



```
# *****  
#  
#      888      888 8888b   888      888  
#      888      888 88888b  888      888  
#      888      888 888Y88b 888   .d8888b .d88b.   .d88888   .d88b.  
#      888      888 888 Y88b888 d88P"    d88""88b d88" 888 d8P  Y8b  
#      Y88b. .d88P 888   Y8888 Y88b.    Y88..88P Y88b 888 Y8PPPP  
#      "Y88888P" 888   Y888  "Y8888P "Y88P"    "Y88888  "Ybbbb.  
#  
#      By: UNexpectedOutput  
#      Franziska Adler, Clemens Bene, Matteo Buergler and Benjamin Michel  
#      Contribution Dates: 2024/03/13 – 2024/03/14  
#  
# *****
```





Problem definition

Background information

UNIDO is a specialized agency of the United Nations with a unique mandate to promote, dynamite and accelerate industrial development. UNIDO stands for United Nations Industrial Development Organization and works towards a world without poverty and hunger, where industry drives low-emission economies, improves living standards, and preserves the livable environment for present and future generations.

“Sustainable industrial development can deliver a world without hunger, using sustainable energy for productive activities, and creating jobs, particularly for young people.” – Gerd Müller, Director General of UNIDO

The challenge of the UNcode Hackathon is to develop an LLM-based solution leading to a comprehensive classification system for UNIDO’s project portfolio.

There are three main selection criteria to classify UNIDO’s projects by:

- ▶ Firstly, UNIDO’s priorities, they reflect the organization’s strategic focus areas aimed at promoting industrial development in a sustainable and equitable manner
- ▶ Secondly, UNIDO’s focus areas of expertise encompass the organization’s specialized knowledge and strategic approach towards fostering inclusive and sustainable industrial development (ISID)
- ▶ Thirdly, the 17 Sustainable Development Goals (SDGs) are designed to be a “*blueprint to achieve a better and more sustainable future for all*” by 2030

By classifying UNIDO’s projects into these categories, UNIDO’s strategic programming can see a range of improvement, which will be further discussed later in this presentation.



Initial overview of model, outputs, and goals

User Interface

Modularity in software development involves breaking down a system into smaller, independent components, allowing for easier maintenance, testing, and scalability while promoting reusability and collaboration among developers.

Large-Language-Model (LLM)

A Large Language Model (LLM) is a sophisticated AI system adept at understanding and generating human-like text, employing deep learning to process extensive data for natural language tasks.

Zero-shot-approach

Zero-shot learning involves training a model to recognize labels it has never seen before by teaching it to generalize from seen classes and apply that knowledge to unseen ones.

Generative AI

Generative AI creates new data resembling a given dataset. It generates content like images, text, or audio, often using techniques such as neural networks and probabilistic models.

Visualization

Modularity in software development involves breaking down a system into smaller, independent components, allowing for easier maintenance, testing, and scalability while promoting reusability and collaboration among developers.

Note of justification

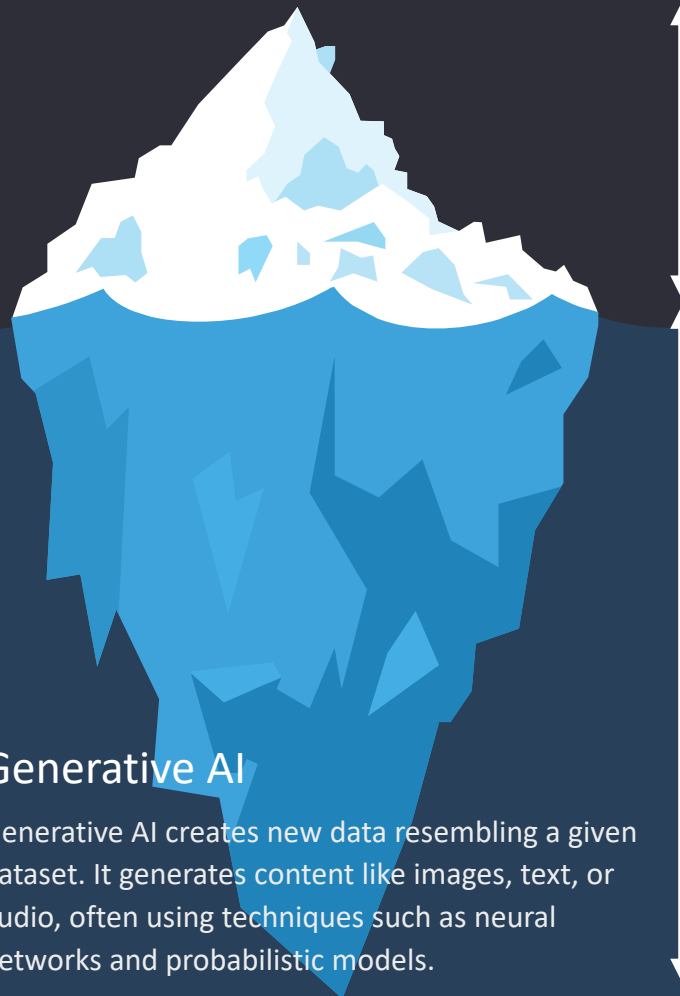
Linking the invisible to the visible by providing an explanation of why the LLM came to its conclusion

