Supercharging Machine Learning with Cloud Computing

Summit2Sea Consulting

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What is Cloud Computing?

- Distributing Storage and Power across many computers
- Usually have ‘pay as you go’ pricing
- Much more resources available (compared to desktop)

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Why use Cloud Computing? Example

System	My Desktop (HP 15t dy200 i7)	Cloud (AWS g4dn.8xlarge)
Storage	512 GB	5 TB
Processing Power	16 GB	128 GB
Time to Complete Benchmark	8 hours	15 minutes

Benchmark Test: Training an AI model to recognize and read hand-written digits based on an input of 50,000 images

Conclusion: Cloud performed the task **30X faster** compared to my desktop!

Real DoD Cloud Example: Advana

- The Advana (Advanced Analytics) platform is a Cloud system that hosts massive amounts of data for dozens of DoD agencies
- Formed via the consolidation of 1200+ different databases, it holds information including 1 billion+ financial transactions (2018-present)
- 20,000+ Users, with a storage capacity of 500 TB, all on a secure CaC-required environment
- Compatible with data analysis tools (Python/Tableau/etc)- hosts 250+ dashboards
- Built by Booz Allen Hamilton and runs on AWS GovCloud

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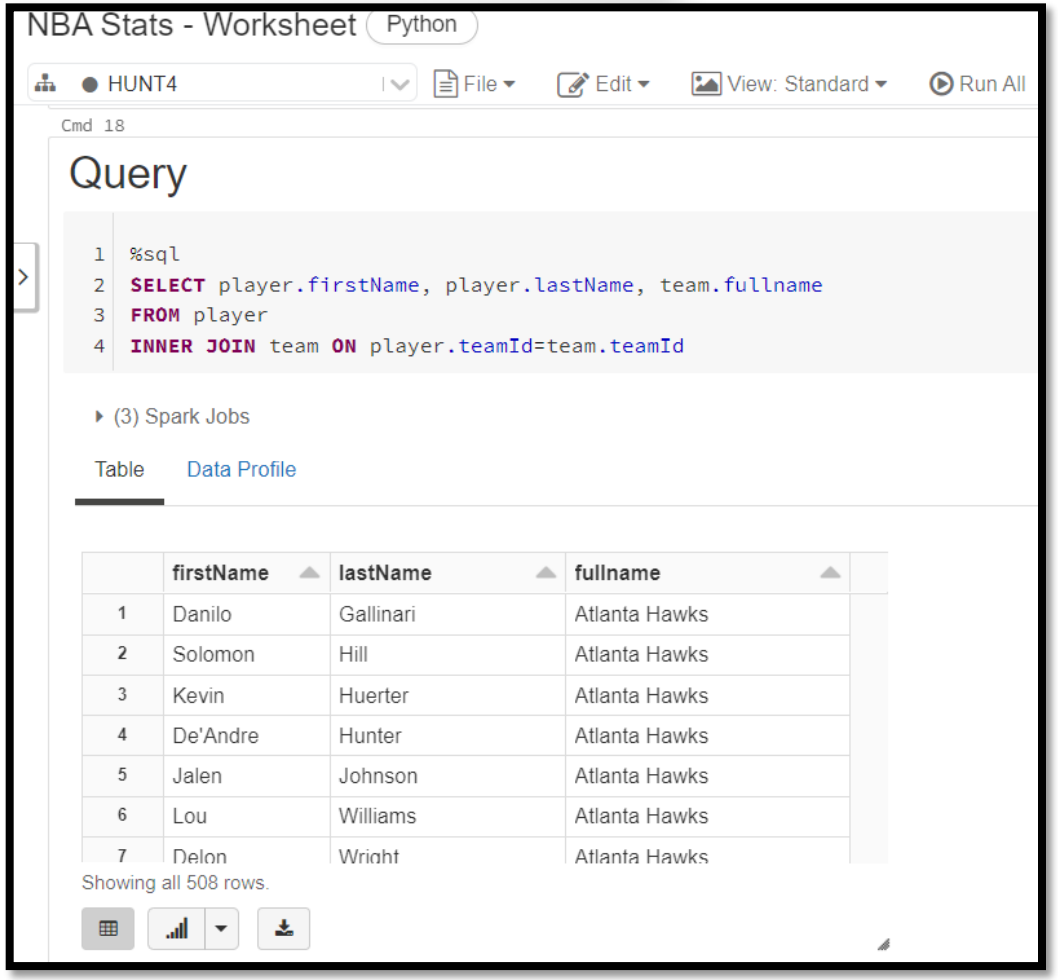
Tools: Databricks

