Improving Accuracy & Efficiency in Document Handling for Business Processes

Introduction to Research in Computer Science
CPSC-59700

Alison Major • 24-August-2021

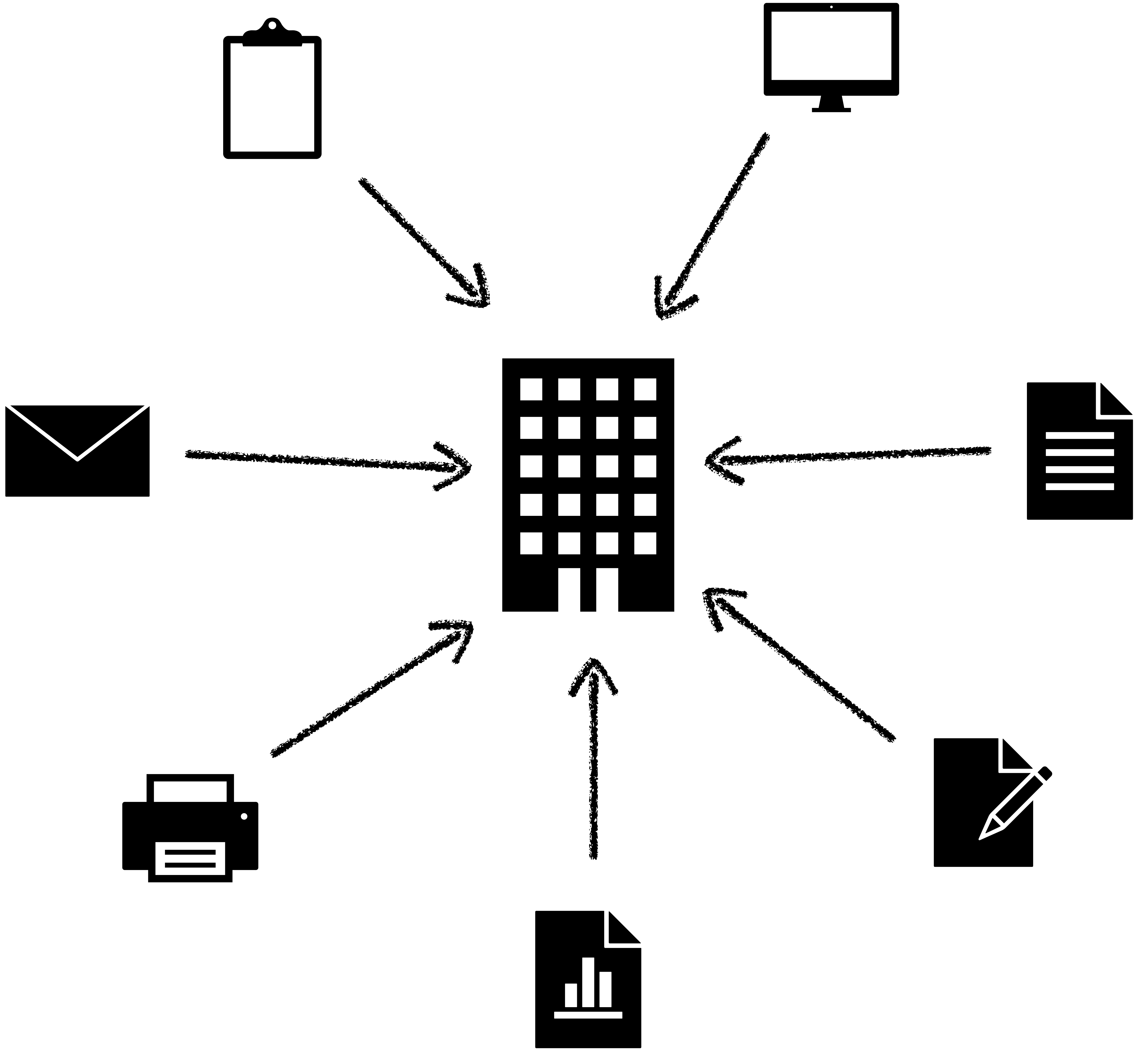
Data comes in many formats .

Manual data extraction is cumbersome and error-prone.

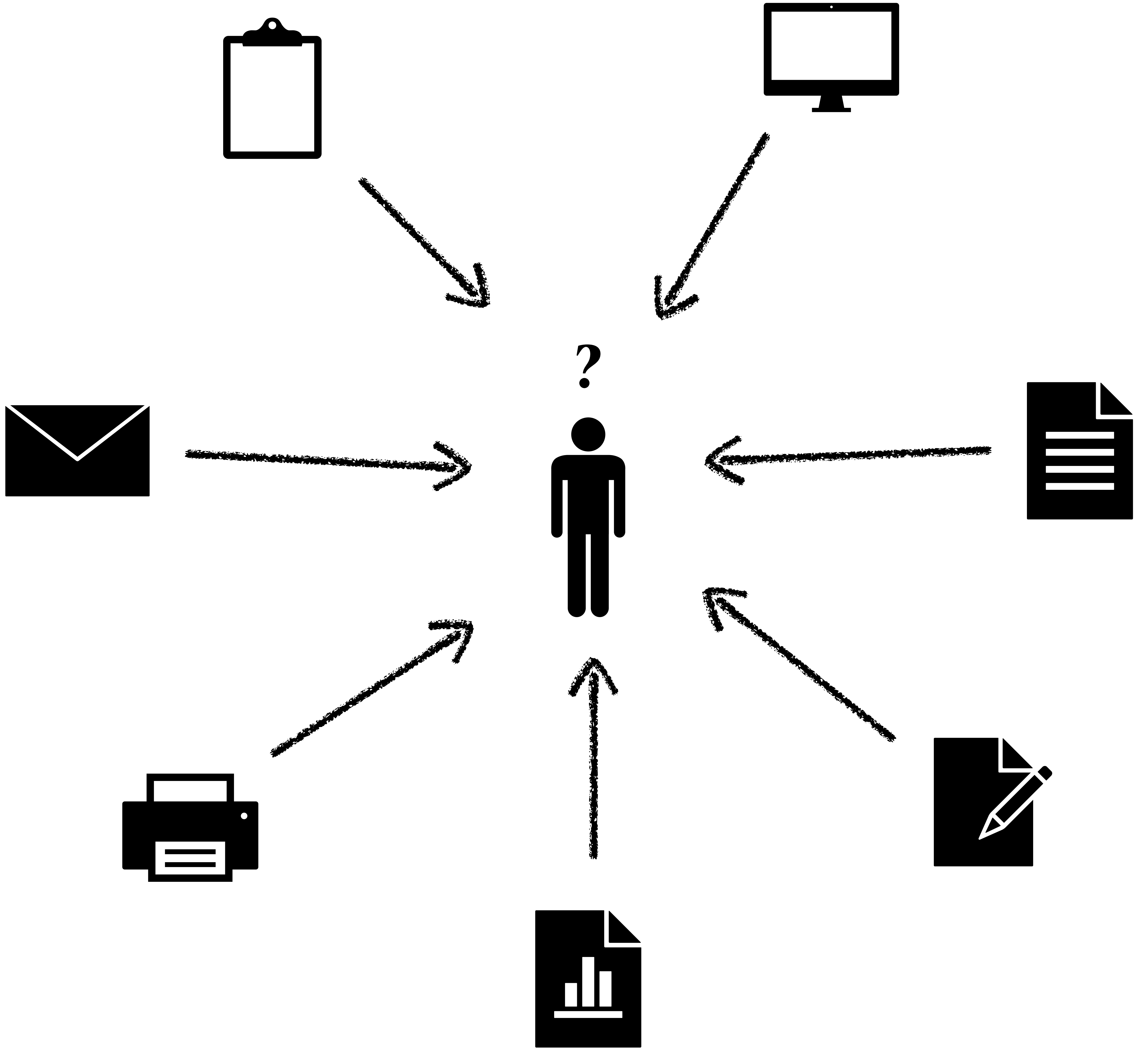
Many tools exist to assist in extracting data,
including OCR, ML, and NLP.

Is there a single method to receive multiple forms of information and automatically pull the desired data?

[Introduction]



[Introduction]



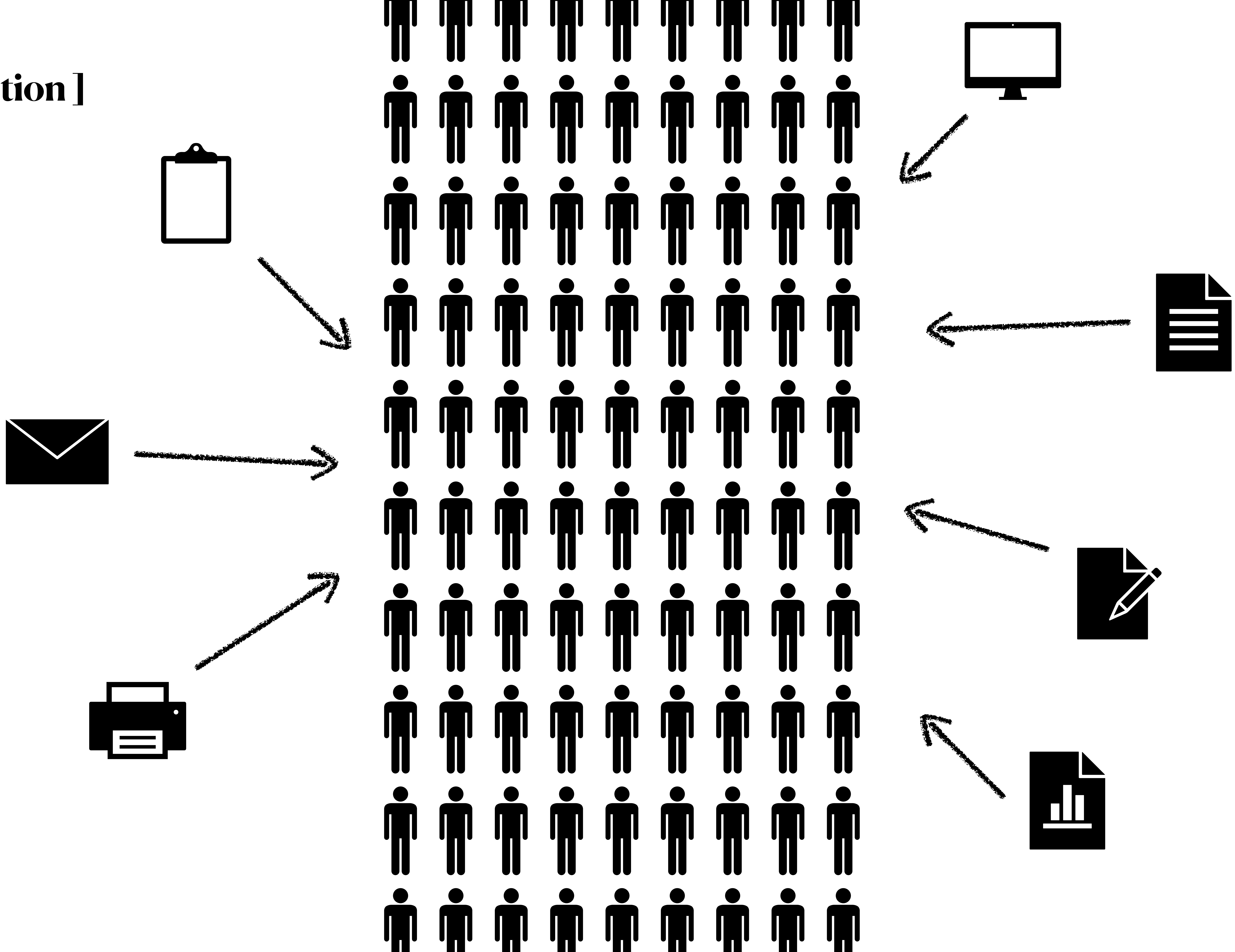
[Introduction]

215 students
30 datasheets
6 data types

Average 10.23 errors

Study from 2009 at UNLV.
Matt Harris. When good info goes bad: The real cost of human data errors, 2014. [Online; accessed 15-August2021].

[Introduction]



[Manual Data Entry]

Direct and indirect cost of manual data entry for global businesses were estimated to be about $2.7 trillion.

2018, Goldman Sachs

James Schneider Ph.D., Bill Schultz, Julia McCrimlisk, Jesse Hulsing, and Ryan M. Nash CFA. B2B: How the next payments frontier will unleash small business. EQUITY RESEARCH, 2018. [Online; accessed 13-August2021].

[Manual Data Entry]

Avoidable Rework for accounting staff of 40: $878,000 per year

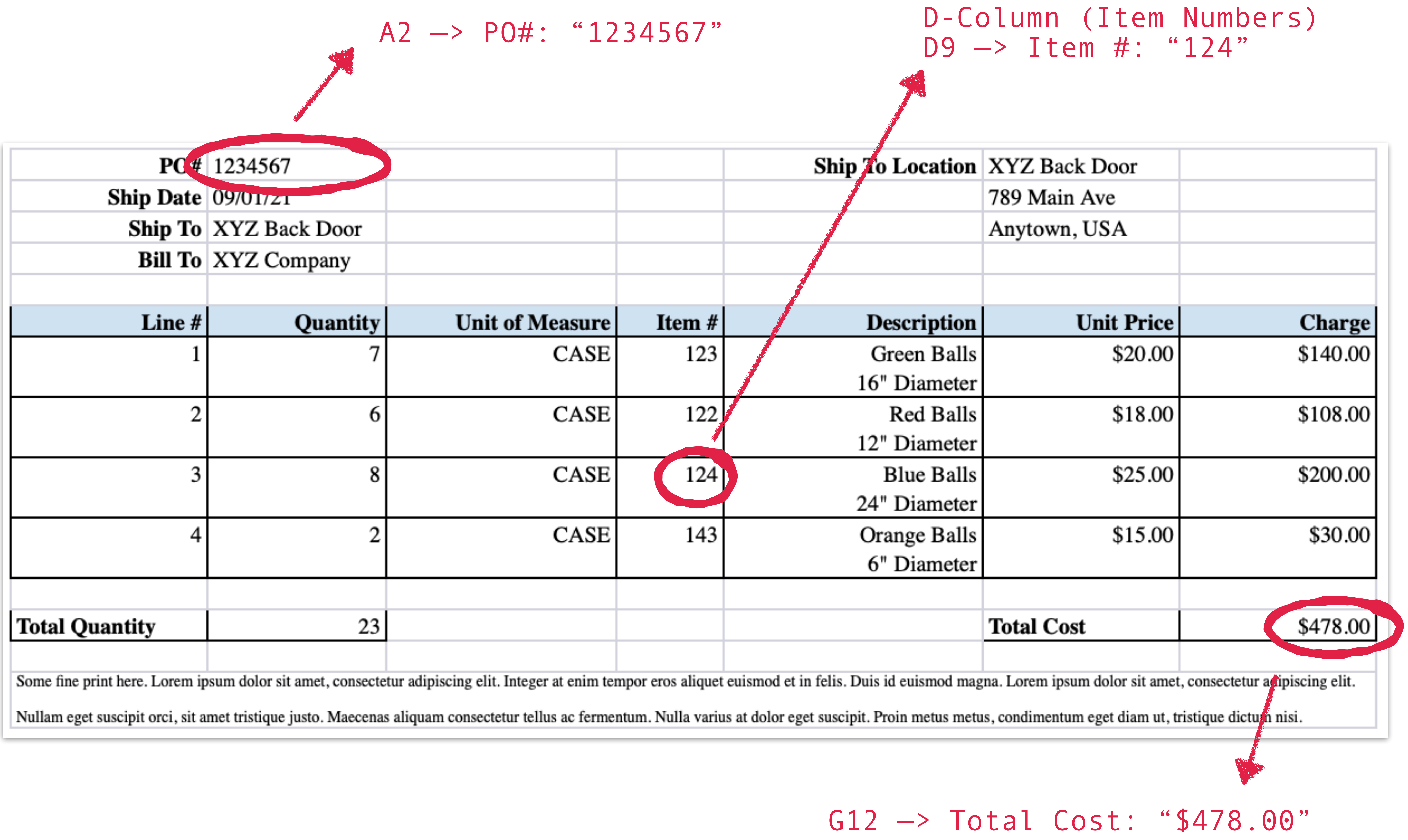
2019, Gartner

Justin Lavelle. Gartner says robotic process automation can save finance departments 25,000 hours of avoidable work annually, 2019. [Online; accessed 13-August2021].