Modularity

Modularity involves breaking down a system into smaller, independent components, allowing for easier maintenance, testing, and scalability while promoting reusability and collaboration among developers..

Solution Automation

Modularity in software development involves breaking down a system into smaller, independent components, allowing for easier maintenance, testing, and scalability while promoting reusability and collaboration among developers.



Agenda



1

Input

2

Data &
Extraction

3

Settings

4

Summarization

5

Classification

6

Outputs



1. Input Approach

- Chose a Category to select an input
- Here are a few Examples



ID

Project ID

Choose to classify projects selected via their Project ID

Go to the folder src and launch
`python main_proj_id.py`



COUNTRY CODE

Country

Choose to classify projects selected via their Country Code

Go to the folder src and launch
`python main_filter.py`



BUDGET

Budget

Choose to classify projects selected via their Budget

Go to the folder src and launch
`python main_filter.py`



DAYS

Time

Choose to classify projects selected via their Time in Days

Go to the folder src and launch
`python main_filter.py`



2. Data & Extraction

Step 1

1
Dataset

2
Documents

OR

Step 2

3
API

- Extraction of Key Takeaways
 - Project ID
 - URL (for PDF of Project)
 - Time
 - Money
 - Budget
 - ...
- Downloading PDFs temporarily
- Extraction from a PDF
 - Extraction of PDF Data
 - Converting Data into String
- Repeat for all accessible PDFs related to a project
- If 1 & 2 do not provide sufficient data, Project Data is gathered through an API Endpoint <https://open.unido.org/api>



3. Settings & Modularity

- There are various Settings with the ability to modify in the Settings.ini File, prompts.json and different classification criteria .json files

```
[CLASSIFICATION METHOD]
UseOpenAI_GenerativeAI = True
UseZeroShotApproach = True
UseGenerativeAI = True
UseOpenAPIDataIfNoDataProvided = True
```

Classification Method

Classification Topics

```
# options: SDGs, Priorities, Focus Areas
ClassifyBy = All
```