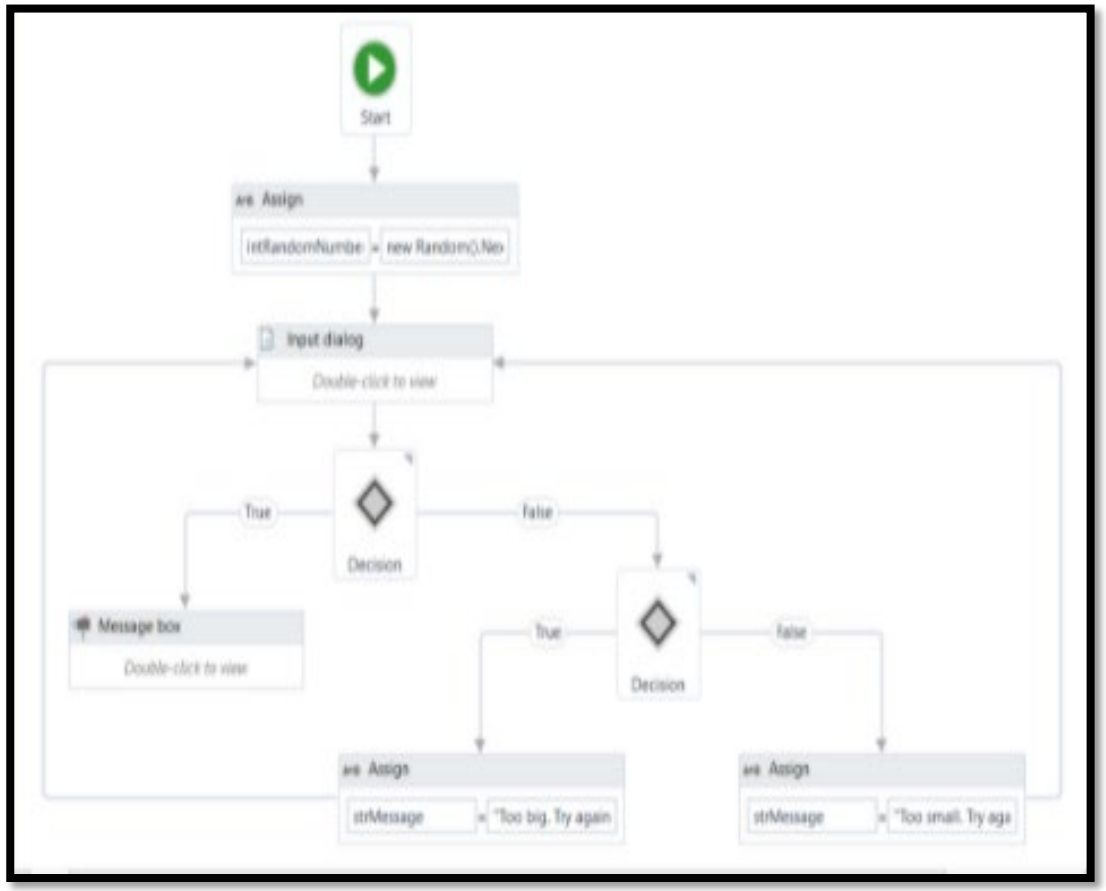
databricks

- Create “Notebooks” in multiple programming languages at once (R,Python,SQL,Scala)
- All notebooks can be worked on by multiple users concurrently
- Version tracking of Notebooks shows changes & can be reverted
- Notebooks can be scheduled to run at repeated time intervals
- Parallelize jobs over Spark for even faster speeds
- Save trained ML models and “Serve” them with a reproducible hyperlink