How can we make data extraction simpler?

Rules & Positions

- Machine-readable files can use rules and positions to capture data
- The data is already digital, therefore accuracy is high



A2 —> PO#: “1234567”

D-Column (Item Numbers)
D9 —> Item #: “124”

PO #	1234567			Ship To Location	XYZ Back Door	
Ship Date	09/01/21				789 Main Ave	
Ship To	XYZ Back Door				Anytown, USA	
Bill To	XYZ Company					
Line #	Quantity	Unit of Measure	Item #	Description	Unit Price	Charge
1	7	CASE	123	Green Balls 16" Diameter	$20.00	$140.00
2	6	CASE	122	Red Balls 12" Diameter	$18.00	$108.00
3	8	CASE	124	Blue Balls 24" Diameter	$25.00	$200.00
4	2	CASE	143	Orange Balls 6" Diameter	$15.00	$30.00
Total Quantity	23				Total Cost	$478.00

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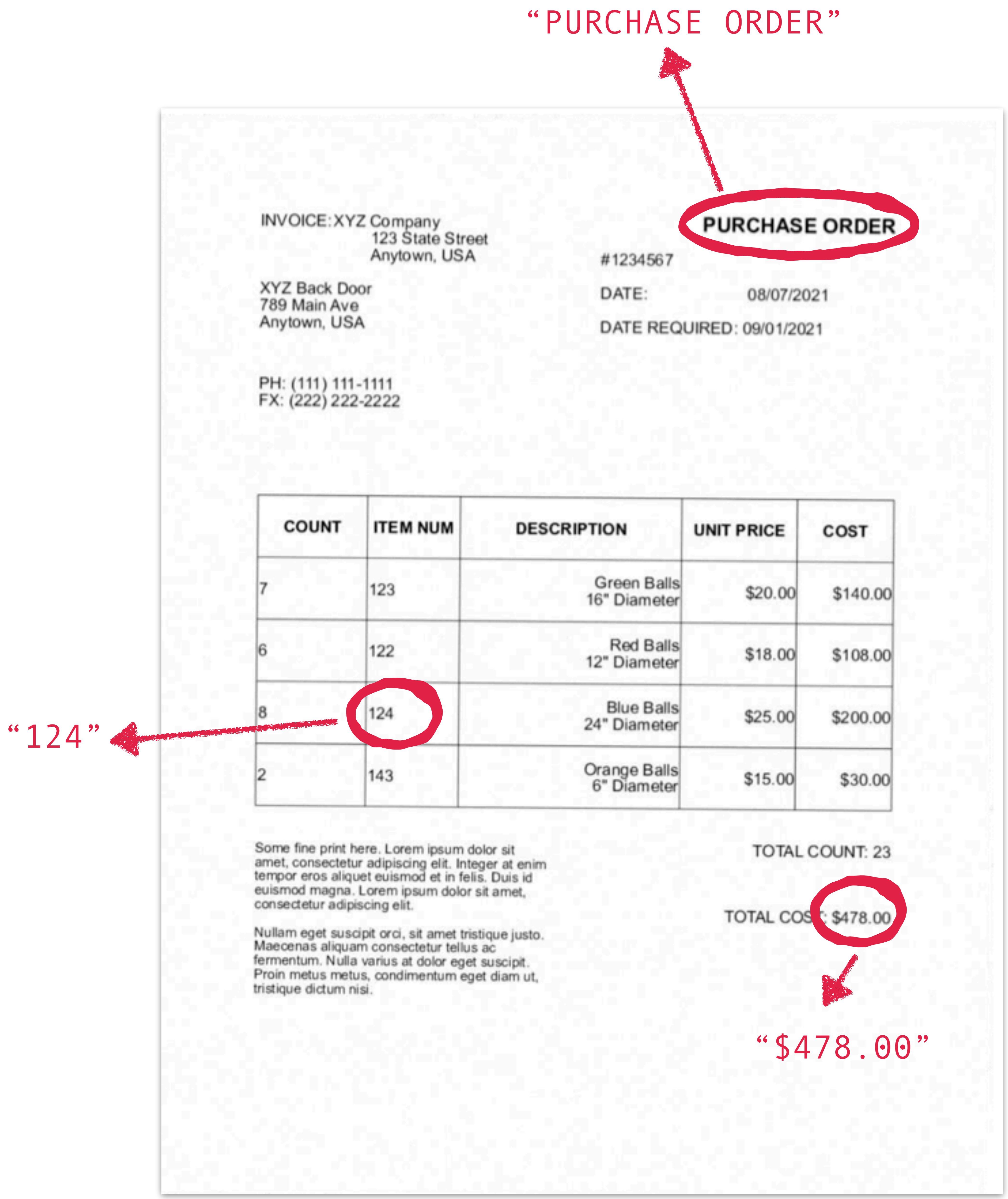
G12 —> Total Cost: “$478.00”

Optical Character Recognition

- Technique that converts images and files into machine-readable data
- Challenges:
  - Orientation & skew
  - Noise or distortion
  - Handwriting or stamps covering printed text



"PURCHASE ORDER"

INVOICE: XYZ Company
123 State Street
Anytown, USA

PURCHASE ORDER

#1234567

XYZ Back Door
789 Main Ave
Anytown, USA

DATE: 08/07/2021

DATE REQUIRED: 09/01/2021

PH: (111) 111-1111
FX: (222) 222-2222

COUNT	ITEM NUM	DESCRIPTION	UNIT PRICE	COST
7	123	Green Balls 16" Diameter	$20.00	$140.00
6	122	Red Balls 12" Diameter	$18.00	$108.00
8	124	Blue Balls 24" Diameter	$25.00	$200.00
2	143	Orange Balls 6" Diameter	$15.00	$30.00

"124"

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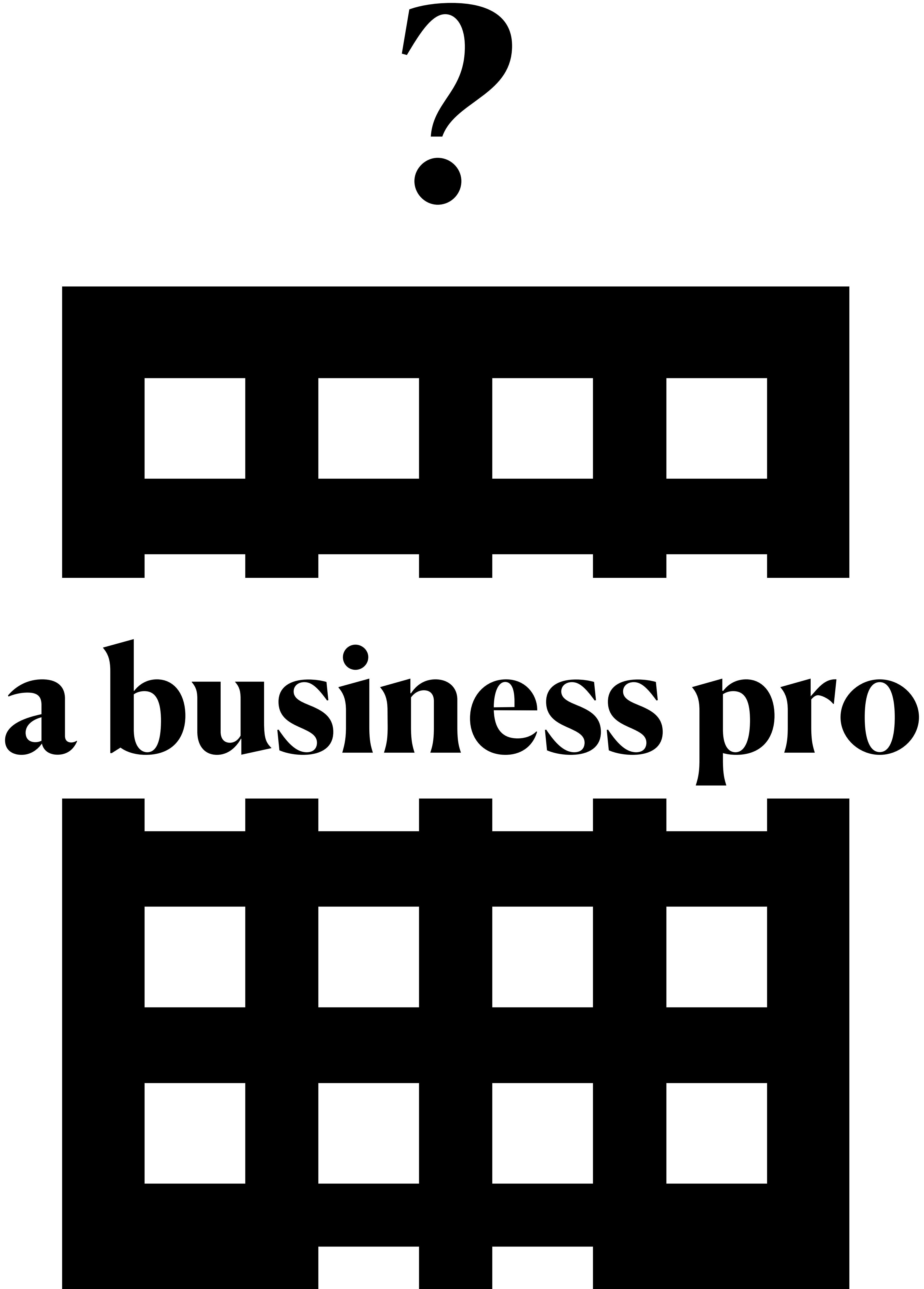
TOTAL COUNT: 23

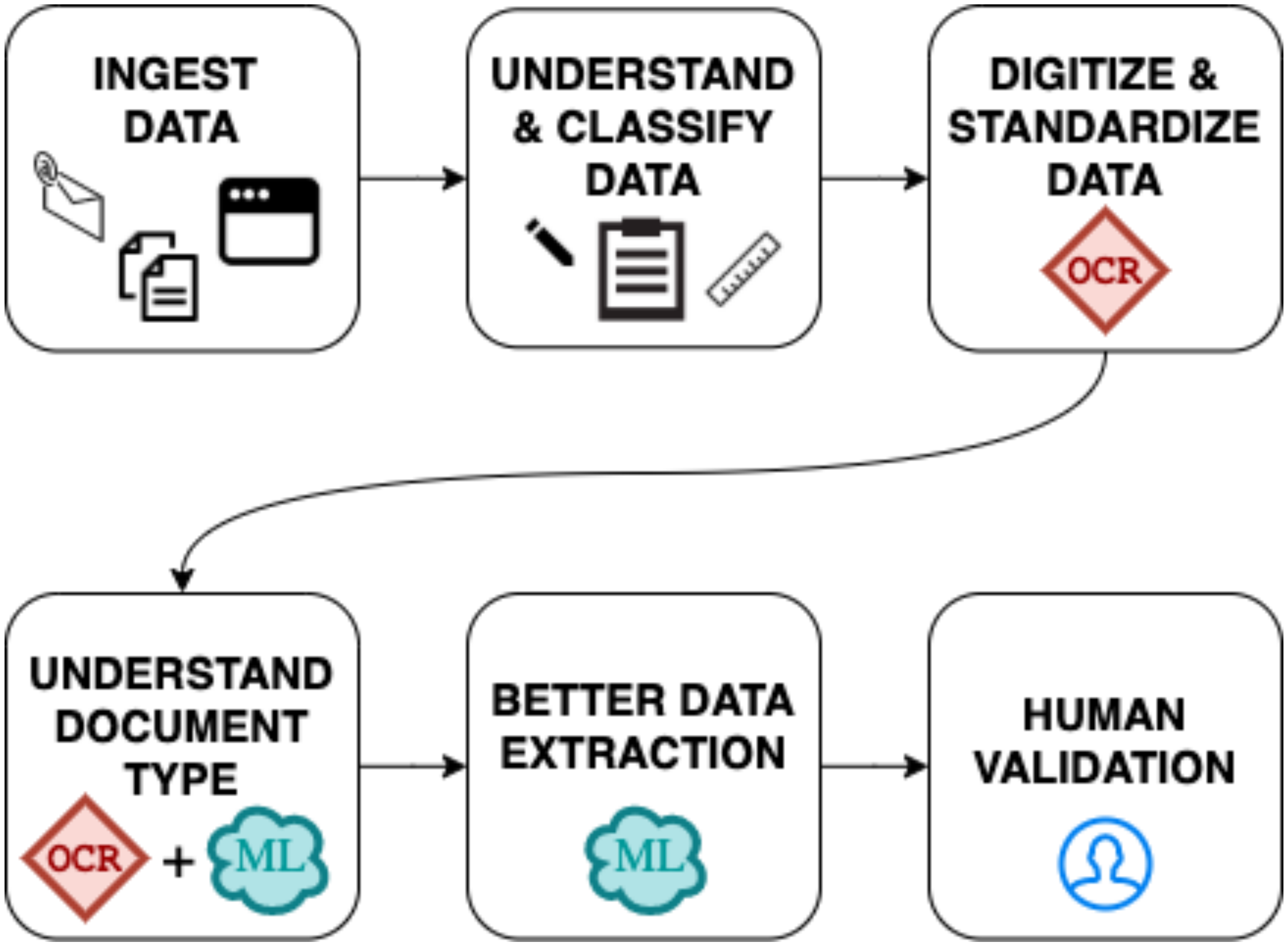
TOTAL COST: $478.00

"$478.00"



How does a business process data?