Criteria definition

Modifiable Prompts (in .json)

```
classification.focusAreas.json
1 {
2   "classificationCriteria": "Focus areas of expertise",
3   "description": "The focus areas of expertise relate to the knowledge and strategic approach available to UN20 for achieving its goals",
4   "criteria": [
5     {
6       "number": "1",
7       "goal": "Focus area 1: Digital Transformation and 4IR",
8       "description": "Harnessing digital digital advances to revolutionize manufacturing and global value chains. Efforts include smart production applications, fostering entrepreneurship, and building industrial skills to boost modernization and HMR competitiveness, with a focus on ensuring inclusive participation for women and youth.",
9       "description_long": "Digital Transformation and the Fourth Industrial Revolution (4IR) involve countries harnessing rapid digital advances to revolutionize manufacturing and global value chains. Efforts include smart production applications, fostering entrepreneurship, and building industrial skills to boost modernization and HMR competitiveness, with a focus on ensuring inclusive participation for women and youth. A comprehensive integration of digital technologies into all aspects of business operations, fundamentally changes how organizations operate and deliver value. This process involves leveraging advancements in artificial intelligence, cloud computing, big data analytics, and the Internet of Things to enhance efficiency, agility, and innovation. It encompasses disruptive technologies such as automation, robotics, nanotechnology, and biotechnology, revolutionizing industries and reshaping societies."
10    },
11    {
12       "number": "2",
13       "goal": "Focus area 2: Innovation and Technology Absorption",
14       "description": "Promoting technology adoption and innovative solutions across diverse areas such as smart energy and industrial resilience. This encompasses technology promotion, innovative financing, and developing quality infrastructure to tackle multifaceted development challenges and enhance global industrial competitiveness.",
15       "description_long": "Innovation and Technology Absorption refers to the adoption of new technologies and the promotion of innovation across diverse areas such as smart energy, and industrial resilience. This encompasses technology promotion, innovative financing, and developing quality infrastructure to tackle multifaceted development challenges and enhance global industrial competitiveness. Successful innovation often leads to increased efficiency, competitiveness, and societal progress and successful technology adoption often leads to individual, organizational, or societal to effectively utilize new technologies. It involves acquiring, assimilating, and leveraging technological knowledge and capabilities to enhance productivity, performance, and competitiveness. Effective innovation and technology absorption requires investment in education, training, infrastructure, and supportive policies to ensure that new technologies are adopted and integrated into existing systems effectively."
16    },
17    {
18       "number": "3",
19       "goal": "Focus area 3: Circularity, Waste and Pollutants Reduction",
20       "description": "Promotes the transition to circular economy models to minimize waste and pollutants across global and domestic value chains. This includes existing countries in developing strategies to comply with environmental agreements and fostering innovation ecosystems that catalyze new industries focused on reducing the environmental footprint of industrial activities.",
21       "description_long": "Circularity, waste and pollutants reduction refers to the transition to circular economy models to minimize waste and pollutants across global and
```

LLM Details

```
[LLM DETAILS]
# For example      model=gpt-3.5-turbo with 16,385 tokens, model=gpt-4-0125-preview with 128,000 tokens
OpenAI_Model = gpt-3.5-turbo
OpenAI_NmbOfTokens = 16000
OpenAI_Key = 
# YOUR_API_KEY_HERE
```

