

# Multimodal LLM Data Processing with Apache Beam

Konstantin Buschmeier, Jasper Van den Bossche, Iris Luden



**BEAM**  
S U M M I T

September 4-5, 2024

Sunnyvale, CA. USA

# ML6

Machine Learning services company.

We help our clients build machine learning applications using technologies such as Apache Beam.



**BEAM**  
SUMMIT





What will be covered in this talk?

# Multimodal LLM Data Processing with Apache Beam

Use case

Multimodal LLMs

Multimodal LLMs in Beam

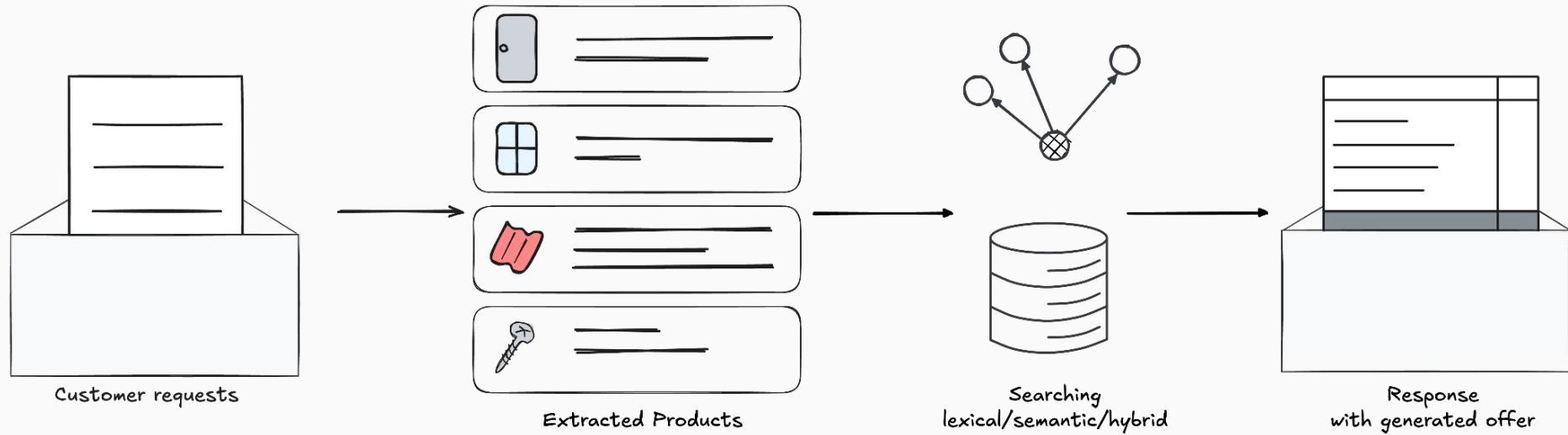
Summary



# Use case

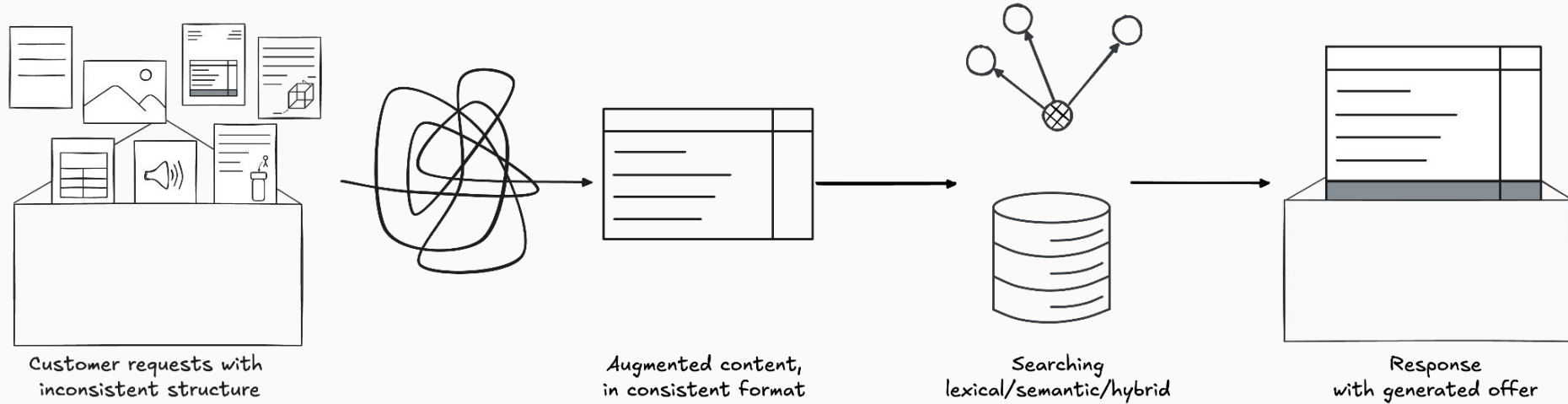


# Use case





# Use case





Hello,

Requesting an offer with price and delivery time for:

- Oak window frame, 48" x 24", double UV glass
- 78 copper nails, 21"
- 200 ceramic shingles, red, matte, 15" x 20"

Best regards,  
Joe Builder



Subject: Request for Quote and Delivery Time for Custom Order

Hello,

I hope this email finds you well. I am writing to request a quote for a custom order of the following items: 7 oak window frames measuring 48" x 24" with double UV glass, 78 copper nails at 21" each, and 200 ceramic shingles in red matte finish, measuring 15" x 20". I would appreciate it if you could provide the pricing details for each item along with the estimated delivery time.

As a contractor currently building a custom home for a client, it is crucial that I receive these materials on time and within budget. Your prompt response with the requested information will help me ensure that the project remains on schedule and meets the client's expectations.

Please let me know if you require any additional information to process this request. I look forward to receiving your quote at your earliest convenience.

Thank you for your assistance.

Best regards,  
Joe Builder



```

<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Request for Quote and Delivery Time</title>
  <style>
    body{font-family:Arial,sans-serif;line-height:1.6;color:#333}.
    pl{margin:15px 0;padding:10px;border:1px solid #ccc;background-color:#f9f9f9}.
    pi{margin-bottom:10px}.pi:last-child{margin-bottom:0}
  </style>
</head>
<body>
  <p>Hello,</p>
  <p>I hope this email finds you well. I am writing to request a quote for a custom order of the following items:</p>
  <div class="pl">
    <div class="pi"><strong>7 oak window frames</strong>, measuring 48" x 24" with double UV glass</div>
    <div class="pi"><strong>78 copper nails</strong>, 21" each</div>
    <div class="pi"><strong>200 ceramic shingles</strong>, red matte finish, measuring 15" x 20"</div>
  </div>
  <p>I would appreciate it if you could provide the pricing details for each item along with the estimated delivery time.</p>
  <p>As a contractor currently building a custom home for a client, it is crucial that I receive these materials on time and within budget. Your prompt response with the requested information will help me ensure that the project remains on schedule and meets the client's expectations.</p>
  <p>Please let me know if you require any additional information to process this request. I look forward to receiving your quote at your earliest convenience.</p>
  <p>Thank you for your assistance.</p>
  <p>Best regards,<br>
  Joe Builder</p>
</body>
</html>

```

# Home Builder Construction LLC



**Material Store**  
123 Main Street  
Some City ST 12345  
(123) 456-7890  
material-store@example.com

September 03, 2024

Hello,

Requesting an offer with price and delivery time for:

- 7 Oak window frame, 48" x 24", double UV glass
- 78 copper nails, 21"
- 200 ceramic shingles, red, matte, 15" x 20"

Sincerely,

**Joe Builder**  
Home Builder Construction LLC  
123 Second Street  
Anytown, ST 67891

---

**Joe Builder**  
Home Builder Construction LLC  
123 Second Street  
Anytown, ST 67891



**Material Store**  
123 Main Street  
Some City, ST 12345  
(123) 456-7890  
material-store@example.com

Hello,

requesting an offer with price and delivery time for:

Item	Size	Quantity
Oak window frame, 48" x 24", double UV glass		7
copper nails, 21"		78
ceramic shingles, red, matte, 15" x 20"		200

Kind regards,

Joe Builder

**Home Builder Construction LLC**





Home Builder Construction LLC

123 Second Street

Anytown, ST

67891(123) 456-7890

## Request for quote

To Material Store  
123 Main Street  
Some City, ST 12345

Date	09-04-24
Ref. no.	
Customer no.	
Contact	

Product	Quantity
<i>Oak window frame, 48" x 24", double UV glass</i>	<i>7</i>
<i>Copper nails, 21" 78</i>	<i>200</i>
<i>Ceramic shingles, red, matte, 15" x 20"</i>	<i>200</i>
<i>Delivery by next Monday possible?</i>	

The above is a request for quote (RFQ), you acknowledge that the information provided is for estimation purposes only and does not constitute a binding agreement. Final terms will be confirmed upon issuance of a formal purchase order or contract. The company reserves the right to decline any RFQ at its discretion.