[Processing Data]



INGEST DATA

UNDERSTAND & CLASSIFY DATA

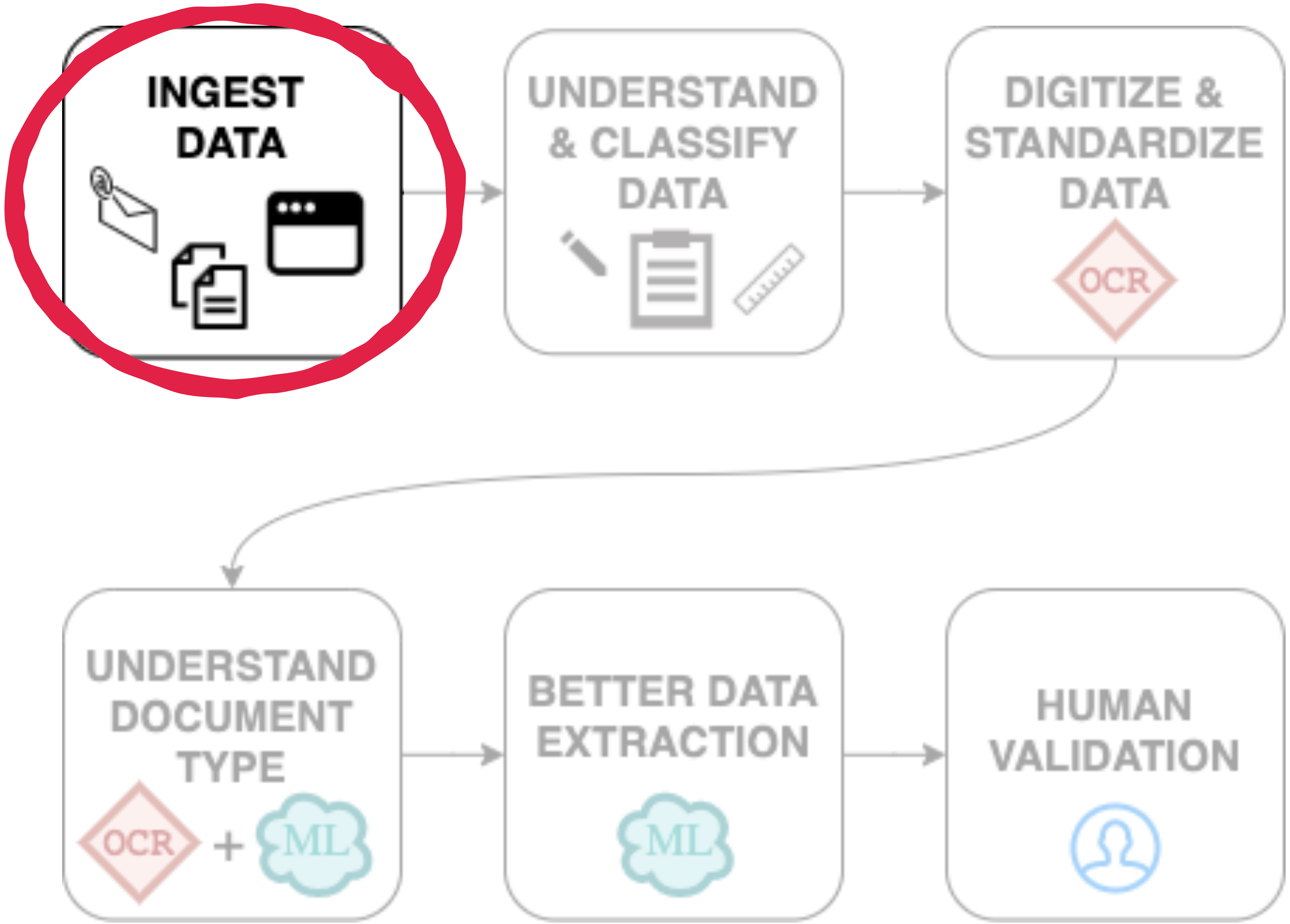
DIGITIZE & STANDARDIZE DATA

UNDERSTAND DOCUMENT TYPE

BETTER DATA EXTRACTION

HUMAN VALIDATION

[Processing Data]



INGEST DATA

UNDERSTAND & CLASSIFY DATA

DIGITIZE & STANDARDIZE DATA

OCR

UNDERSTAND DOCUMENT TYPE

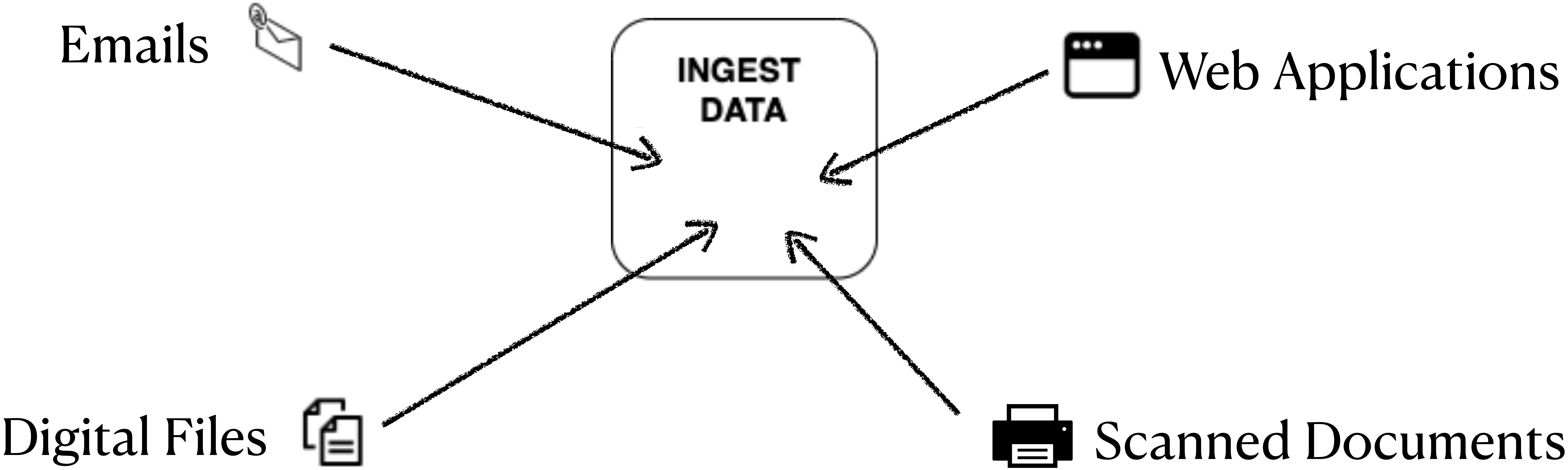
OCR + ML

BETTER DATA EXTRACTION

ML

HUMAN VALIDATION

[Processing Data]



INGEST DATA

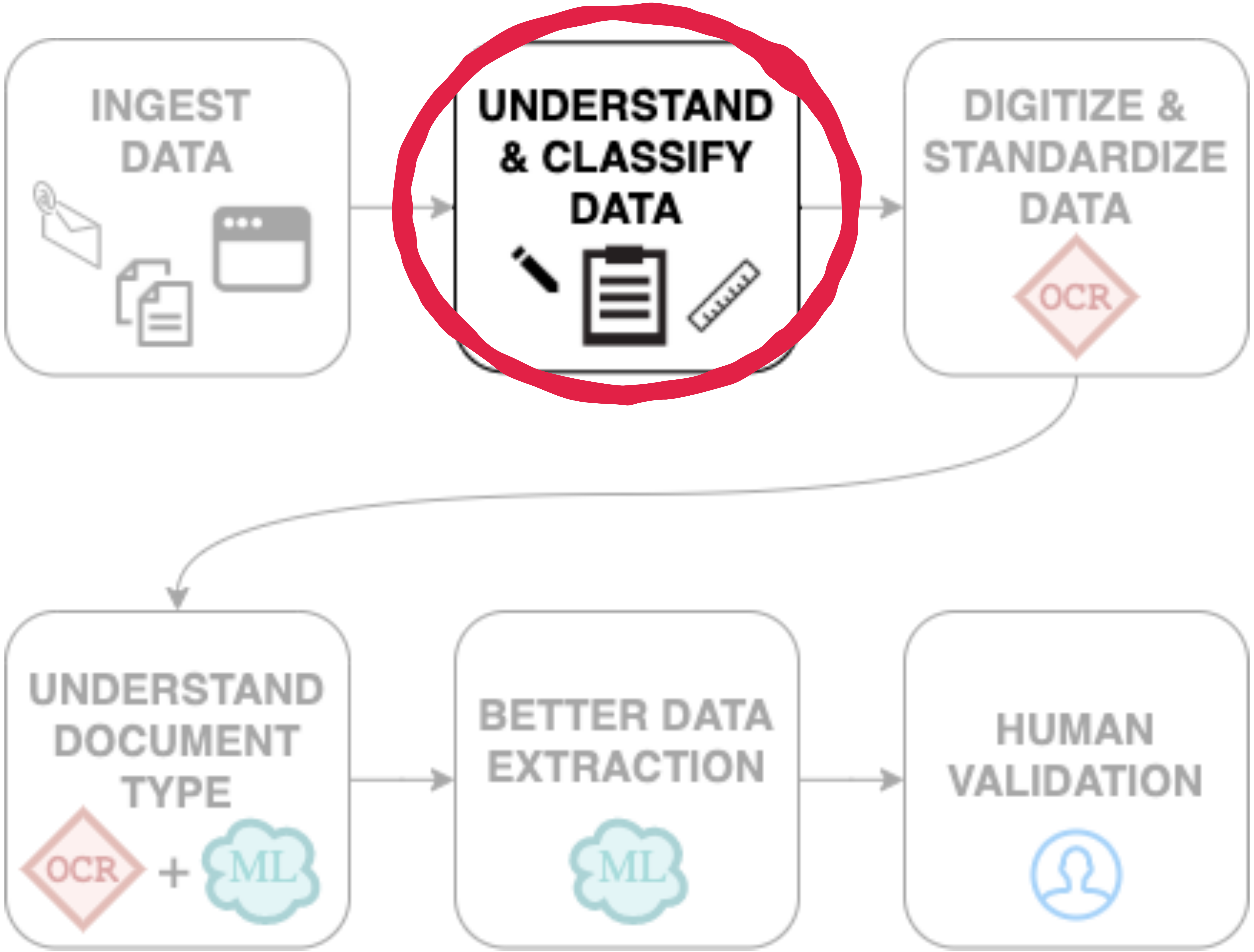
Emails

Web Applications

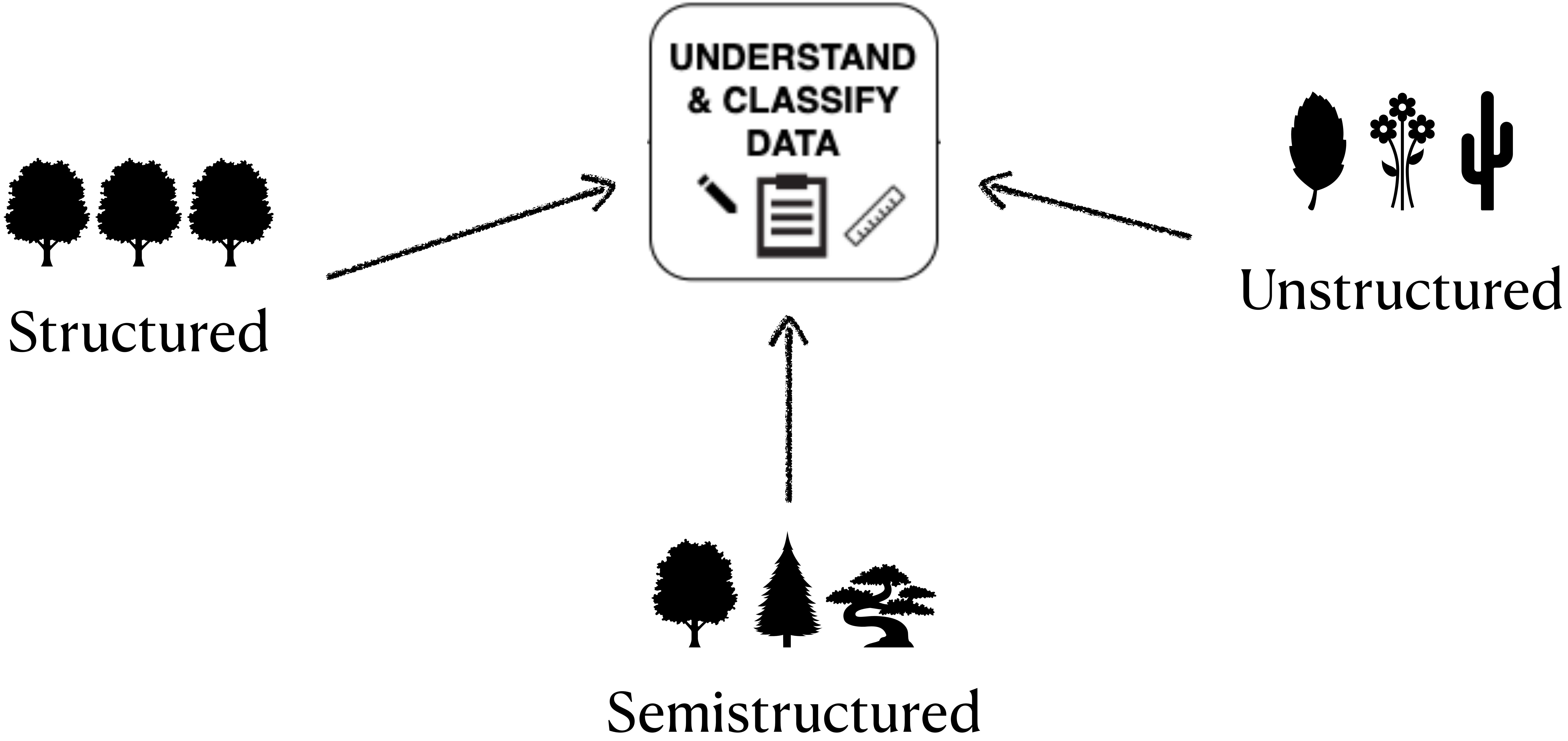
Digital Files

Scanned Documents

[Processing Data]



[Processing Data]



UNDERSTAND & CLASSIFY DATA

Structured

Unstructured

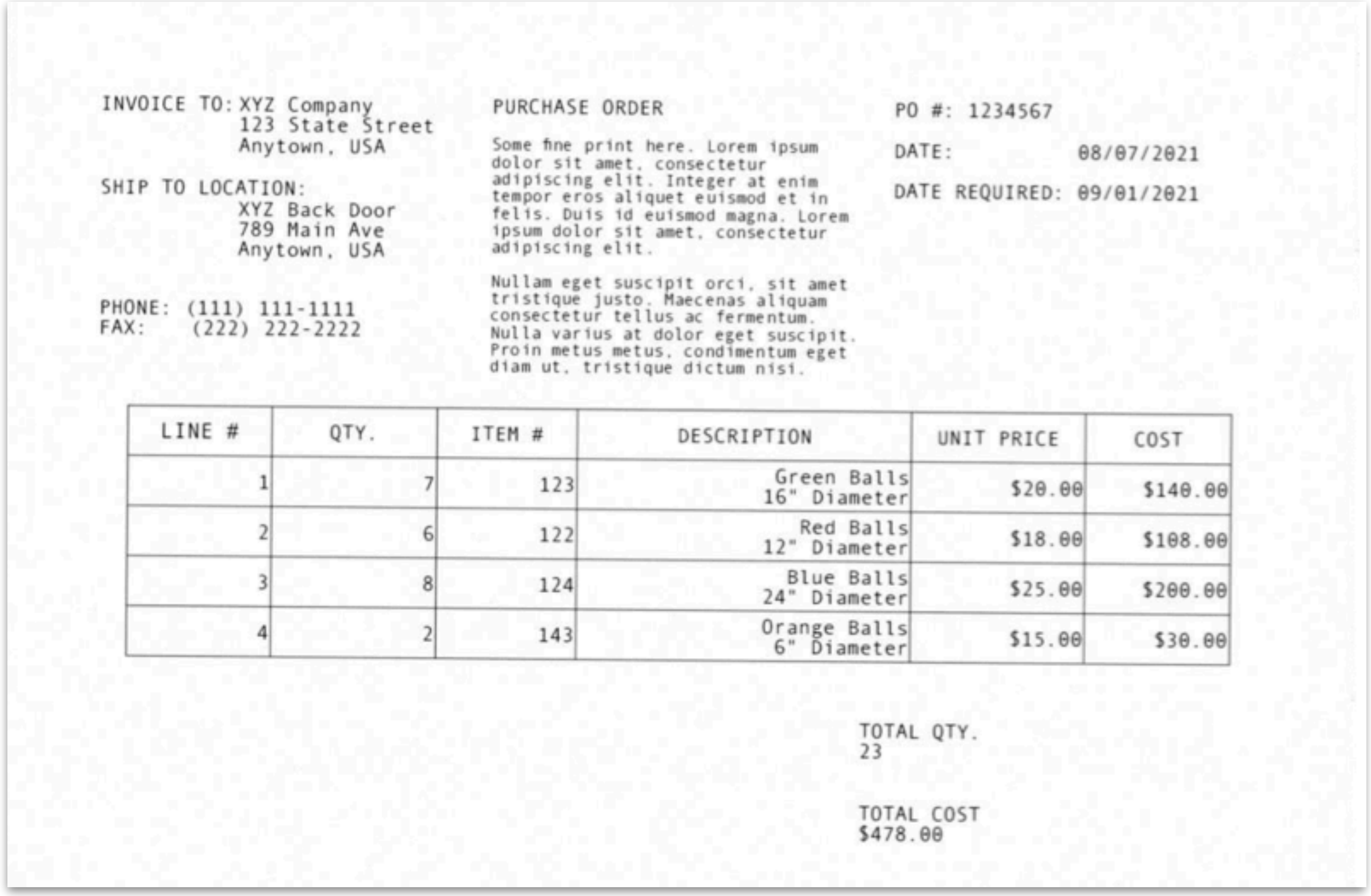
Semistructured

[Processing Data]

