big Data



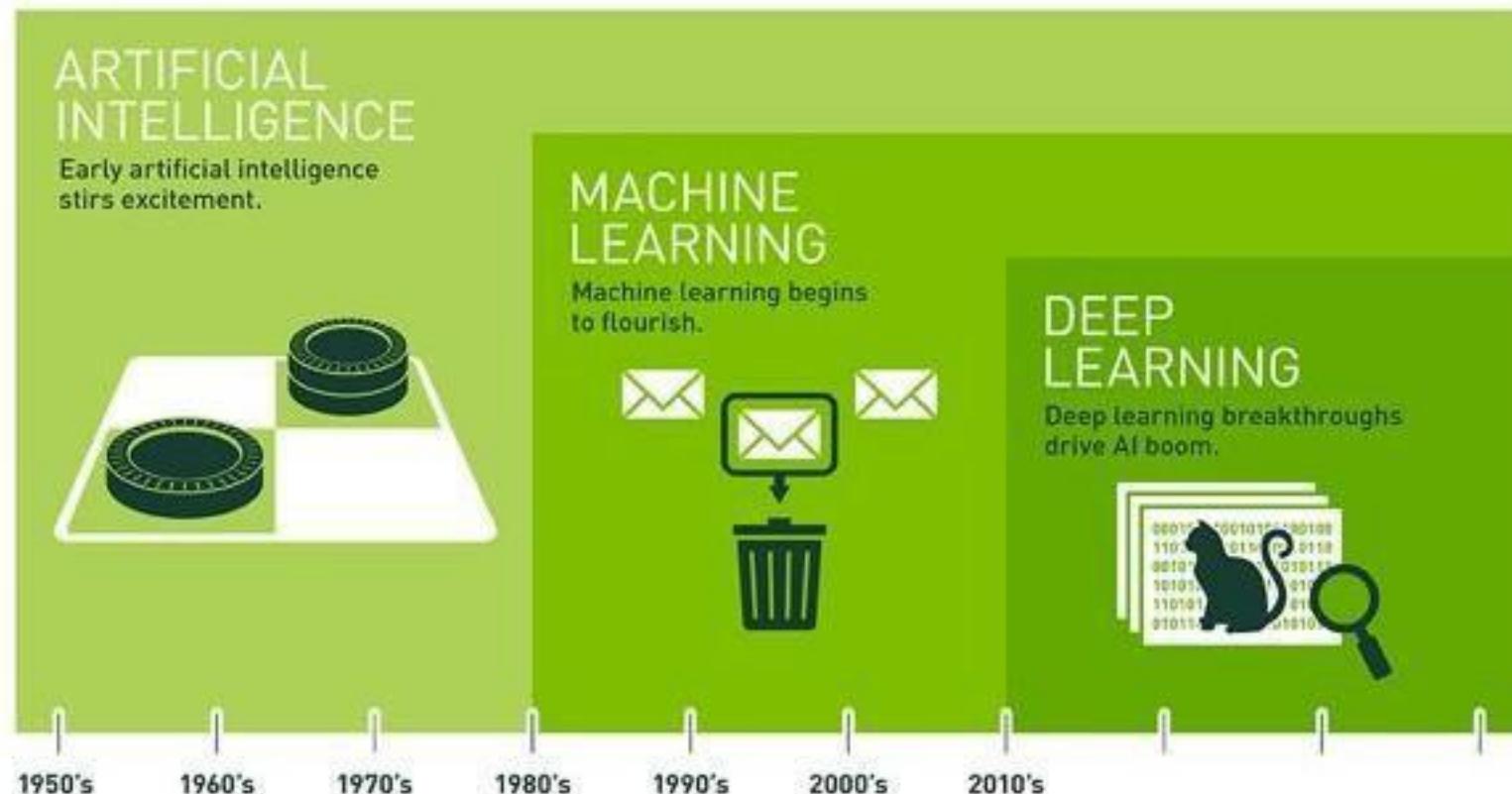
Definition of AI: a branch of computer science trying to get computers to exhibit intelligence.

- Machine Learning is a range of techniques for computers to perform cognitive functions
- Deep Learning (a type of Machine Learning that uses layers of neural networks) has been the most accurate and productive technique in AI research

Frank Chen of a 16z

Big Data Tools and Algorithm Exploration

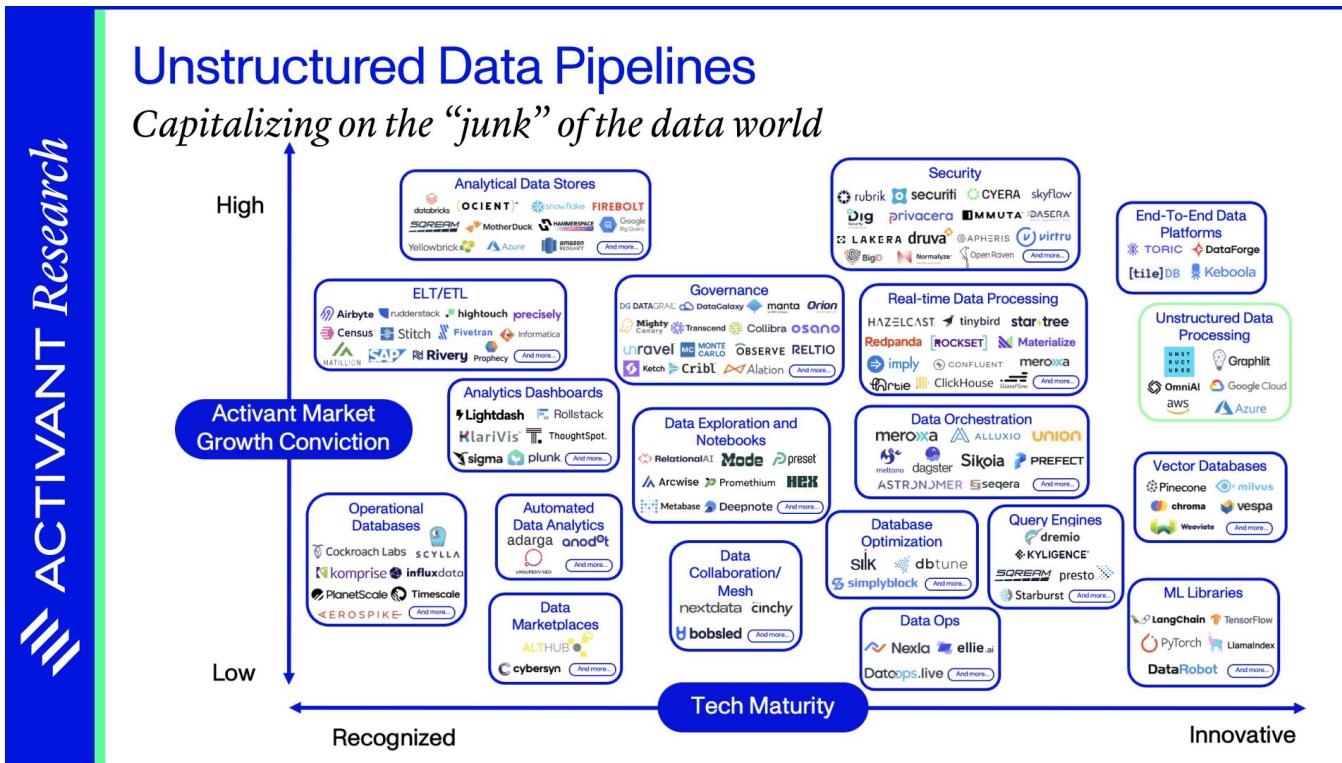
Difference Between AI, Machine Learning & Deep Learning