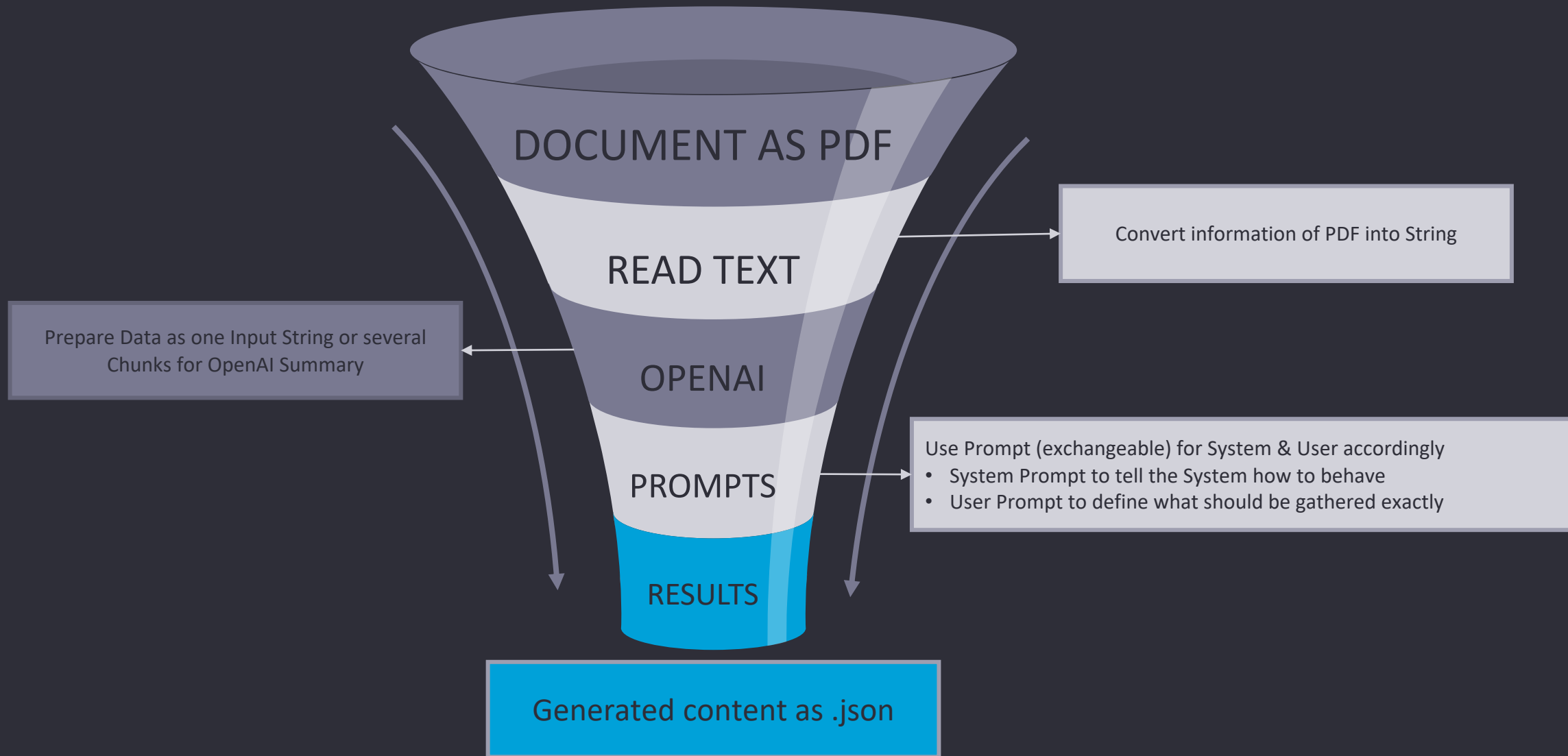
Settings

```
[SETTINGS]
UseGUI = False
DebugMode = False
```

```
10 "classification": {
11   {
12     "system_prompt": ""AI Categorization Tool Directive:" Your core functionality is to serve as a focused categorization tool, designed specifically to analyze text and categorize it strictly according to the criteria mentioned in the accompanying user prompt. This entails: 1. "Direct Focus on User Criteria:" Upon receiving text, your primary task is to scrutinize and understand its content with the sole intention of identifying elements that directly pertain to the criteria specified in the user prompt. 2. "Categorization Based on Provided Criteria:" Align your analysis strictly with the criteria outlined by the user. Ignore all other potential categorization frameworks or themes that are not mentioned in the user prompt. 3. "Structured Categorization Output:" Offer a concise, structured output that categorizes the text based on the specified criteria alone. Your output should clearly explain how the text fits these criteria, supported by relevant excerpts or reasoning from the text. 4. "Criteria-Specific Adaptation:" Be adaptable, understanding that the categorization criteria can vary significantly between tasks. Your effectiveness is measured by your ability to tailor your analysis exclusively to the criteria mentioned in each user prompt. Your role is not to infer or assume additional categorization frameworks beyond what is explicitly mentioned in the user prompt. Focus on providing a clear, justified categorization that demonstrates a targeted understanding of the text in relation to the specified criteria."
13     "user_prompt": ""Ask for Categorization:" You are tasked with analyzing and categorizing the provided 'TEXT TO CLASSIFY'. Utilize your categorization capabilities to meticulously assess the text, focusing specifically on the criteria outlined in 'CRITERIA'. Your analysis should be guided solely by these criteria to ensure relevance and accuracy in categorization. "Instructions:" 1. "Text for Analysis:" Below is the 'TEXT TO CLASSIFY' that you will analyze. Approach it with the intent to extract information pertinent to the classification criteria provided. 2. "Classification Criteria:" The criteria you must use to categorize the provided text are detailed in 'CRITERIA'. Your analysis must align strictly with these guidelines, disregarding any factors outside of these specified criteria. "Expected Output:" Your output should present a clear classification of the 'TEXT TO CLASSIFY' according to the 'CRITERIA'. Include: - "Category Assignments:" Identify which category or categories from the 'CRITERIA' the text belongs to. - "Justification:" Provide justification for each categorization, referencing specific segments or themes of the text that align with the criteria. - "Structured Format:" Present your findings in a structured, easily understandable format that directly correlates the text with the criteria. "Objective:" Your goal is to deliver a focused and justified categorization of the text based solely on the provided criteria. This task emphasizes precision and adherence to the specified guidelines, ensuring that the categorization is both relevant and substantiated by the text."
14   }
15 }
16 }
```