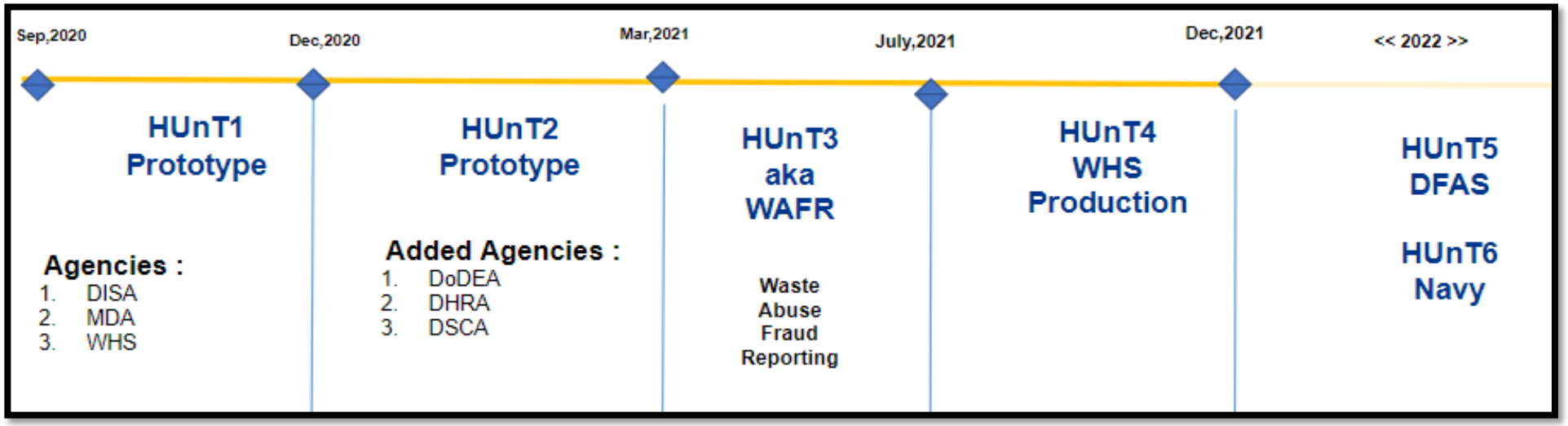
Tools: UiPath

- UiPath is a tool for “Robotic Process Automation” (RPA)
- Essentially can set up complex macros (“automations”)
  - Automations run across multiple programs (Excel, Internet Browser, etc)
  - Can do advanced actions like humans (right click, scroll, etc)
  - Built in AI (Find words within image, etc)
  - “Unattended” automations can run on Virtual Machines without interfering
  - Can execute SQL code and interface with Databricks



Case Study: Humanless UNmatched Transactions (HUnT)

- ML & RPA project to correct 'unmatched' transactions in DoD financial system
- Multiple Stakeholders including OUSD, Missile Defense Agency (MDA), Dept of Navy, Washington Headquarter Service (WHS)



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Background: Unmatched Transactions

- DoD Financial Transactions that for some reason did not go though
- May have a typo or missing value in fields
- May have wrong dollar amount
- Reason & Action
  - Reason- Why did it not work?
  - Action- How do we fix this?
  - There are ~20 unique Reason-Action combinations

Reason - Action
Credit to Invoice - Credit to Invoice
Credit to POET - Credit to POET
Incorrect PO Number - Match with correct PO
Direct Invoice - Direct Invoice
Suspense LOA - Suspense LOA
Incorrect or undefined PO Line - Match with correct PO Line
Split Payment to Inv Lines - Split Payment to Inv Lines
Incorrect PO - Use Doc Ref No
Incorrect PO Number - Match with correct PO and LOA from Contract
Incorrect PO docref - Match with correct PO
Incorrect PO docref CLIN REQ ACRN - Match with correct PO
Incorrect PO Number - Match with PSB PO
Insufficient RCV Amt - Add receipt to contract
Insufficient PO Amt - Add funding to contract

