Transforming Mortgage Operations with AI-powered Intelligent Document Processing

Presented by aws

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Manager, Solutions Architecture
Housing & Mortgage Industry
Amazon Web Services

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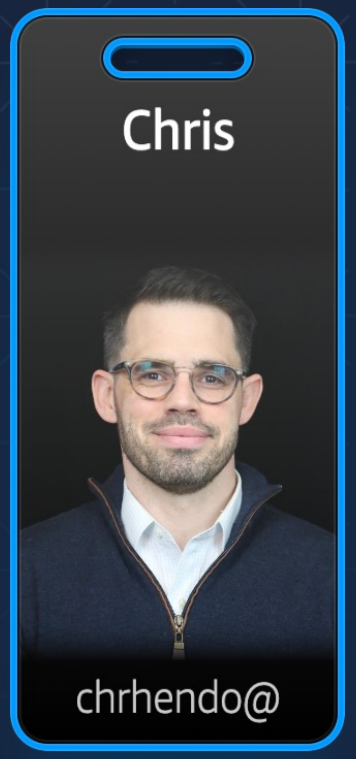
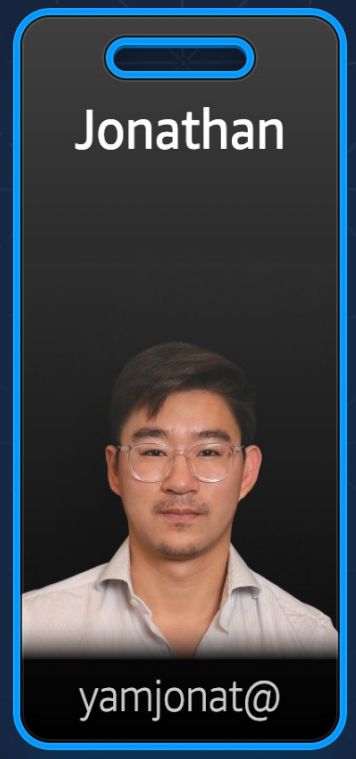
Senior Solutions Architect
Housing & Mortgage Industry
Amazon Web Services



Manager of Solutions Architecture
Housing & Mortgage Industry

aws



Senior Solutions Architect
Housing & Mortgage Industry

aws

Amazon Web Services is the world's most comprehensive and broadly adopted cloud, enabling customers to build anything they can imagine.

We offer the greatest choice of innovative cloud capabilities and expertise, on the most extensive global infrastructure with industry-leading security, reliability, and performance.

https://aws.amazon.com/what-is-aws/

With the most comprehensive set of AI services, tools, and resources, AWS brings deep expertise to over 100,000 customers to meet the demands of their business and unlock the value of their data.

https://aws.amazon.com/ai/

Agenda

- The cost of document processes:
  Time, Complexity & Money
- Modernization opportunities
- Technology solution overview:
  Intelligent Document Processing (IDP)
- End-to-end IDP with AI Agents
- Deploying modern AI solutions

The cost of document processes:
Time, Complexity & Money

The cost of document processes:
Time, Complexity & Money

Loan Process Input Documents

Proof of Income

Credit Reports

Employment Verification

Assets & Debts Statements

Property & Appraisal Docs

W2, 1040, 1099, 4506-C, etc

Identity Documents

Loan Application Docs

… and many other doc types/variants

The cost of document processes:
Time, Complexity & Money

Structured and Unstructured Documents

LEGACY

The cost of document processes:
Time, Complexity & Money

Structured and Unstructured Documents

LEGACY

Classify & Split Docs → **Extract Data**

- Doc type
- Page ranges
- Reorder

- Key:Value text
- Entity type
- Bounding box
- Conf score

Document overload, …

The cost of document processes:
Time, Complexity & Money

Structured and Unstructured Documents

LEGACY

Classify & Split Docs
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Extract Data
- Key:Value text
- Entity type
- Bounding box
- Conf score

Normalize Fields
- Normalized key
- Normalized vals
- Parsing

Validate Form Quality
- Completeness
- Invalid type/form
- Inconsistency

Document overload, human error, …

The cost of document processes:
Time, Complexity & Money

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Verify & Confirm

- Cross-doc variances
- Sparse disclosure
- Misrepresentations
- Suspect (meta)data

Document overload, human error, inconsistent decision-making, etc.

The cost of document processes:
Time, Complexity & Money

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Verify & Confirm

- Cross-doc variances
- Sparse disclosure
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Document overload, human error, inconsistent decision-making, etc.

Scaling challenges result in painful ***backlogs & costly errors.***

Modernization opportunities:
Automation & Optimization with AI

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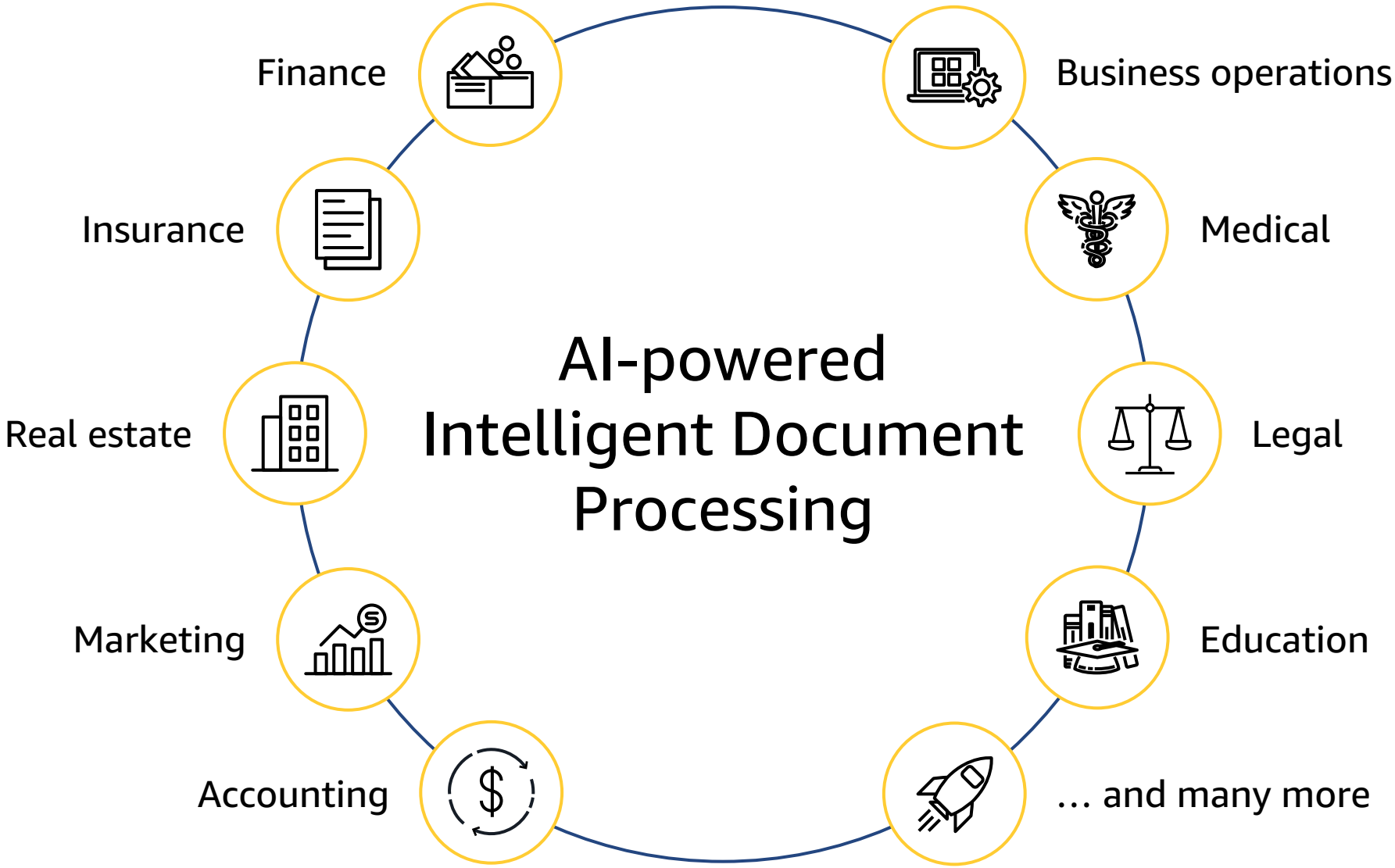
Automation & Optimization with AI



Modernization opportunities:
Automation & Optimization with AI

According to a Fannie Mae survey of senior mortgage executives in 2023:

65% of lenders in 2023 report that they are familiar with AI/ML technology, but only 7% said they have deployed AI/ML.

https://www.fanniemae.com/research-and-insights/perspectives/lenders-motivation-ai-adoption (2023)

Modernization opportunities:
Automation & Optimization with AI

LEGACY

Classify & Split Docs → Extract Data → Normalize Fields → Validate Form Quality → Verify & Confirm

+

MODERN

Classify & Split Docs → Extract Data → Normalize Fields → Validate Form Quality → Verify & Confirm

ML document classifier model

Modernization opportunities:
Automation & Optimization with AI

LEGACY

Classify & Split Docs → Extract Data → Normalize Fields → Validate Form Quality → Verify & Confirm

+

MODERN

Classify & Split Docs	Extract Data	Normalize Fields	Validate Form Quality	Verify & Confirm
ML document classifier model	OCR *plus* AI for form/layout detection & entity recognition			

Modernization opportunities:
Automation & Optimization with AI

LEGACY

Classify & Split Docs → **Extract Data** → **Normalize Fields** → **Validate Form Quality** → **Verify & Confirm**

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MODERN

Classify & Split Docs → **Extract Data** → **Normalize Fields** → **Validate Form Quality** → **Verify & Confirm**

ML document classifier model

OCR *plus* AI for form/layout detection & entity recognition

Automated normalizations & transformations

Modernization opportunities:
Automation & Optimization with AI

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MODERN

Classify & Split Docs	**Extract Data**	**Normalize Fields**	**Validate Form Quality**	**Verify & Confirm**
ML document classifier model	OCR *plus* AI for form/layout detection & entity recognition	Automated normalizations & transformations	Automated checks & *confidence-based* **human-in-the-loop**	

Modernization opportunities:
Automation & Optimization with AI

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MODERN

Classify & Split Docs	**Extract Data**	**Normalize Fields**	**Validate Form Quality**	**Verify & Confirm**
ML document classifier model	OCR *plus* AI for form/layout detection & entity recognition	Automated normalizations & transformations	Automated checks & *confidence-based* **human-in-the-loop**	Automated complex task decisioning & execution with Gen AI powered **AI Agents**

Modernization opportunities:
Automation & Optimization with AI

According to a top U.S. mortgage technology provider:

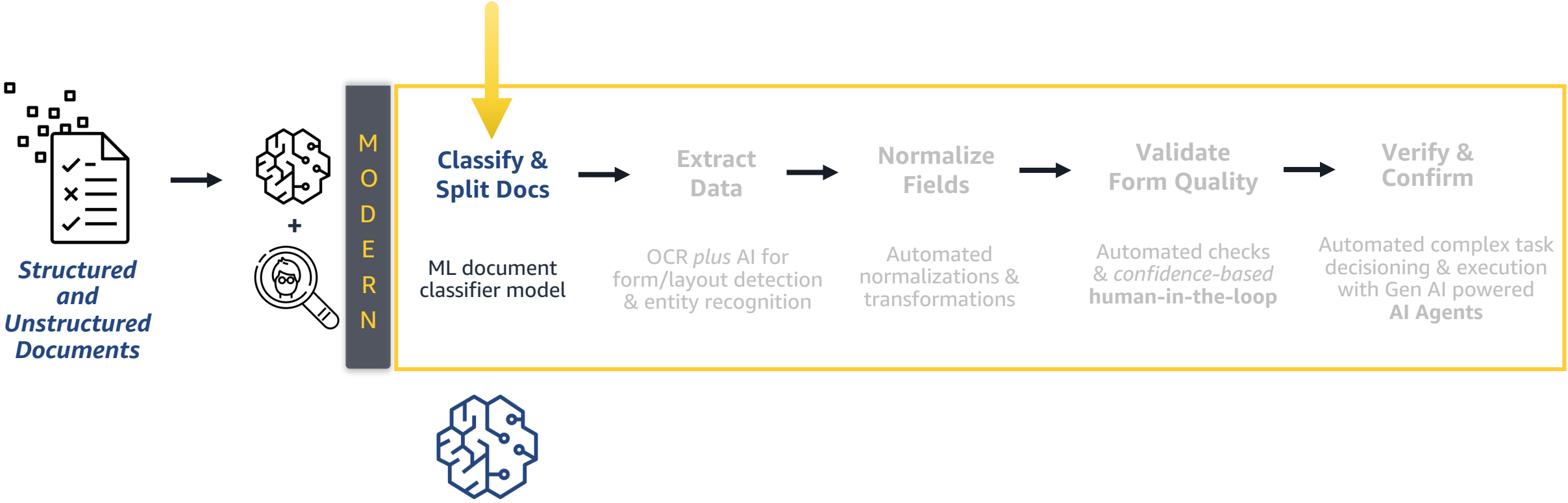
"Using AWS AI services like Amazon Textract has provided us a way to further automate the underwriting process for our clients, reducing their manual reviews of documents by up to 4 hours.