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

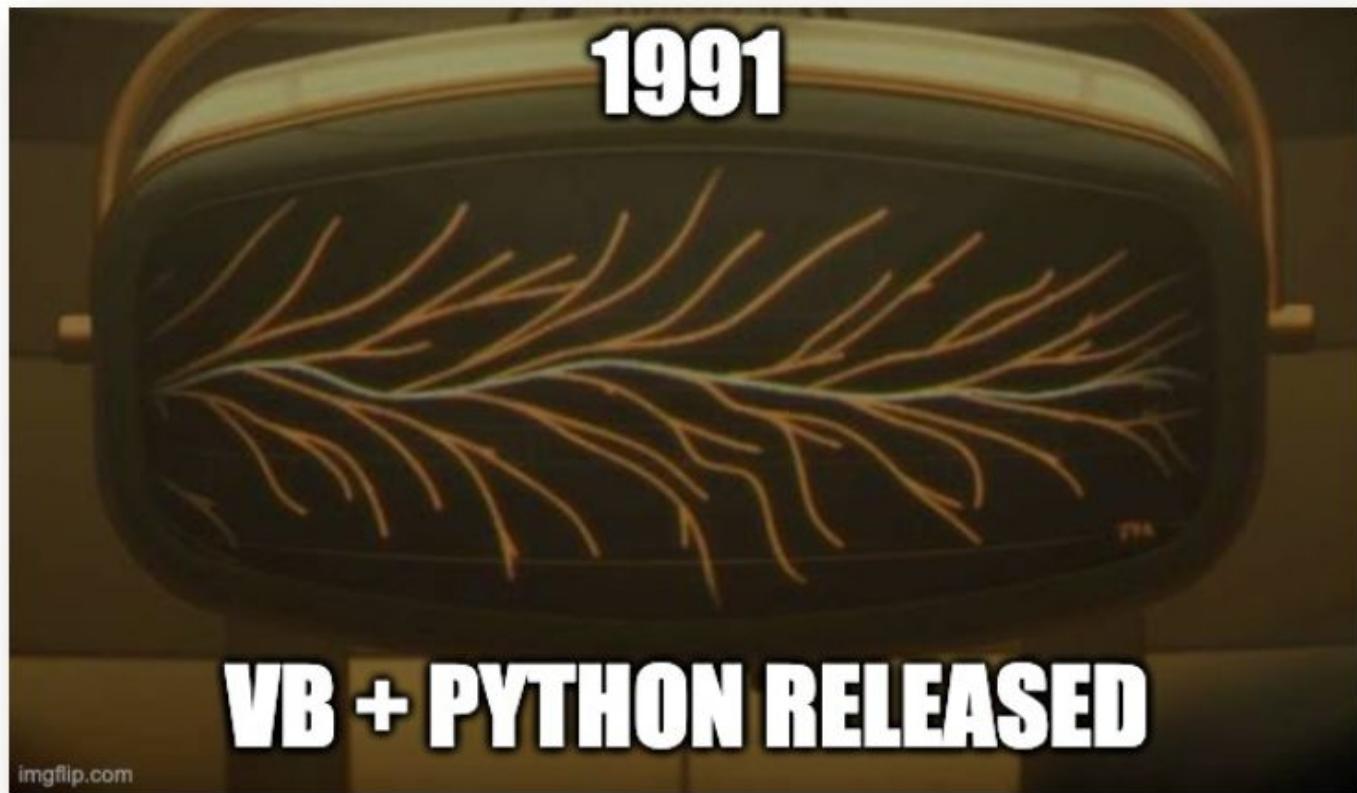
IPA – Data Science

IPA's integration with data science is particularly impactful in several areas:
Unstructured Data Processing: IPA can convert unstructured data into structured formats suitable for analysis, enabling businesses to leverage insights from previously untapped data source.



Python – Origin

- Released in 1991 (same as Visual Basic)
- Free and open-source



Business Process Automation with Python

Motivation – Soft Limits

- Protective measures not matching modern days

Feature	Maximum limit
Total number of rows and columns on a worksheet	1,048,576 rows by 16,384 columns
Column width	255 characters
Row height	409 points
Page breaks	1,026 horizontal and vertical

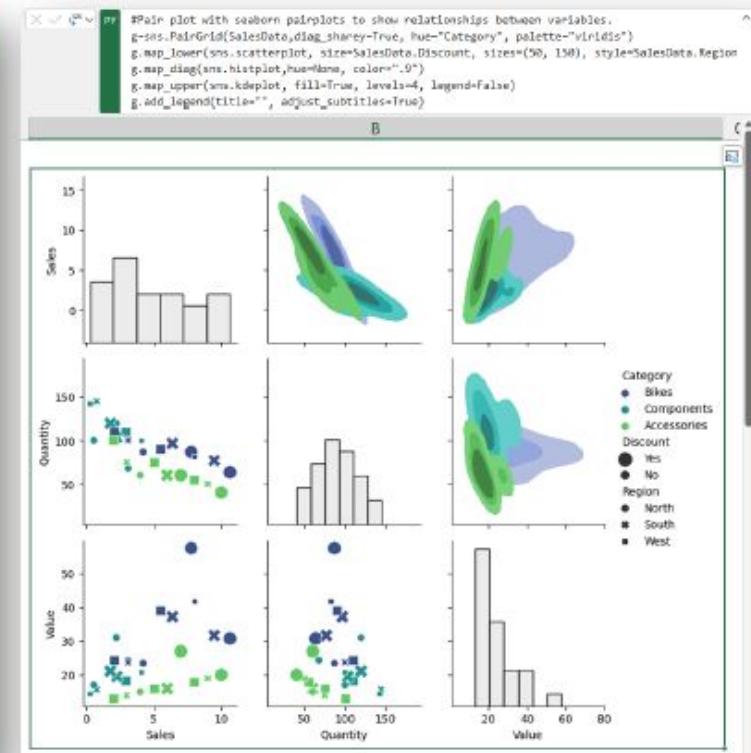
1. Microsoft. Excel Specifications and limits. <https://support.microsoft.com/en-us/office/excel-specifications-and-limits-1672b34d-7043-467e-8e27-269d656771c3>

Business Process Automation with Python

Motivation – Extensibility

- Python in Excel¹

The screenshot shows a Microsoft Excel spreadsheet titled "Python in Excel.xlsx". In the formula bar, the code "#Announcing Python in Excel!" is visible. Below it, the code `DataFrame=xl("A1:B10", headers=True)` and `DataFrame.groupby('Category').agg('mean')` is displayed. The spreadsheet contains a table of data with columns "Category" and "\$". To the right of the table, there are two data visualizations: a bar chart titled "Image" and a scatter plot titled "Image". The bar chart shows values for Components (\$20), Bikes (\$17), Accessories (\$9), Bikes (\$9), Clothing (\$8), Accessories (\$4), Clothing (\$4), Components (\$3), and Components (\$1). The scatter plot shows the same data points.