**Home Builder Construction LLC**  
 123 Second Street  
 Anytown, ST  
 67891(123) 456-7890

**Request for quote**

To Material Store  
123 Main Street  
Some City, ST 12345

Date	09-04-24
Ref. no.	
Customer no.	
Contact	

Product	Quantity
<i>Oak window frame, 48" x 24", double UV glass</i>	<i>7</i>
<i>Copper nails, 21" 78</i>	<i>200</i>
<i>Ceramic shingles, red, matte, 15" x 20"</i>	<i>200</i>
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**Home Builder Construction LLC**  
 123 Second Street  
 Anytown, ST  
 67891(123) 456-7890

**Request for quote**

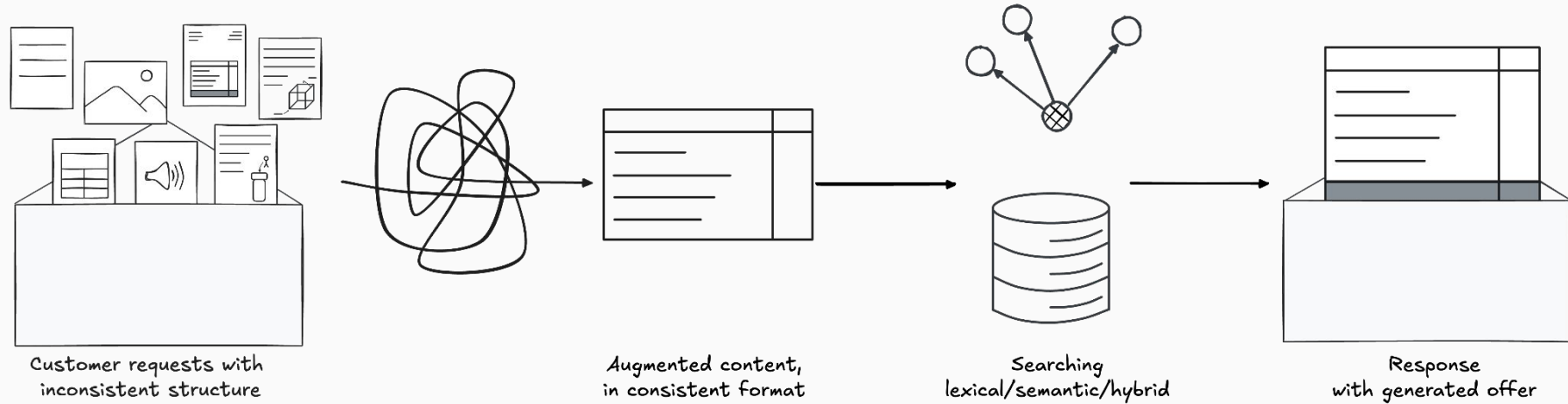
To Material Store  
123 Main Street  
Some City, ST 12345

Date	09-04-24
Ref. no.	
Customer no.	
Contact	

Product	Quantity
<i>Window frame, 48" x 24"</i>	<i>7</i>
<i>Window frame, 48" x 24", double UV glass</i>	<i>4</i>
<i>Sliding patio door, 56" x 24"</i>	<i>2</i>
<i>All in oak, patio door also in aluminium</i>	

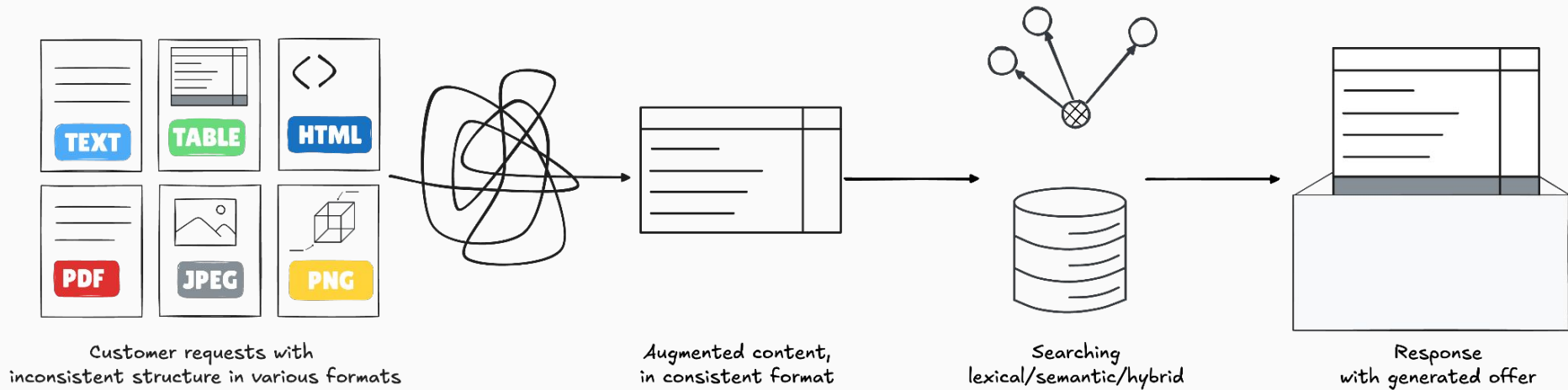
The above is a request for quote (RFQ), you acknowledge that the information provided is for estimation purposes only and does not constitute a binding agreement. Final terms will be confirmed upon issuance of a formal purchase order or contract. The company reserves the right to decline any RFQ at its discretion.

# Use case





# Use case



# Challenges

Challenge 1:

**Orchestrate** this workflow

Challenge 2:

**Mismatch** in customer's product **description** and **product catalog**.

Challenge 3:

No fixed structure, **unstructured** data, **various** file **formats**.

More generally:

> **Extract structured data** for search from **unstructured documents** in **various formats**.