This saves their employees' time all while improving the mortgage experience to their customers."

https://aws.amazon.com/blogs/machine-learning/aws-is-redefining-how-companies-process-documents-in-a-digital-world/ (2021)

Technology solution overview:
Intelligent Document Processing (IDP)

Technology solution overview:
Intelligent Document Processing – Classification



Technology solution overview:
Intelligent Document Processing – Classification

Loan Process Docs

Proof of Income

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Property & Appraisal Docs

W2, 1040, 1099, 4506-C, etc

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Loan Application Docs

… and many other documents

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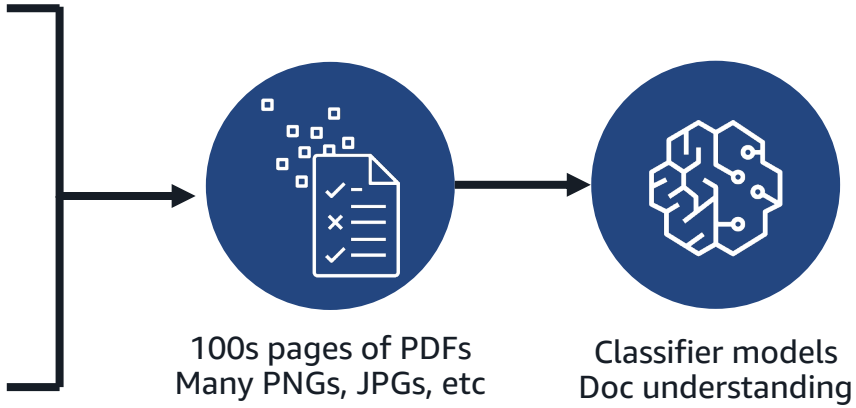

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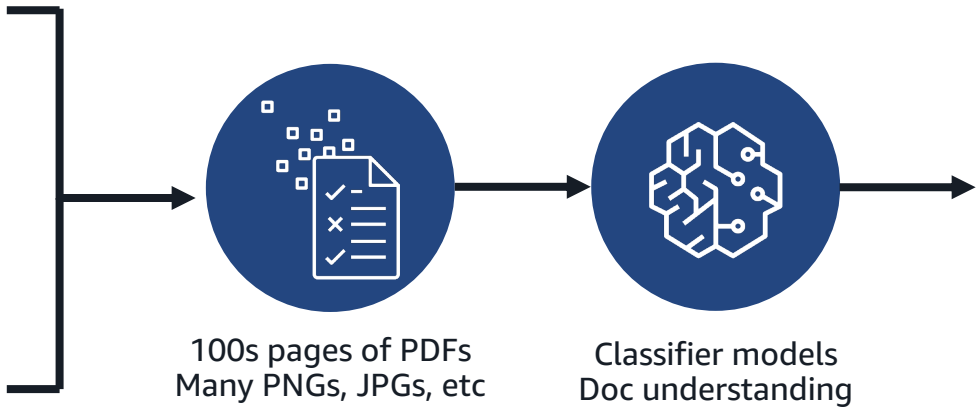
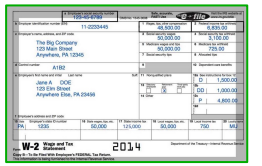
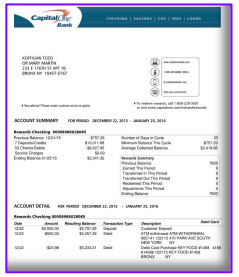


100s pages of PDFs
Many PNGs, JPGs, etc

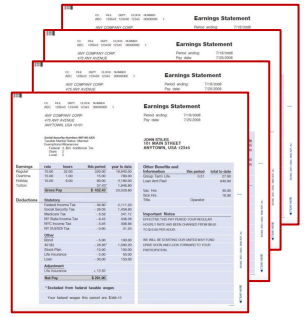
Classifier models
Doc understanding



W2



Bank Statement



Payslips

IDs

For each page:

Infer if there are parts of multiple documents on the page.
Predict the likely document types.
Infer groupings of documents spanning multiple pages.

Technology solution overview:
Intelligent Document Processing – Classification

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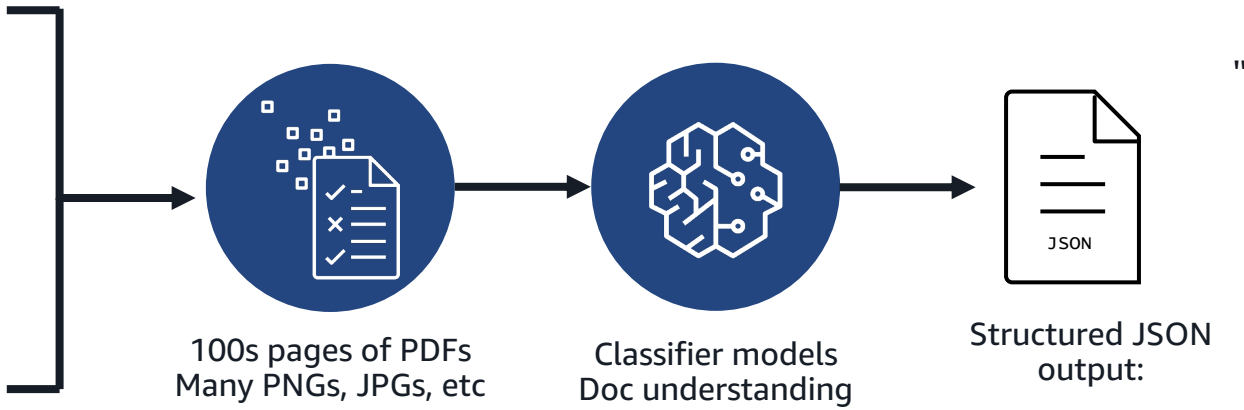
… and many other documents



100s pages of PDFs
Many PNGs, JPGs, etc

Classifier models
Doc understanding

Structured JSON output:

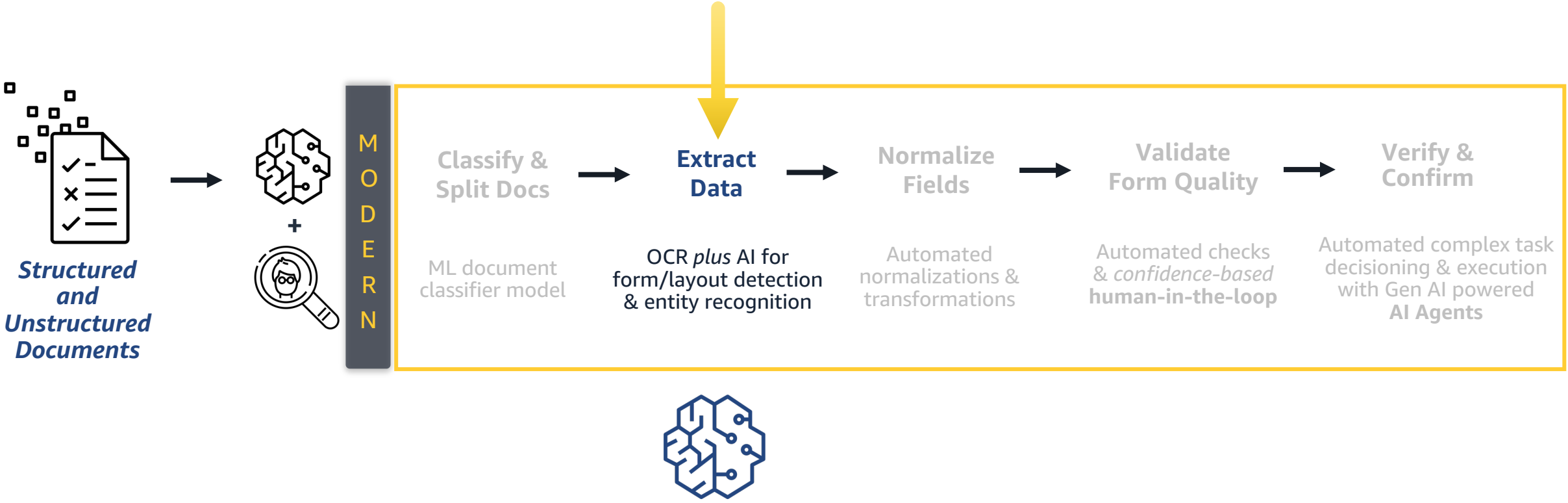
Doc class prediction
Confidence scores
Page numbers
Doc groupings

```
"Results": [
  {
     "Page": 9,
     "PageClassification": {
        "PageType": [
           {
              "Value": ”BANK_STATEMENT",
              "Confidence": 99.47357
           }
           ...
```

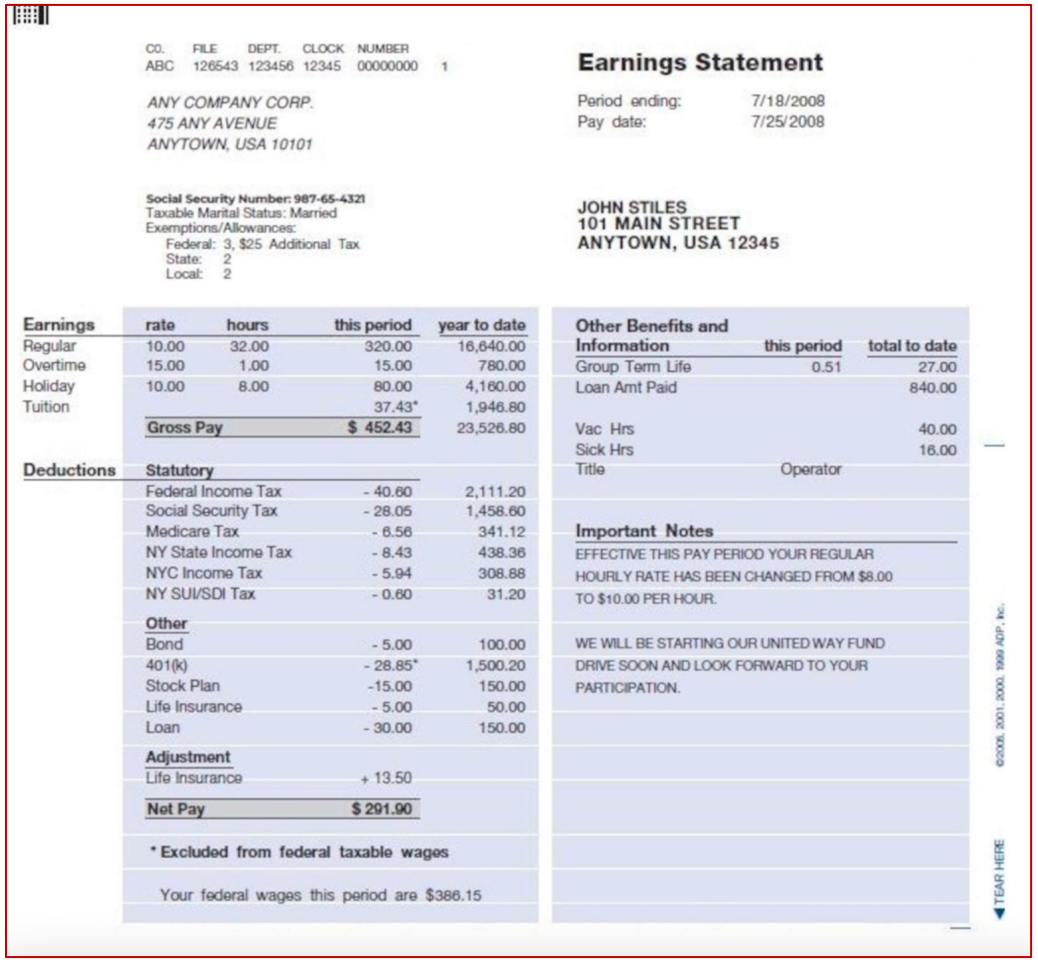
```
"Summary": {
   "DocumentGroups": [
      {
         "Type": "W_2",
         "Index": 1,
         "Pages": [1,2]

         ...
      },
      {
         "Type": "BANK_STATEMENT",
         "Index": 2,
         "Pages": [7,8,9]
         ...
      },
      {
         "Type": "PAYSLIPS",
         "Index": 1,
         "Pages": [5,6]
         ...
```

Technology solution overview:
Intelligent Document Processing – Extraction



Technology solution overview:
Intelligent Document Processing – Extraction



CO. FILE DEPT. CLOCK NUMBER
ABC 126543 123456 12345 00000000 1

ANY COMPANY CORP.
475 ANY AVENUE
ANYTOWN, USA 10101

Earnings Statement

Period ending: 7/18/2008
Pay date: 7/25/2008

Social Security Number: 987-65-4321
Taxable Marital Status: Married
Exemptions/Allowances:
Federal: 3, $25 Additional Tax
State: 2
Local: 2

JOHN STILES
101 MAIN STREET
ANYTOWN, USA 12345

Earnings	rate	hours	this period	year to date
Regular	10.00	32.00	320.00	16,640.00
Overtime	15.00	1.00	15.00	780.00
Holiday	10.00	8.00	80.00	4,160.00
Tuition			37.43*	1,946.80
	Gross Pay		**$ 452.43**	23,526.80
Deductions	**Statutory**			
	Federal Income Tax		- 40.60	2,111.20
	Social Security Tax		- 28.05	1,458.60
	Medicare Tax		- 6.56	341.12
	NY State Income Tax		- 8.43	438.36
	NYC Income Tax		- 5.94	308.88
	NY SUI/SDI Tax		- 0.60	31.20
	Other			
	Bond		- 5.00	100.00
	401(k)		- 28.85*	1,500.20
	Stock Plan		-15.00	150.00
	Life Insurance		- 5.00	50.00
	Loan		- 30.00	150.00
	Adjustment			
	Life Insurance		+ 13.50	
	Net Pay		**$ 291.90**	

Other Benefits and Information	this period	total to date
Group Term Life	0.51	27.00
Loan Amt Paid		840.00
Vac Hrs		40.00
Sick Hrs		16.00
Title	Operator	

Important Notes

EFFECTIVE THIS PAY PERIOD YOUR REGULAR HOURLY RATE HAS BEEN CHANGED FROM $8.00 TO $10.00 PER HOUR.

WE WILL BE STARTING OUR UNITED WAY FUND DRIVE SOON AND LOOK FORWARD TO YOUR PARTICIPATION.

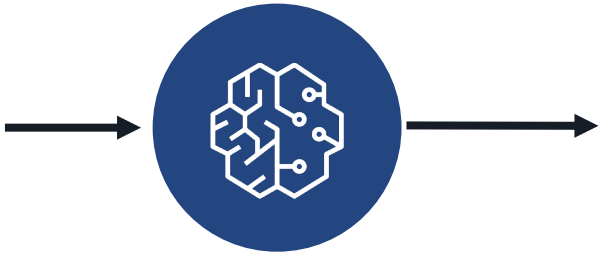
* Excluded from federal taxable wages

Your federal wages this period are $386.15

©2008, 2001, 2000, 1999 ADP, Inc.