1. Announcing Python in Excel: Combining the power of Python and the flexibility of Excel. TECHCOMMUNITY.MICROSOFT.COM.
<https://techcommunity.microsoft.com/t5/excel-blog/announcing-python-in-excel-combining-the-power-of-python-and-the/ba-p/3893439>

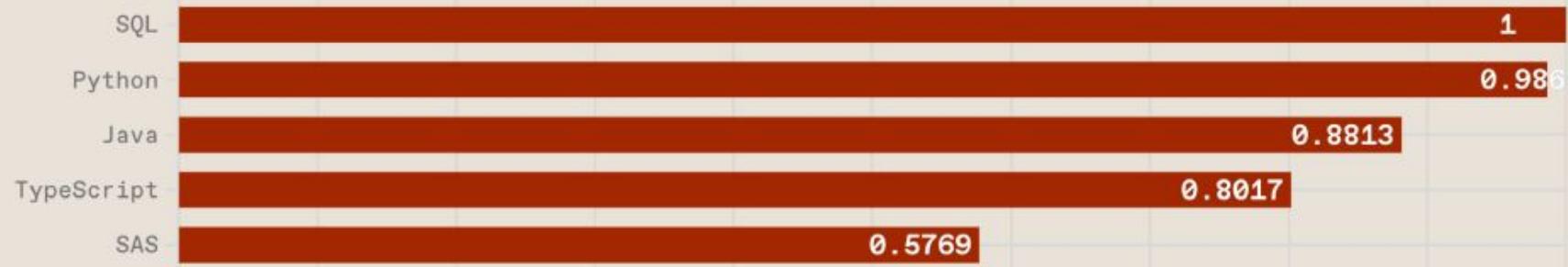
Business Process Automation with Python

Motivation – Jobs

- Python → 1 of the top languages for work

Top Programming Languages 2024

Click a button to see a differently weighted ranking



1. *The Top Programming Languages 2024.* (2024 August 22). IEEE Spectrum.
<https://spectrum.ieee.org/top-programming-languages-2024>

Business Process Automation with Python

Motivation – Jobs

- Python → Recently added as part of CFA exams

Level II

- Python Programming Fundamentals**

A fundamentals course to demonstrate the basics of Python and how to use Jupyter Notebook for developing, presenting, and sharing data science projects related to finance. (if not taken at Level I)

- Analyst Skills**

Focuses on the skills equity and credit analysts need using insights gained from hundreds of successful analysts.

- Python, Data Science & AI**

Introduces candidates to machine learning, artificial intelligence, and data science to understand financial statements, reporting, and analysis using Python.

1. *Practical Skills Module | CFA Program Evolution.* Practical Skills Module | CFA Program Evolution.
<https://evolve.cfainstitute.org/practical-skills-modules.html>

Business Process Automation with Python

Python runtime

- The language and basic runtime environment
- Just like Apple iOS, it keeps updating (e.g., Python 3.12.2)
 - Python 2 was no longer supported from 2020¹



1. Sunsetting Python 2. Python.org. <https://www.python.org/doc/sunset-python-2/>

Business Process Automation with Python

Installation – Python Runtime

- Official website
 - <https://www.python.org/downloads/>
- Installing in Windows → Tick “Add python.exe to PATH”

The screenshot shows the Python Downloads page for macOS. At the top, there's a navigation bar with links for About, Downloads, Documentation, and Community. Below that, a large button says "Download the latest version for macOS". Underneath this button is a yellow call-to-action button labeled "Download Python 3.11.3". To the right of the main content area, there's a sidebar with two main sections: "Install Now" and "Customize installation". The "Install Now" section shows the download path: C:\Users\Jacki\AppData\Local\Programs\Python\Python312. It also includes a note that it "Includes IDLE, pip and documentation" and "Creates shortcuts and file associations". The "Customize installation" section allows users to "Choose location and features". Two checkboxes are present: one for "Use admin privileges when installing py.exe" (unchecked) and one for "Add python.exe to PATH" (checked). A blue arrow points to the checked "Add python.exe to PATH" checkbox.

python™

About Downloads Documentation Community

Download the latest version for macOS

Download Python 3.11.3

→ Install Now
C:\Users\Jacki\AppData\Local\Programs\Python\Python312

Includes IDLE, pip and documentation
Creates shortcuts and file associations

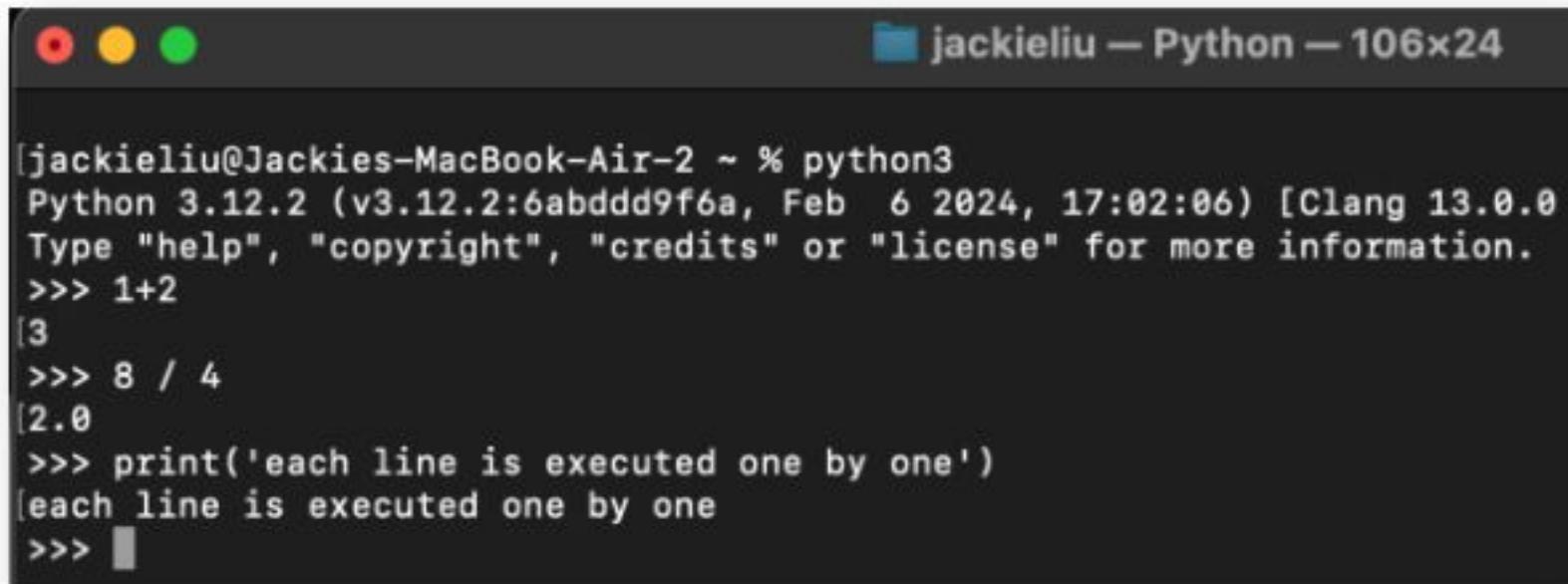
→ Customize installation
Choose location and features

Use admin privileges when installing py.exe

Add python.exe to PATH

How to run Python – In the old days

- Python interpreter
 - This is the core of Python
 - Input a line of codes → Press Enter → Run



```
[jackieliu@Jackies-MacBook-Air-2 ~ % python3
Python 3.12.2 (v3.12.2:6abddd9f6a, Feb  6 2024, 17:02:06) [Clang 13.0.0
Type "help", "copyright", "credits" or "license" for more information.
>>> 1+2
[3
>>> 8 / 4
[2.0
>>> print('each line is executed one by one')
each line is executed one by one
>>> ]
```

Business Process Automation with Python

How to run Python – Running as a file

- Python interpreter + Text editor
 - Write codes in a text editor (e.g., Notepad, Vim, Sublime Text)
 - Save codes as a “.py” file
 - Run all the lines in one go