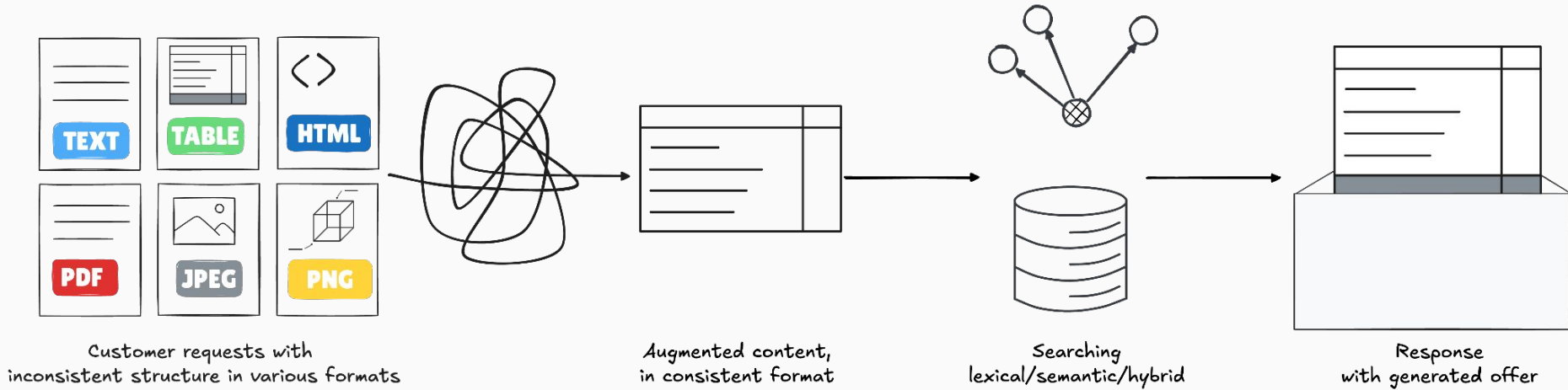
→ Apache **Beam**

→ **LLMs: intrinsic knowledge & prompting**

→ **Multimodal** LLMs provide SOTA performance for **document processing**

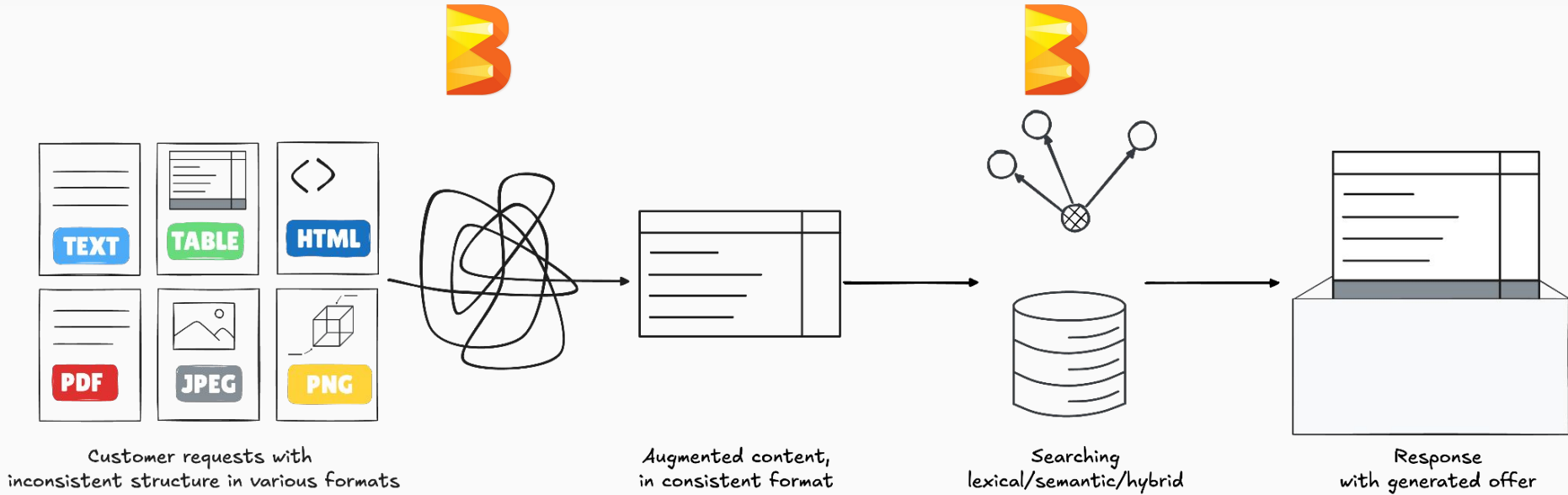


# Use case

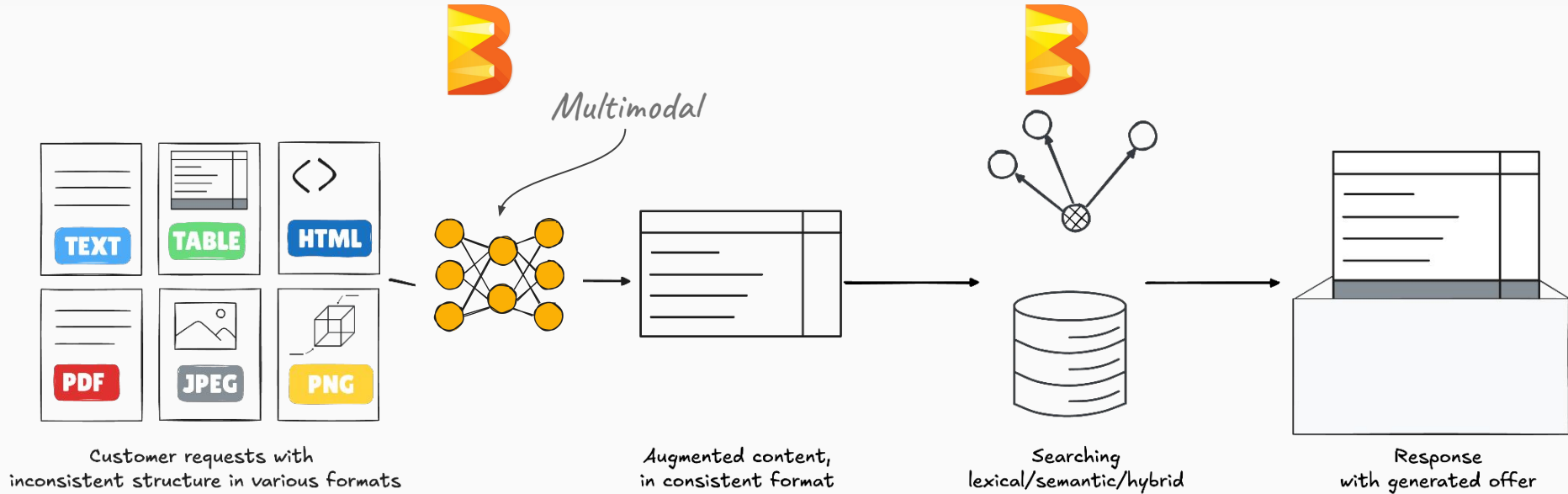




# Use case



# Use case



# Challenges

Challenge 1:

**Orchestrate** this workflow

Challenge 2:

**Mismatch** in customer's product **description** and **product catalog**.

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More generally:

> **Extract structured data** for search from **unstructured documents** in **various formats**.

→ Apache **Beam**

→ **LLMs: intrinsic knowledge & prompting**

→ **Multimodal** LLMs provide SOTA performance for **document processing**





# Challenges

Challenge 1:

**Orchestrate** this workflow

Challenge 2:

**Mismatch** in customer's product **description** and **product catalog**.

Challenge 3:

No fixed structure, **unstructured** data, **various** file **formats**.

Challenge 4 (?):

Call **LLMs from Beam**

More generally:

> **Extract structured data** for search from **unstructured documents** in **various formats**.

