TUTORIAL 14: RECAP ON VALIDATION

Creating Business Value with Generative AI
Fall 2025

AARHUS BSS
DEPARTMENT OF MANAGEMENT
AARHUS UNIVERSITY

5. December 2025

Magnus Bender
Assistant Professor

AGENDA FOR TODAY

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A. Validation in general

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B. An exemplary mini project
    a. Data generation
    b. An app
    c. Validation
    d. Archive export for WISEflow

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A. Validation in general
B. An exemplary mini project
    a. Data generation
    b. An app
    c. Validation
    d. Archive export for WISEflow
C. Teaching evaluation

VALIDATION IN GENERAL

- Overview
- Metrics

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OVERVIEW

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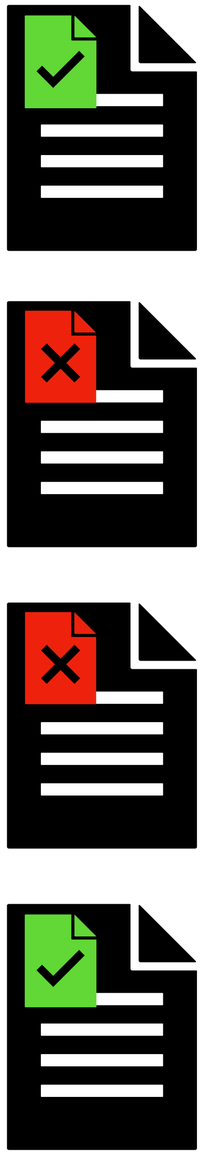
Data with labels
(real or synthetic)



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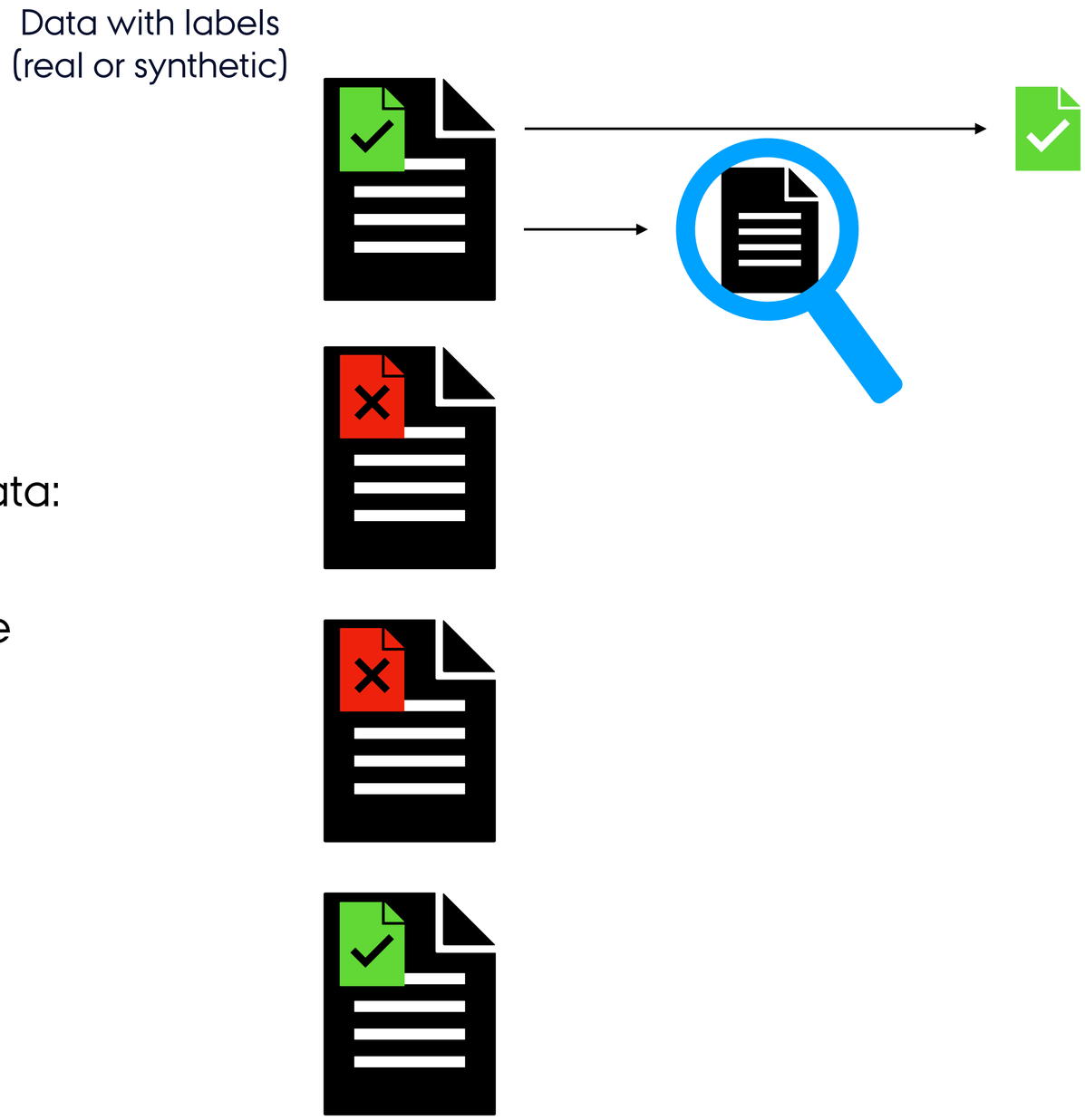