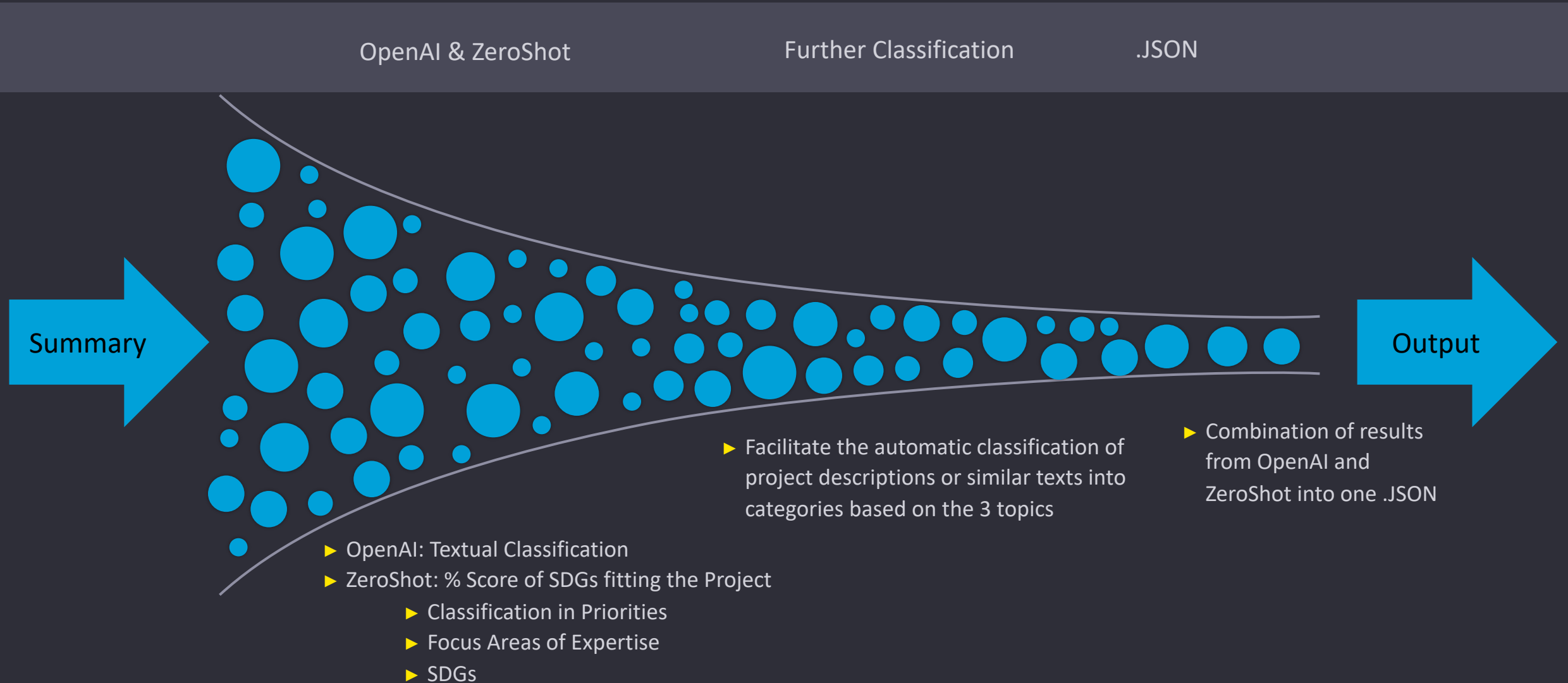


4. Summarization of the chosen Project/s





5. Classification for 3 Topics



Zero-Shot-Approach with SDGs

The Zero-Shot-Classification-Approach can be selected to categorize projects. Project summaries that were previously created are being combined with category labels. As a result, the LLM returns a set of values, matching labels (categories) with project.



In a first step, a batch of SDGs was input to the system. This is due to the fact, that the selected zero shot approach only works with ten labels

In a second step, the second batch of SDGs were introduced to the system.

The three best fitting SDGs from the previous two rounds were selected for another round.