TEAR HERE

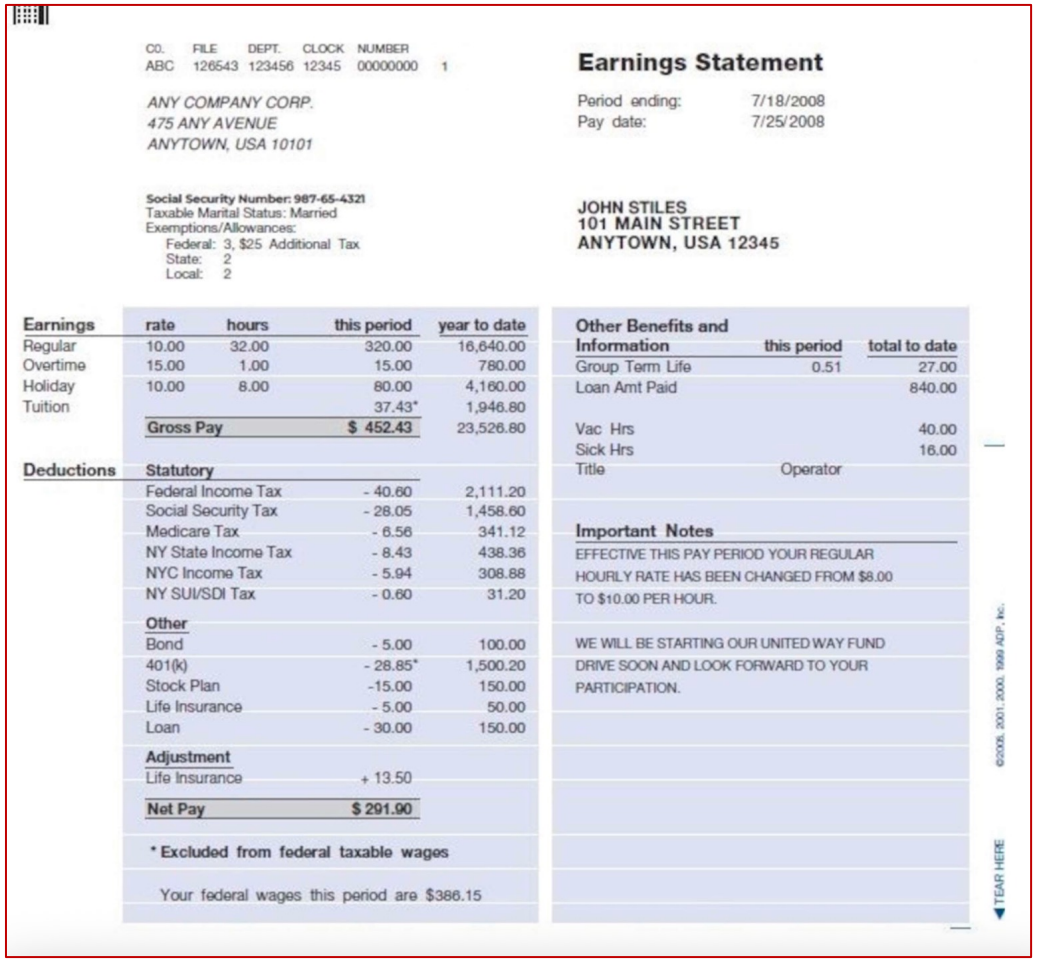
Payslip document



OCR models
Entity recognition models*
Key-value & table detectors*

** Customized to doc type*

Technology solution overview:
Intelligent Document Processing – Extraction



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Exemptions/Allowances:
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JOHN STILES
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Earnings	rate	hours	this period	year to date
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TEAR HERE

Payslip document

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Entity recognition models*
Key-value & table detectors*

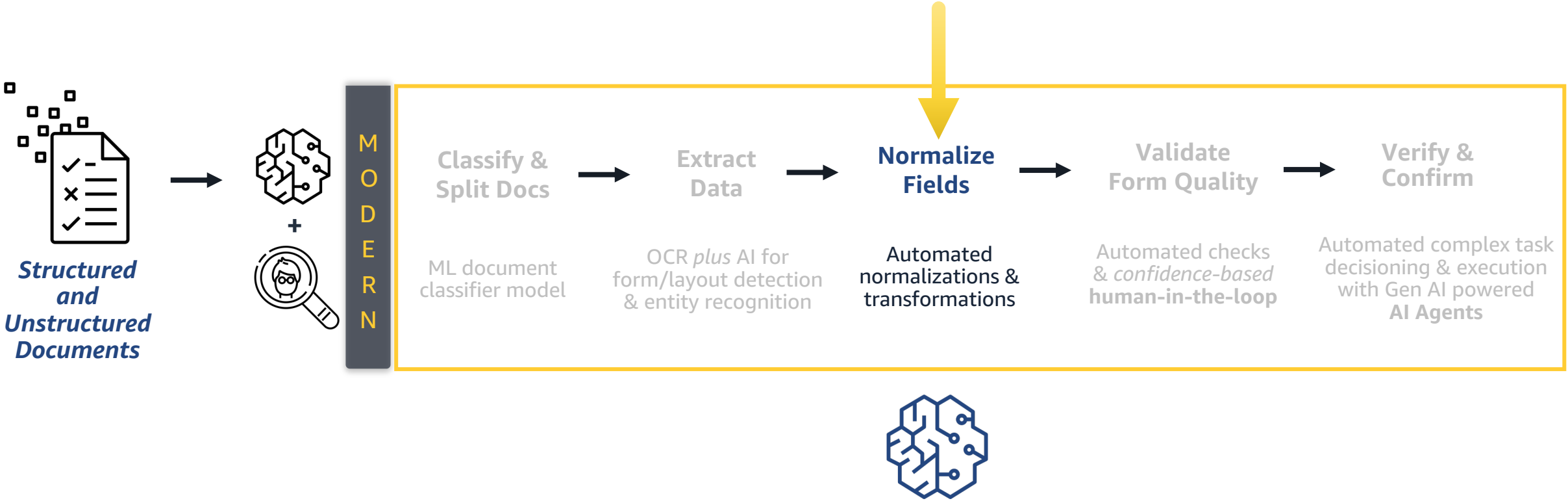
** Customized to doc type*

```
Pay Period (key-value)
   Period ending          = “7/18/2008”
   Pay date               = “7/25/2008”

Earnings (table)
   Regular, rate           = 10.00
   Regular, hours          = 32.00
   Regular, period gross   = 320.00
   Regular, YTD gross      = 16,640.00
   Overtime, rate          = 15.00
   ...

Deductions (table)
   Federal income tax      = -40.60
   Social security tax     = -28.05

Net Pay (key-value)
   Net pay this period     = $291.90

Name (key entity)          = “JOHN STILES”
St Address (key entity)    = 101 MAIN STREET

...
```

For each document type:

Extracted **particular** data elements
… based on that document type’s **specific schema & entities**
… with understanding of **document structures**.

Technology solution overview:
Intelligent Document Processing – Normalize & Transform



Technology solution overview:
Intelligent Document Processing – Normalize & Transform

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Net Pay (key-value)
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...
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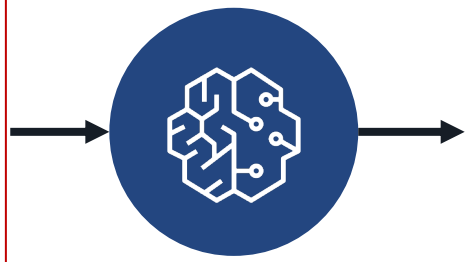

Normalization pipeline
Custom transform pipeline

Technology solution overview:
Intelligent Document Processing – Normalize & Transform

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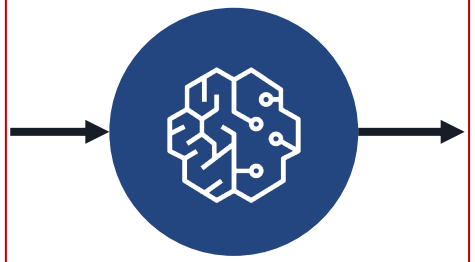

Normalization pipeline
Custom transform pipeline

```
Pay Period (key-value)
   Period ending          = “7/18/2008”     -> pay_end
   Pay date               = “7/25/2008”     -> pay_date


Earnings (table)
   Regular, rate           = 10.00          -> ...
   Regular, hours          = 32.00          -> ...
   Regular, period gross   = 320.00         -> ...
   Regular, YTD gross      = 16,640.00      -> ...
   Overtime, rate          = 15.00          -> ...
   ...

Deductions (table)
   Federal income tax     = -40.60          -> fed_inc_tax

   Social security tax    = -28.05          -> ss_tax

Net Pay (key-value)
   Net pay this period    = $291.90         -> net_pay

Name (key entity)         = “JOHN STILES”   -> name




St Address (key entity)   = 101 MAIN STREET -> ...

...
```

Technology solution overview:
Intelligent Document Processing – Normalize & Transform

```
Pay Period (key-value)
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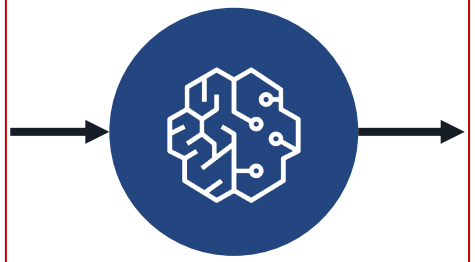

Normalization pipeline
Custom transform pipeline

```
Pay Period (key-value)
   Period ending          = “7/18/2008”     -> pay_end     = “2008-07-18”
   Pay date               = “7/25/2008”     -> pay_date    = “2008-07-25”


Earnings (table)
   Regular, rate           = 10.00          -> ...
   Regular, hours          = 32.00          -> ...
   Regular, period gross   = 320.00         -> ...
   Regular, YTD gross      = 16,640.00      -> ...
   Overtime, rate          = 15.00          -> ...
   ...

Deductions (table)
   Federal income tax     = -40.60          -> fed_inc_tax = 291.90

   Social security tax    = -28.05          -> ss_tax      = 28.05

Net Pay (key-value)
   Net pay this period    = $291.90         -> net_pay     = 291.90

Name (key entity)         = “JOHN STILES”   -> name        = “John Stiles”



St Address (key entity)   = 101 MAIN STREET -> ...

...
```

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Intelligent Document Processing – Normalize & Transform

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Pay Period (key-value)
   Period ending          = “7/18/2008”
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   Federal income tax     = -40.60
   Social security tax    = -28.05

Net Pay (key-value)
   Net pay this period    = $291.90

Name (key entity)         = “JOHN STILES”
St Address (key entity)   = 101 MAIN STREET

...
```
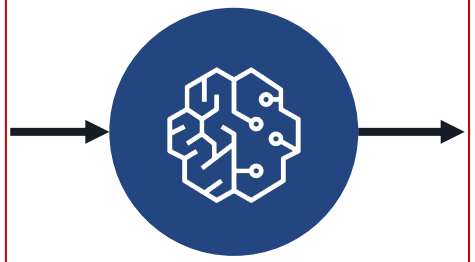
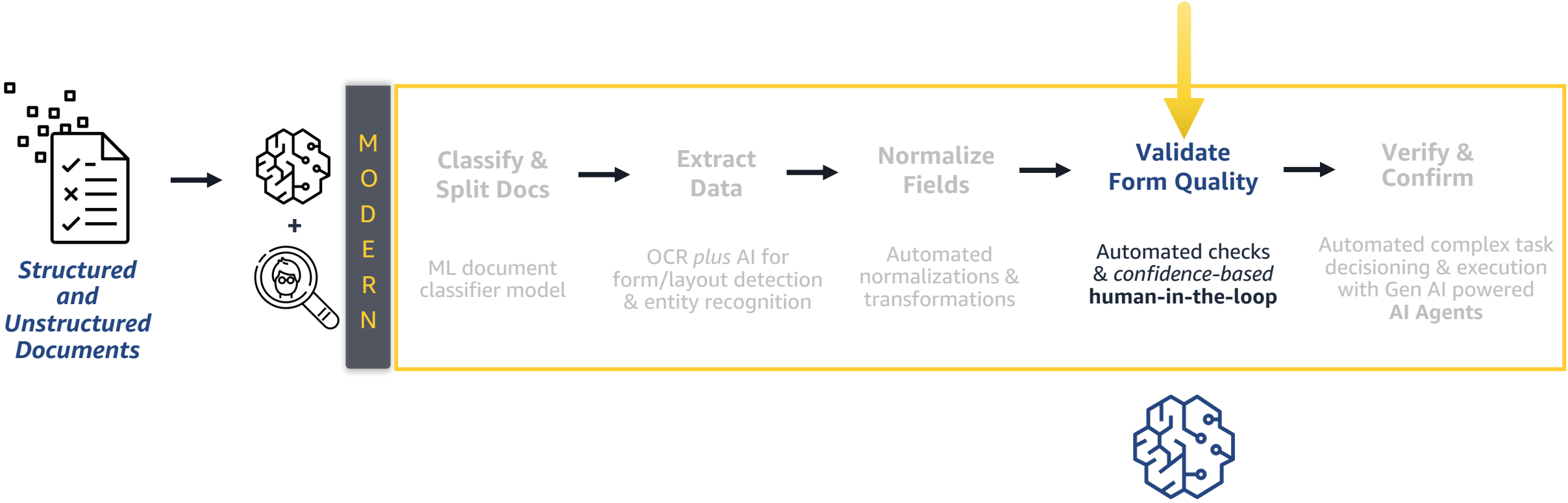