→ Apache **Beam**

→ **LLMs: intrinsic knowledge & prompting**

→ **Multimodal** LLMs provide SOTA performance for **document processing**

→ RunInference / Enrichment Transform



# Multimodal LLMs



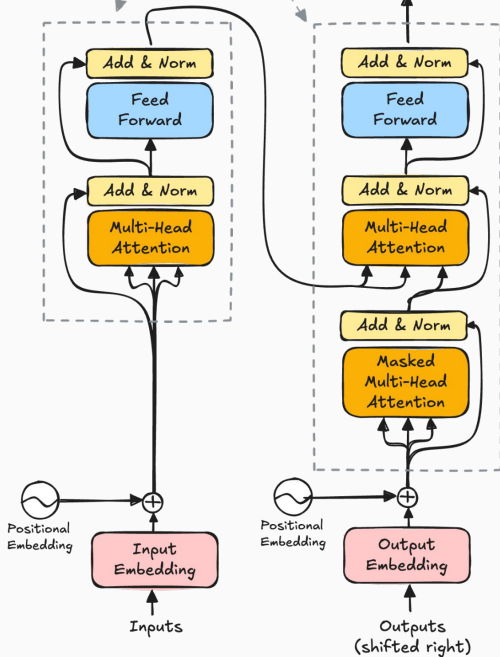
# Language Models

## Transformer

Encoder

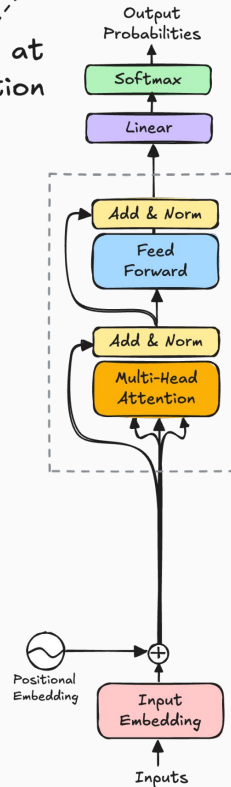
Decoder

repeated as layers



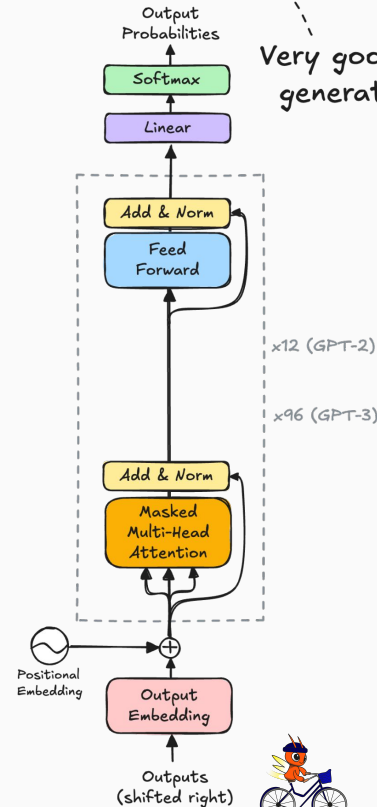
## BERT

Very good at classification



## GPT

Very good at generation

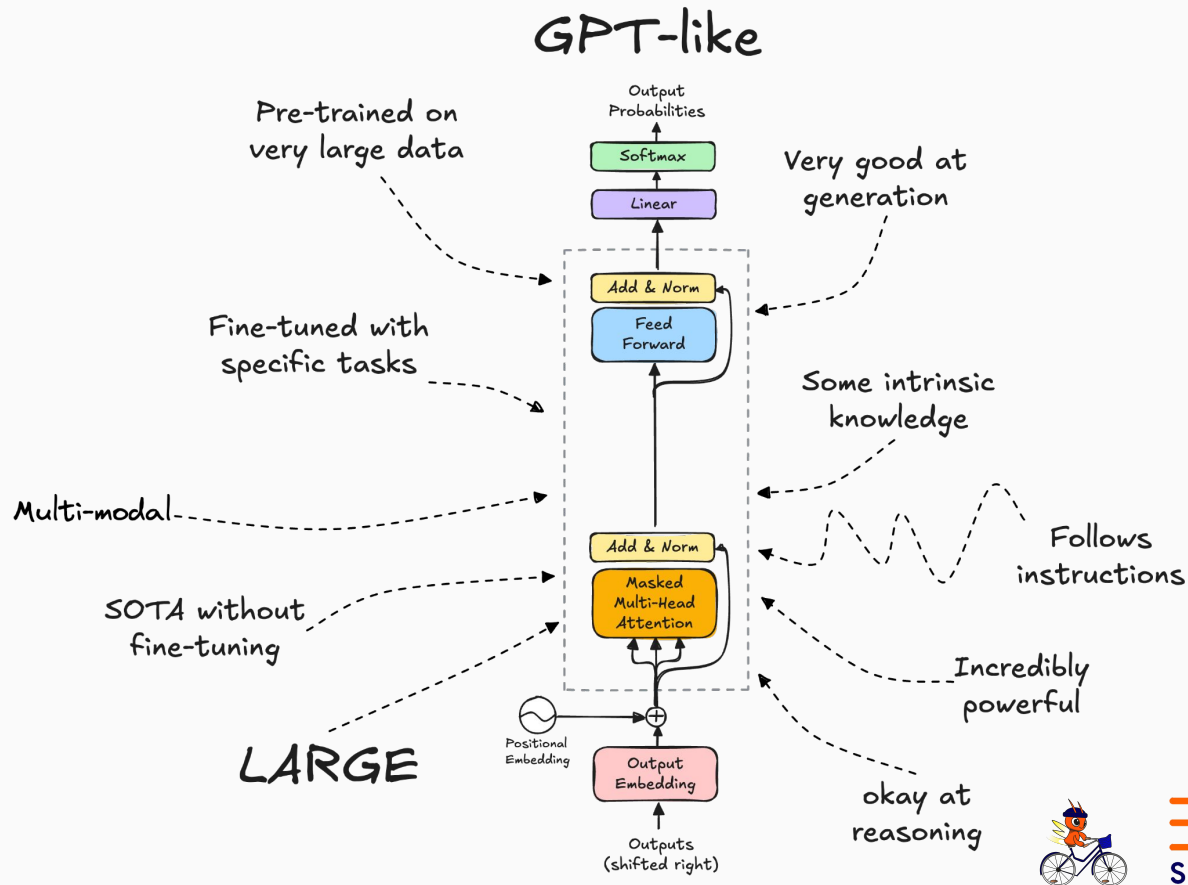


"Attention Is All You Need" by Vaswani et al. (2017)