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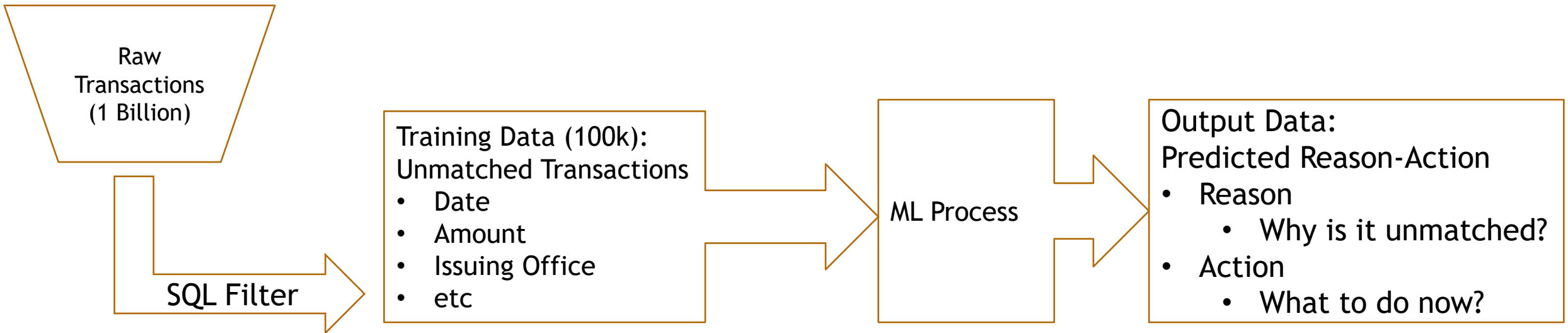
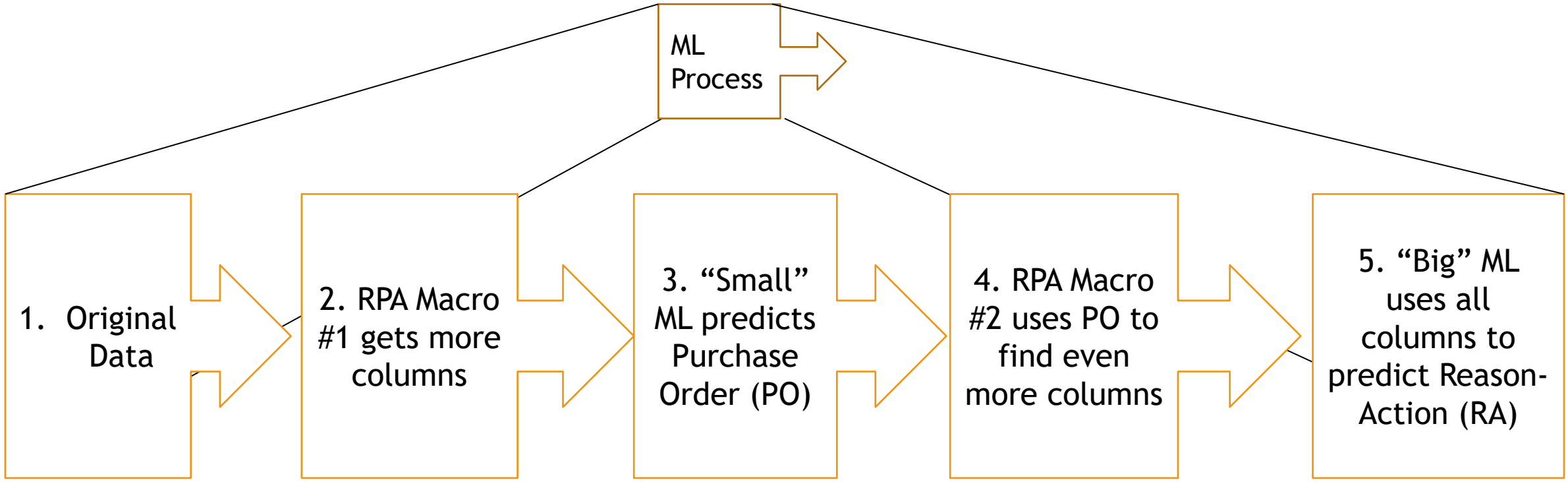
Framing the ML Problem

- SQL to Filter down to only relevant data
- Training Dataset now consists of relevant transactions (100,000 data points)
- Classification Problem with numeric and categorical inputs (90 columns)
- Determine which Reason-Action to give (20 unique classes)



Detailed View

- Multiple ML Models and RPA Macros used together sequentially
- "Snowball" effect where each step gets more data for final "Big" ML