The screenshot displays two windows side-by-side. On the left is a text editor window titled "test.py". The code inside is:

```
print(f'1 + 2 = {1 + 2}')
```

The right window is a "Command Prompt" showing the output of running the script:

```
C:\Users\Jacki\Documents>python test.py
1 + 2 = 3

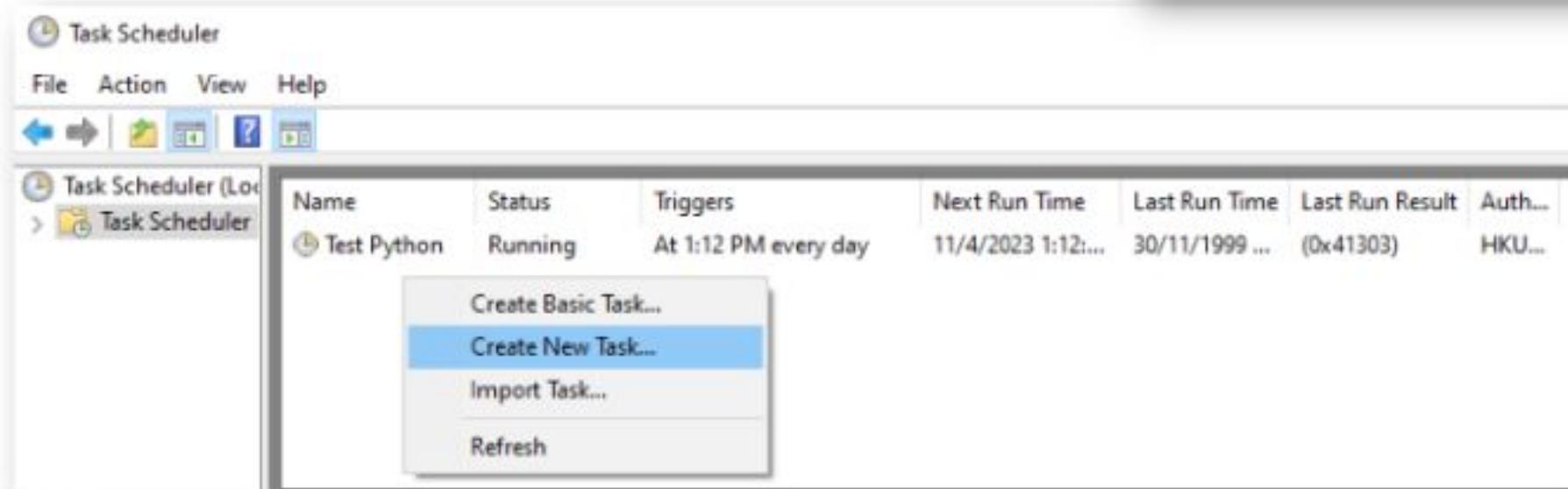
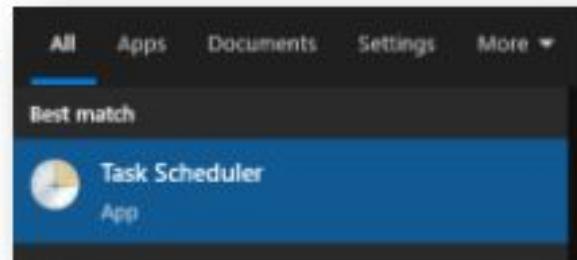
C:\Users\Jacki\Documents>
```

A yellow dashed circle highlights the "test.py" file tab in the text editor, and another yellow dashed circle highlights the command "python test.py" in the Command Prompt.

Business Process Automation with Python

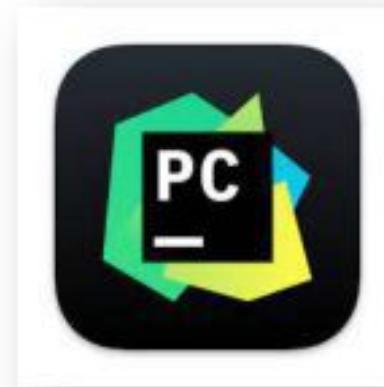
How to run Python – Running as a file (bonus)

- Python interpreter + Text editor + Task Scheduler
 - Running a Python script daily/ hourly
 - e.g., Task Scheduler/ Cron / Autosys etc
 - Create a task pointing to the .py file



How to run Python – IDE

- Integrated Development Environment (IDE)
 - A smart editor tailored for writing codes
 - e.g., Syntax highlighting, variable tracking, debugging mode
 - May support useful extensions/plugins (e.g., GitHub Copilot)
 - Common IDEs
 - e.g., Spyder, PyCharm, Visual Studio Code



Business Process Automation with Python

Example - PyCharm

The screenshot shows a PyCharm interface with a Jupyter notebook open. The notebook contains Python code for data analysis, specifically focusing on Ames Housing dataset. The code includes handling missing values, feature engineering (creating 'AreaCategory' based on living area), statistical analysis (describing the data), and data visualization (a scatter plot of SalePrice vs. Br-Liv-Area grouped by AreaCategory).

```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np

df = pd.read_csv("/Users/Stasislav.Garkusha/Downloads/Shad_Python_81.2/Ames_dataset/AmesHousing.csv")

# Handle Missing Values
# Use apply function to apply a specific function across each column of the DataFrame
df = df.apply(lambda x: x.fillna(x.mean()) if x.dtype.kind in 'biufc' else x.fillna(x.mode()[0]))

# Feature Engineering
df["AreaCategory"] = pd.cut(df["Br-Liv-Area"], bins=[0, 1000, 2000, df["Br-Liv-Area"].max()], labels=["small", "medium", "large"], include_lowest=True)

print(df.groupby("AreaCategory")[
      "SalePrice"].mean()) # printing mean sales price for small, medium, and large living areas

# Statistical Analysis
print(df.describe()) # prints descriptive statistics of all numerical columns

# Data Visualization
fig, ax = plt.subplots()
ax.scatter(df["Br-Liv-Area"], df["SalePrice"], alpha=0.5)
ax.set_title('Scatter plot of Br-Liv-Area vs SalePrice')
ax.set_xlabel('Br-Liv-Area')
ax.set_ylabel('SalePrice')

# Scatter plot instead of boxplot
fig, ax = plt.subplots()
area_categories = ['small', 'medium', 'large']
for category in area_categories:
    ax.scatter(df[df['AreaCategory'] == category]['Br-Liv-Area'], df[df['AreaCategory'] == category]['SalePrice'])
```

Scatter plot of SalePrice grouped by AreaCategory

SalePrice

Br-Liv-Area

Data View

#	Order	PID	MS SubClass	MS
1553	1554	9102510...	20	A (agr)
2903	2904	923125...	20	A (agr)
942	943	9111030...	50	C (all)
727	728	9024771...	30	C (all)
726	727	9024771...	30	C (all)
1557	1558	9112260...	30	C (all)

How to run Python – Jupyter Notebook

- Google Colaboratory (Colab)
 - Jupyter Notebook powered by Google Cloud ¹
 - <https://colab.research.google.com/>
 - Benefits ²
 - “Zero configuration required”
 - Easy sharing
 - Free access: CPU & GPU

Google Colaboratory



1. Google Colab FAQ. <https://research.google.com/colaboratory/faq.html>

2. Google Colaboratory. <https://colab.research.google.com>

Cloud Software Introduction

Colaboratory, or Colab for short, is a Google Research product, which allows developers to write and execute Python code through their browser. Google Colab is an excellent tool for deep learning tasks. It is a hosted Jupyter notebook that requires no setup and has an excellent free version, which gives free access to Google computing resources such as GPUs and TPUs.