Structured

- Formatted in a consistent template
- Tables with values in predictable positions
- Same layout for every document

Layout 1



INVOICE TO: XYZ Company
123 State Street
Anytown, USA

SHIP TO LOCATION:
XYZ Back Door
789 Main Ave
Anytown, USA

PHONE: (111) 111-1111
FAX: (222) 222-2222

PURCHASE ORDER

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DATE: 08/07/2021

DATE REQUIRED: 09/01/2021

LINE #	QTY.	ITEM #	DESCRIPTION	UNIT PRICE	COST
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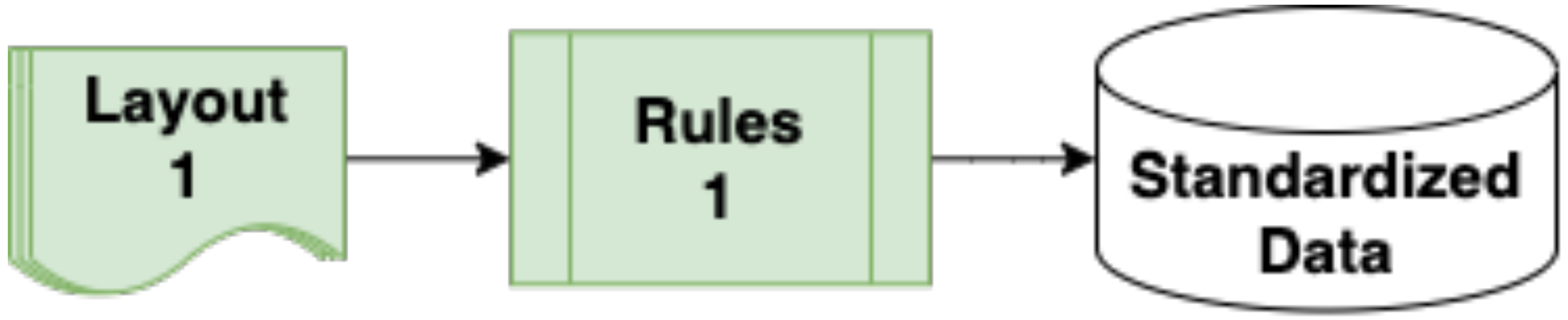
TOTAL QTY.
23

TOTAL COST
$478.00

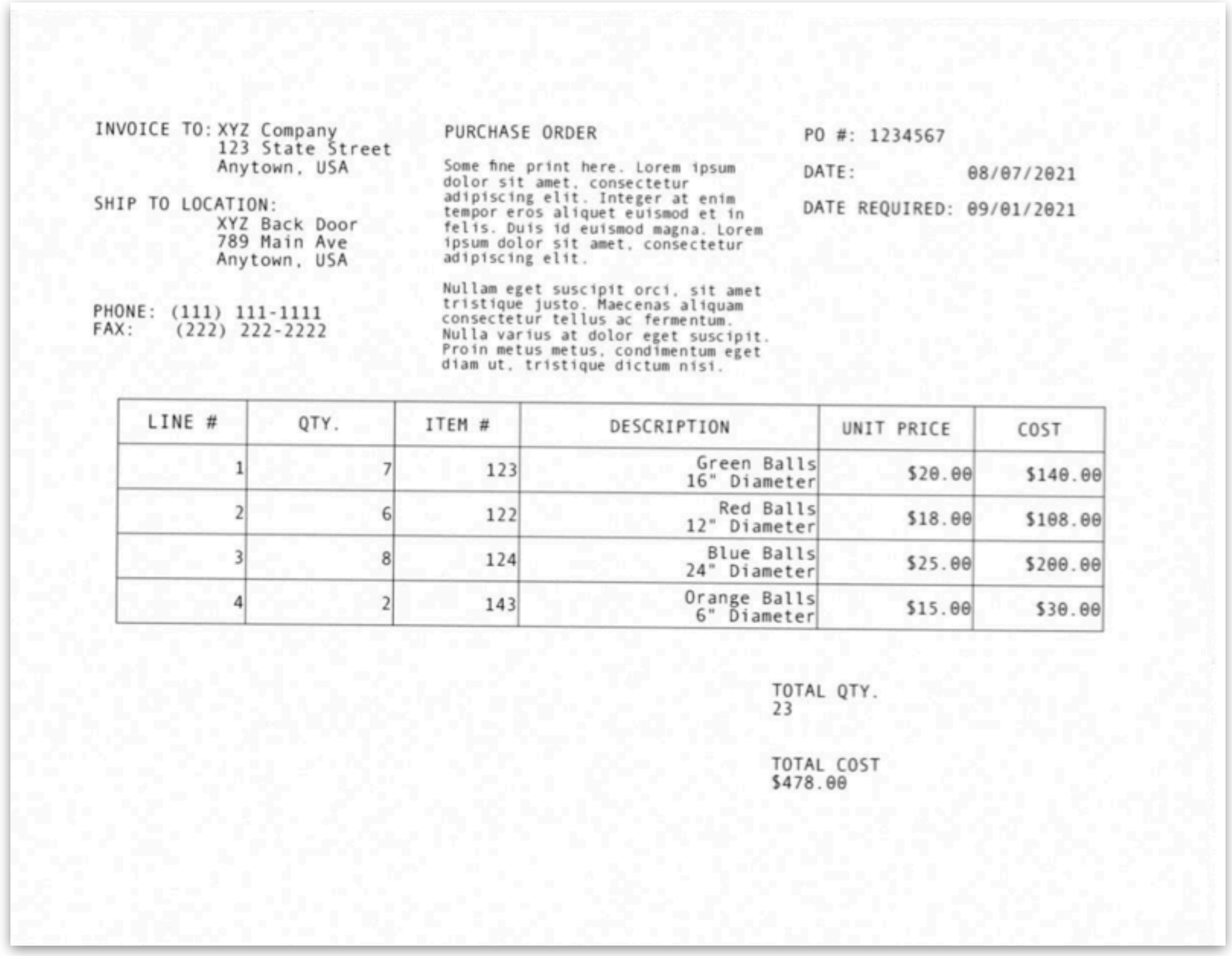


[Processing Data]

Semistructured

- Same key-value pairs
- Different layouts for the information
- Positions of values vary
- Using the same rules for a different layout results in low accuracy for the "wrong" layout

Layout 1



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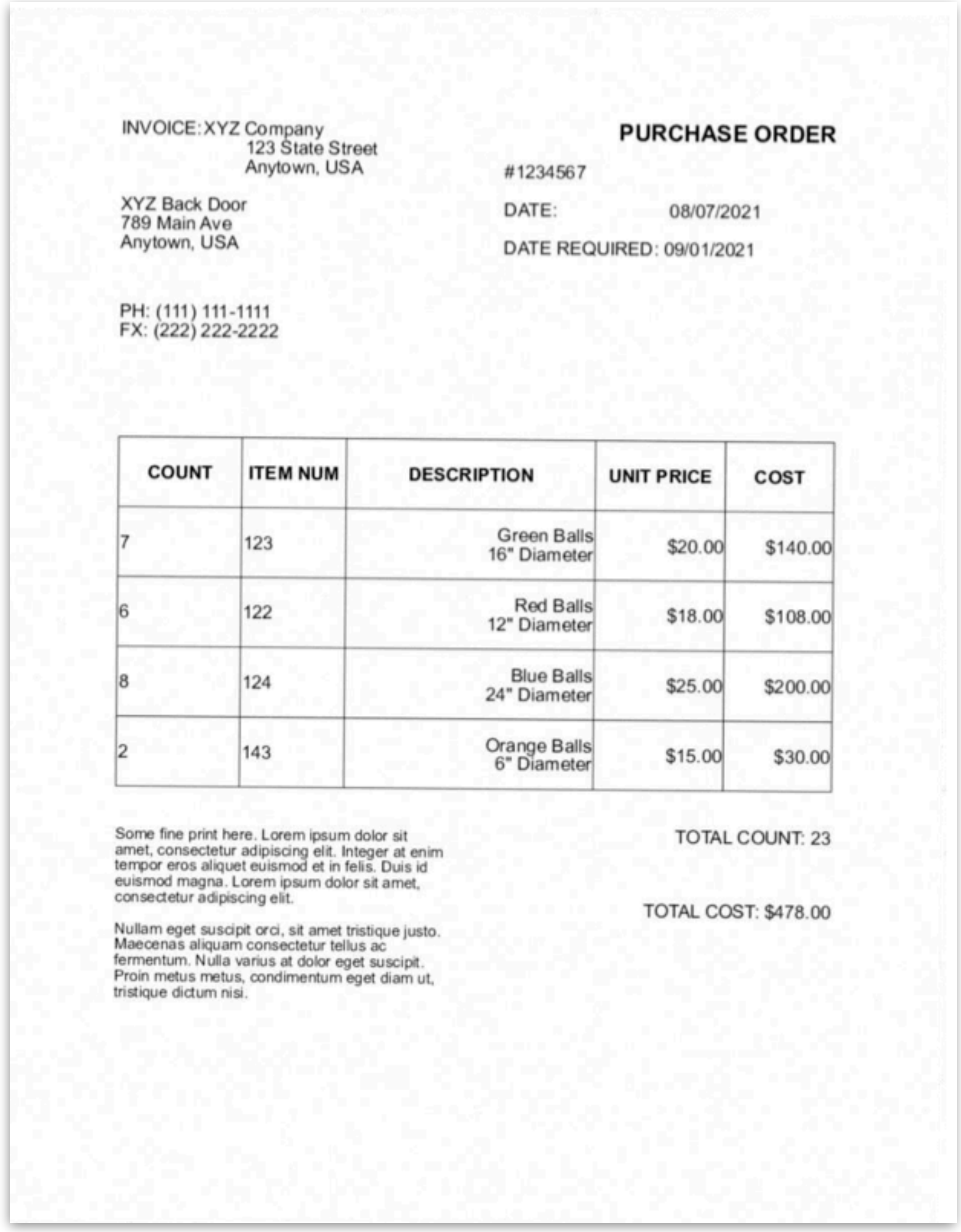
TOTAL QTY.
23

TOTAL COST
$478.00

Layout 2



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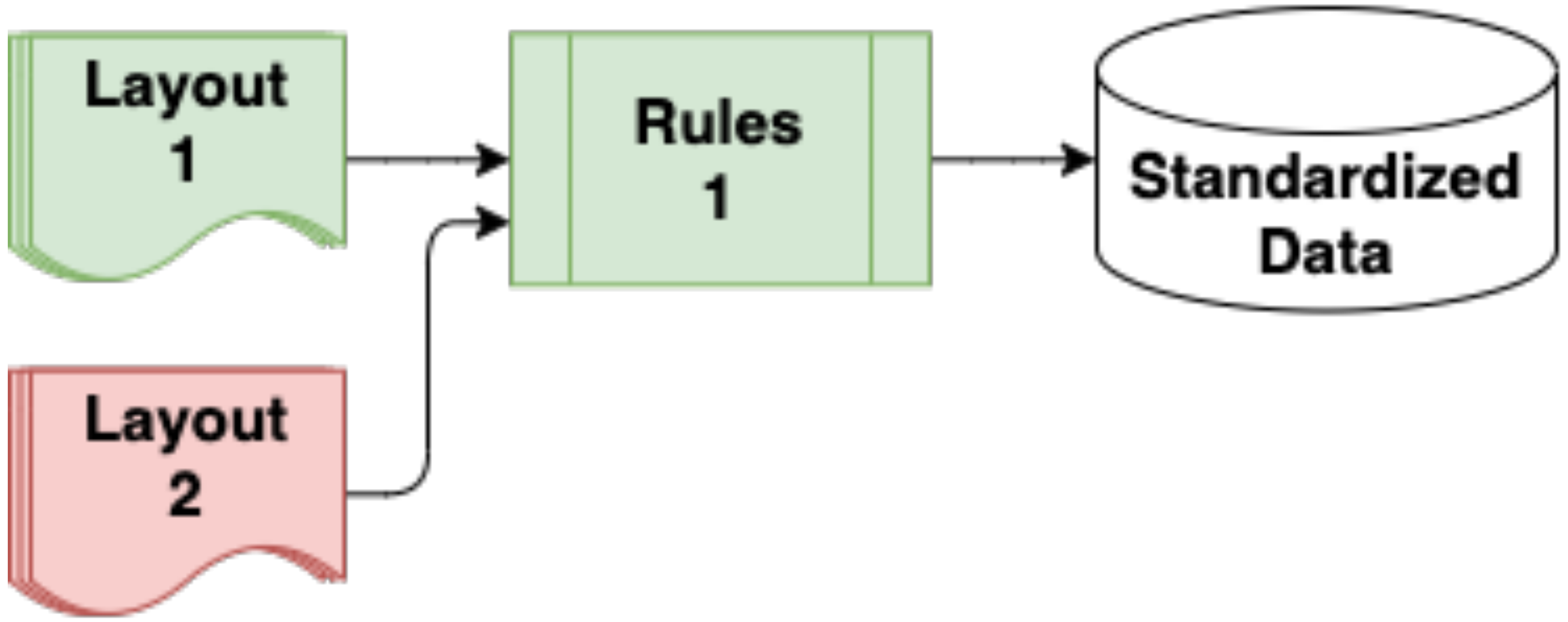