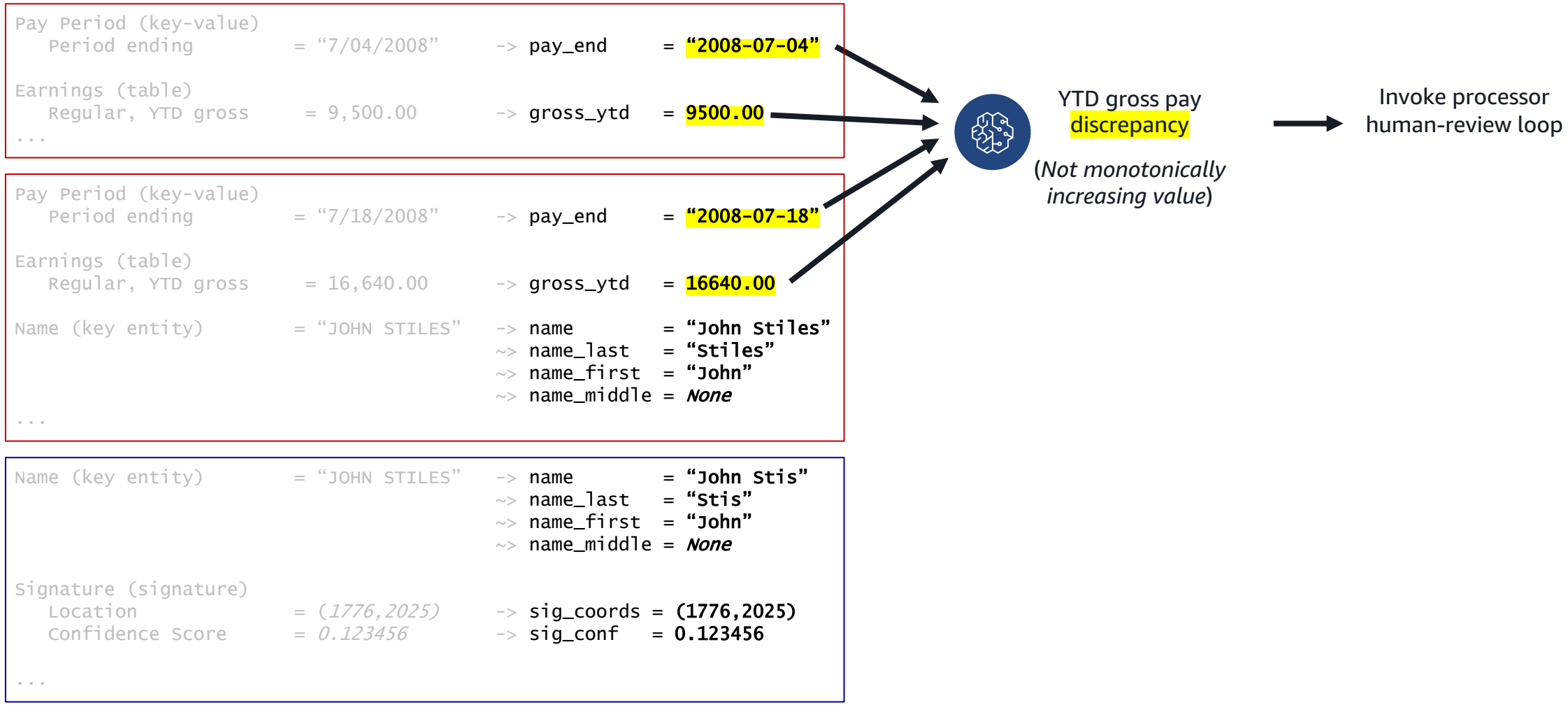
Normalization pipeline
Custom transform pipeline

```
Pay Period (key-value)
   Period ending          = “7/18/2008”     -> pay_end     = “2008-07-18”
   Pay date               = “7/25/2008”     -> pay_date    = “2008-07-25”
                                            ~> pay_denom   ~ 7

Earnings (table)
   Regular, rate           = 10.00          -> ...
   Regular, hours          = 32.00          -> ...
   Regular, period gross   = 320.00         -> ...
   Regular, YTD gross      = 16,640.00      -> ...
   Overtime, rate          = 15.00          -> ...
   ...

Deductions (table)
   Federal income tax     = -40.60          -> fed_inc_tax = 291.90

   Social security tax    = -28.05          -> ss_tax      = 28.05

Net Pay (key-value)
   Net pay this period    = $291.90         -> net_pay     = 291.90

Name (key entity)         = “JOHN STILES”   -> name        = “John Stiles”
                                            ~> name_last   = “Stiles”
                                            ~> name_first  = “John”
                                            ~> name_middle = None

St Address (key entity)   = 101 MAIN STREET -> ...

...
```

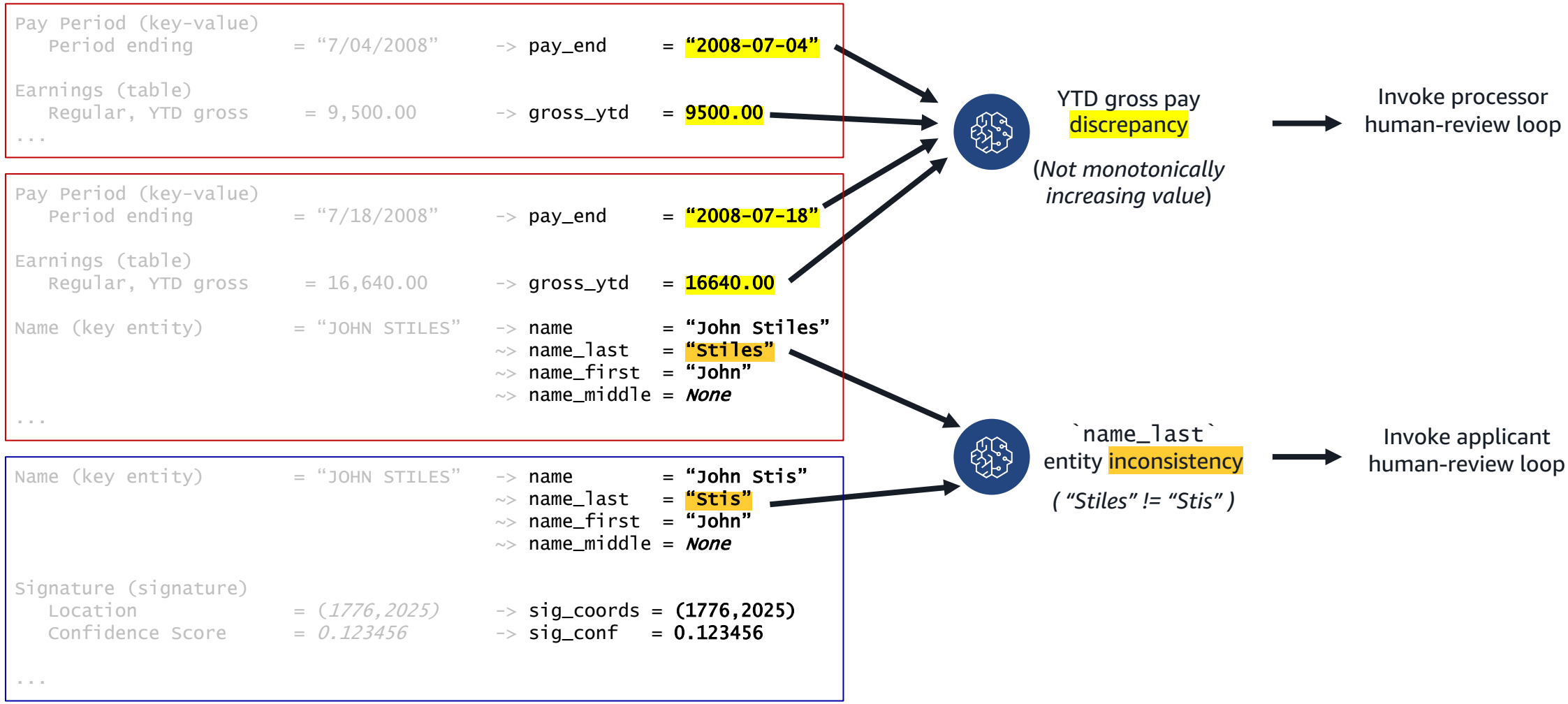
Technology solution overview:
Intelligent Document Processing – Validation



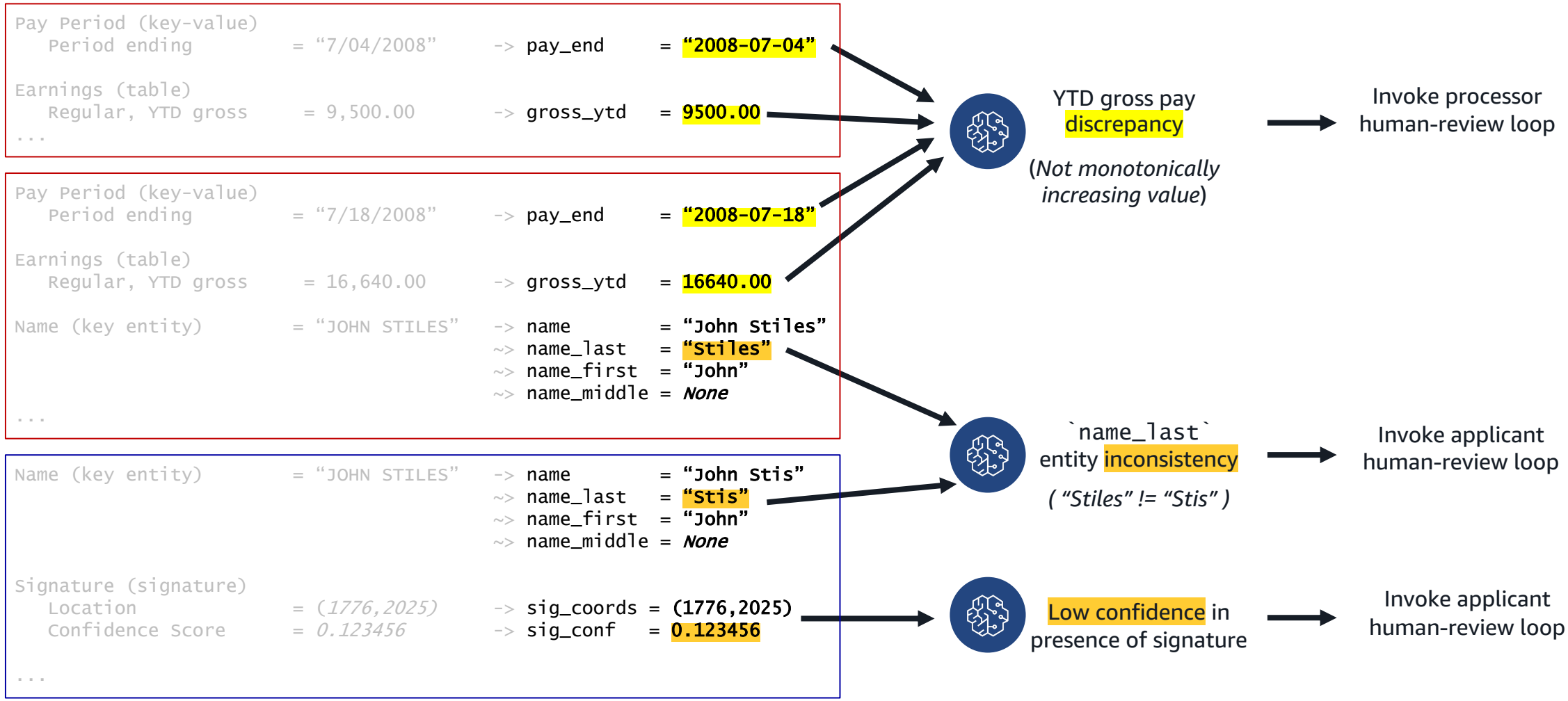
Technology solution overview:
Intelligent Document Processing – Validation



Technology solution overview:
Intelligent Document Processing – Validation

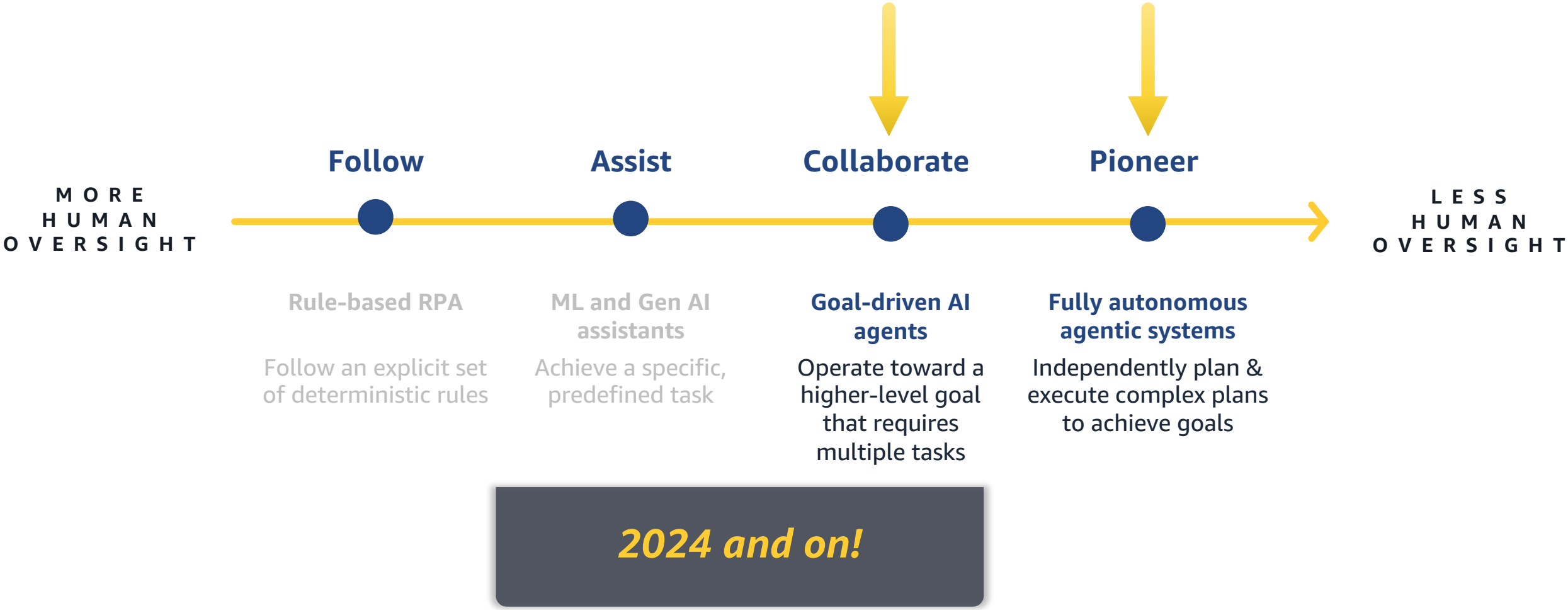


Technology solution overview:
Intelligent Document Processing – Validation

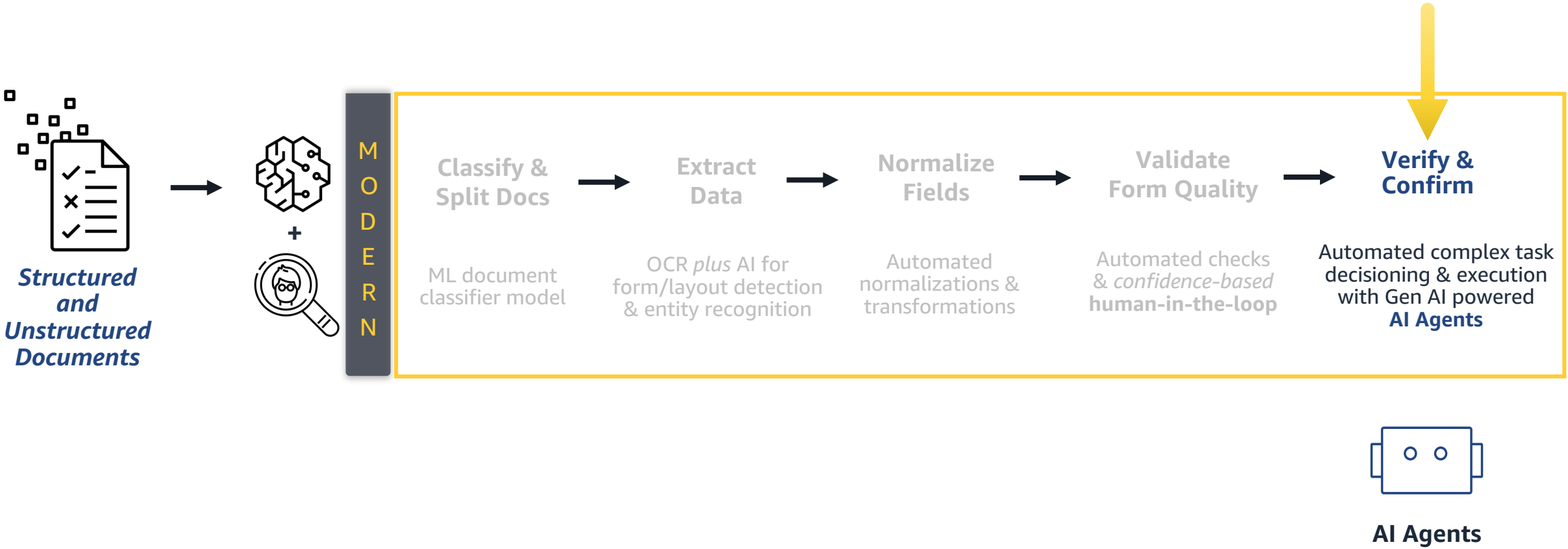


Technology solution overview:
Intelligent Document Processing…

Technology solution overview:
Intelligent Document Processing… with Agentic AI



Technology solution overview:
Intelligent Document Processing – Complex analysis/action



Bringing it all together:
End-to-end IDP with AI Agents

Bringing it all together:
AI Agents concepts

LLMs are getting
smarter, **faster**, and more **cost effective**

Purpose-built models → General-purpose LLMs

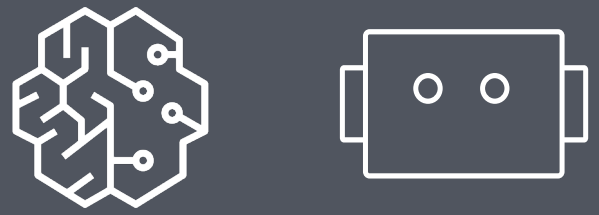
Bringing it all together:
AI Agents concepts

AI agents

A TECTONIC SHIFT FOR HOW WE BUILD DEPLOY INTERACT

Bringing it all together:
AI Agents concepts

What are AI agents?