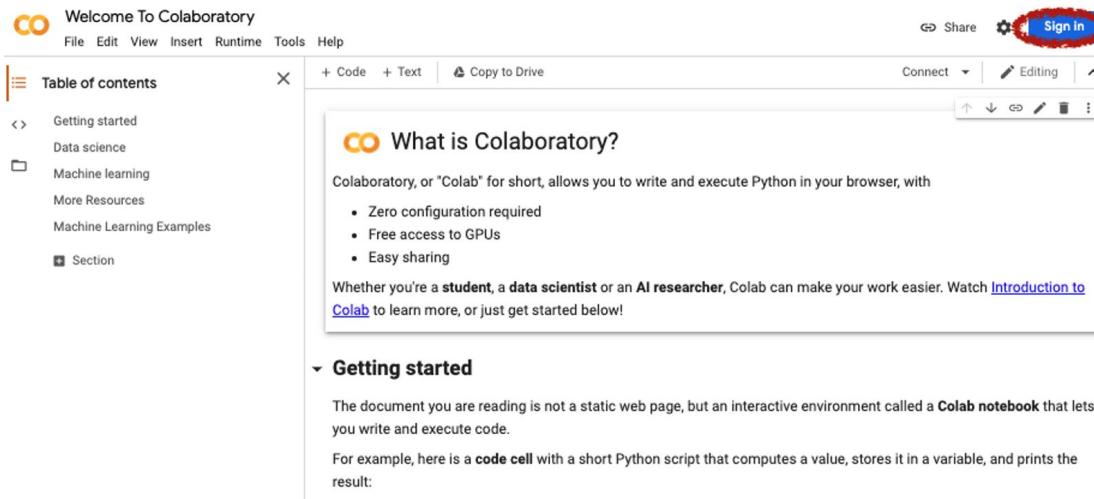
Why Should I Use Google Colab?

There are several reasons to opt to use Google Colab instead of a plain Jupyter Notebook instance:

- Pre-Installed Libraries
- Saved on the Cloud
- Collaboration
- Free GPU and TPU Use

Google Colab Setup

1. Visit the [Google Colab](http://colab.research.google.com/) (<http://colab.research.google.com/>) page, which will direct you to the [Google Colaboratory Welcome Page](#).
2. Click the **Sign in** button on the right top.



Welcome To Colaboratory

File Edit View Insert Runtime Tools Help

Table of contents

- Getting started
- Data science
- Machine learning
- More Resources
- Machine Learning Examples
- Section

+ Code + Text Copy to Drive Connect Editing

What is Colaboratory?

Colaboratory, or "Colab" for short, allows you to write and execute Python in your browser, with

- Zero configuration required
- Free access to GPUs
- Easy sharing

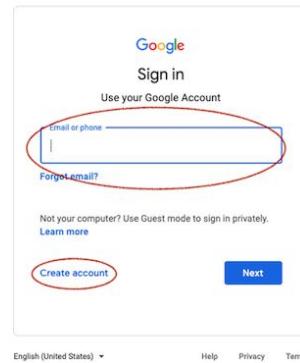
Whether you're a **student**, a **data scientist** or an **AI researcher**, Colab can make your work easier. Watch [Introduction to Colab](#) to learn more, or just get started below!

Getting started

The document you are reading is not a static web page, but an interactive environment called a **Colab notebook** that lets you write and execute code.

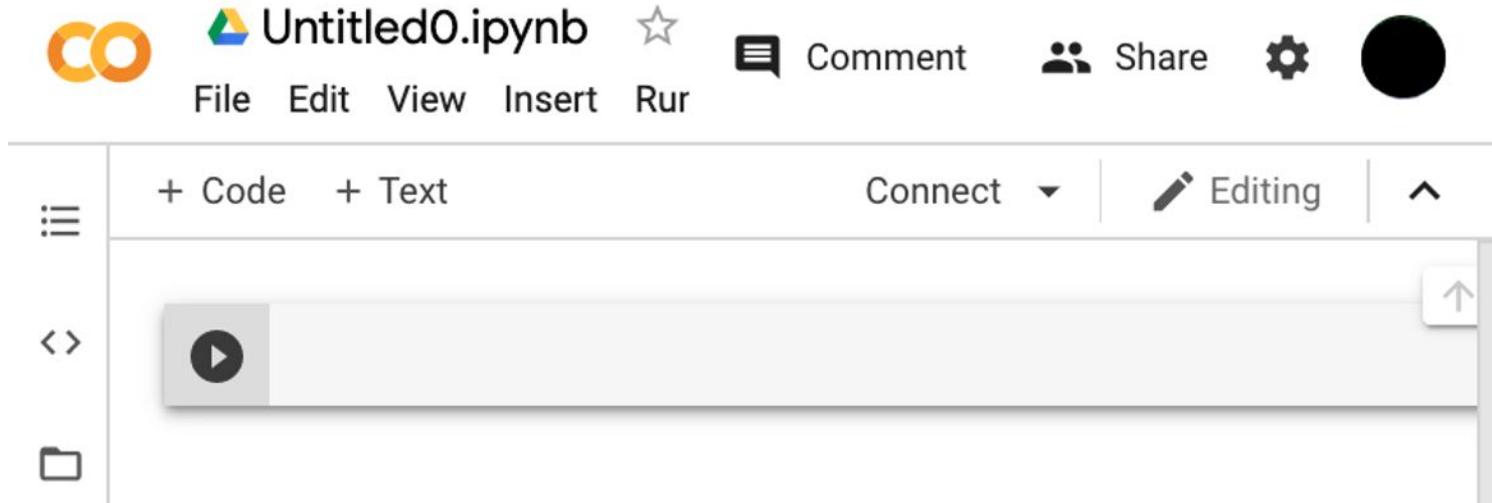
For example, here is a **code cell** with a short Python script that computes a value, stores it in a variable, and prints the result:

3. Sign in with your Gmail account.



Google Colab Setup

4. As soon as you complete the sign-in process, you are ready to use Google Colab.
5. You may easily create a new Colab notebook on this page by clicking *File> New notebook*.



How to run Python – Summary

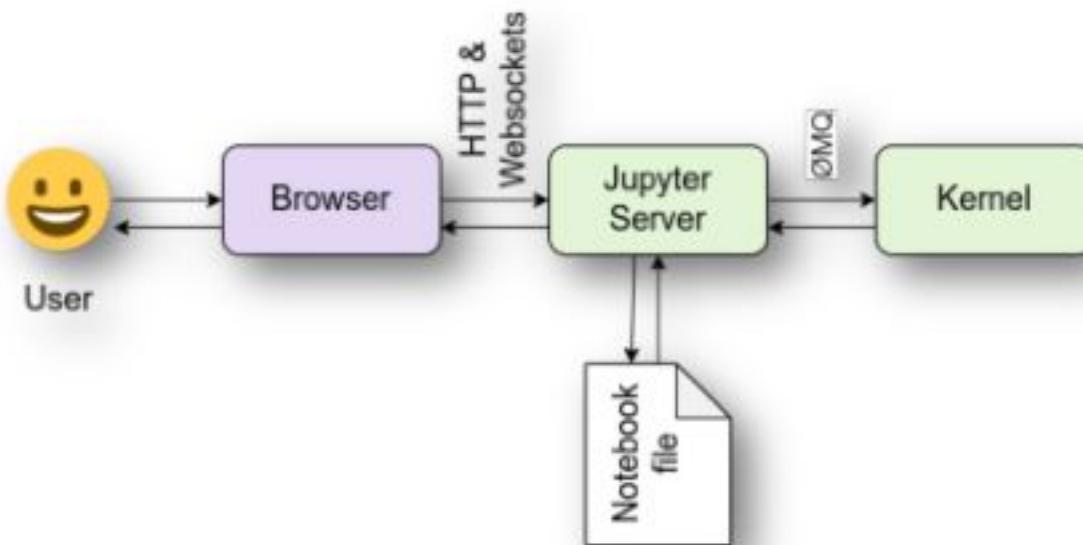
- Python interpreter
- Python (.py) files with
 - Text editors
 - IDEs
- Jupyter Notebook running
 - Locally
 - Remotely