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HUnT Demo

- https://vimeo.com/540679399

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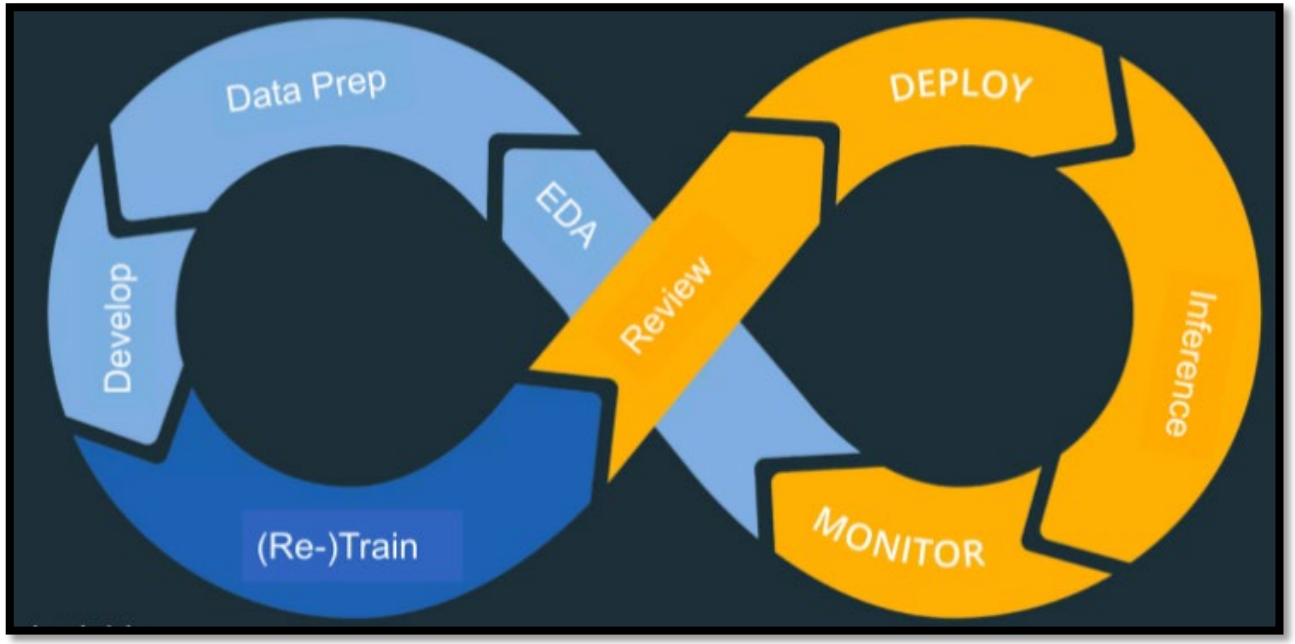
MLOps

- Deploy system into production with minimal intervention needed
- Automatically re-train ML every month when database updates
- Automatically infer on new data every day
- Monitor accuracy metrics and add control logic



Schedule notebooks to run automatically via Databricks

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HUnT Results

- Surpassed accuracy goals of 70%
- ML Techniques tested include Logistic Regression, Decision Trees, XGBoost, Neural Networks
- First in DoD to connect Databricks and UiPath
- First in DoD to use 'AutoML'

		Phase 1			Phase 2		
		Agencies					
	Reason - Action	WHS	MDA	DISA	DHRA	DoDEA	DSCA
Phase 1	Credit to Invoice - Credit to Invoice	100	100	100	100	100	100
	Credit to POET - Credit to POET	100	100	100	97.96	100	100
	Incorrect PO Number - Match with correct PO		99.43			89.74	
Phase 2	Direct Invoice - Direct Invoice	98.72	100	100	100	100	100
	Suspense LOA - Suspense LOA	100		90.35	100		98.38
	Incorrect or undefined PO Line - Match with correct PO Line	100			74.07	81.98	
	Split Payment to Inv Lines - Split Payment to Inv Lines		72.05		100		
	Incorrect PO - Use Doc Ref No			88.12	70.02		
	Incorrect PO Number - Match with correct PO and LOA from Contract			73.3			
	Incorrect PO docref - Match with correct PO						87.5
	Incorrect PO docref CLIN REQ ACRN - Match with correct PO						92.06
	Incorrect PO Number - Match with PSB PO	78.79					
	Insufficient RCV Amt - Add receipt to contract					94.74	
	Insufficient PO Amt - Add funding to contract		84.76				

HUnT Impact

- Our automated system cleared tens of thousands of transactions, saving time and money for the Government