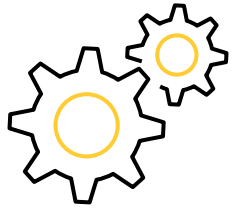
Autonomous or semi-autonomous software systems that can reason, plan, and act to accomplish goals in digital or physical environments.

Bringing it all together:
AI Agents use case evolution

Internal productivity

e.g. Internal research, internal Q&A chatbots, software development

Defined business workflows

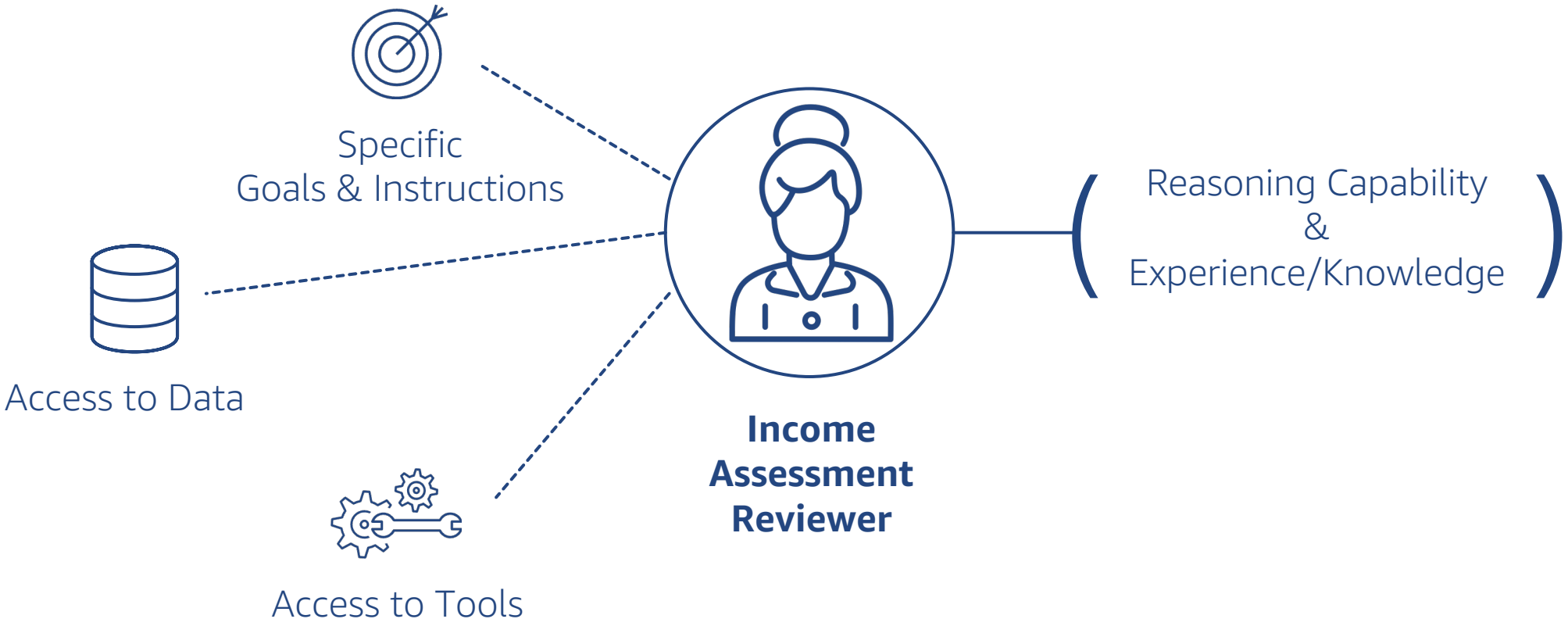


e.g. Document processing, compliance validation, fraud detection

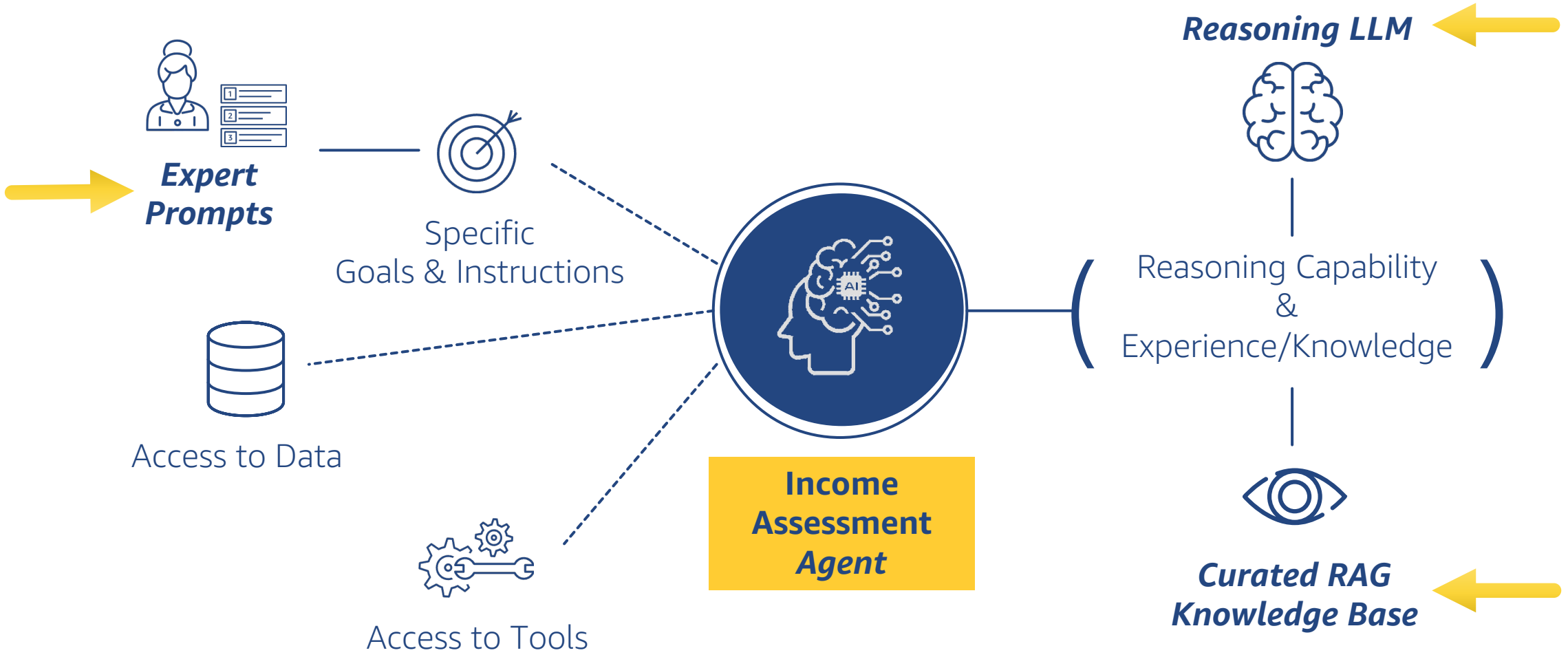
Fully-autonomous workflows

e.g. End-to-end self-orchestrating LOS customer assistants

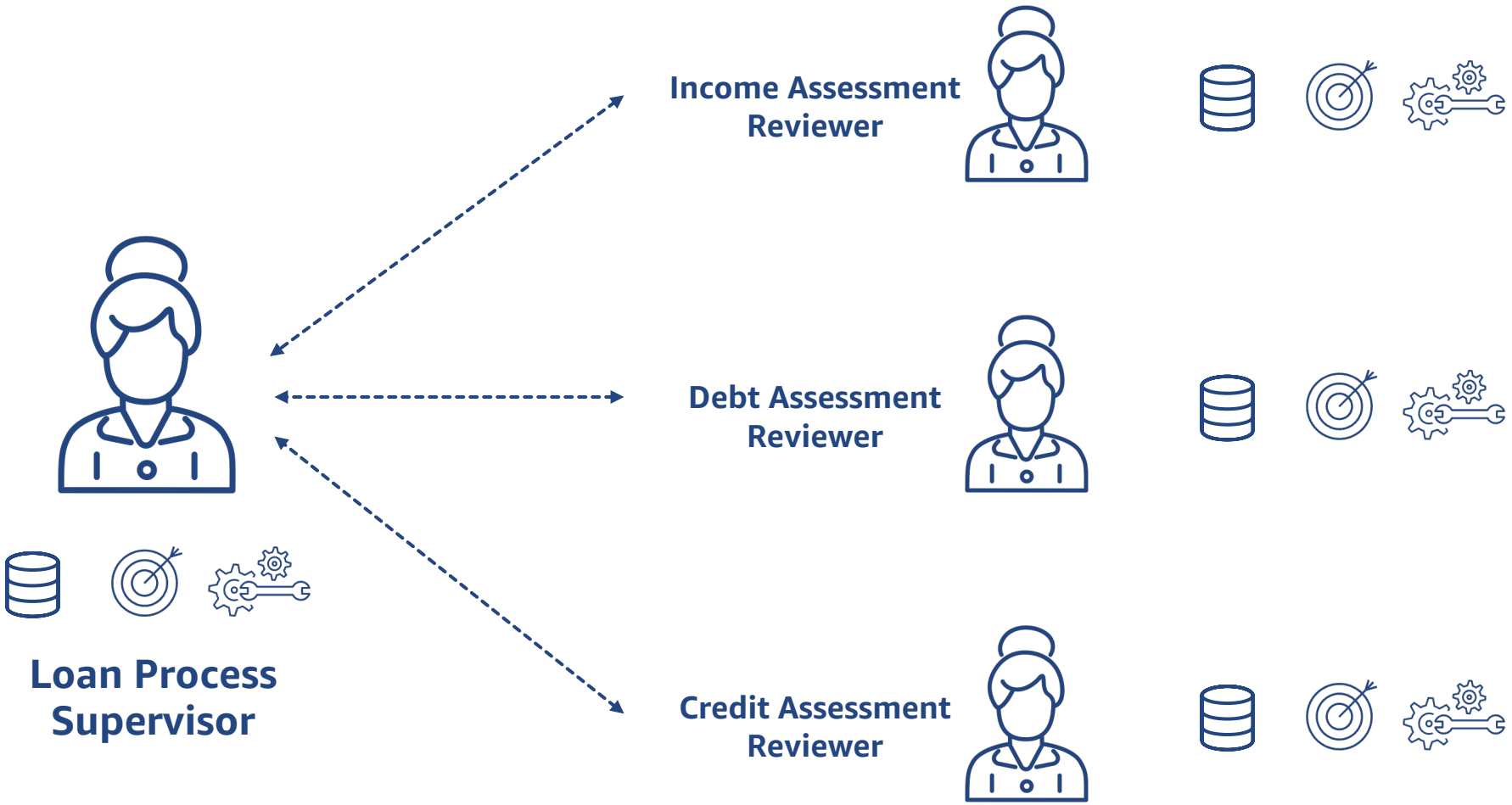
Bringing it all together:
AI Agents for complex loan process