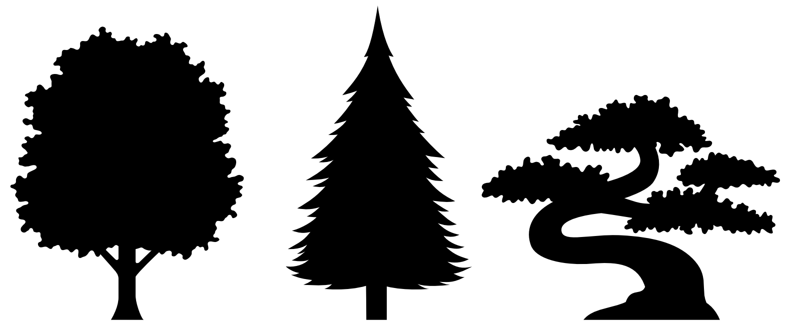
Layout 1

Layout 2

Rules 1

Standardized Data

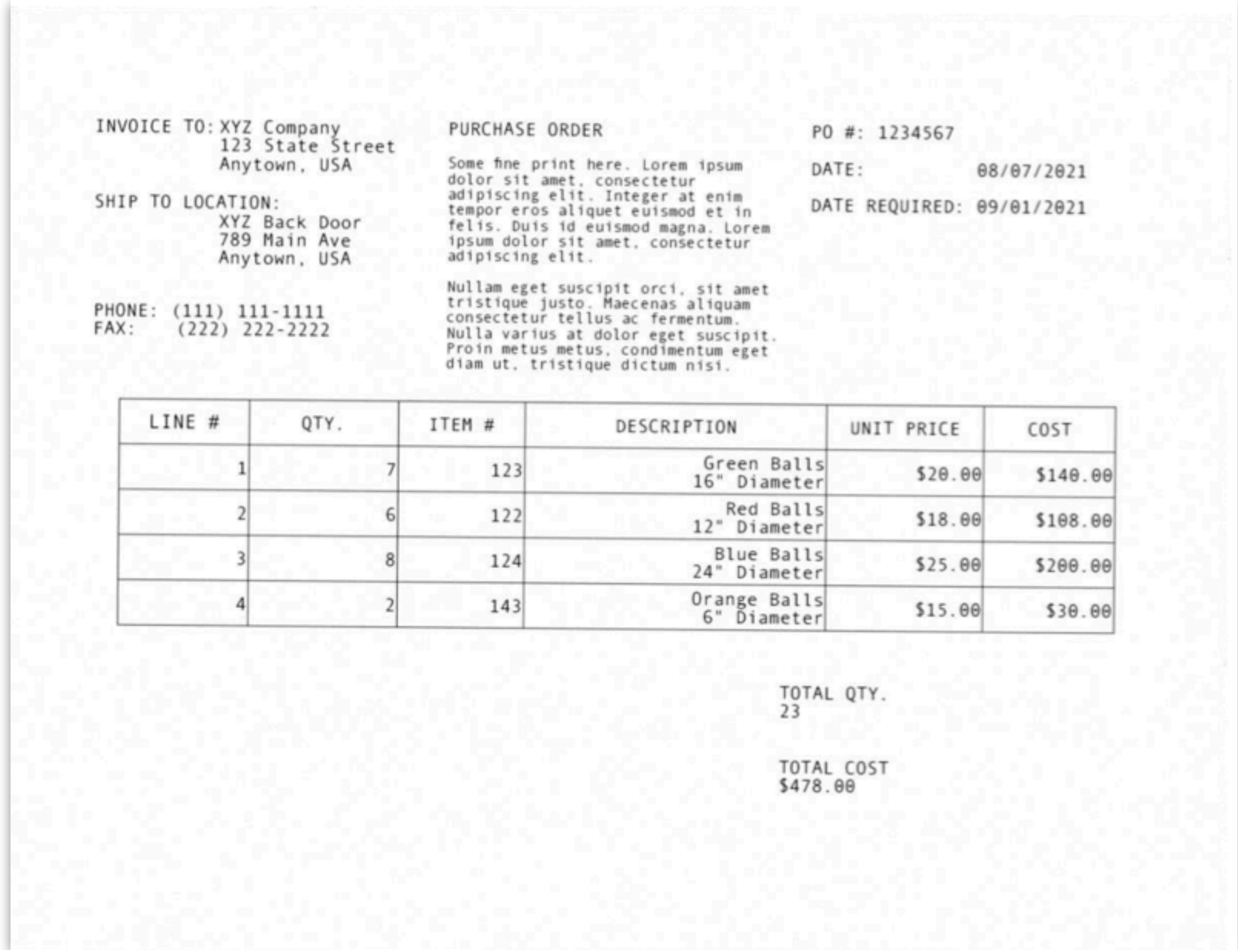
[Processing Data]



Semistructured

- Create rules for each layout
- Scaling...
  requires template
  and rules management!

Layout 1



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TOTAL QTY.
23

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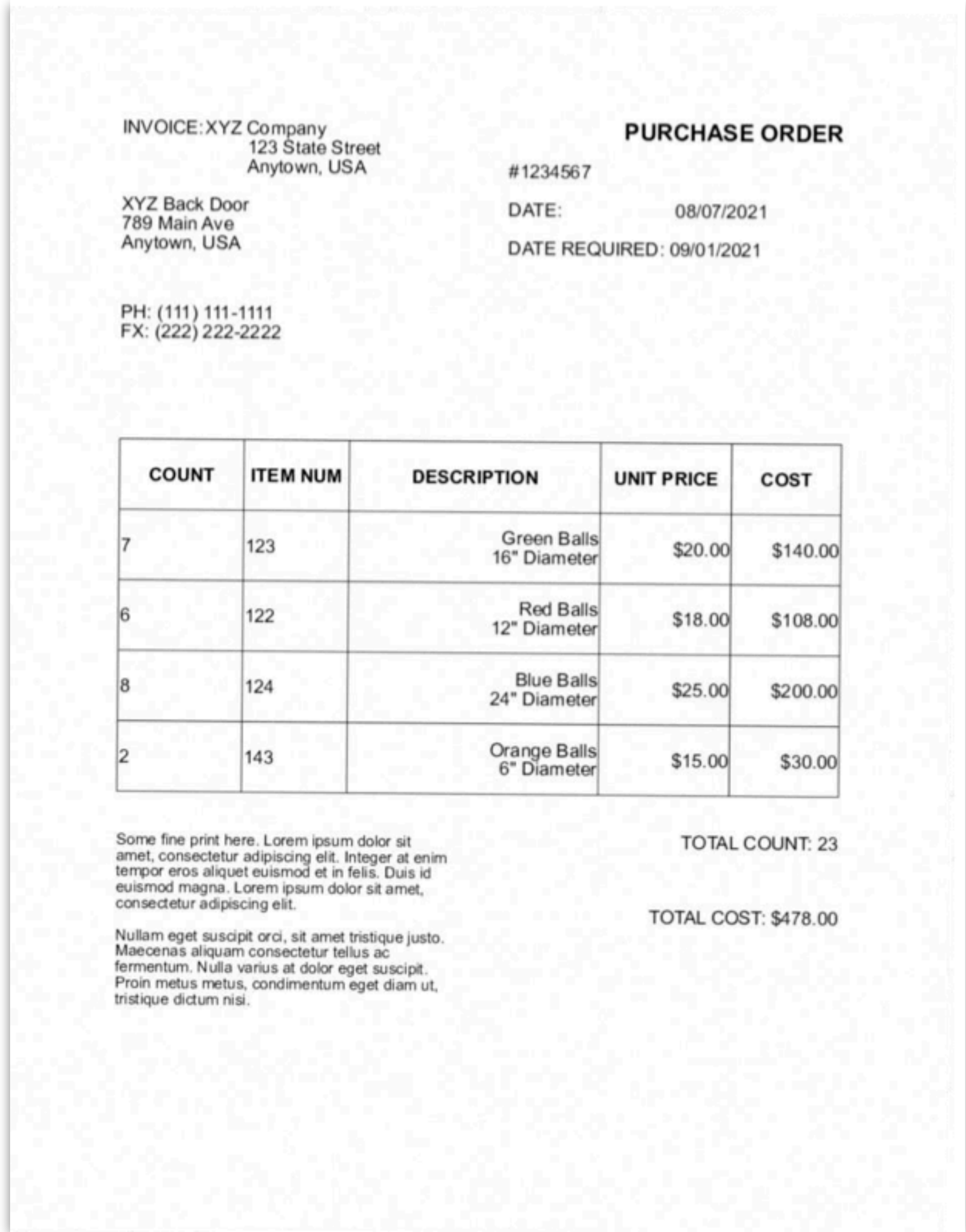
Layout 2



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Anytown, USA

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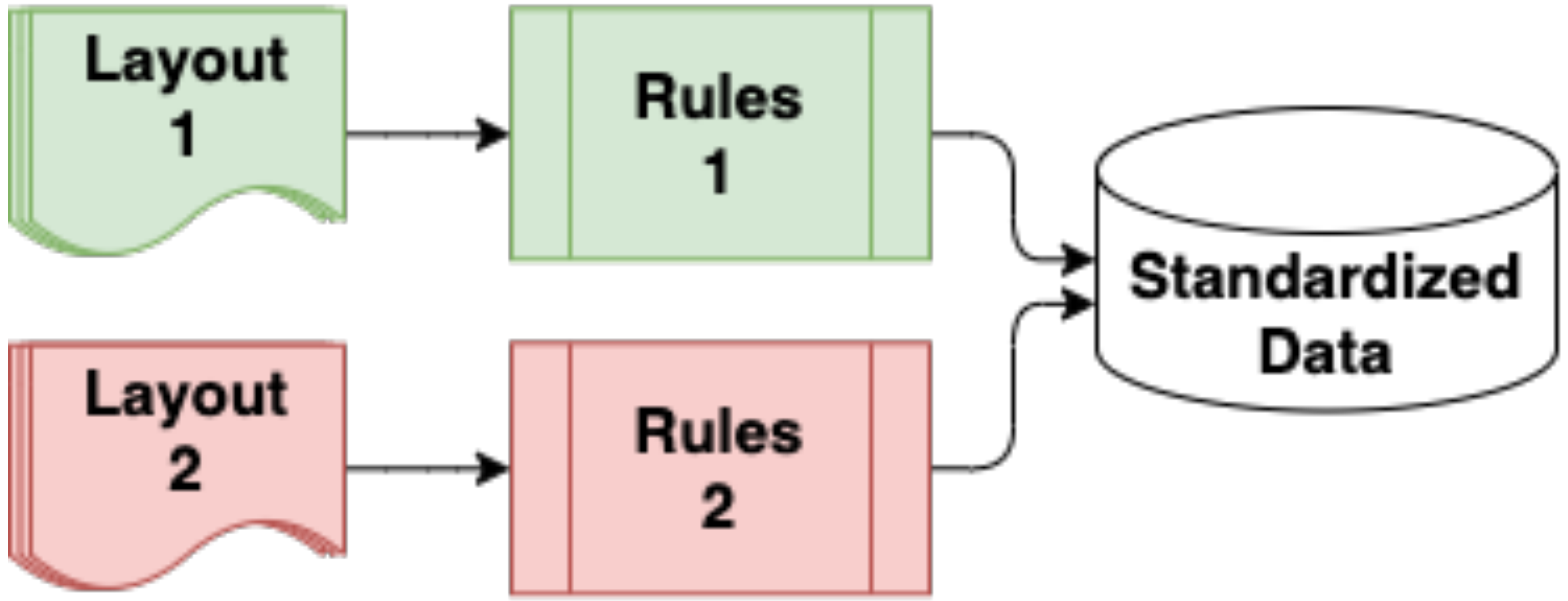


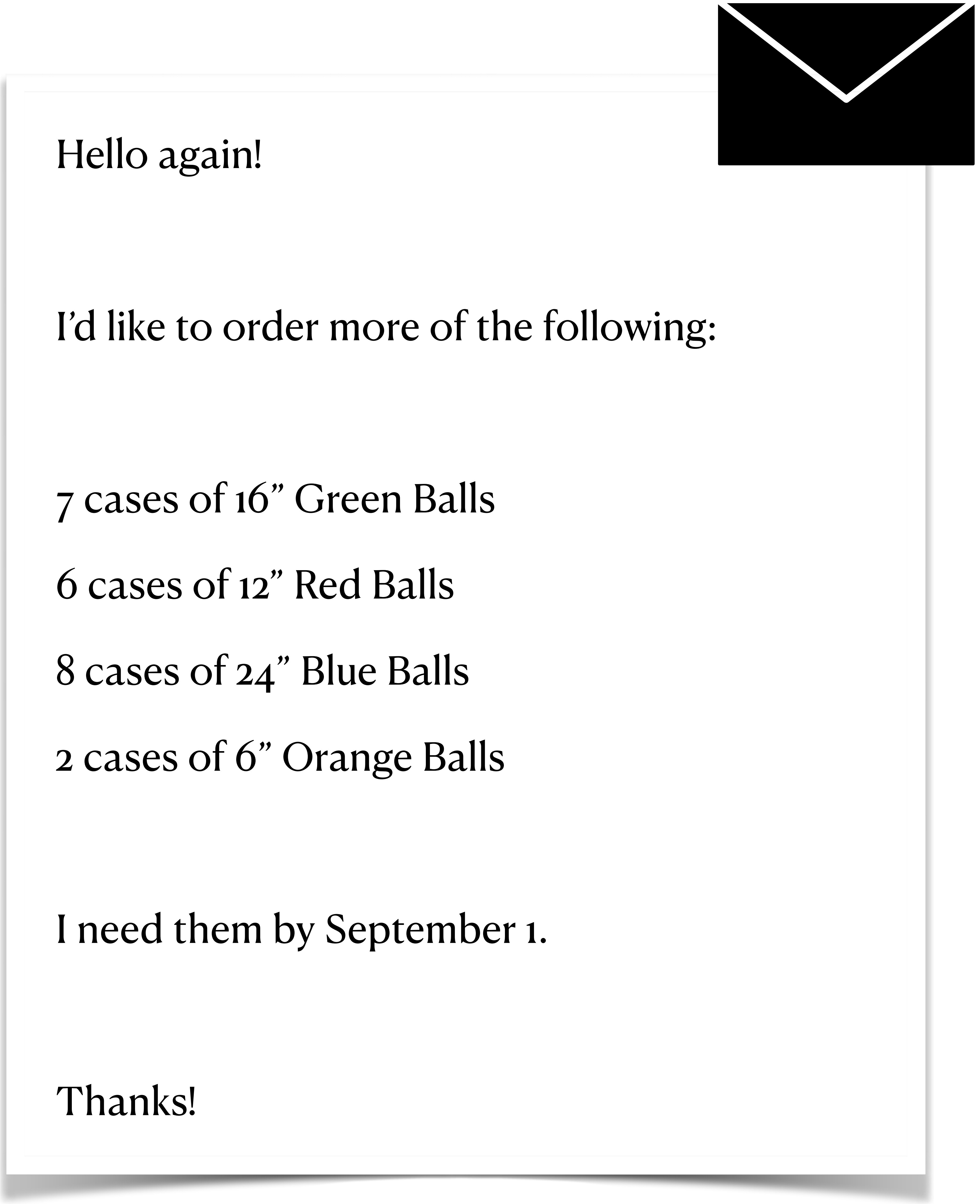
Layout 1 → Rules 1 → Standardized Data

Layout 2 → Rules 2 → Standardized Data

[Processing Data]

Unstructured

- No key-value pairs
- Free-flowing
- Lacks consistency
- May contain handwriting
- Consider NLP for extraction



Hello again!