Business Process Automation with Python

How to run Python – Jupyter Notebook

- Web-based interactive platform
 - Accessible: Python runtime on a web server

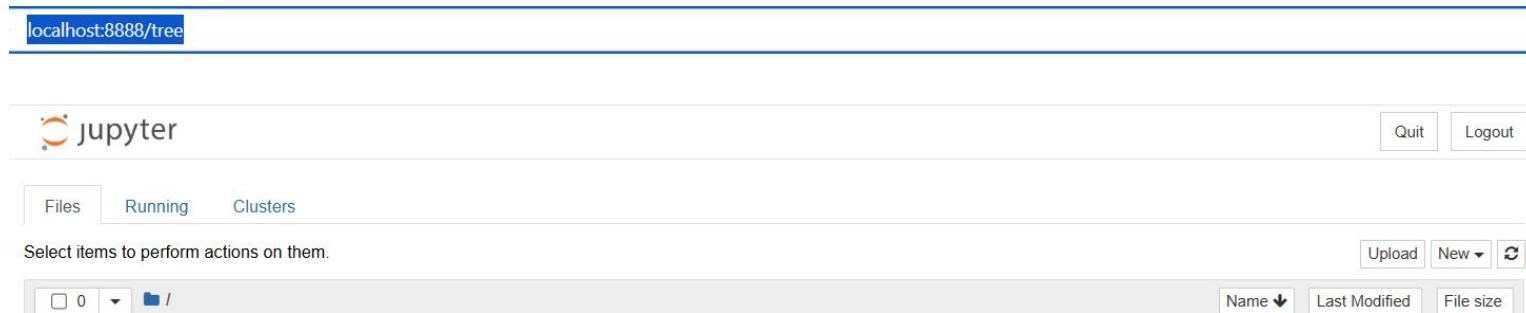


1. Architecture — Jupyter Documentation 4.1.1 Alpha Documentation.
<https://docs.jupyter.org/en/latest/projects/architecture/content-architecture.html>

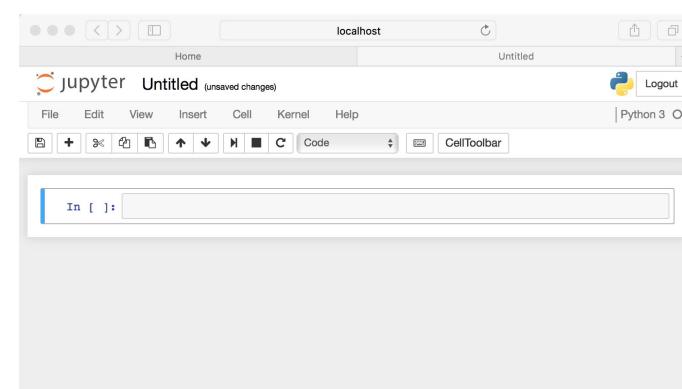
Python Coding Environment Practise - Jupyter notebook

Open Jupyter notebook

1. In Desktop, click 'Startup' button
2. Type Anaconda Prompt (Anaconda3)
3. Type jupyter notebook to trigger your first notebook
4. <http://localhost:8888/tree> is opened



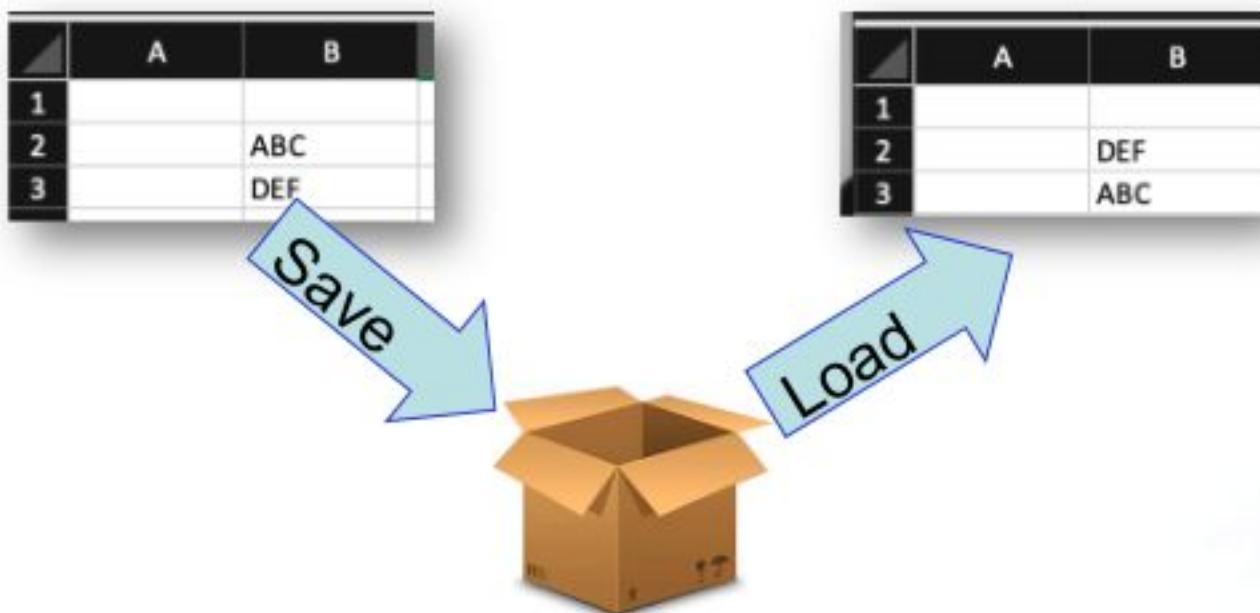
5. In right top side, click New -> Python 3



Business Process Automation with Python

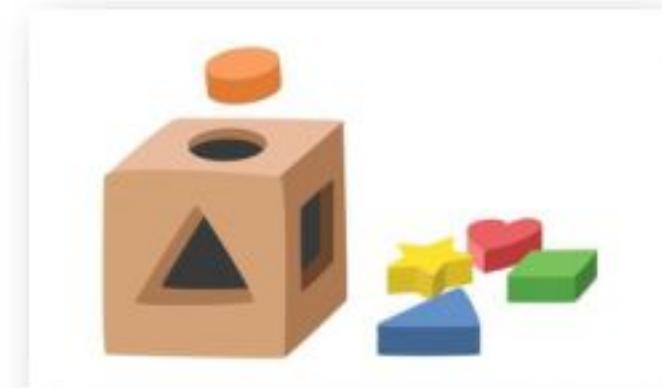
Variables

- From the previous lecture
 - Variables → Storage of values
 - Values → carry data types



Variables

- Declaration
 - In VBA, declarations (“dim”) are recommended
 - Dim year As **Integer**
 - year = **2024**
- In Python, variables are created during **assignment**
 - year = **2024**
- To assign without an actual value
 - year = **None**