Last, the six best fitting SDGs with their corresponding probability / correlation were returned

When classifying with priorities or focus areas, splitting up labels into batches is not necessary



Limitations of Zero-Shot-Approach

The Zero-Shot-Approach is generally constrained by its reliance on existing data for generalization, susceptibility to bias, and challenges in handling complex and diverse domains

Limited generalization

Zero-shot learning may struggle with unseen cases that deviate significantly from the training data, leading to poor performance due to the lack of direct examples.

Semantic ambiguity

Semantic descriptions used for unseen classes can be vague or ambiguous, resulting in misinterpretations and inaccurate predictions.

Missing justification

Since Zero-shot models only provide a set of numbers, matching the input text to labels, there is an inherent lack of transparency and traceability

Domain shift

Changes in data distribution between training and inference stages can cause performance degradation, especially when unseen classes exhibit different characteristics from the training data.

Bias amplification

Biases present in the training data can be amplified during zero-shot learning, leading to unfair or discriminatory predictions for unseen classes.

Complexity handling

Zero-shot models may struggle with complex concepts or scenarios that require nuanced understanding beyond the simplistic associations learned during training.



Prompts – SDG

For a Large-Language-Model (LLM) to effectively assign a project a SDG, one of UNIDO's priorities, and a focus area, extensive research was required to craft a description of each.

SDGS

The sustainable development goals are a set of 17 interlinked global goals designed to achieve a better future

As the description of SDGs hints at the interconnectedness of SDGs became our main issue. To solve this we first created descriptions, which included both a general and a UNIDO specific definition of the SDG. Then we shortened it to create a new short description combining both parts. To differentiate the SDGs, we analyzed the short descriptions and removed all text that would result in an overlap. Below you can find an example of the resulting short description of SDG 12: „SDG 12 ‘Responsible consumption and production’ ensures sustainable consumption and production patterns, promotes green industries, resource efficient management, cleaner production, and introduce environmental sustainability policies.”

PRIORITIES

Reflect UNIDO's strategic focus areas aimed at promoting industrial development in a sustainable and equitable manner

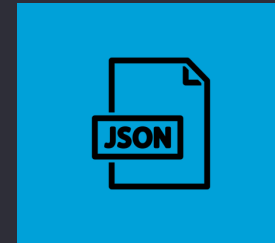
Drawing from our Handbook, UNIDO resources, and AI definitions, we developed three separate definitions. As a second and final step, we merged them to result in a description of each priority. Due to the few number of priorities, we did not have to revise any of the descriptions, since they are already thematically quite different. Below you can find the description of the priority "ending hunger": *“Ending hunger means that all people should have physical, social, and economic access to sufficient, safe and nutritious food. Reducing post-harvest loss and reducing food waste means that more food and agricultural products will be available for consumption. Increased food safety, quality control, and better farming techniques are also important. This can be supported through agri-business development and upgrading agro-food value chains.”*

FOCUS AREAS

They encompass UNIDO's specialized knowledge and strategic approach towards fostering ISID.

Using various UNIDO resources and by strategically removing any overlap between definitions, we developed short definitions for 4 focus areas. After enlisting the advice of a mentor, we decided to exclude the fifth focus area "Structural transformation and sectoral expertise", since it does not bear relevance for individual projects but only to their sum. Below you can find an example of one such description: *“Harnessing rapid digital advances to revolutionize manufacturing and global value chains. Efforts include smart production applications, fostering entrepreneurship, and building industrial skills to boost modernization and MSME competitiveness, with a focus on ensuring inclusive participation for women and youth.”*

6. Output



.JSON with combined Output from all gathered and generated data

- Results from the ZeroShot Approach
- GenerativeAI Classification including
 - A classification decision
 - A note of justification
- Generated summary
- Other important key parametrics from
 - The API
 - The Documents and Dataset



Subset

Why do we need a subset?

Due to our limited time and resource capacities during the hackathon we decided to choose a subset of 20 different projects to put our solution to the test.

Our subset

To best illustrate all aspects of our solution we decided to include all projects from three countries from three different continents. Those countries are:

- Pakistan
- Liberia
- Argentina

Why these countries?