I'd like to order more of the following:

7 cases of 16" Green Balls

6 cases of 12" Red Balls

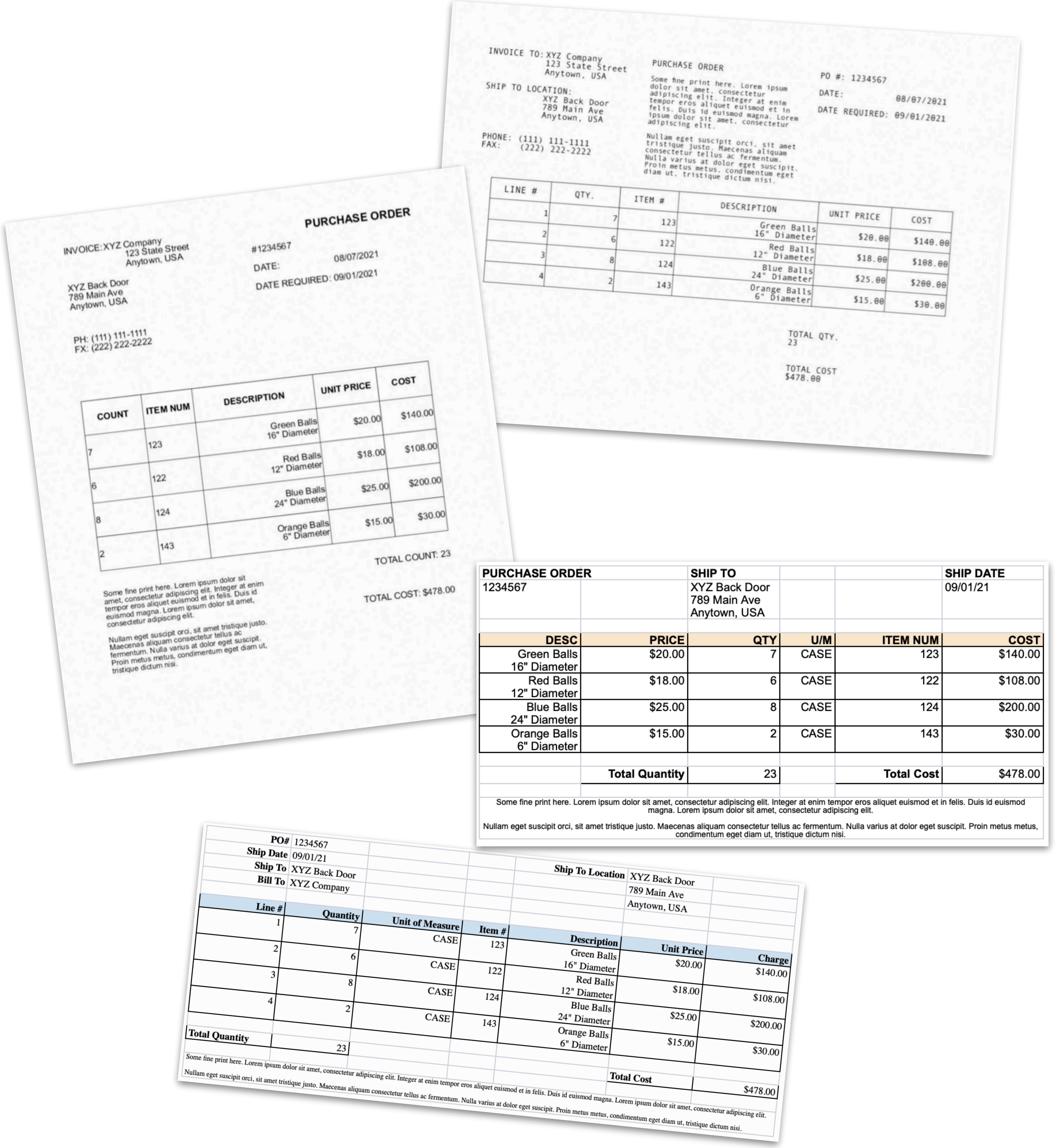
8 cases of 24" Blue Balls

2 cases of 6" Orange Balls

I need them by September 1.

Thanks!

[Processing Data]



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SHIP TO LOCATION:
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PURCHASE ORDER

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DATE: 08/07/2021
DATE REQUIRED: 09/01/2021

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TOTAL QTY.
23

TOTAL COST
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PURCHASE ORDER
1234567

SHIP TO
XYZ Back Door
789 Main Ave
Anytown, USA

SHIP DATE
09/01/21

DESC	PRICE	QTY	U/M	ITEM NUM	COST
Green Balls 16" Diameter	$20.00	7	CASE	123	$140.00
Red Balls 12" Diameter	$18.00	6	CASE	122	$108.00
Blue Balls 24" Diameter	$25.00	8	CASE	124	$200.00
Orange Balls 6" Diameter	$15.00	2	CASE	143	$30.00
	Total Quantity	23		Total Cost	$478.00

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PO# 1234567
Ship Date 09/01/21
Ship To XYZ Back Door
Bill To XYZ Company

Ship To Location XYZ Back Door
789 Main Ave
Anytown, USA

Line #	Quantity	Unit of Measure	Item #	Description	Unit Price	Charge
1	7	CASE	123	Green Balls 16" Diameter	$20.00	$140.00
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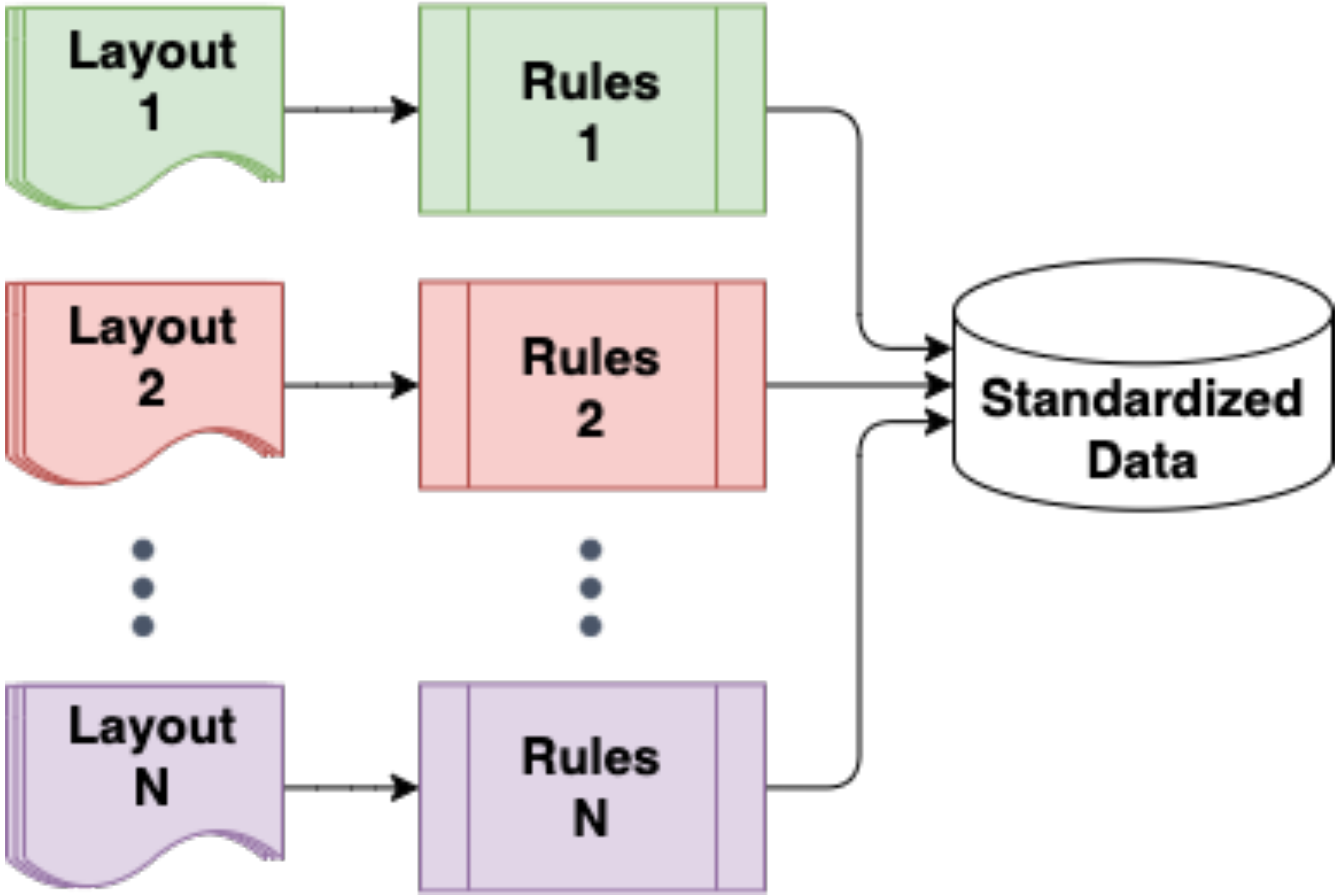
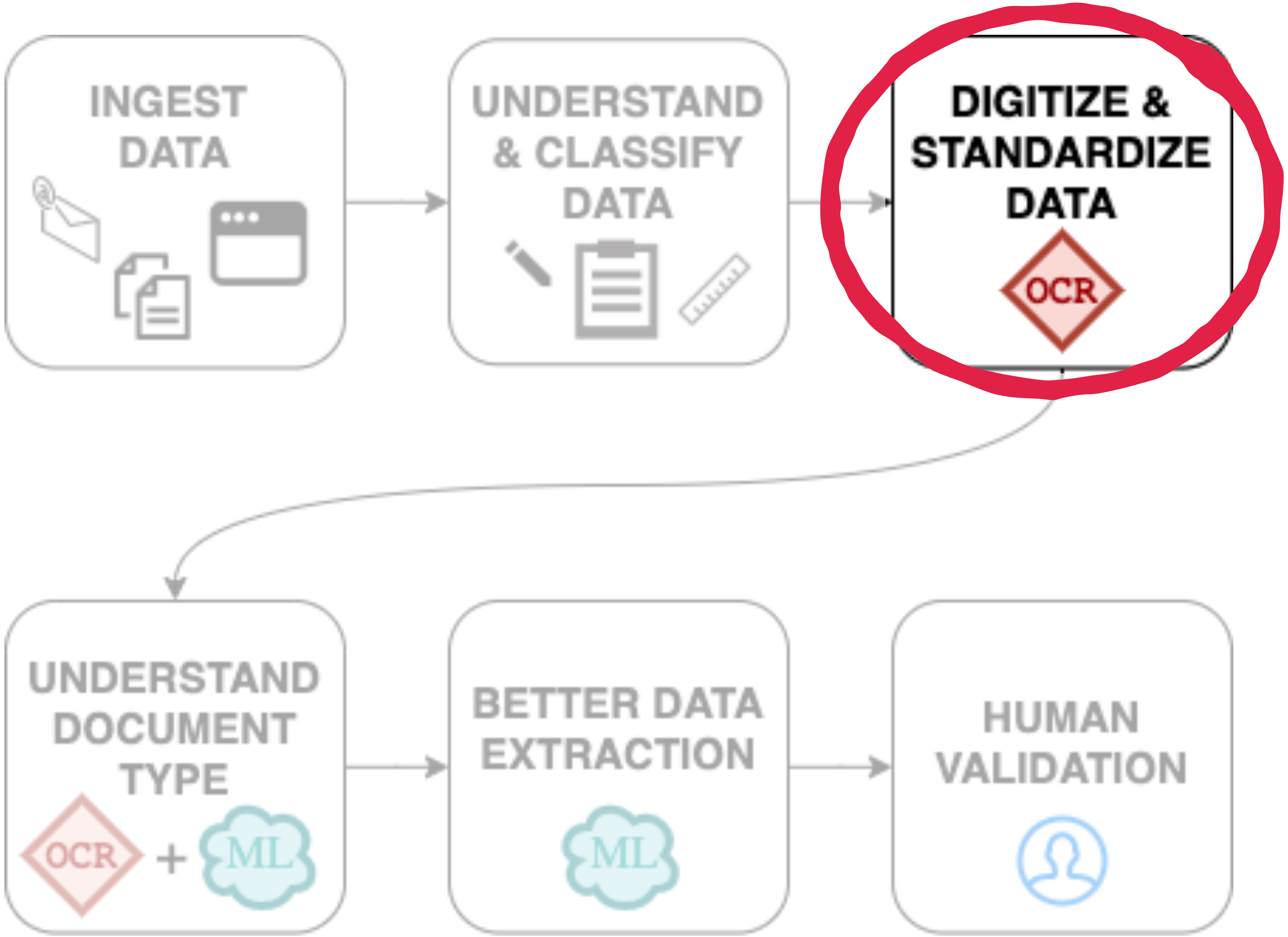


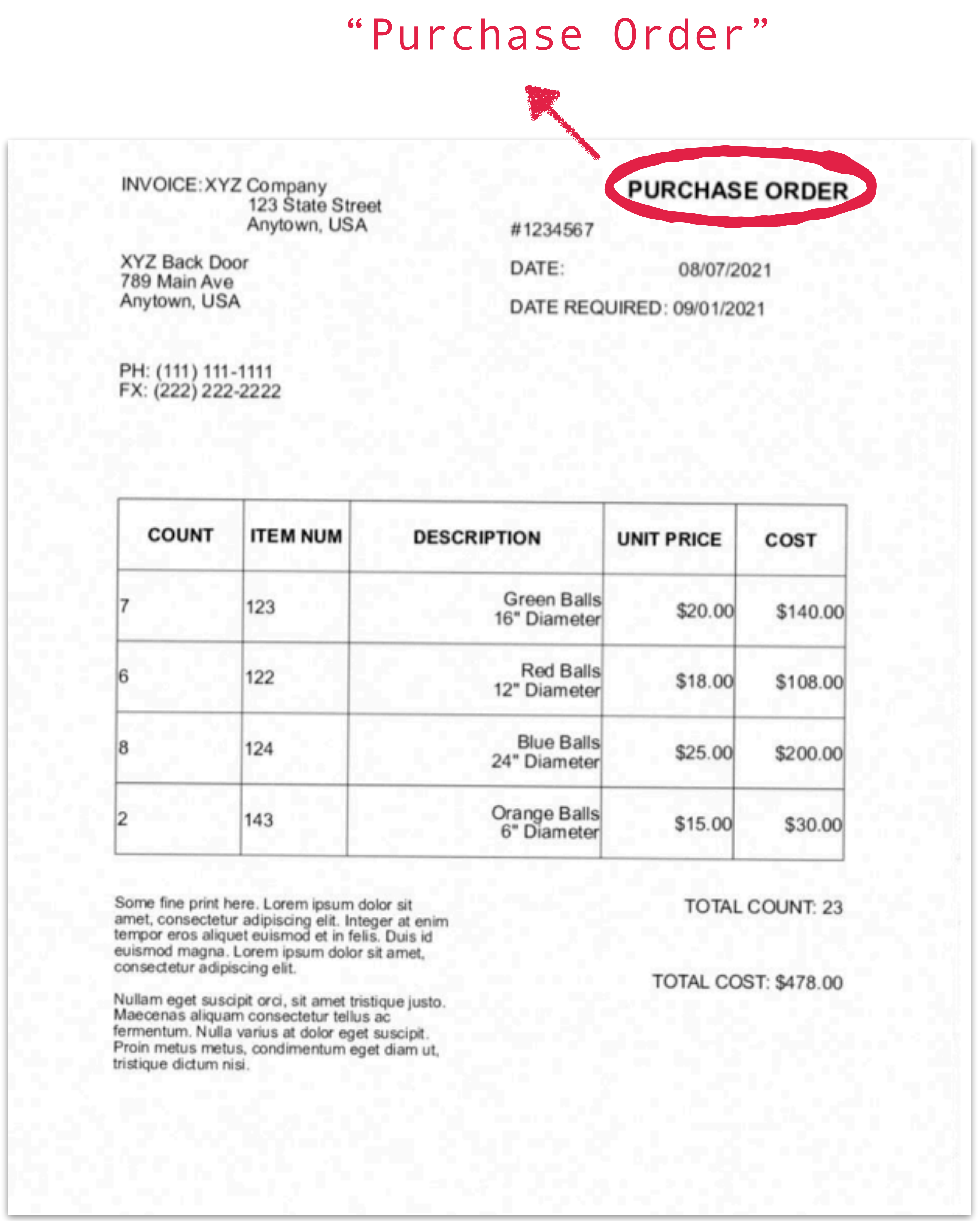
[Processing Data]



[Processing Data]

DIGITIZE & STANDARDIZE DATA

- Shallow pass data collection
- Enough to determine type
- Is there a title like…?
  - “Purchase Order”
  - “Invoice”
  - “Mortgage Application”



“Purchase Order”