Business Process Automation with Python

Value Check

- VBA
 - 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

- Python
 - print()
 - Last line in a block

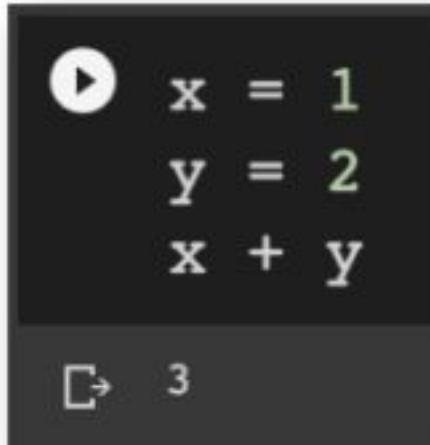
```
▶ print(1 + 2)          # This gives 3
  print(1 + 2 + 3)      # This gives 6
□ 3
  6
```

```
▶ 1 + 2          # This is not shown
  1 + 2 + 3      # This is shown
□ 6
```

Business Process Automation with Python

Primitive Data Types - Numeric

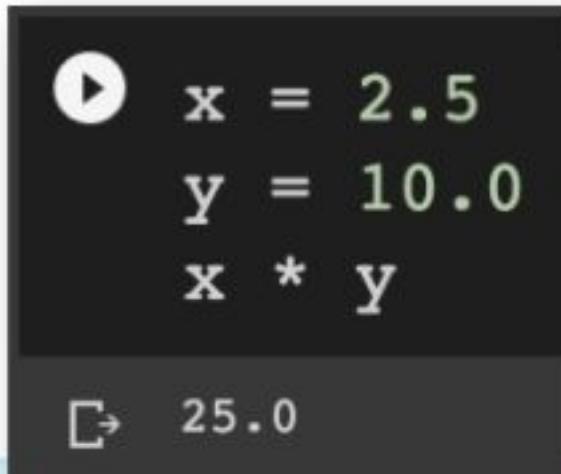
- Int



A screenshot of a Jupyter Notebook cell. The code section contains three lines of Python code: `x = 1`, `y = 2`, and `x + y`. The output section below shows the result `3`.

```
x = 1
y = 2
x + y
3
```

- Float



A screenshot of a Jupyter Notebook cell. The code section contains three lines of Python code: `x = 2.5`, `y = 10.0`, and `x * y`. The output section below shows the result `25.0`.

```
x = 2.5
y = 10.0
x * y
25.0
```

Primitive Data Types - Numeric

- Complex (For scientific calculations)

THE QUADRATIC FORMULA

© CHILIMATH.COM

If $ax^2 + bx + c = 0$ but $a \neq 0$

then

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

DISCRIMINANT

- $b^2 - 4ac > 0$ two real solutions
- $b^2 - 4ac = 0$ one real solutions
- $b^2 - 4ac < 0$ zero real solutions

▶ $x = 3 + 4j$
 $y = 2 + 2j$
 $x - y$
⇒ $(1+2j)$

$i = \sqrt{-1}$

Primitive Data Types - Numeric

- Common Functions
 - `round()` / `pow()` / `abs()`

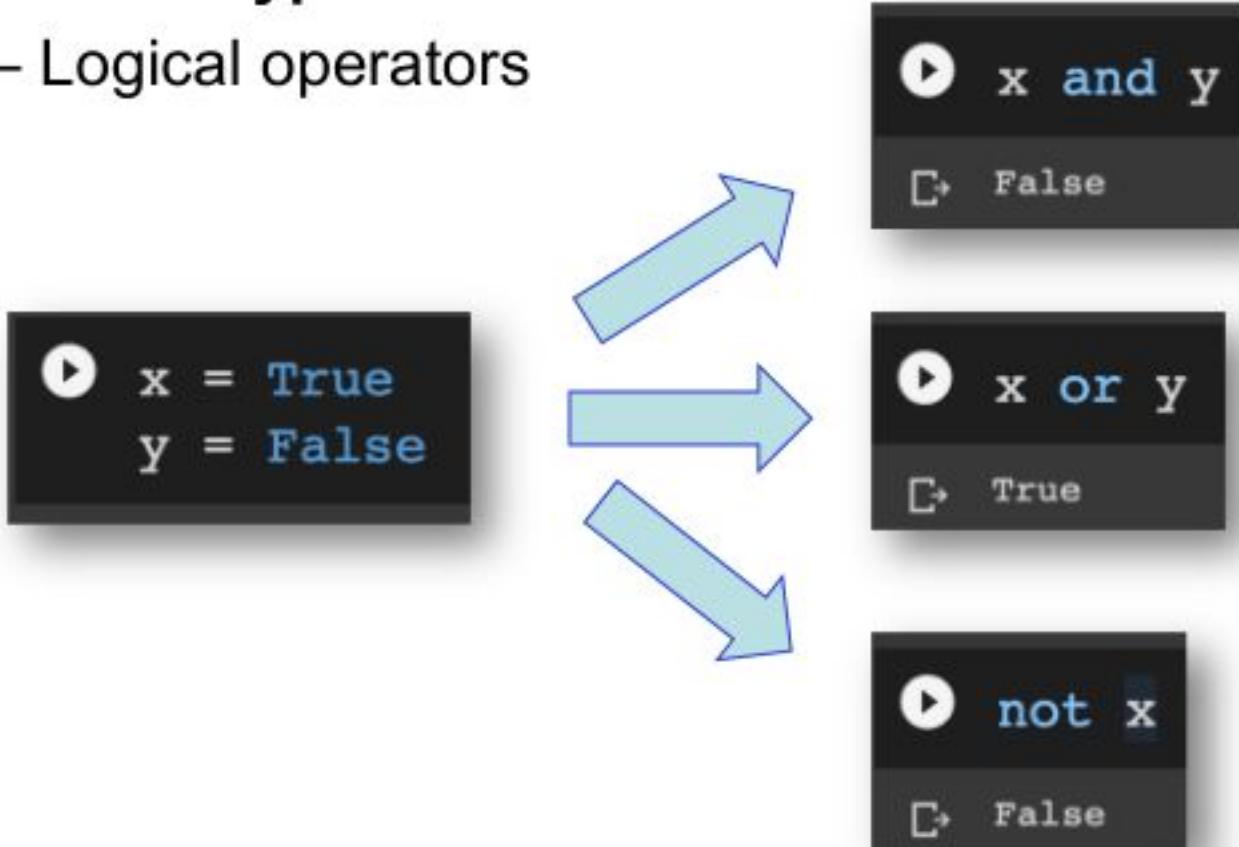
```
▶ print(round(9876.54321, 2))      # Round to 2 decimal places
    print(round(9876.54321, 0))      # Round to nearest integer
    print(pow(2, 3))                  # 2 * 2 * 2 = 8
    print(abs(-5))                   # Negative numbers become positive
```

```
▷ 9876.54
  9877.0
  8
  5
```

Business Process Automation with Python

Primitive Data Types - Boolean

- Bool – Logical operators



Business Process Automation with Python

Primitive Data Types - Boolean

- Bool – comparators
 - Generates True/ False

Operator	Name	Example
<code>==</code>	Equal	<code>5 == 5</code>
<code>!=</code>	Not equal	<code>26 != 3</code>
<code>></code>	Greater than	<code>100 > 67</code>
<code><</code>	Less than	<code>89 < 216</code>
<code>>=</code>	Greater than or equal to	<code>90 >= 54</code>
<code><=</code>	Less than or equal to	<code>23 <= 77</code>