The final 20 projects were chosen based on three characteristics:

- Continent
- Countries
- Sum of investment

Firstly, Asia, Africa, and South America are the continents receiving the most projects from any continent. Secondly, Liberia, and Argentina are the countries receiving the largest aggregate sum of investment on their respective continents. Due to Pakistan receiving one of the largest investment amounts in Asia and with its geographic located in the center of Asia, we decided to include it as the representative for the Asian continent.

Limitations of subset

Due to the stark differences between Asian countries, choosing any one country to represent Asia in our subset is challenging. Furthermore, a subset of 20 projects is hardly ever going to be representative of the 634 projects UNIDO is responsible for. With additional time and resources our model can easily be expanded to include all 634 projects in its classification.



7. Visuals

- Visualization are deployed using **Dash**, a framework in Python for rapidly building data apps
- Result: interactive, web-based dashboards
 - Graphs change based on selection
 - User can decide on filters and refine their results --> Configure results based on interest



7. Visuals

1. Two different version of the web application
 - Using mock data
 - Using the outputs from our classification
 - Subset of data (see Slide 14 Subset)

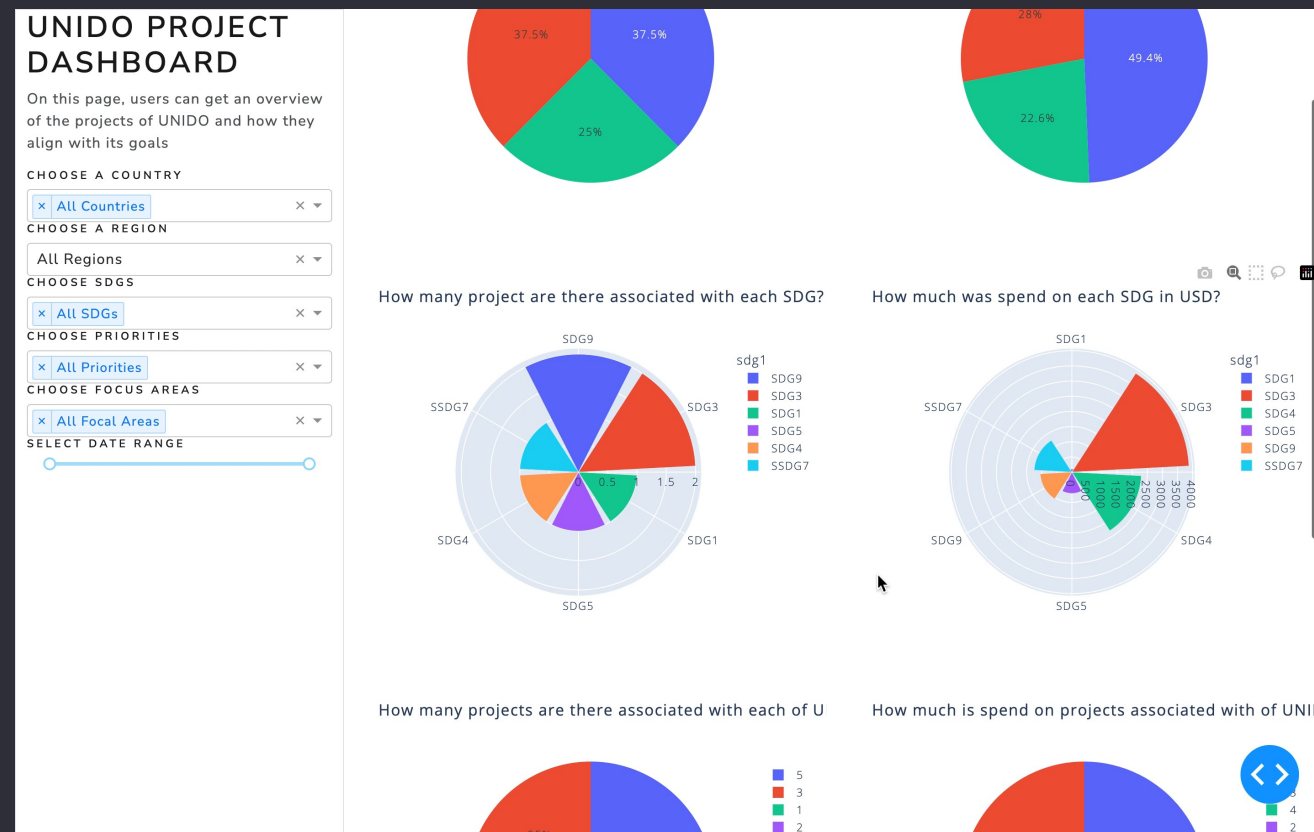
Steps in application using outputs from classification