INVOICE: XYZ Company
123 State Street
Anytown, USA

PURCHASE ORDER

#1234567

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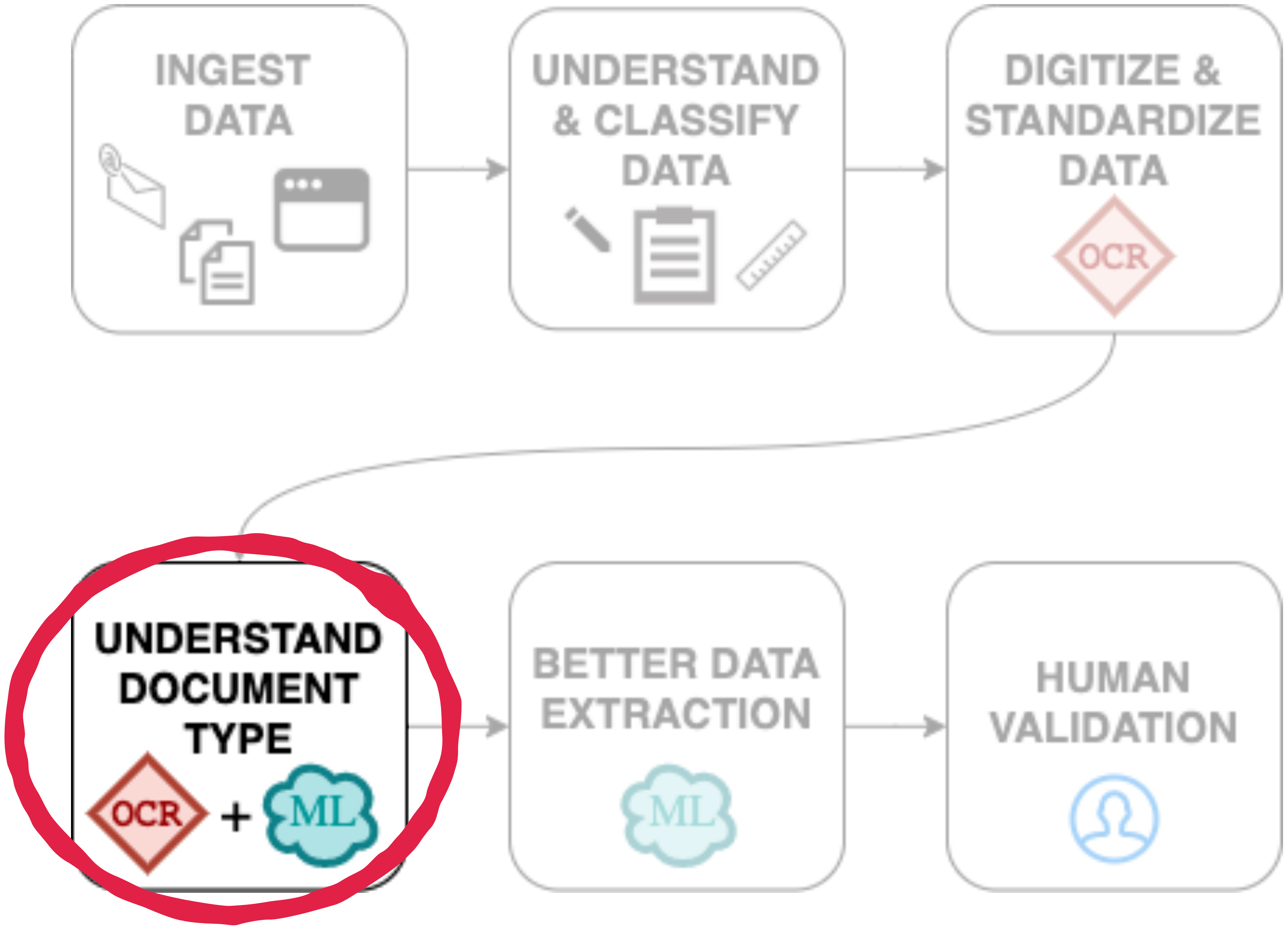
TOTAL COST: $478.00

[Processing Data]

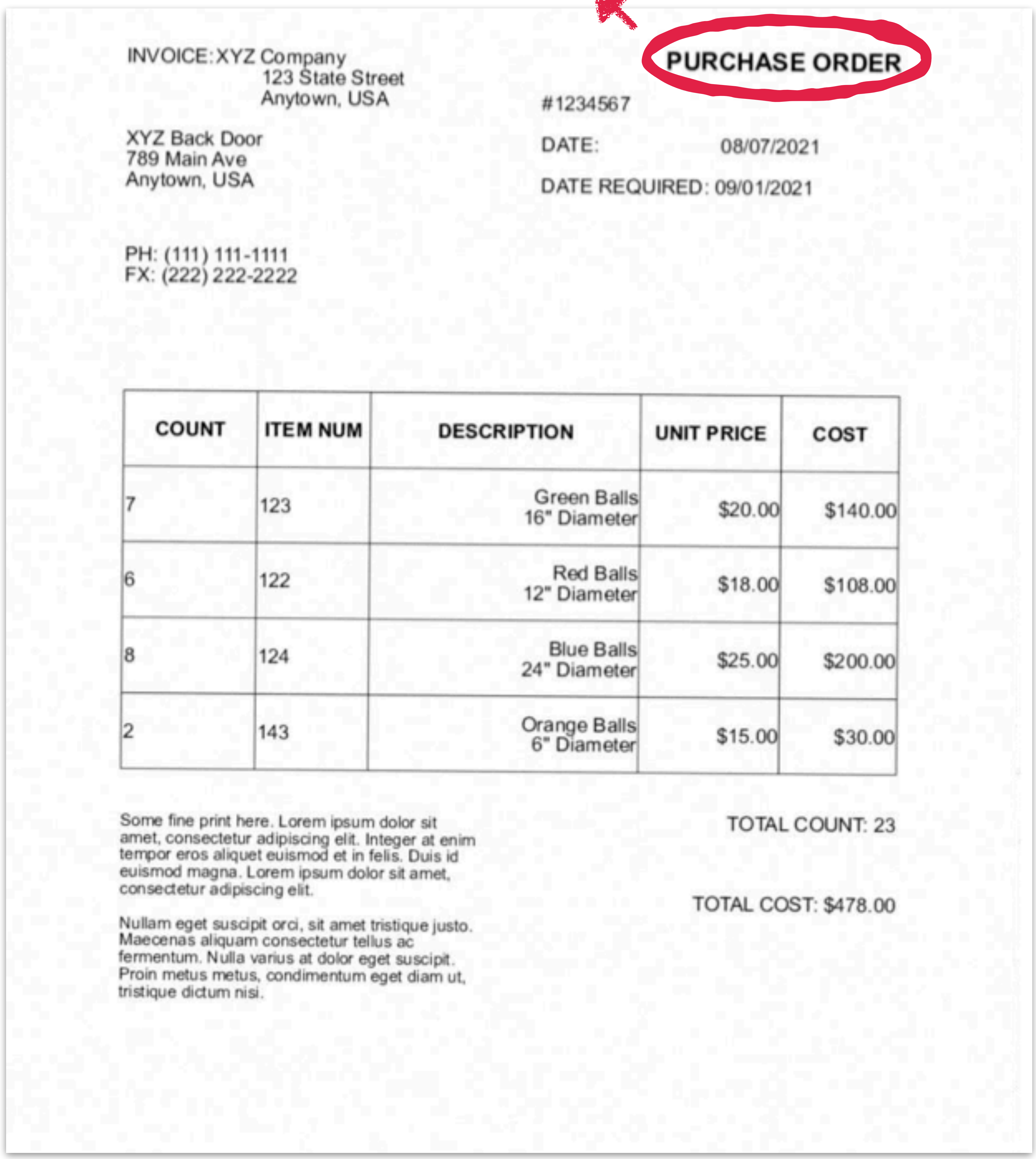


[Processing Data]

UNDERSTAND DOCUMENT TYPE

- Structured data is easy to understand type
- Semistructured & unstructured can be more difficult
- Are more than one document type ingested into the same system?
  - Purchase Orders
  - Invoices
  - Mortgage Applications

DOCUMENT TYPE:
PURCHASE ORDER



INVOICE:XYZ Company
123 State Street
Anytown, USA

PURCHASE ORDER

#1234567

XYZ Back Door
789 Main Ave
Anytown, USA

DATE: 08/07/2021

DATE REQUIRED: 09/01/2021

PH: (111) 111-1111
FX: (222) 222-2222

COUNT	ITEM NUM	DESCRIPTION	UNIT PRICE	COST
7	123	Green Balls 16" Diameter	$20.00	$140.00
6	122	Red Balls 12" Diameter	$18.00	$108.00
8	124	Blue Balls 24" Diameter	$25.00	$200.00
2	143	Orange Balls 6" Diameter	$15.00	$30.00

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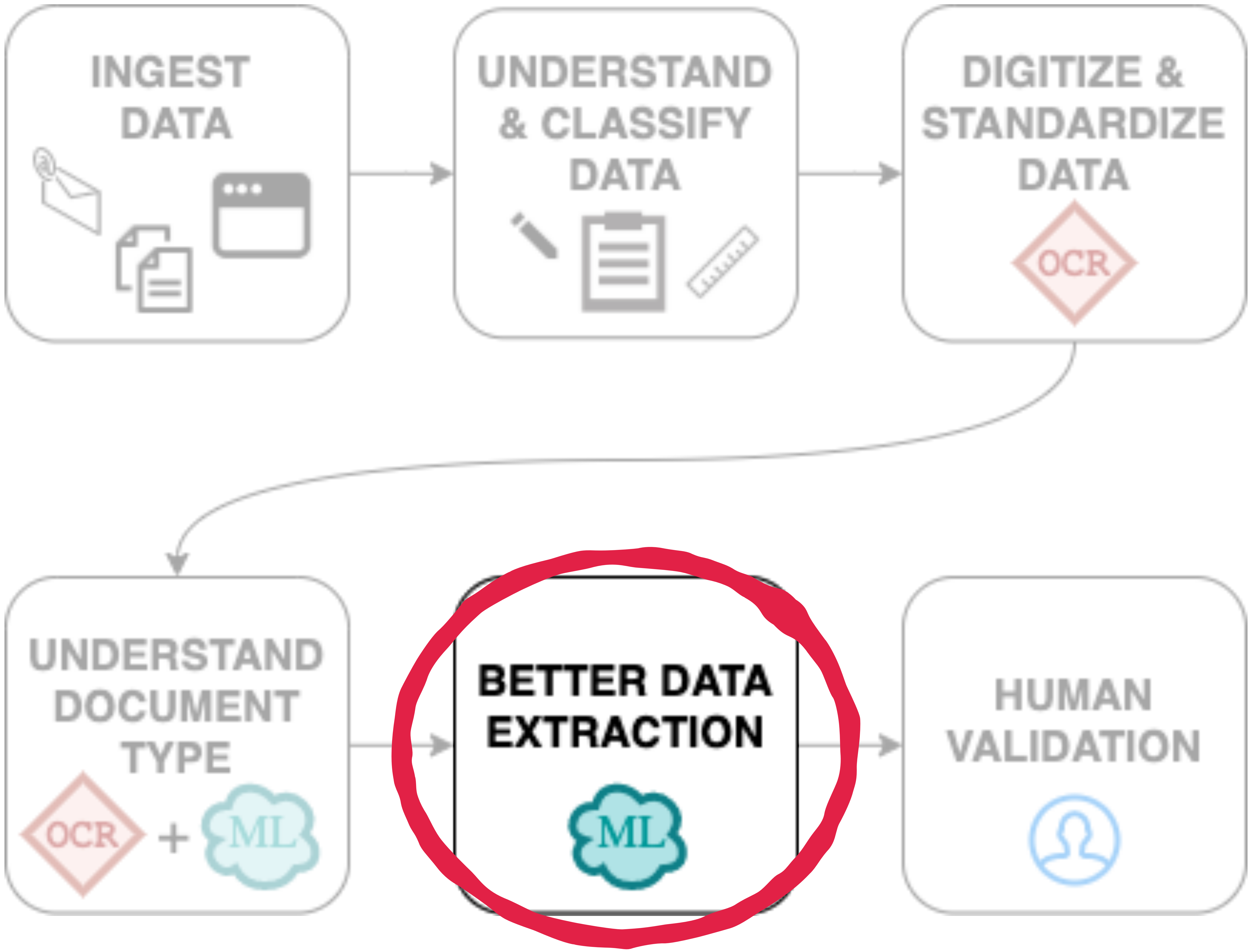
TOTAL COUNT: 23

TOTAL COST: $478.00

[Processing Data]



[Processing Data]

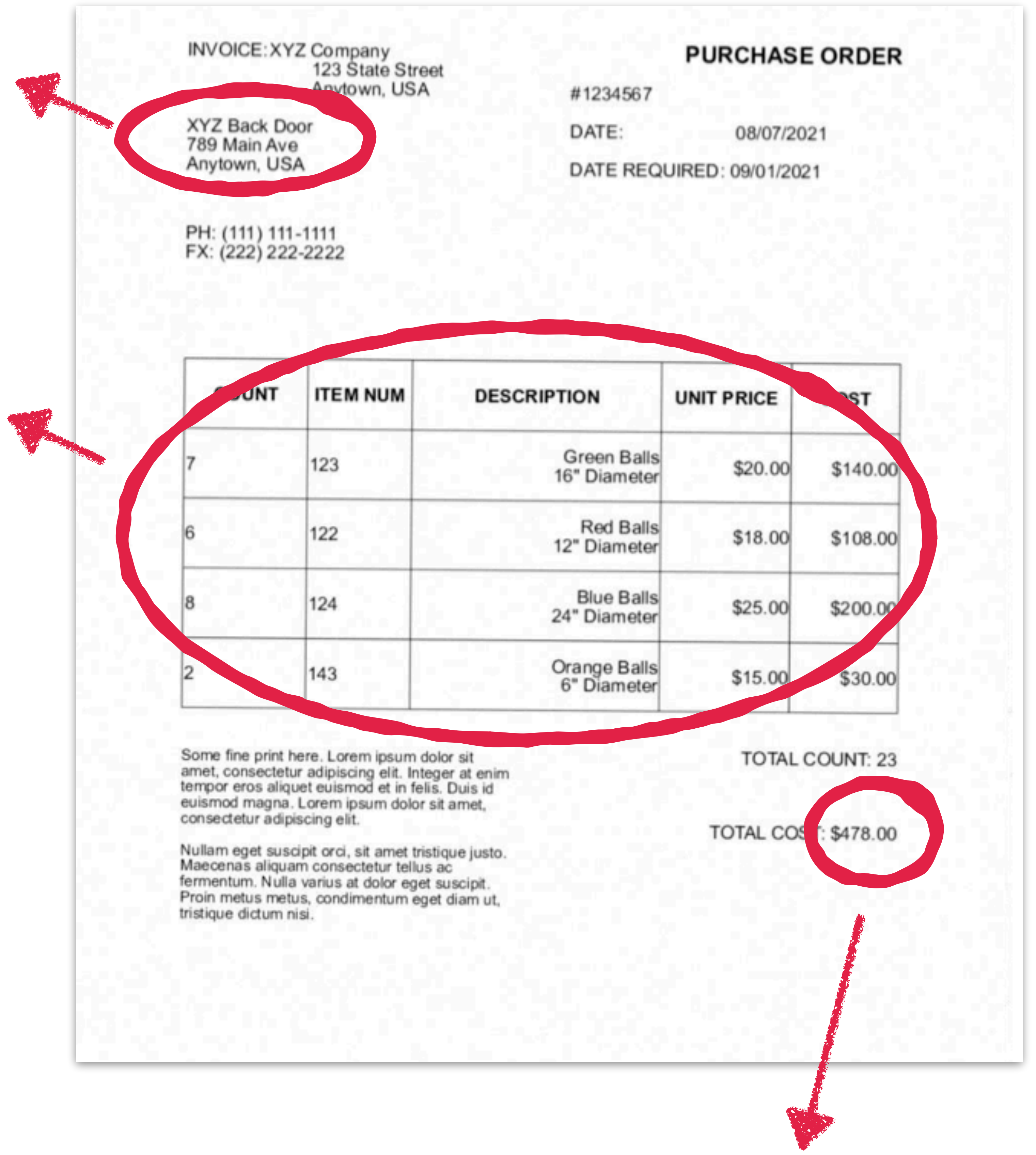
BETTER DATA EXTRACTION

ML

- Knowing the document type, we can extract more specifics
  - Shipping Information
  - Item Details Table
  - Total Cost
- If classified as semistructured or unstructured, we may need to leverage machine learning to map values to the correct keys.