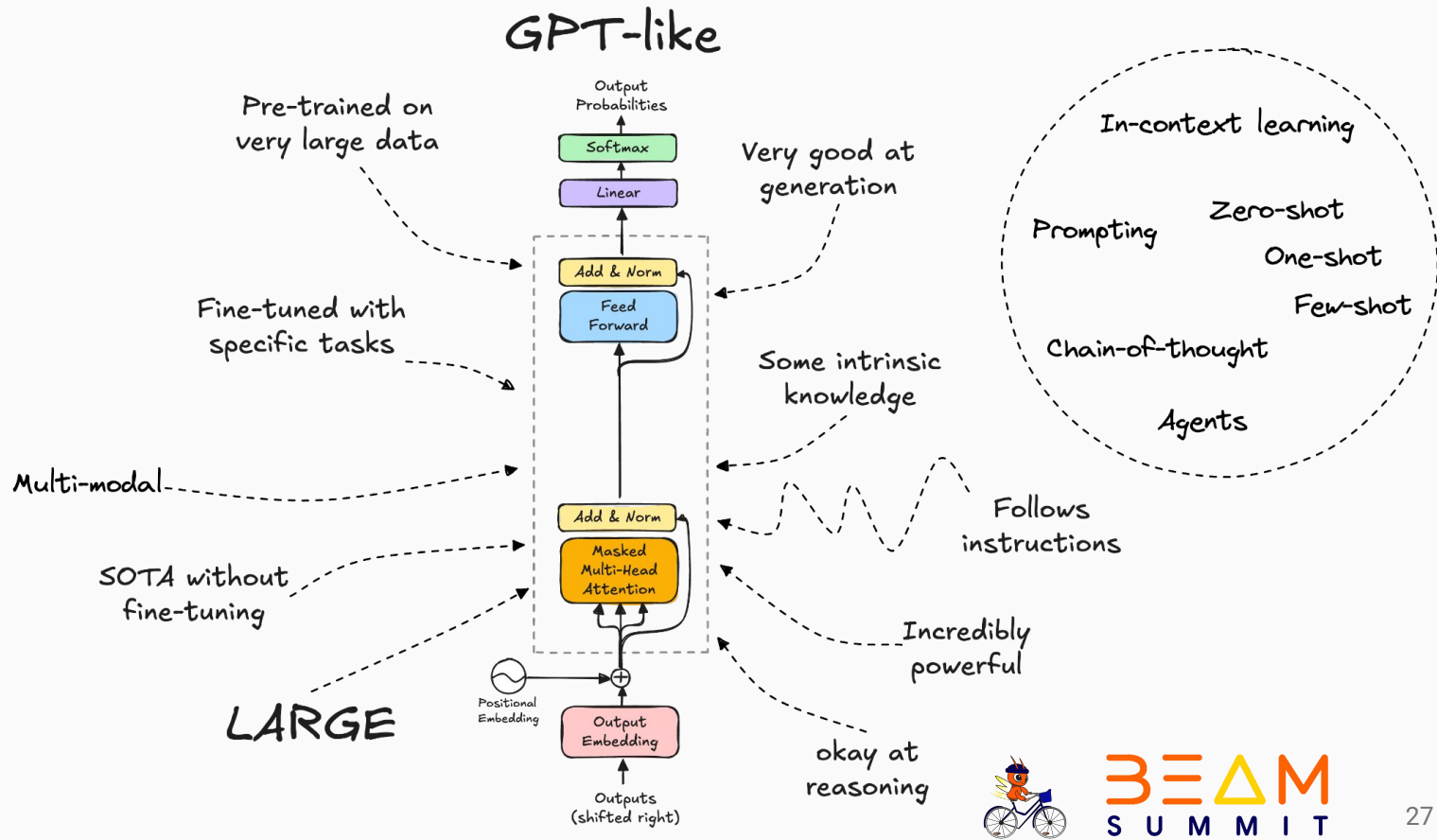


# Large Language Models

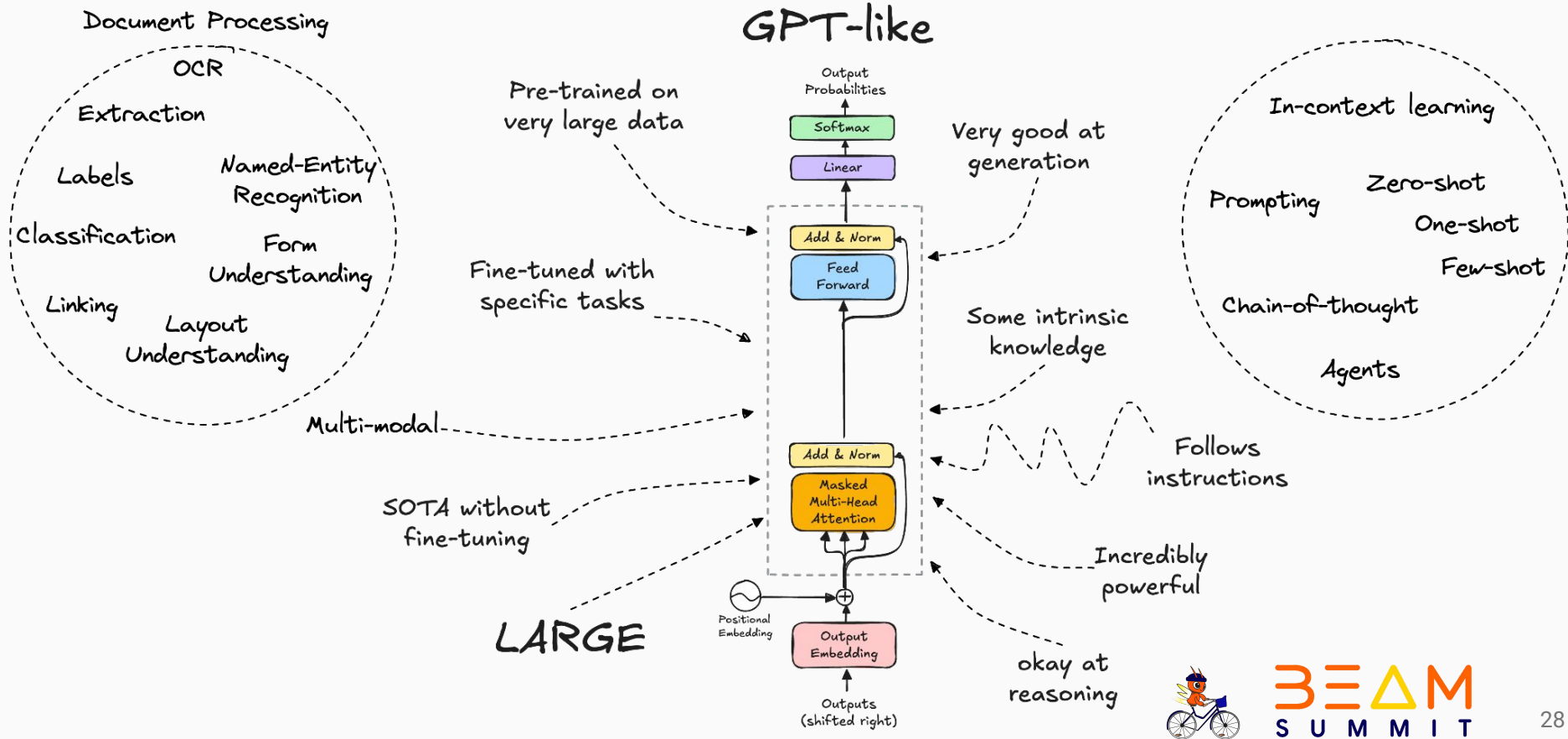




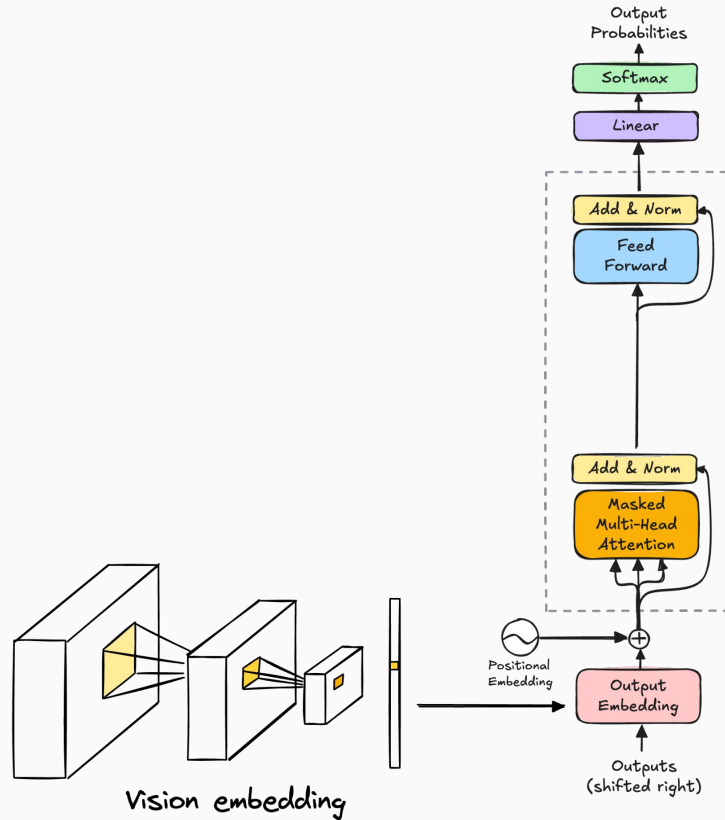
# Large Language Models



# Large Language Models

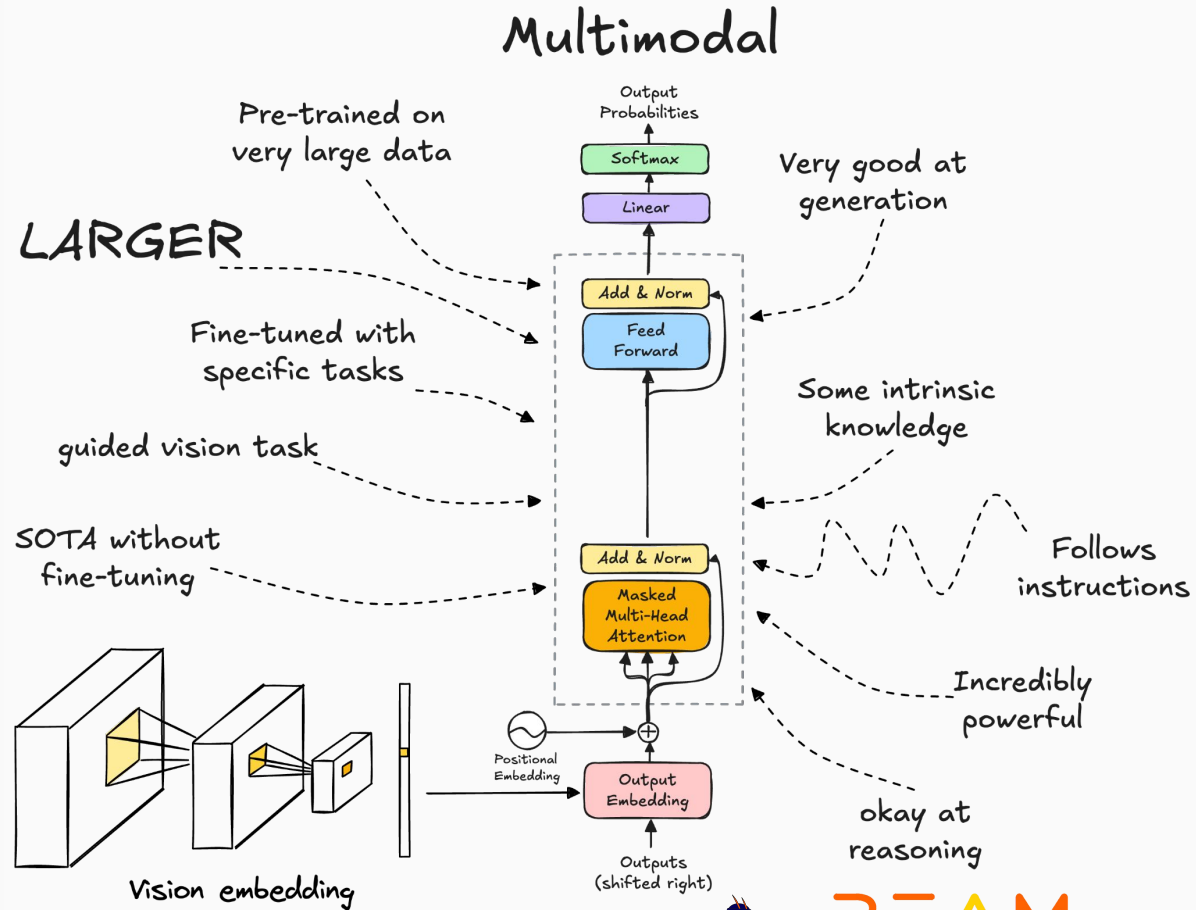


## Multimodal



# Multimodal LLMs

- State-of-the-art performance for document processing
- Guided information extraction
- Intrinsic domain knowledge





# Use cases

Organise document collection

Order form processing

Repair service claims

Product recommendation

Online community moderation

Video Processing