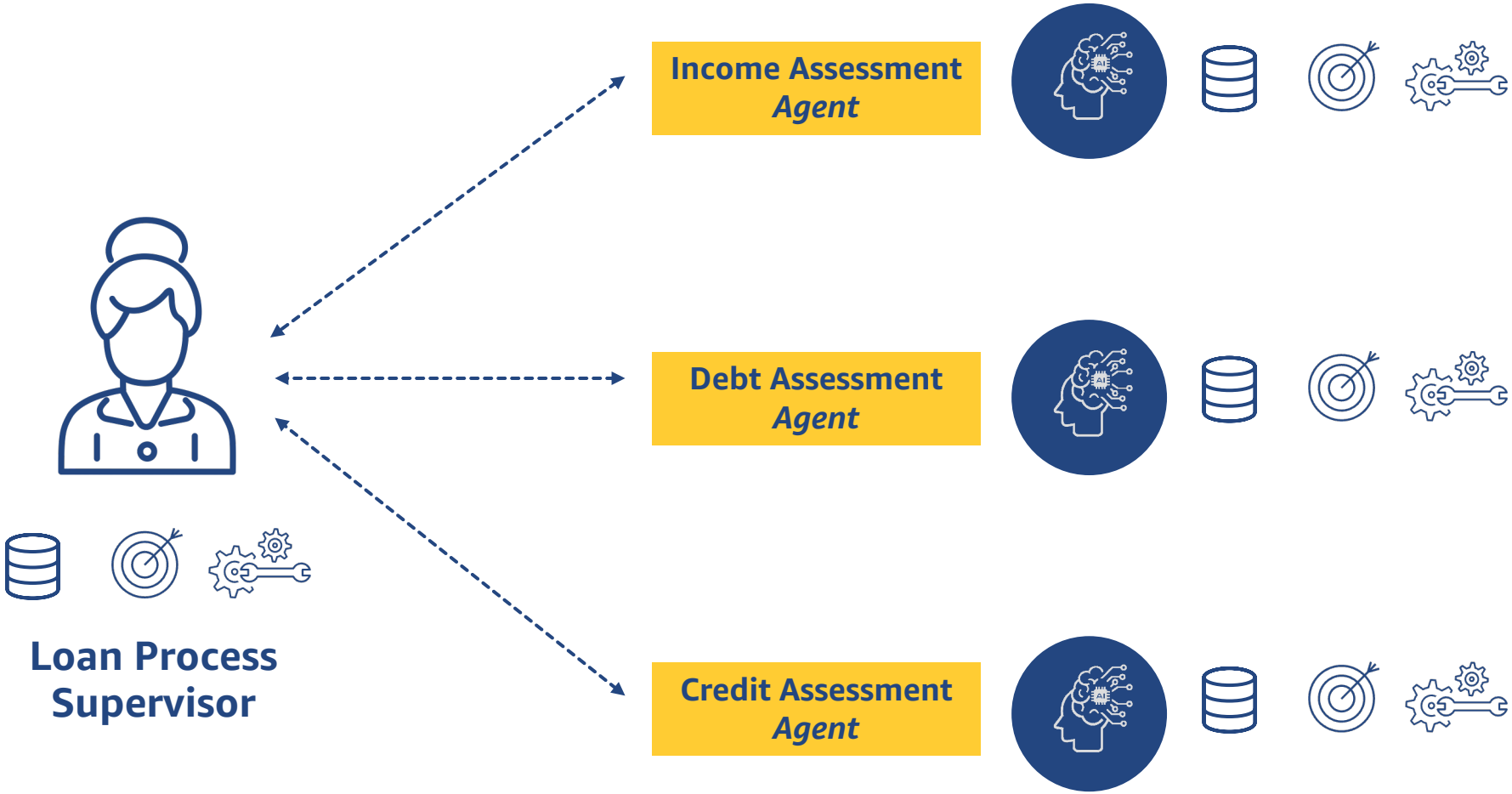
Bringing it all together:
AI Agents for complex loan process



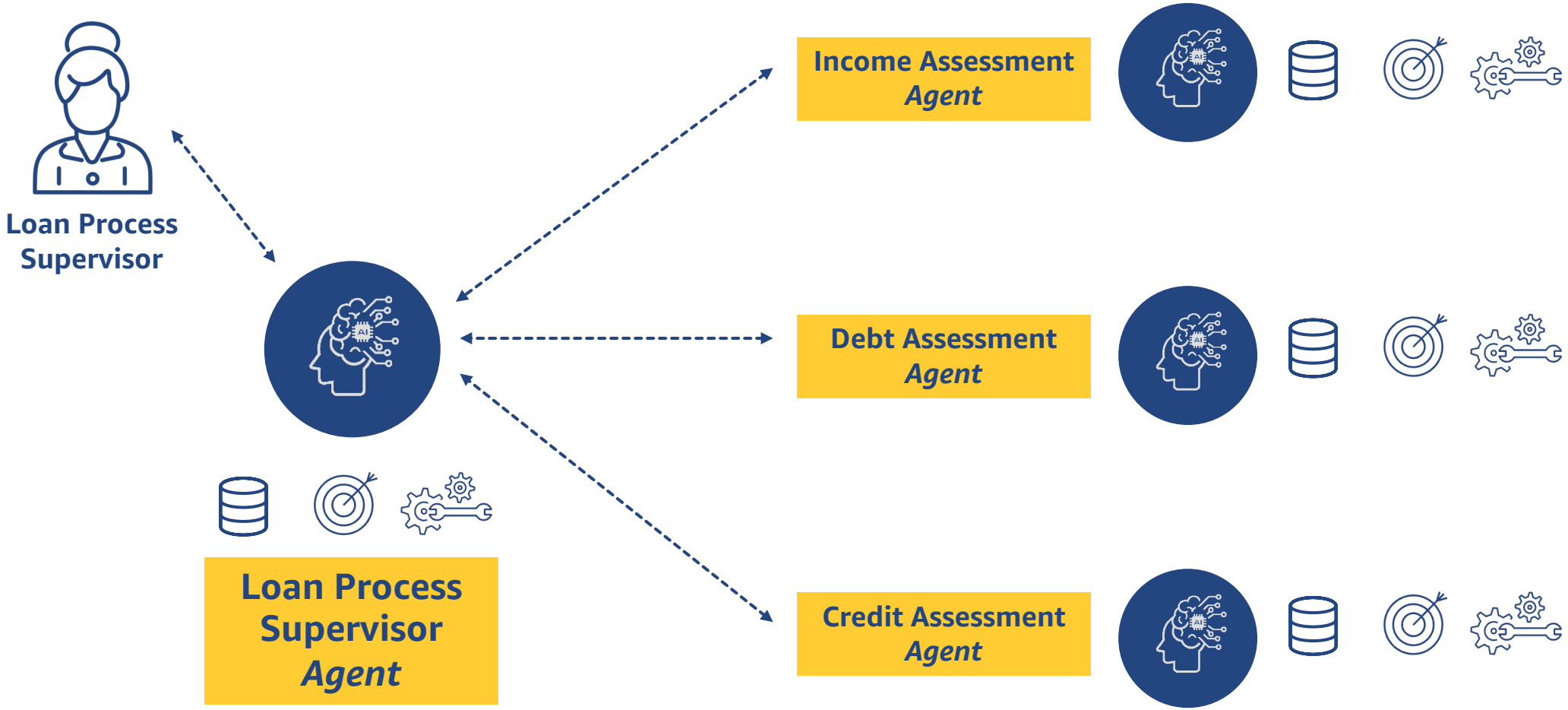
Bringing it all together:
AI Agents for complex loan process



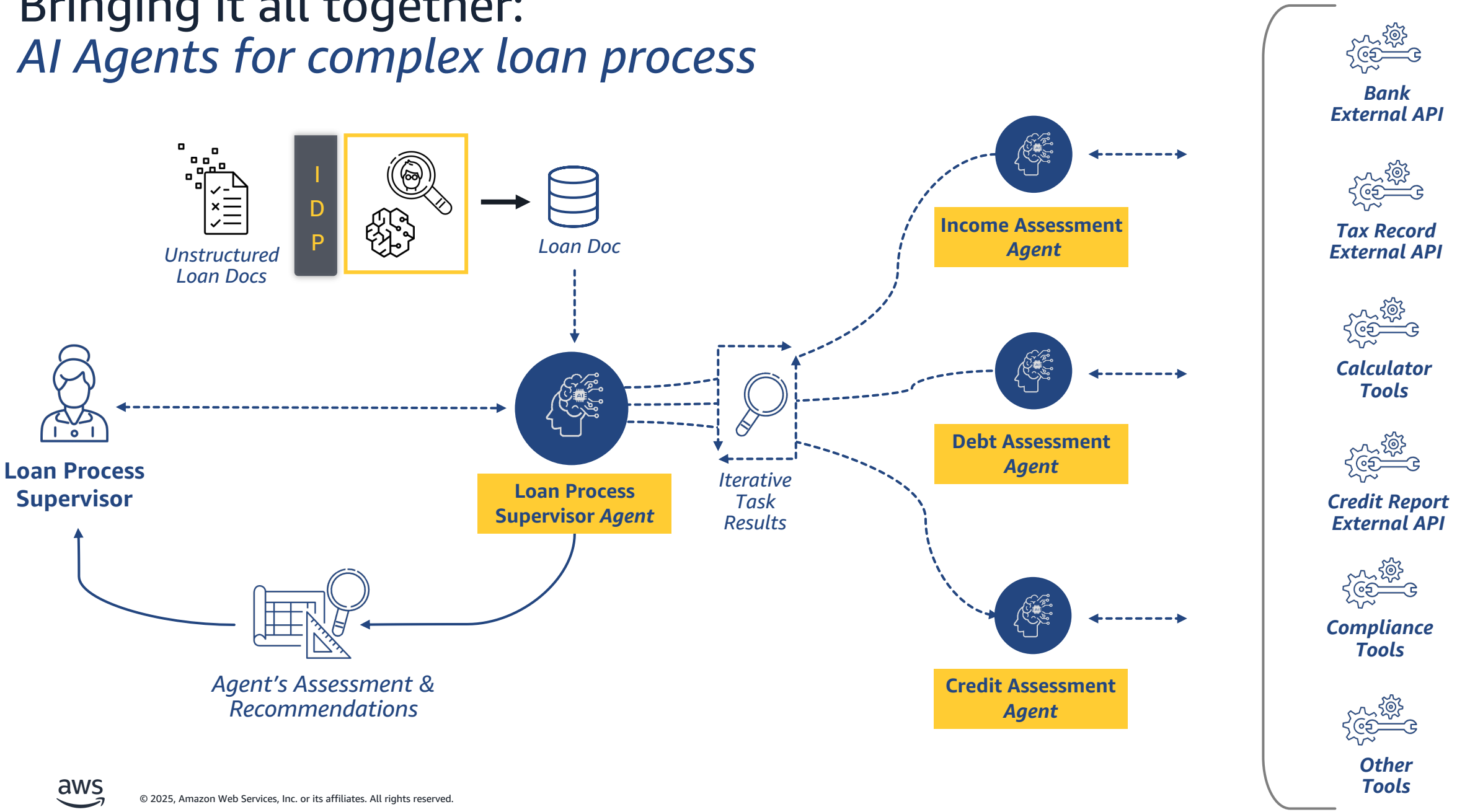
Bringing it all together:
AI Agents for complex loan process



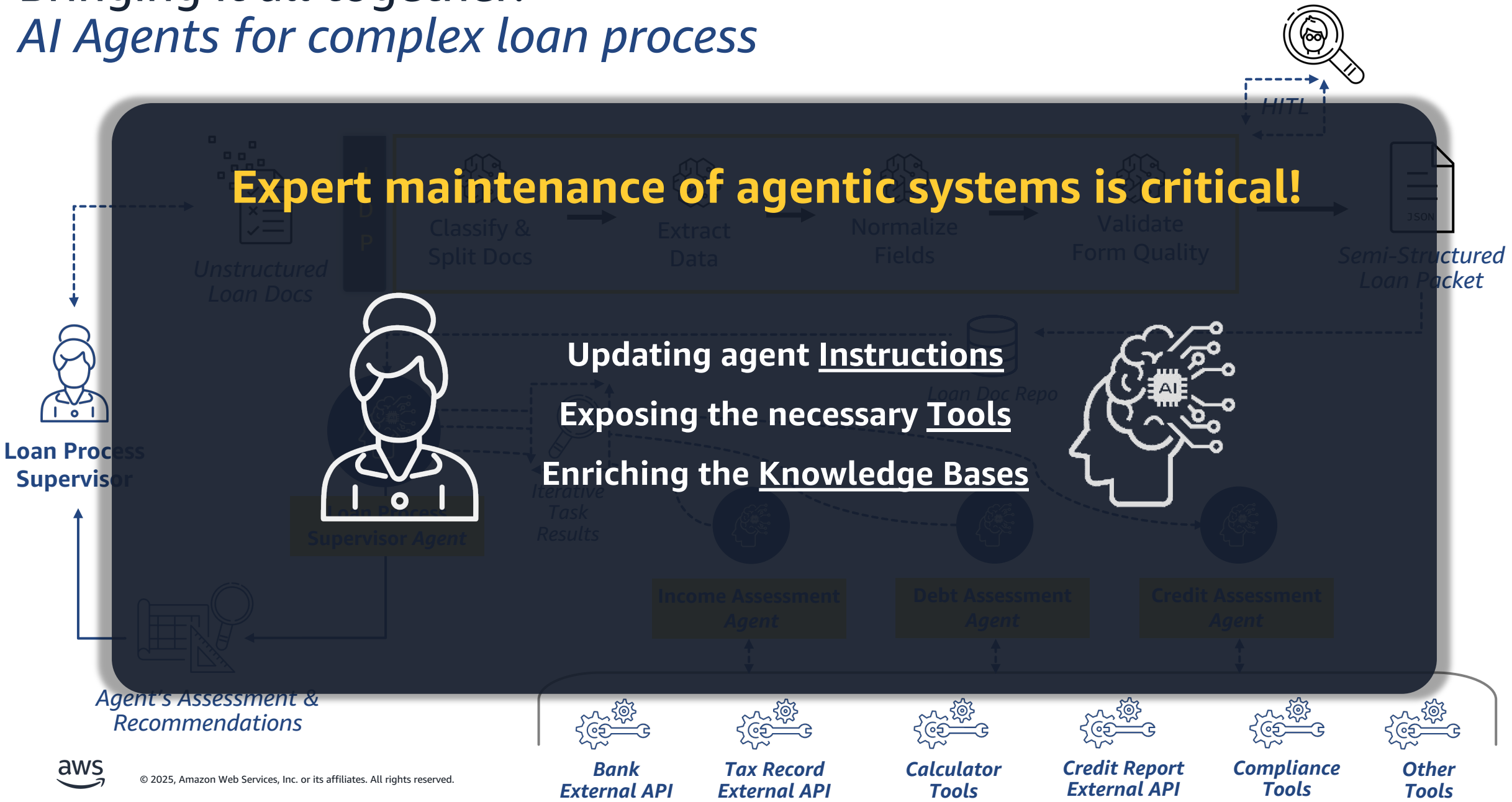
Bringing it all together:
AI Agents for complex loan process



Bringing it all together:
AI Agents for complex loan process



Bringing it all together:
AI Agents for complex loan process



Bringing it all together:

End-to-end IDP with AI Agents

DEMO

aws **Agentic Loan Underwriting**

Borrower View

Please upload your payslip, bank statement, and credit report

Pro Tip

Don't worry about naming the files a certain way. Our AI agents will automatically identify and process your documents.

Applicant: John Citizen

Upload Documents (3 required)

Drop files here or click to browse

0/3 files selected • PDF, DOC, DOCX, JSON, Images

Back | Submit Application

Loan Underwriting

- Home
- Cases
- Agent Assessment

v1.0.0 Online

Agentic Loan Underwriting

Choose your experience:

Case Management

View and manage all applicant documents, track their status, and access detailed processing information. Validate the data with intelligent document processing.