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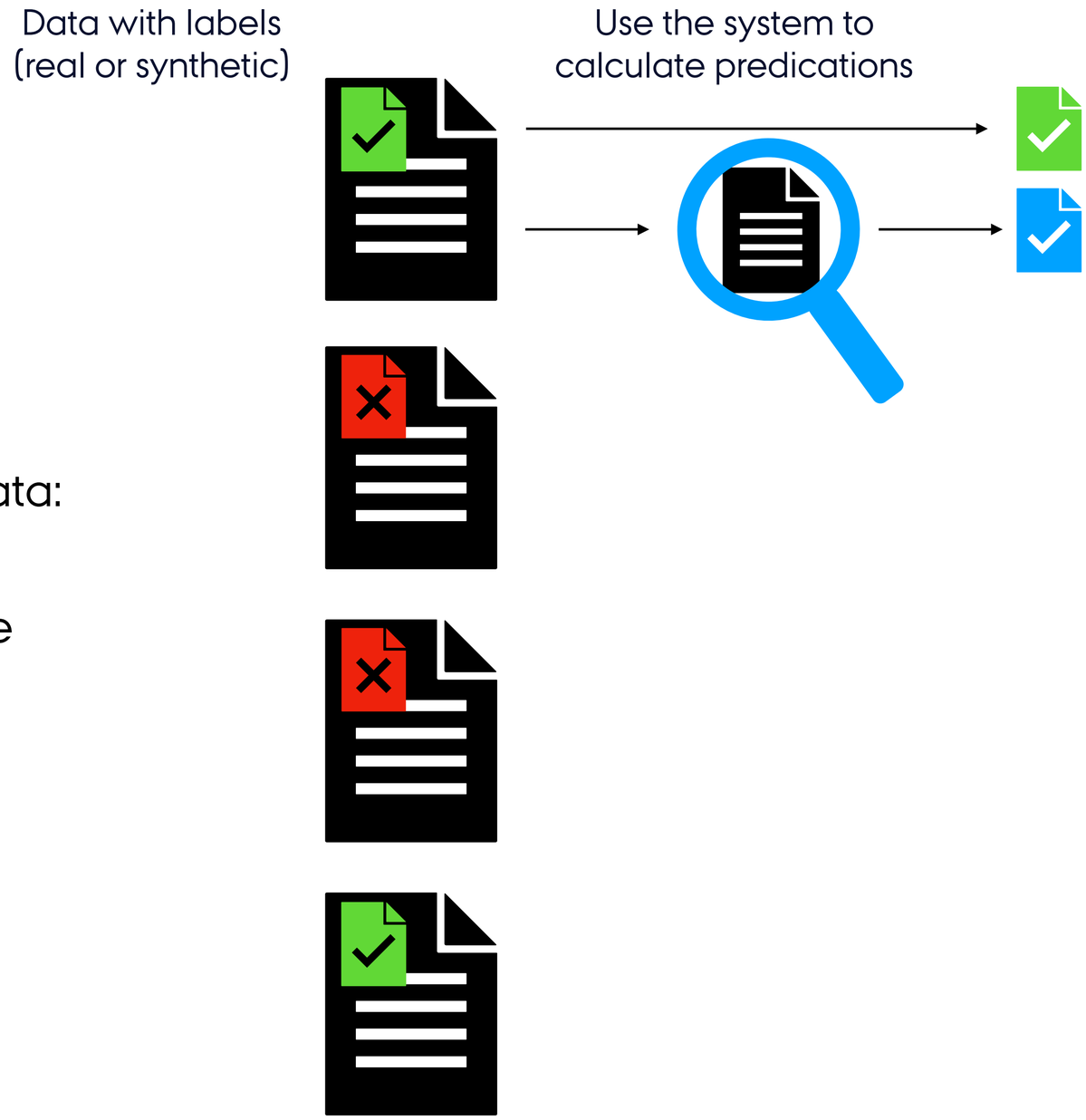