RAG ingestion

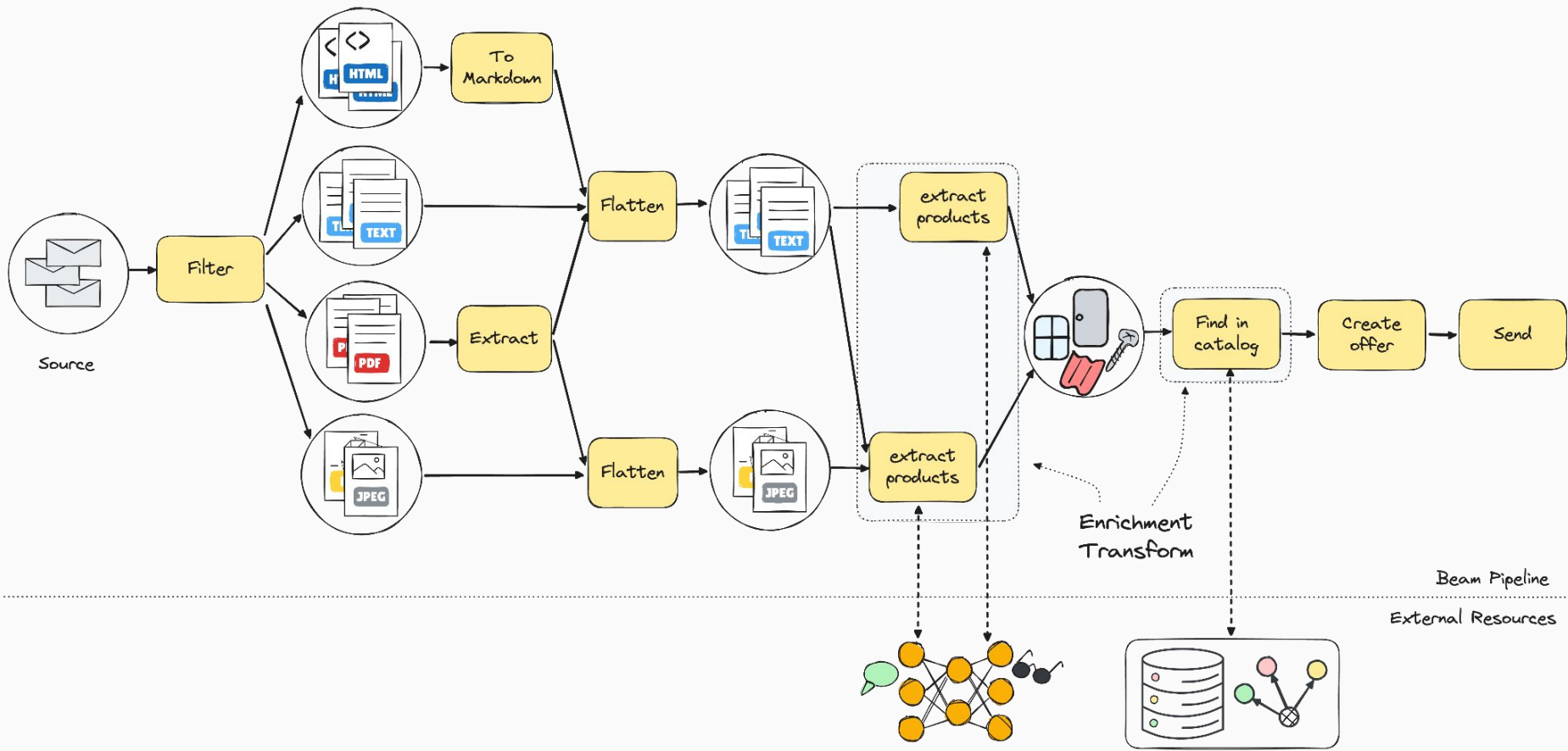
Process Insurance claims

News feed augmentation



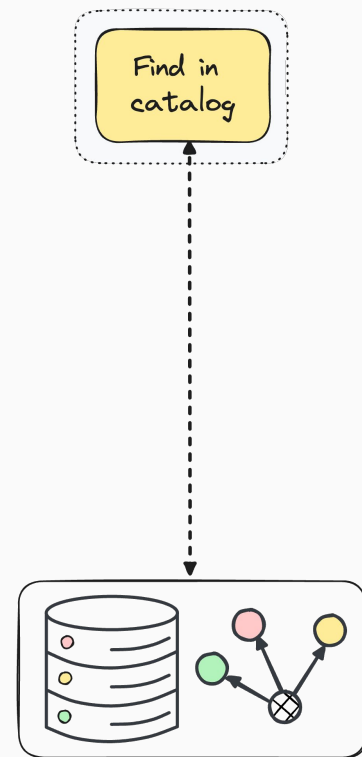
# Multimodal LLMs in Beam





```
from apache_beam.transforms.enrichment_handlers.bigquery import BigQueryEnrichmentHandler

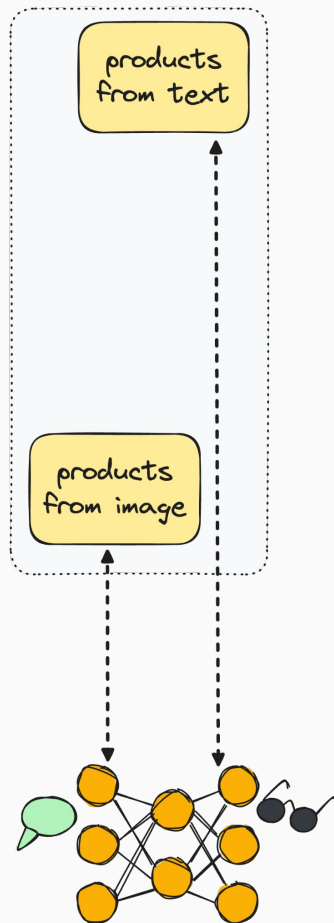
bigquery_handler = BigQueryEnrichmentHandler(
    project=config.project_id,
    table_name=config.table_name,
    row_restriction_template=config.row_restriction_template,
    fields=config.fields,
    condition_value_fn=condition_value_fn,
)
```