Data Across FY 19/20/21Q1			
Agency	**Total UMT**	**Can Automate**	**Percent**
WHS	50,345	21,950	43.60%
MDA	18,810	8,350	44.39%
DSCA	57,325	8,860	15.46%
DISA	56,975	7,885	13.84%
DHRA	16,075	1,015	6.31%
DoDEA	44,855	29,090	64.85%
TOTAL 6	**244,385**	**77,150**	**31.57%**

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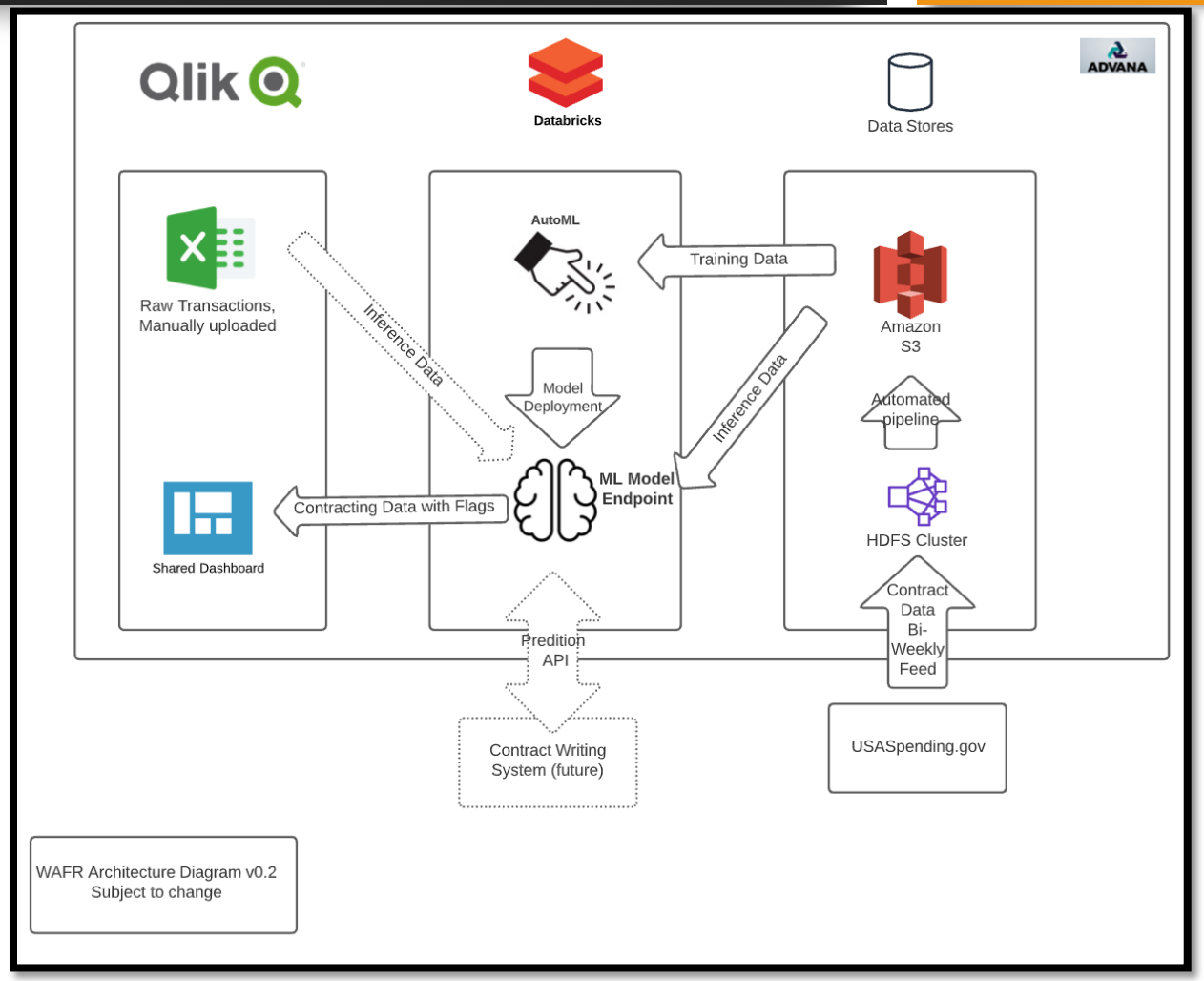
Case Study #2: WAFR