Primitive Data Types - Text

- String
 - Representation

```
▶ x = 'This is a string'                      # Single quote
    y = "This is also a string"                 # Double quote
    z = '''This is a very long string
spanning across more than 1 line'''           # Multi-line

    print(x)
    print(y)
    print(z)

⇒ This is a string
    This is also a string
    This is a very long string
        spanning across more than 1 line
```

Primitive Data Types - Text

- String
 - Concatenation → “+” → glue 2 strings together

```
▶ x = 'This is a string'  
    y = "This is also a string"
```

```
▶ print(x + ' and ' + y) # Adding 2 strings together  
◀ This is a string and This is also a string
```

Business Process Automation with Python

Primitive Data Types - Text

- String
 - Concatenation → Number vs Text



```
lobster_price = 936
lobster_text = str(lobster_price)
print(2 * lobster_price) # 1872
print(2 * lobster_text) # 936936
```

1872
936936

```
▶ print(10 * '=')
▶ print('WELCOME')
▶ print(10 * '=')
```

```
=====
WELCOME
=====
```

- 星島日報. (2023, May 6). 荃灣中菜館驚現「天價龍蝦」兩隻竟索價90萬元 酒樓姍解釋. Singtaousa.com; 星島日報.
<https://www.singtaousa.com/2023-05-06/%e8%bd%83%e7%81%a3%e4%b8%ad%e8%8f%9c%e9%a4%a8%e9%a9%9a%e7%8f%be%e3%80%8c%e5%a4%a9%e5%83%b9%e9%be%8d%e8%9d%a6%e3%80%8d-%e5%85%a9%e9%9a%bb%e7%ab%9f%e7%b4%a2%e5%83%b990%e8%90%ac%e5%85%83%e9%85%92/4488305>

Primitive Data Types - String formatting

- F-String (Python 3.6 or newer)
 - A smart way to format strings

```
▶ x = 4
  y = 8.8
  f'x is {x} and y is {y}; y divided by x is {y / x}'
⇒ 'x is 4 and y is 8.8; y divided by x is 2.2'
```

1. *Input and Output.* Python Documentation. <https://docs.python.org/3/tutorial/inputoutput.html>

Primitive Data Types - String formatting

- F-String (Python 3.6 or newer)
 - A smart way to format strings (advanced)

```
▶ z = 1234.56789
    print(z)
    print(f'{z:.2f}')
    print(f'{z:,.2f}')

⇨ 1234.56789
    1234.57
    1,234.57
```

1. *Input and Output.* Python Documentation. <https://docs.python.org/3/tutorial/inputoutput.html>

Primitive Data Types - String

- Common Functions
 - upper() / lower() / replace()

```
▶ # Common functions
    test_string = 'Hello Hong Kong!'
    print(test_string.upper())
    print(test_string.lower())
    print(test_string.replace('Hello', 'Bello'))
```



```
⇨ HELLO HONG KONG!
    hello hong kong!
    Bello Hong Kong!
```

Primitive Data Types - Conversion

- **VBA**
 - CInt() / CDbl() / Format()
- **Python**
 - int() / float() / str() / bool()

```
▶ int(4.5)
□ 4
```



```
▶ float(5)
□ 5.0
```



```
▶ str(5.55)
□ '5.55'
```

❗

```
▶ bool('Some values')
□ True
```



```
▶ bool('')
□ False
```

Methods

- VBA
 - Sub-routine: reusable code blocks
 - Function: sub-routine which gives an output
- Python
 - Methods: Use “`return`” if output is required

VBA

```
Function AddNumbers(x As Double, y As Double) As Double
    AddNumbers = x + y
End Function
```

```
?AddNumbers(1,2)
3
```

Python

```
def add_numbers(x, y):
    return x + y
```

```
def add_numbers(x, y):
    return x + y

print(add_numbers(1,2))
```

How to Manage Your Budget with a Simple Python Script (Algorithm)

Open Jupyter notebook

1. Getting User Input

```
import pandas as pd  
import matplotlib.pyplot as plt
```

```
def get_user_input():  
    """Get user input for income and expenses."""  
    income = float(input("Enter your income: "))  
    # Expecting expenses to be a dictionary input  
    expenses = {}  
    while True:  
        category = input("Enter expense category (or 'done' to finish): ")  
        if category.lower() == 'done':  
            break  
        amount = float(input(f"Enter amount for {category}: "))  
        expenses[category] = amount  
    return income, expenses
```

How to Manage Your Budget with a Simple Python Script

2. Calculating the Budget

```
def calculate_budget(income, expenses):
    """Calculate total expenses and balance."""
    total_expenses = sum(expenses.values())
    balance = income - total_expenses
    return total_expenses, balance
```

3. Displaying the Budget Summary

```
def display_budget_summary(income, total_expenses, balance):
    """Display the budget summary."""
    print(f"Income: ${income:.2f}")
    print(f"Total Expenses: ${total_expenses:.2f}")
    print(f"Balance: ${balance:.2f}")
```

How to Manage Your Budget with a Simple Python Script

4. Plotting the Expenses

```
def plot_expenses(expenses):
    """Plot the expenses as a bar chart."""
    df = pd.DataFrame(list(expenses.items()), columns=['Category', 'Amount'])
    df.plot(kind='bar', x='Category', y='Amount', legend=False)
    plt.ylabel('Amount ($)')
    plt.title('Expense Distribution')
    plt.show()
```

How to Manage Your Budget with a Simple Python Script

5. Main Function

```
income, expenses = get_user_input()  
total_expenses, balance = calculate_budget(income, expenses)  
display_budget_summary(income, total_expenses, balance)  
plot_expenses(expenses)
```

How to Manage Your Budget with a Simple Python Script

5. Main Function

Main Input

Enter your income: 10000

Enter expense category (or 'done' to finish): rent

Enter amount for rent: 2000

Enter expense category (or 'done' to finish): car

Enter amount for car: 500

Enter expense category (or 'done' to finish): utilities

Enter amount for utilities: 250

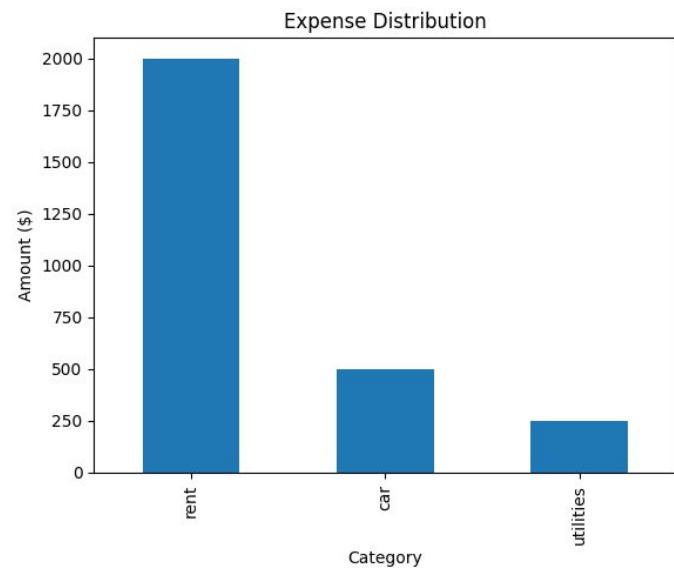
Enter expense category (or 'done' to finish): done

Result

Income: \$10000.00

Total Expenses: \$2750.00

Balance: \$7250.00



Business Process Automation with Python

Practice 1 – Market Capitalization

- Compute market capitalization of 2 companies
- Show the difference between the two
- Format the result up to 2 decimal places



- **Starting notebook:**

https://github.com/innoviai/IPA_Courses-Jan2026/blob/main/practice1_simple_calc_202409.ipynb



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THANK YOU