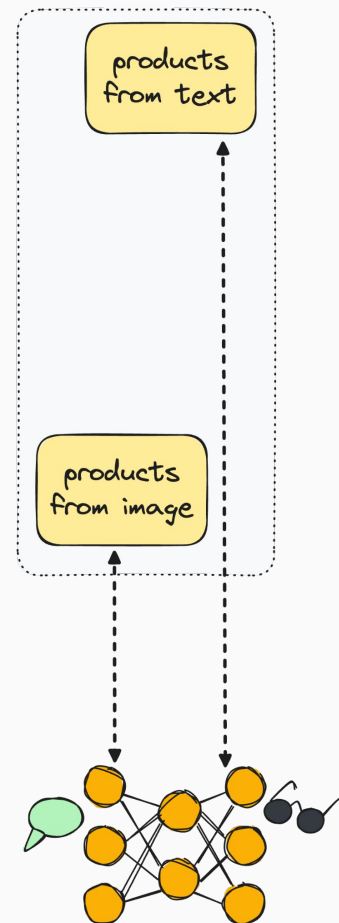


```
class LLMEnrichmentHandler(EnrichmentSourceHandler[beam.Row, beam.Row]):  
    """Enrichment handler for multi-modal LLMs (Google Gemini)."""  
    def __init__(self, project_id: str, location: str, model_name: str, row_key: str,  
                 *, exception_level: ExceptionLevel = ExceptionLevel.WARN, **kwargs):  
        ...  
  
    def __enter__(self):  
        """Connect to the client API."""  
        vertexai.init(project=self.project_id, location=self.location)  
        self.model = GenerativeModel(self.model_name)  
  
    def __call__(self, request: beam.Row, *args, **kwargs):  
        """Generate LLM response."""  
        prompt = request._asdict()[self.row_key]  
        response = self.model.generate_content(prompt)  
        response_dict = {  
            "response": response.text,  
            "usage_metadata": response.usage_metadata,  
        }  
        return request, beam.Row(**response_dict)  
  
    def __exit__(self, exc_type, exc_val, exc_tb):  
        """Clean the instantiated Vertex AI client."""  
        self.model = None  
  
    def get_cache_key(self, request: beam.Row) -> str:  
        """Returns a string formatted with unique entity-id for the feature values."""  
        return 'entity_id: %s' % request._asdict()[self.row_key]
```





```
llm_enrichment_handler = LLMEnrichmentHandler(  
    project_id=config.project_id,  
    location=config.location,  
    model_name=config.model_id,  
    model_provider=config.llm_provider,  
    row_key='extraction_prompt')  
  
llm_answer_handler = LLMEnrichmentHandler(  
    project_id=config.project_id,  
    location=config.location,  
    model_name=config.model_id,  
    model_provider=config.llm_provider,  
    row_key='answer_prompt')
```



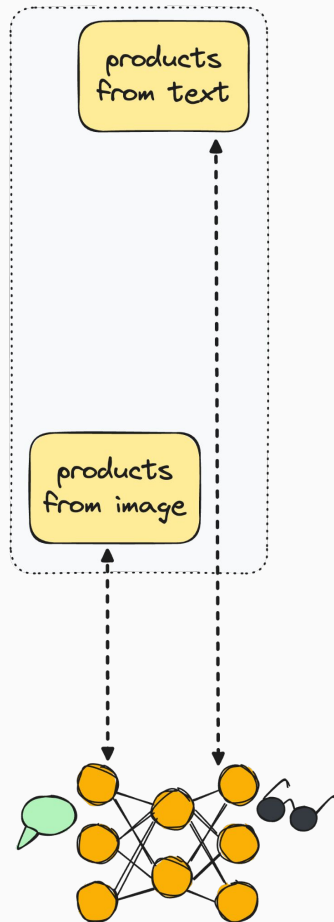


```
import apache_beam as beam
from apache_beam.transforms.enrichment import Enrichment

with beam.Pipeline() as pipeline:
    customer_emails = (
        pipeline
        | "Create customer request data" >> beam.Create(customer_data)
    )

    requested_products = (
        customer_emails
        | "Compose multi-modal prompt" >> beam.Map(
            lambda mail: compose_multimodal_prompt(extraction_task_instructions, mail))
        | "Extract products" >> Enrichment(llm_enrichment_handler, timeout=100)
    )

    found_products = (
        requested_products
        | "Parse DB query" >> beam.Map(
            lambda x: parse_db_query_response(x.response).SQL_query)
        | "Find in catalog" >> beam.ParDo(ExecuteSQLQuery(db_file))
    )
```





```
extraction_task_instructions = f"""  
You are an assistant to take customer orders for a constructions materials and parts company.
```

```
You can receive all kinds of customer orders. The customers generally don't look  
carefully into the product catalog, and just send a general message with what they require.
```

```
Your task is to construct an SQL query to search the catalog.
```

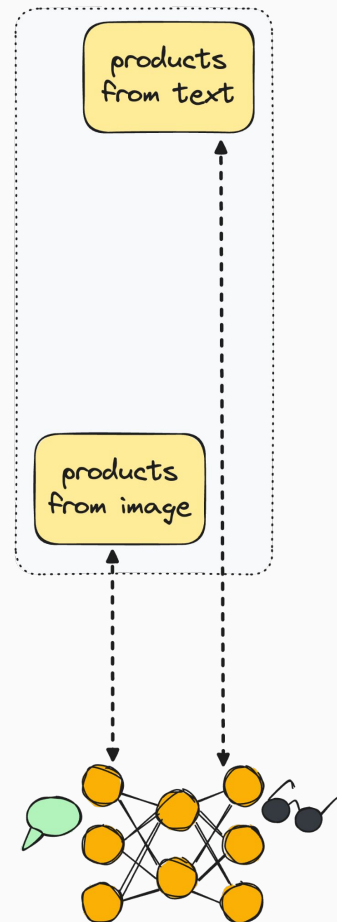
```
The challenge is to extract the relevant details from the customer's request  
such that you can write a query that matches the database columns.  
Hence only use keys in the query that are also present in the database.  
The database contains the following columns and unique values: {database_columns}
```

```
Please write an SQL query to search the database.
```