- Waste, Abuse, & Fraud Report (WAFR) was an offshoot of HUnT between downtime of initial prototyping and final production
- WAFR was built in conjunction with the JAIC – DoD Joint AI Center
- Project aimed to use ML to detect potential Fraud in the form of "Split Buys"
  - Breaking large transaction into smaller pieces to avoid scrutiny

	issuing_office	award_id_piid	recipient_name	award_description	action_date	cage_code	extent_competed	federal_action_obligation
1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NOT COMPETED UNDER SAP	249999
2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NOT COMPETED	249000
3	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NOT COMPETED	249000
4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NOT COMPETED	249000
5	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NOT COMPETED	249000
6	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NOT COMPETED	249000

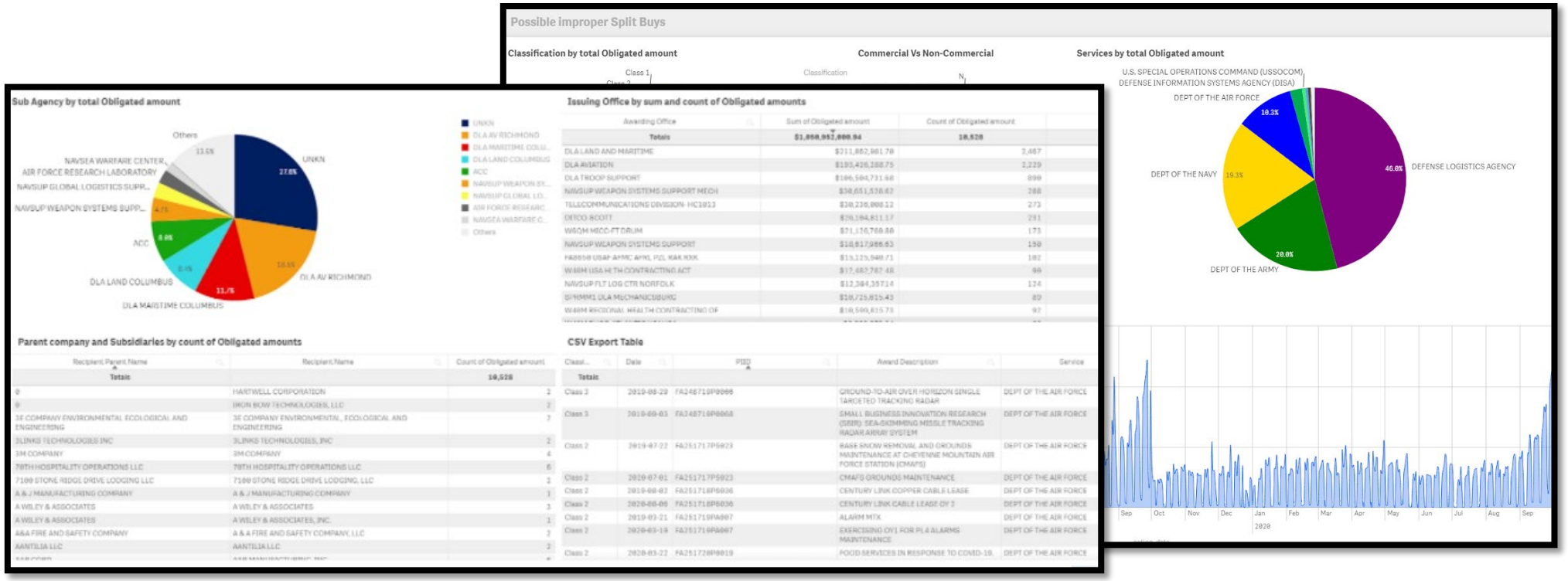
WAFR Architecture

- Data added regularly to cloud
- ML Model on Databricks to detect fraud
- Visualize results in Qlik Dashboard



WAFR Dashboard

- Interactive Qlik Dashboard of ML output



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WAFR Results

- Training Labeling done via aggregating transactions and check sum > 250K
- ML predictions at individual level compared to training label
  - “Stateless” model- does not compare or add transactions moving forward
  - Model Example: “If Tuesday & dept is Navy, then fraud”
- Model has Accuracy (Precision & Recall) of 95%+