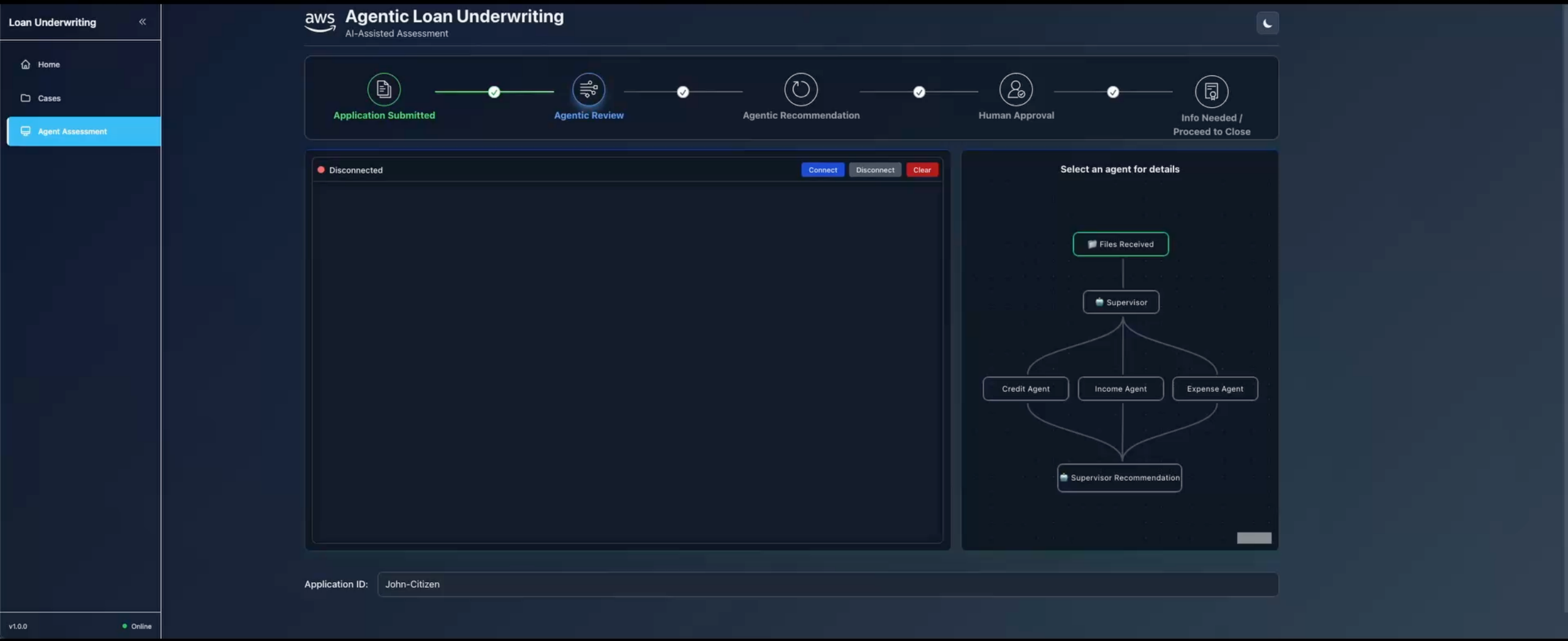
View Cases

AI-Assisted Assessment

Witness AI agents process the same loan: automating document analysis, cross-checking data, and providing quick assessment recommendations, all under human supervision.

Start AI-Assisted Assessment

For demo purposes, start with the borrower view to upload new documents!


Loan Underwriting
Home
Cases
Agent Assessment
v1.0.0
Online
aws
Agentic Loan Underwriting
AI-Assisted Assessment
Application Submitted
Agentic Review
Agentic Recommendation
Human Approval
Info Needed / Proceed to Close
Disconnected
Connect
Disconnect
Clear
Select an agent for details
Files Received
Supervisor
Credit Agent
Income Agent
Expense Agent
Supervisor Recommendation
Application ID:
John-Citizen

Deploying modern AI solutions:
Where to start? Buy? Build?

Deploying modern AI solutions:
The problem space for AI… much broader than IDP!

Deploying modern AI solutions:
The problem space for AI… much broader than IDP!

According to a top U.S. retail mortgage lender servicing millions of clients, building AWS cloud-native automation solutions resulted in:

- **40,000 team hours** saved annually by post-call interaction AI
- **20,000 team hours** saved annually by +10% in first-call resolution
- **70% fully self-serve** with generative AI powered servicing client IVR

https://aws.amazon.com/blogs/machine-learning/transforming-home-ownership-with-amazon-transcribe-call-analytics-amazon-comprehend-and-amazon-bedrock-rocket-mortgages-journey-with-aws/ (2024)

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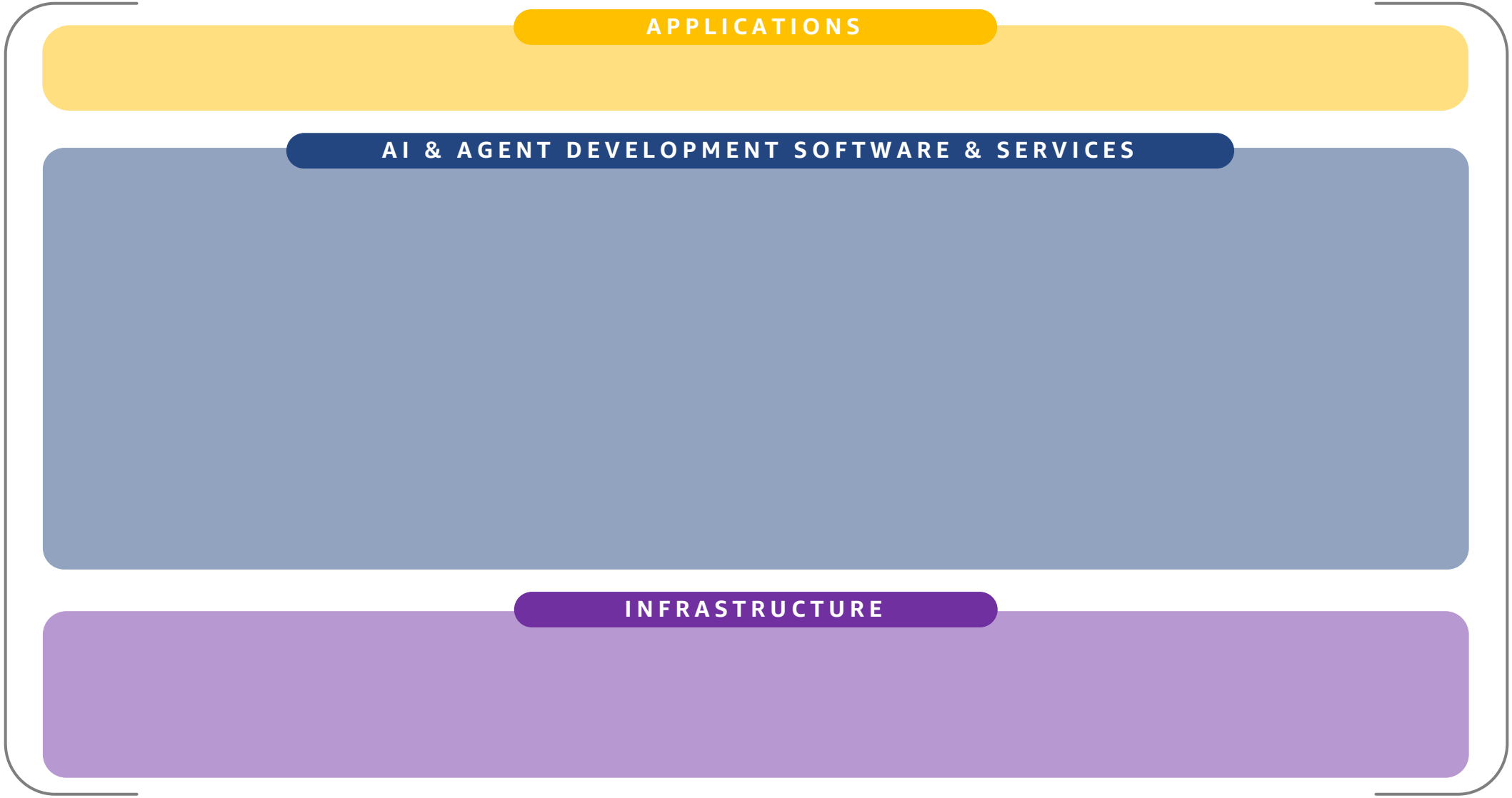
Deploying modern AI solutions:
The AWS AI services stack



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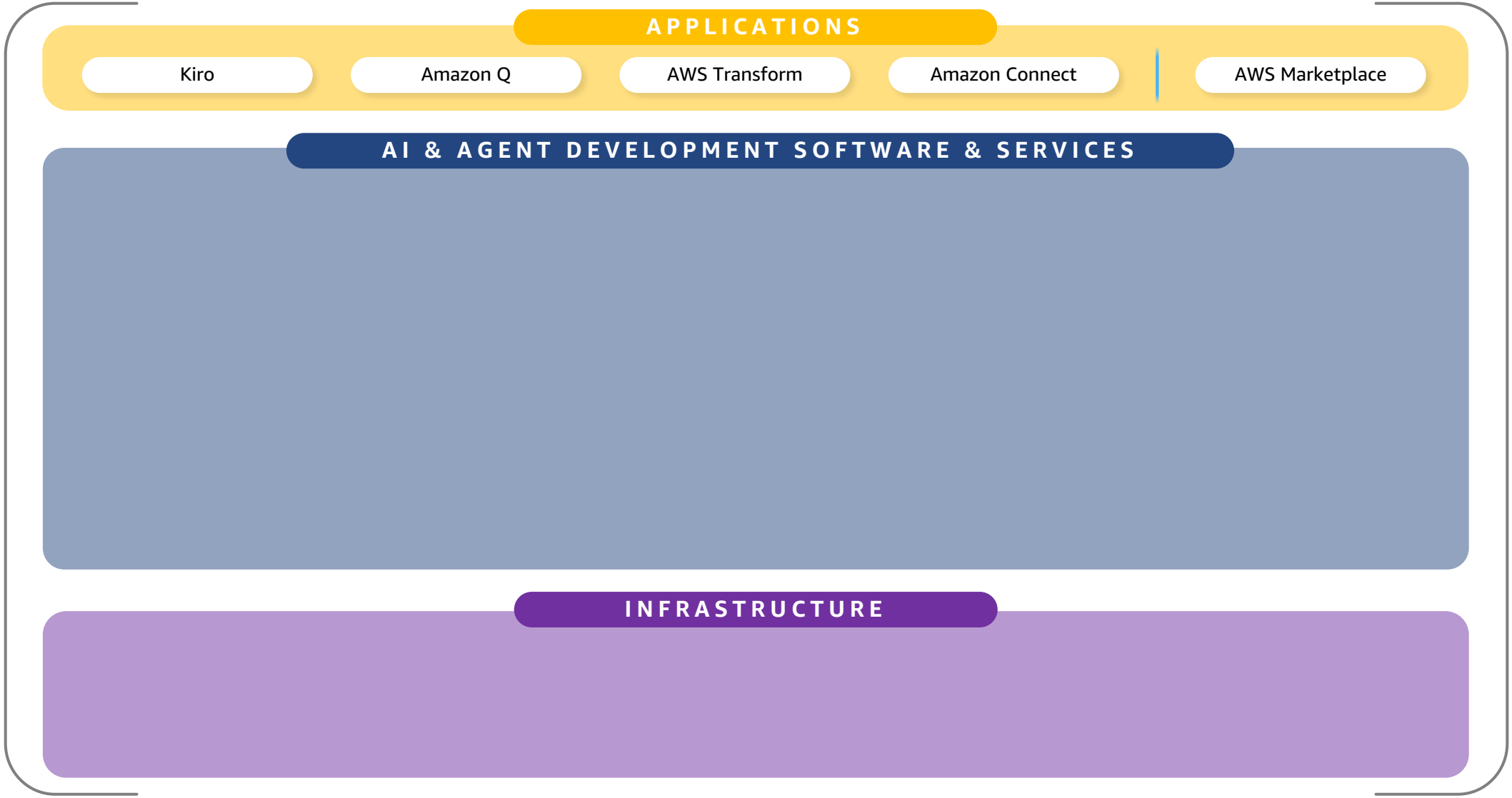
The AWS AI services stack



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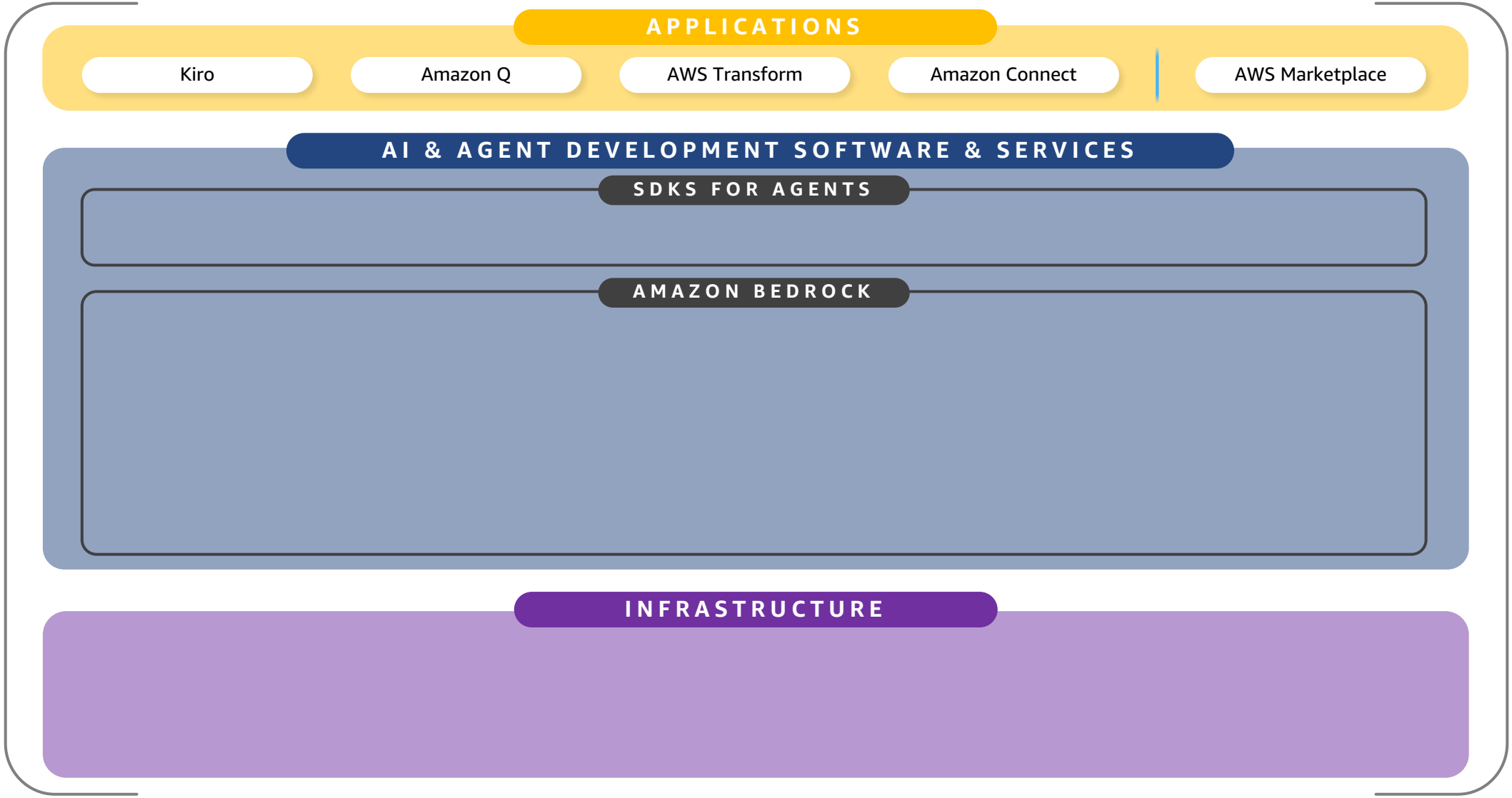
The AWS AI services stack