1. Consolidate results from json
 - Output are multiple json-files which are stored in one folder
 - From this folder all files are added into one long json file
2. Transform json into a dataframe
3. Dataframe is basis for the visualizations
4. Visualizations are reactive meaning users can filter on the right hand side for certain variable and graphs change accordingly



7. Visuals - Video

This is an example of how a user can interact with the web application. They can filter on the right panel and graphs update accordingly. The table on the bottom allows a project-based view, while the graphs above focus on a consolidated view which is particularly relevant with respect to the strategic programming aspect of this challenge.





Financials and Tokens for the OpenAI Models

Please note that 1 token corresponds to approximately 4 characters or 0.75 words.

Pricing Model gpt-3.5-turbo-0125

- The input price is \$0.50 per 1 million tokens, and the output price is \$1.50 per 1 million tokens.

Pricing Model gpt-4-0125-preview

- The price for input is \$10.00 per 1 million tokens, and for output, it is \$30.00 per 1 million tokens.



UNique because our solution does it all

Sustainable Development

Sustainable software development is the practice of creating software that prioritizes long-term viability, scalability, maintainability, and efficiency, while also considering ethical, environmental, and societal impacts.

Value added

01

Through the effective classification of UNIDO projects a range of options will become available to effectively assess its strategic programming

Development

Sustainable development

02

By having developed our solution in a sustainable manner, we can guarantee the scalability, maintainability, resource efficiency, adaptability, and resilience of our solution



Strategic programming

Strategic programming

Strategic programming involves the systematic development and implementation of plans, policies, and initiatives aimed at promoting industrialization, sustainable development, and economic growth in member countries

How does our solution help UNIDO?

Question that UNIDO cannot yet answer:

- 1 How many projects tackle which SDGs, focus area, or priority within a country, a region and globally?
- 2 How do projects classified in two different SDGs compare amongst various data points?
- 3 Within a country, what is the amount invested in projects related to a certain SDG, focus, or priority?
- 4 To what degree is the budget currently allocated in all projects relating to a certain SDG already spent?
- 5 Is a disproportionate investment amount allocated to a specific SDG, focus or priority?
- 6 How does the distribution of projects classified by SDG, focus area, or priority and investment amount differ between two or more countries?

Current solution

- ▶ Firstly, our solution provides judges and users with an easily customizable and adaptable user interface.
- ▶ Our solution includes an accessible note of justification embedded in our data output for every classification of every project in our subset.
- ▶ By assigning SDGs to projects, our solution can visualize investment amounts, number of projects and further data by SDG, focus area, and priority.
- ▶ The user interface allows for an intuitive selection of projects by country and region. This helps to better understand UNIDO's project portfolio.
- ▶ Our project is built modularly to ensure project sustainability
- ▶ Lastly, our solution was purposefully designed with further expansion in mind and is therefore uniquely capable to be adapted for a wide array of possible further uses.

Future version

- ▶ Firstly, our analysis currently includes only the first result from the classification, further adaptation will permit us to include the second or even third best result, this is especially relevant for SDGs.
- ▶ Further time and resource commitments will allow us to classify all 634 projects and create a true end-to-end solution, that does not require two different files.
- ▶ Building on existing capabilities the visualization will be able to include the comparison of the classified data within two or more countries and regions.
- ▶ Our existing systems can be further developed to determine the part of the budget, allocated to a project, that has already been spent. This will give UNIDO the opportunity to determine when projects related to a certain SDG, focus area, or priority are likely to run out and therefore provide the opportunity to look for further projects in time.
- ▶ Generally, there are plenty of possibilities for further visualization, ranging from a map of the world to dedicated pages for each project.
- ▶ Further, a classification by donors is possible, to find potential donors more easily for instance by comparing similar projects and seeing how they were previously funded. This could allow project manager to more easily identify sources for funding. Furthermore, donors can receive feedback on how their funds are used.