Shipping Address

Item Details



INVOICE: XYZ Company
123 State Street
Anytown, USA

PURCHASE ORDER

XYZ Back Door
789 Main Ave
Anytown, USA

#1234567

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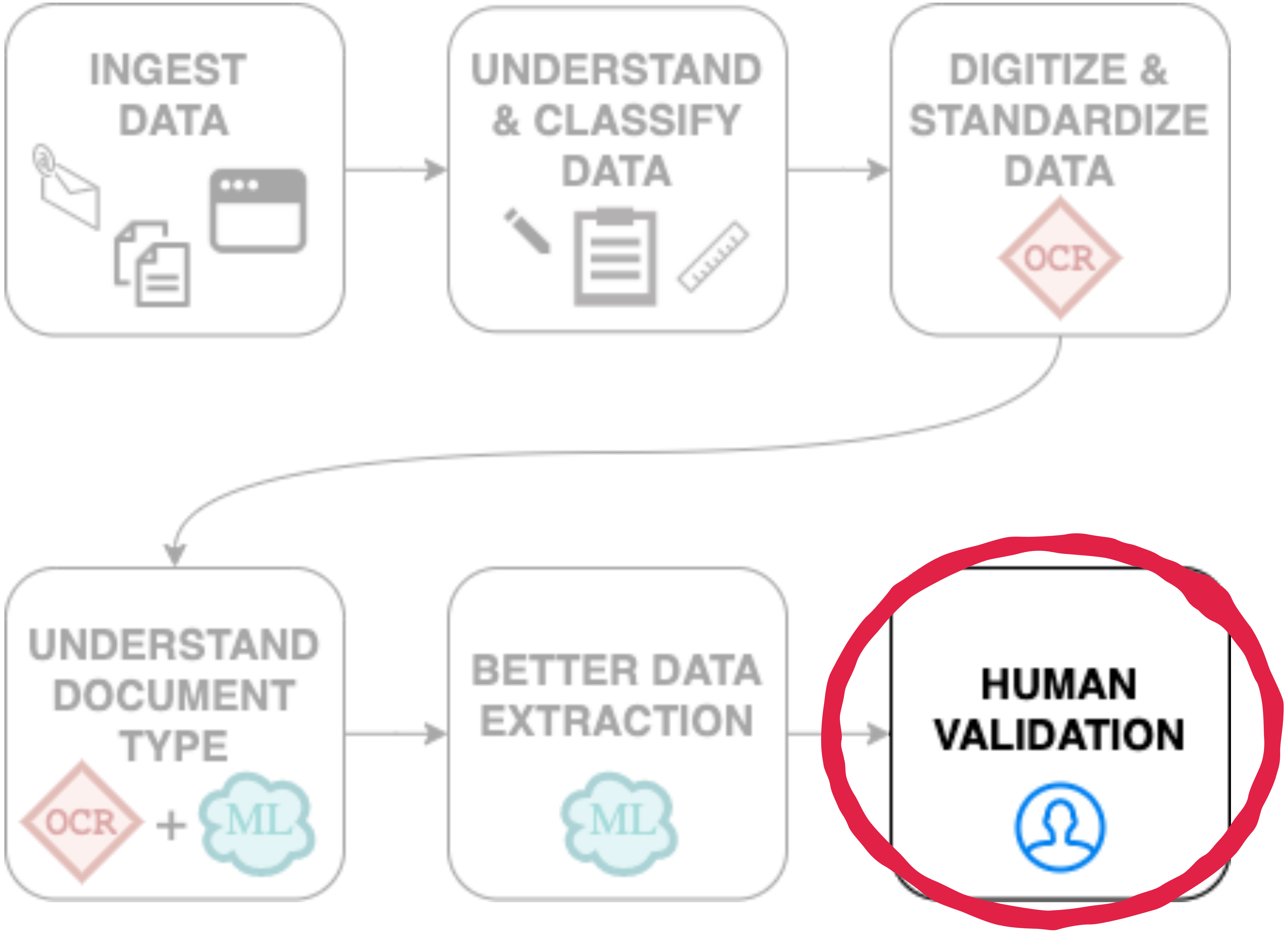
TOTAL COUNT: 23

TOTAL COST: $478.00

Total Cost

[Processing Data]



[Processing Data]

HUMAN VALIDATION

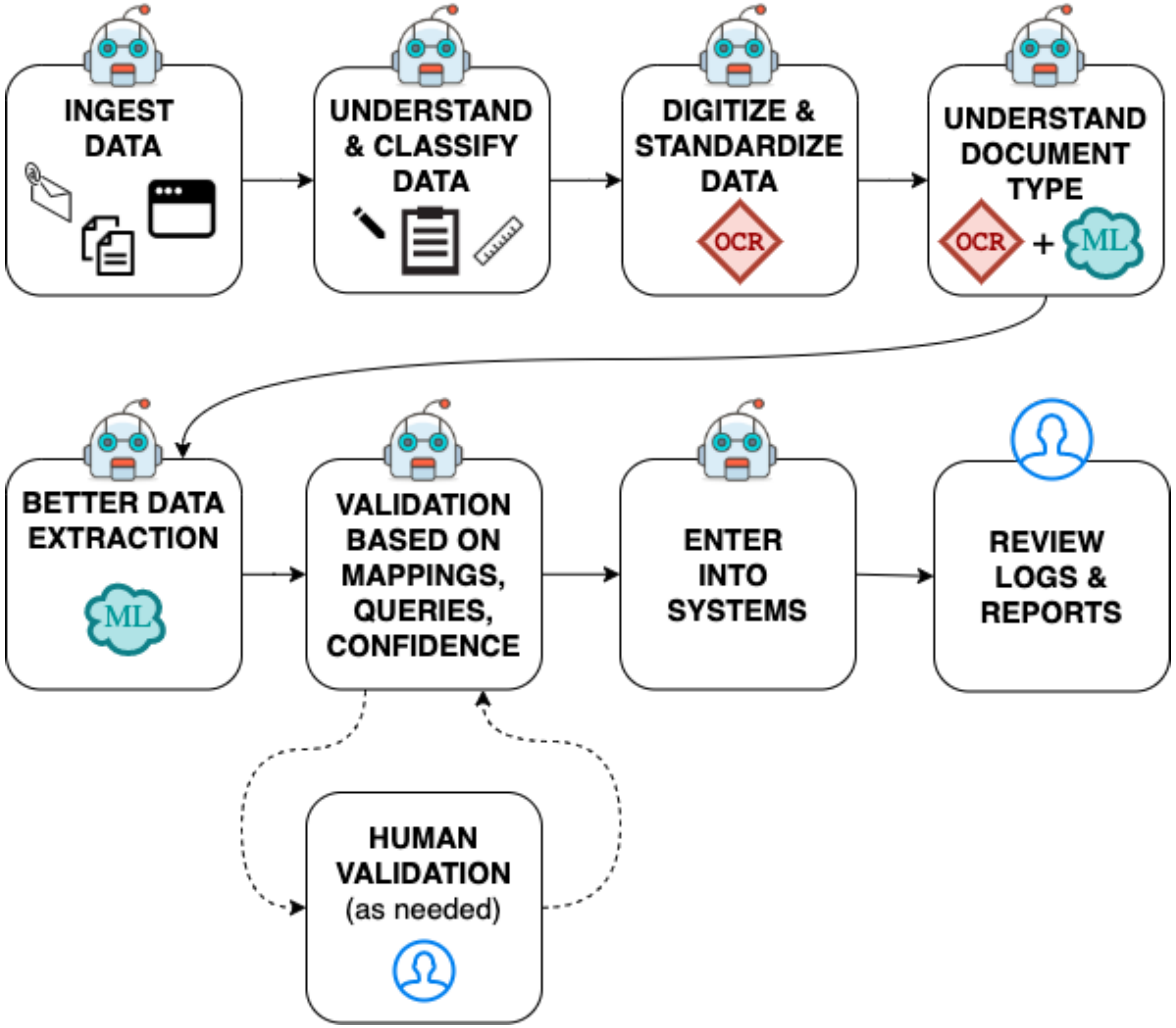
- Certain level of human-in-the-loop is necessary (and good)
  - Confirm accurate information
- Machine learning models improve with more samples and verifications
- Some cross-checking can be automated

How do we link this all together?

[Single Pipeline]

Robotic Process Automation

- Also known as RPA
- Method of automating repetitive tasks
- Often use the screen same as a live user would
  - Avoids the wait/requirement for application integration
- Perform faster, with accuracy, can run without stopping


INGEST DATA
UNDERSTAND & CLASSIFY DATA
DIGITIZE & STANDARDIZE DATA
OCR
UNDERSTAND DOCUMENT TYPE
OCR + ML
BETTER DATA EXTRACTION
ML
VALIDATION BASED ON MAPPINGS, QUERIES, CONFIDENCE
ENTER INTO SYSTEMS
REVIEW LOGS & REPORTS
HUMAN VALIDATION (as needed)

[Single Pipeline]

Case Study: PepsiCo

PEPSICO

- CHALLENGE
  - Slow document processing
  - Prone to errors
  - Very manual

- SOLUTION
  - Single process flow
  - ABBYY FlexiCapture

- RESULTS
  - Lower error rates
  - Reduced processing times
  - Team worked more efficiently

PepsiCo automates invoice processing with ABBYY FlexiCapture, 2021. [Online; accessed 13-August2021].

[Single Pipeline]

Case Study: Sysco

- CHALLENGE
  - Very manual processes
  - Prone to errors
  - Not enough time

- SOLUTION
  - Robotic Process Automation
  - Multiple departments and processes

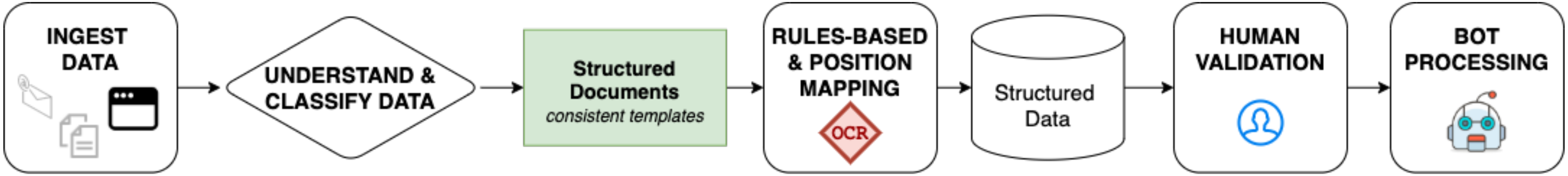
- RESULTS
  - Over 200,000 hours productivity saved in first 3.5 years
  - Built a culture of automation

Alison Major and Kim Meredith. Sysco: Scaling an rpa program without compromise, 2021. [Online; accessed 15-August2021].

Blue Prism Cafe´. Sysco: Scaling an intelligent automation program without compromise, 2021. [Webinar; accessed 15- August2021].

[Single Pipeline]

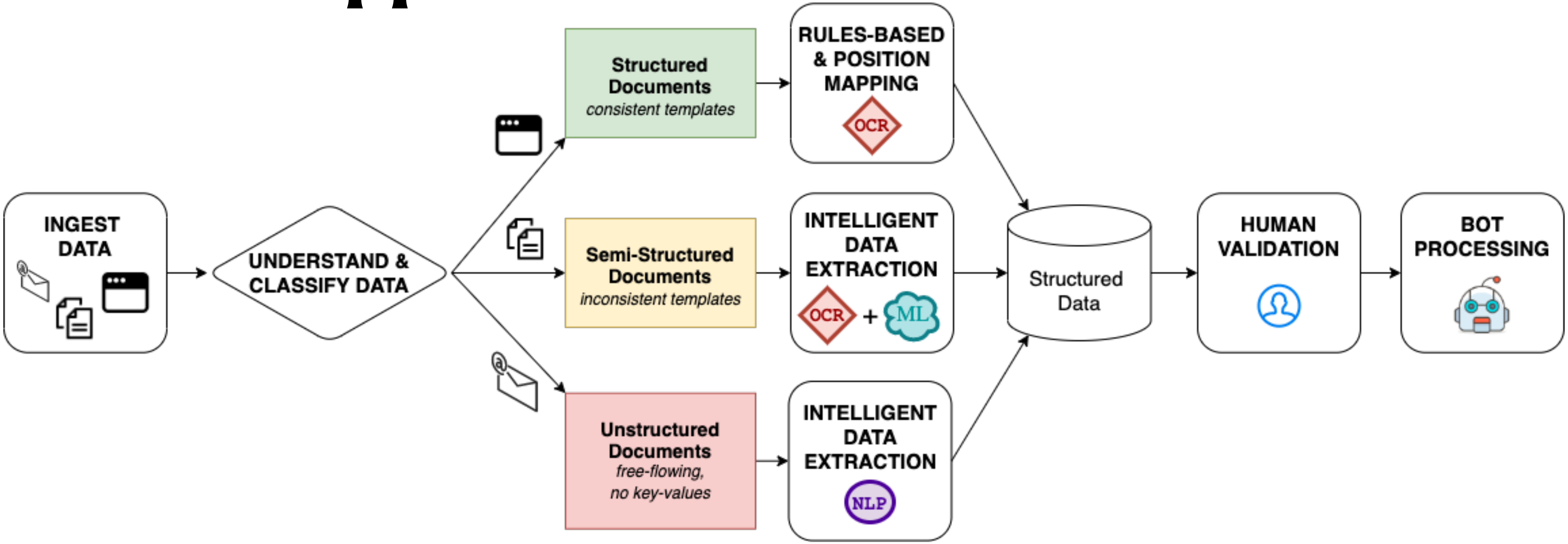
General Application



- Start with a single input method
- One classification (structured data)
- One document type
- Automate end-to-end using RPA

[Single Pipeline]

General Application


INGEST DATA
UNDERSTAND & CLASSIFY DATA
Structured Documents
consistent templates
Semi-Structured Documents
inconsistent templates
Unstructured Documents
free-flowing, no key-values
RULES-BASED & POSITION MAPPING
OCR
INTELLIGENT DATA EXTRACTION
OCR + ML
INTELLIGENT DATA EXTRACTION
NLP
Structured Data
HUMAN VALIDATION
BOT PROCESSING

- Begin adding new ingestion methods that automatically tie into the existing process

[Solutions & Costs]

ABBYY FlexiCapture

- Best NLP, ML
- Starting at $0.028 per page plus training/setup costs

Amazon Textract

- Powerful OCR
- Built-in Human-in-the-Loop
- $0.0015 per page

Google Tesseract

- Open Source
- Less accurate
- Free

Microsoft PowerAutomate

- Variety of solutions available
- Easy to link processes

Monarch

- Good for Structured & Unstructured Data
- Desktop based

Blue Prism Decipher

- RPA Software
- Direct integration to OCR with human-in-the-loop

[Conclusion]

Is there a single method to receive multiple forms of information and automatically pull the desired data?

Many tools are available, but they can be combined into a single solution.

Consider including RPA to make your solution more robust.

Start small, then build more methods to ingest different document types.