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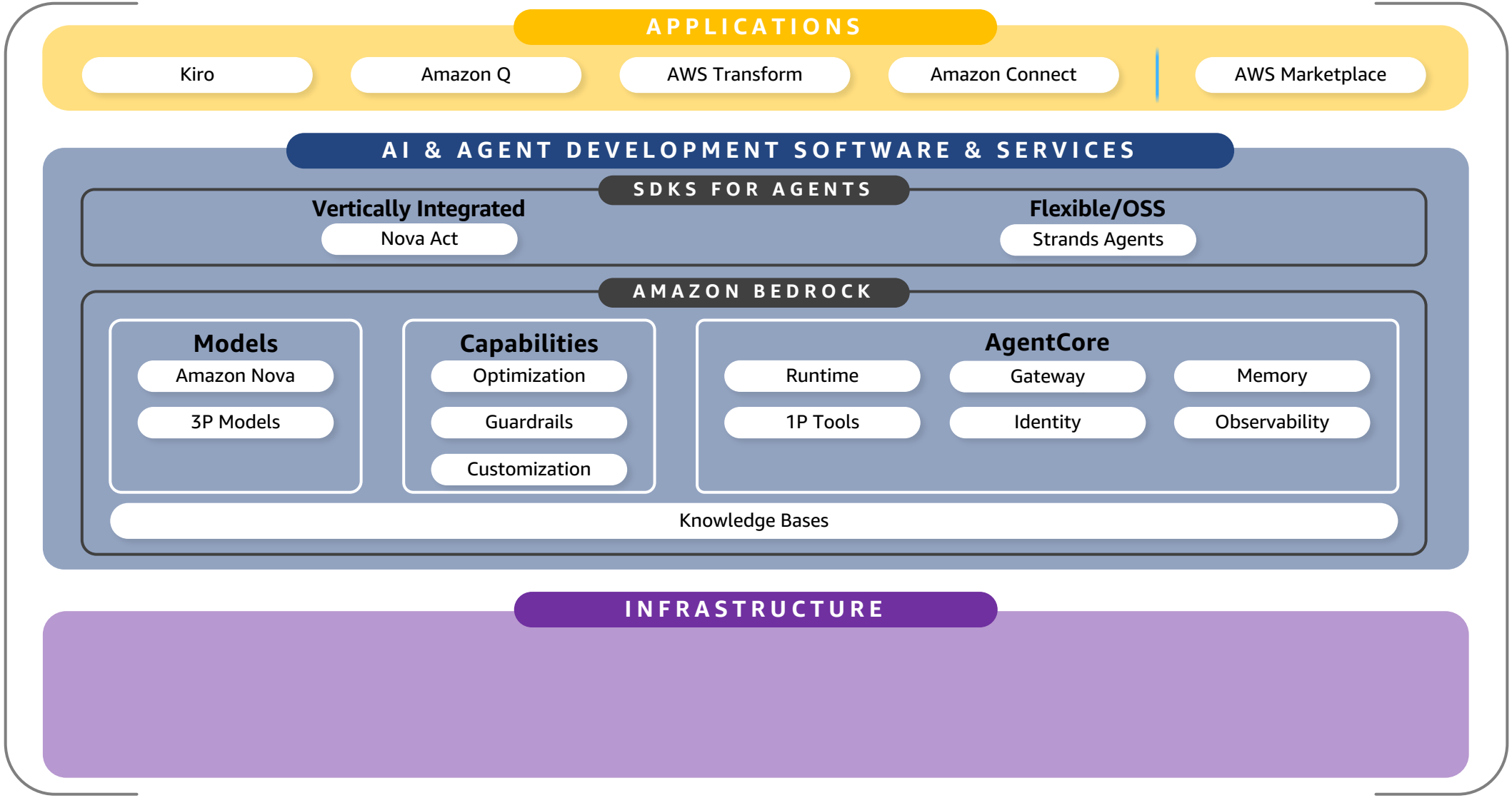
The AWS AI services stack



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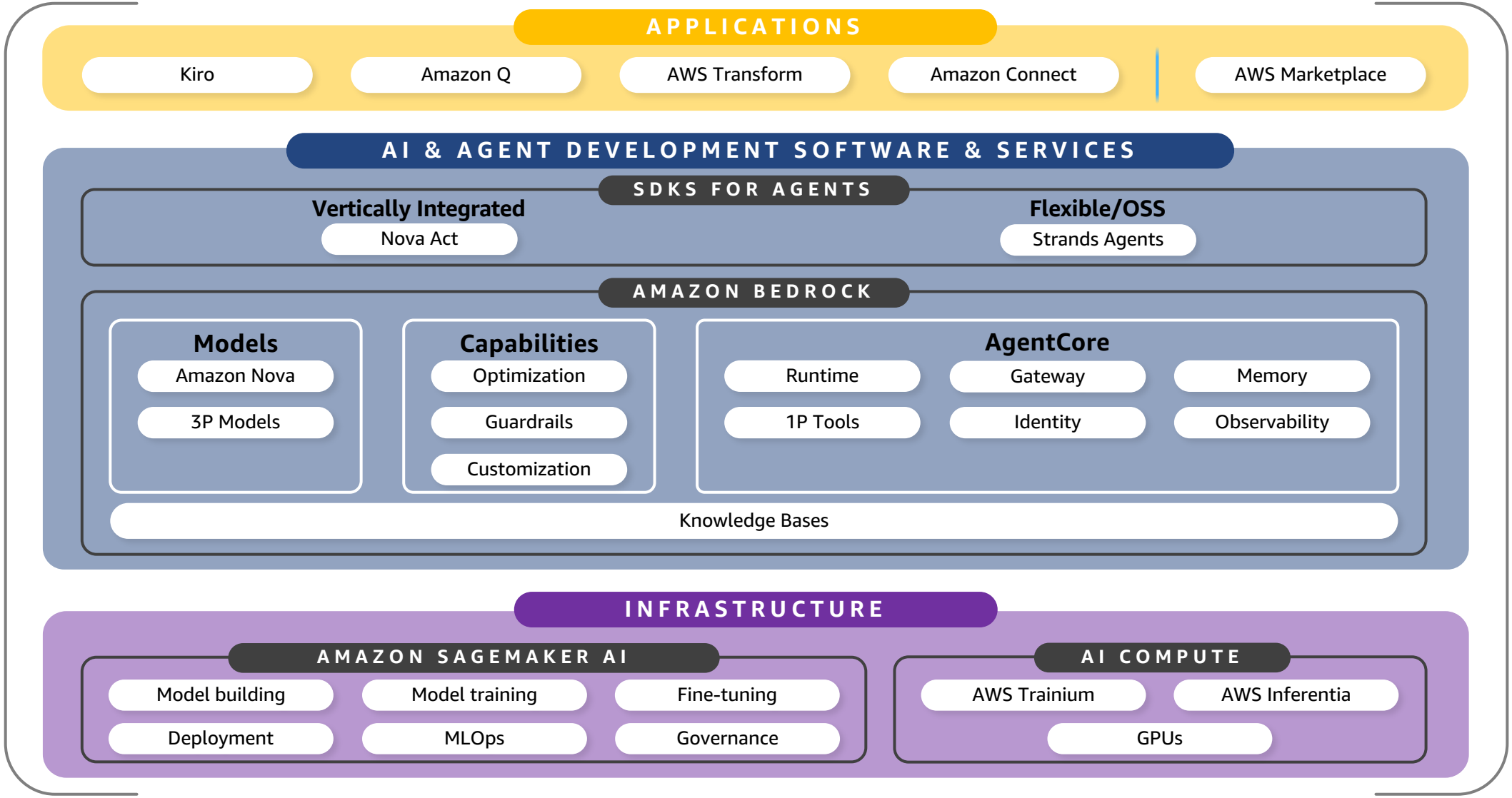
The AWS AI services stack



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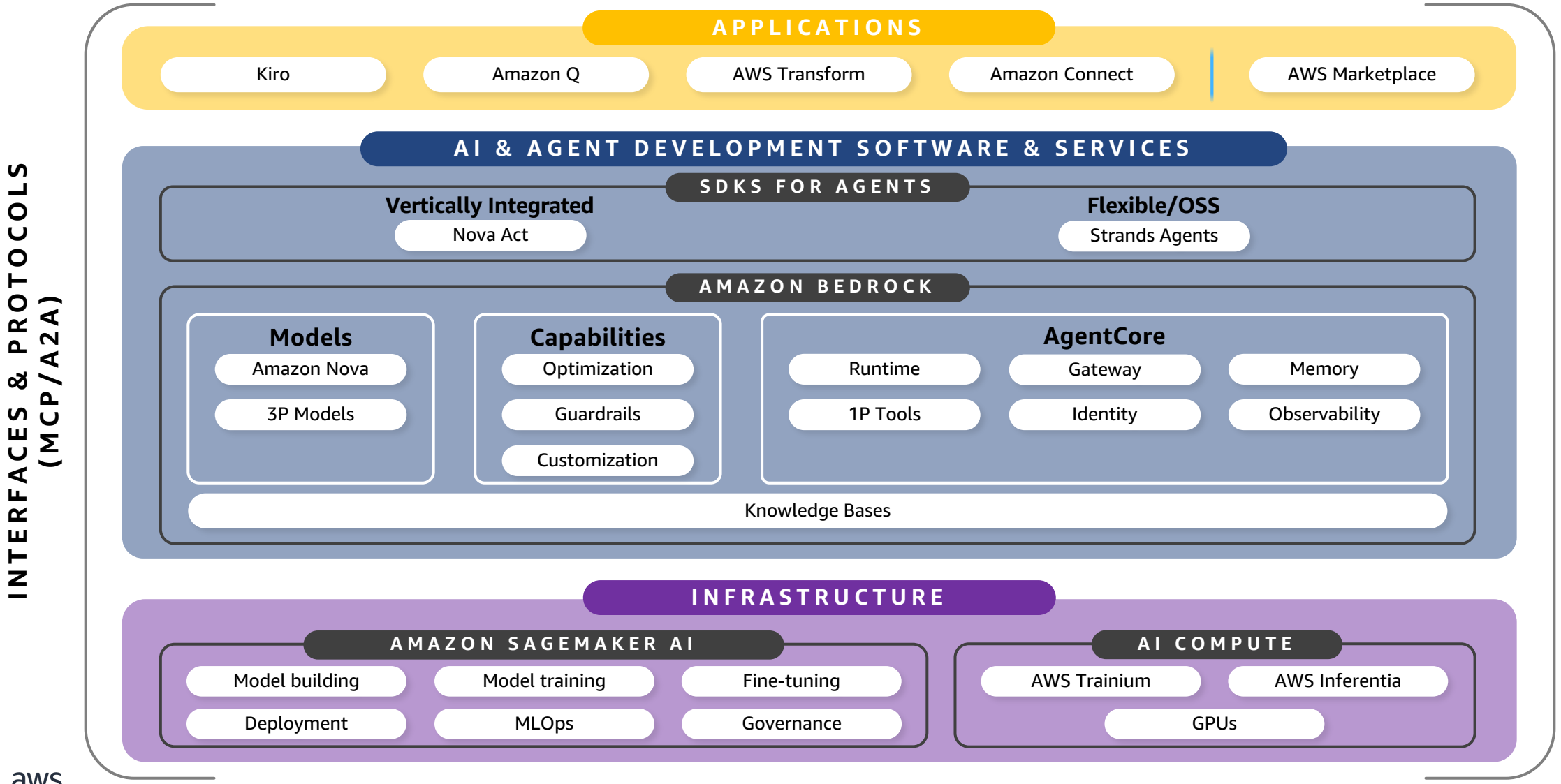
The AWS AI services stack



Deploying modern AI solutions:
Why build production AI workloads on AWS?

EXPERIENCE

18 years

helping millions
of customers

GLOBAL REACH

38 Regions

120 Availability Zones
140+ Direct Connect locations

SECURITY

300+

security features

Supporting regulated FSI workloads

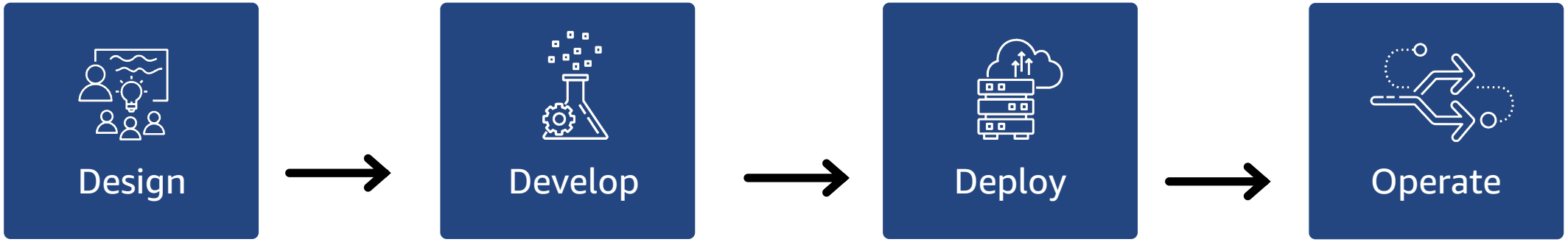
INNOVATION

250+

service offerings

with 30+ ML & AI services

Deploying modern AI solutions:
How can we get started?



AWS Generative AI Innovation Center

AWS Prototyping and Cloud Engineering

AWS Professional Services

Amazon Partner Network & AWS Solution Architects

AI-powered IDP on AWS

https://aws.amazon.com/ai/generative-ai/use-cases/document-processing/

AWS for Financial Services

https://aws.amazon.com/financial-services/machine-learning/

aws

Thank you!

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yamjonat@amazon.com