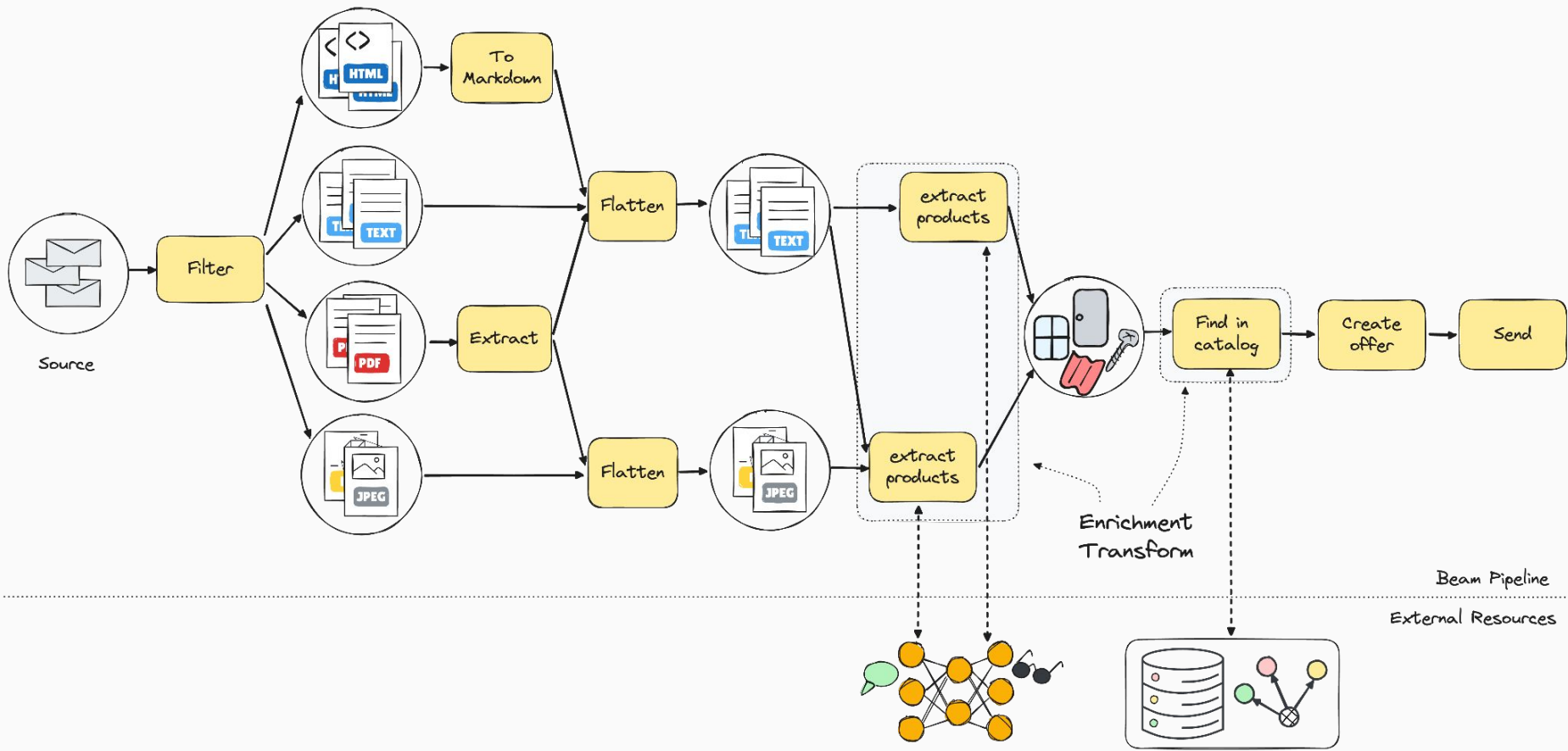
```
Your output should be formatted as follows:
```

```
# user intent >> <insert here>  
# SQL query explanation >> <insert here>  
# SQL query >> <insert here>
```

```
The customer sent the following email:  
"""
```









**Home Builder Construction LLC**  
 123 Second Street  
 Anytown, ST  
 67891(123) 456-7890

**Request for quote**

To Material Store  
123 Main Street  
Some City, ST 12345

Date	09-03-24
Ref. no	
Customer no.	
Contact	

Product	Quantity
Oak window frame, 48" x 24", double UV glass	7
Copper nails, 21" 78	200
Ceramic shingles, red, matte, 15" x 20"	200
<i>Delivery by next Monday possible?</i>	

The above is a request for quote (RFQ), you acknowledge that the information provided is for estimation purposes only and does not constitute a binding agreement. Final terms will be confirmed upon issuance of a formal purchase order or contract. The company reserves the right to decline any RFQ at its discretion.



We have reviewed your request and can confirm the following items are available:

- \* **200 copper nails, 21"**: We can fulfill this request.
- \* **200 ceramic shingles, red, matte, 15" x 20"**: We can fulfill this request.

For the oak window frame, 48" x 24", double UV glass, we do not have any window frames in stock that meet those exact specifications. However, we have several oak windows that are very close to your request, and we would be happy to discuss those options with you.

Here are a few suggestions:

- \* **Classic Oak Single-Glazed Pivot Window 082**: This window is 48" x 24" with single glazing and a pivot opening. We could potentially upgrade the glass to double UV glass, but it would come at an additional cost.
- \* **Classic Oak Single-Glazed Hinged Window 092**: This window is also 48" x 24" with single glazing and a hinged opening. Again, we could consider upgrading the glass to double UV glass, but it would impact the price.

We are happy to provide you with a quote for these options and discuss the potential upgrade to double UV glass.

We can also explore alternative window frame materials, such as Meranti or Accoya, that might be a better fit for your needs.

Please let us know if you have any questions or would like to proceed with an order.

You can review the available items in the pre-filled shopping cart:

<https://material-store.com/cart?id=95afe5bb-8de9-4580-ad8b-8fa8d047aa1e>

# (Multimodal) LLMs in Beam

Enrichment Transform:

RunInference:



# (Multimodal) LLMs in Beam

## Enrichment Transform:

- Remote models
- Custom enrichment handler
- Based on RequestResponseIO
  - Client-side throttling
  - Retry & backoff
- Caching

## RunInference:

- Local models
- Remote models with custom model handler
- Resource Allocation
- Batching





# Summary



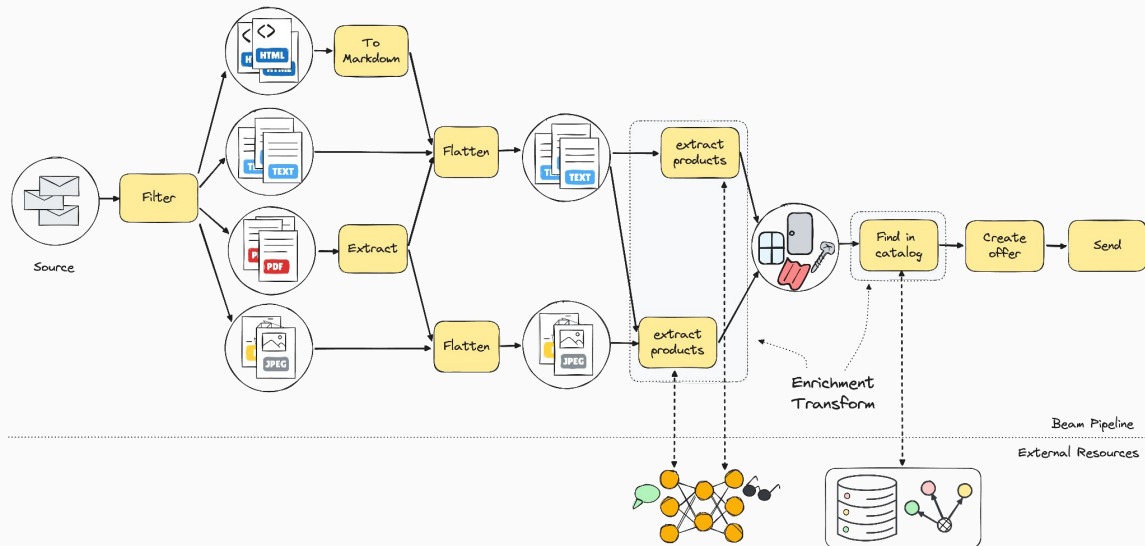
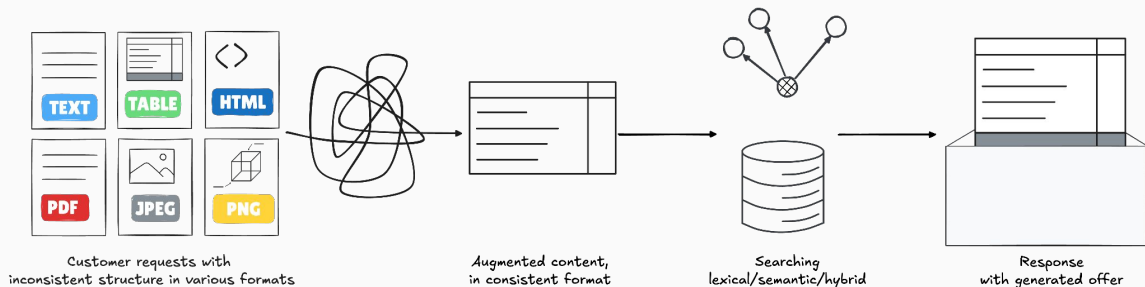
# Summary

LLMs take **context** into account, understand **imprecise phrasing**, & have **domain knowledge**.

Multimodal LLMs are very good at **extracting data** from **documents**.

Beam's **Enrichment Transform** is great for **data augmentation**.

It can be used to integrate **LLMs**.





# Thank you!

Questions?

Konstantin Buschmeier

Jasper Van den Bossche

Iris Luden

ML6 is hiring

 <https://jobs.ml6.eu/>



**BEAM**  
SUMMIT