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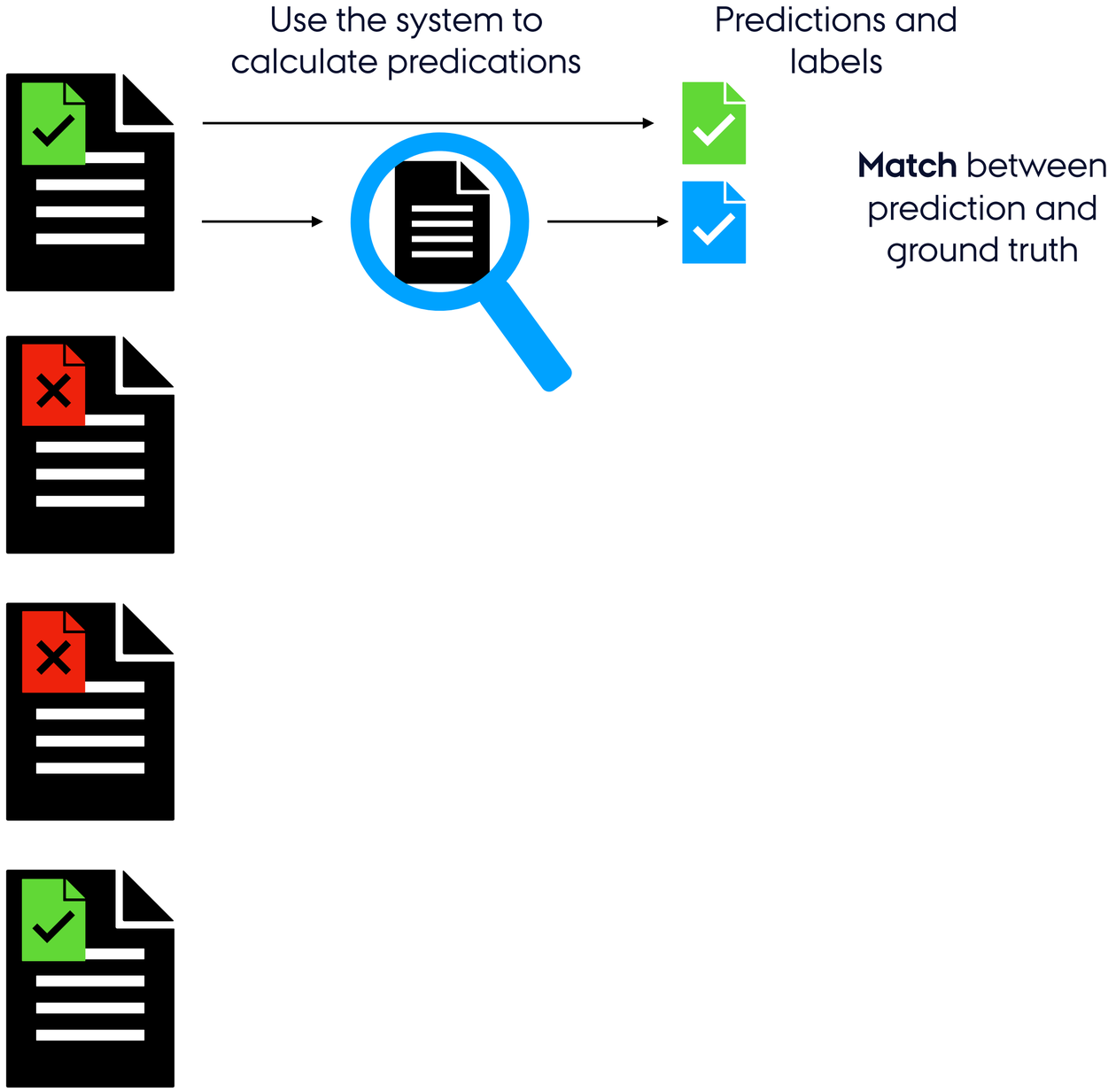
  - A way to compare of prediction matches desired output



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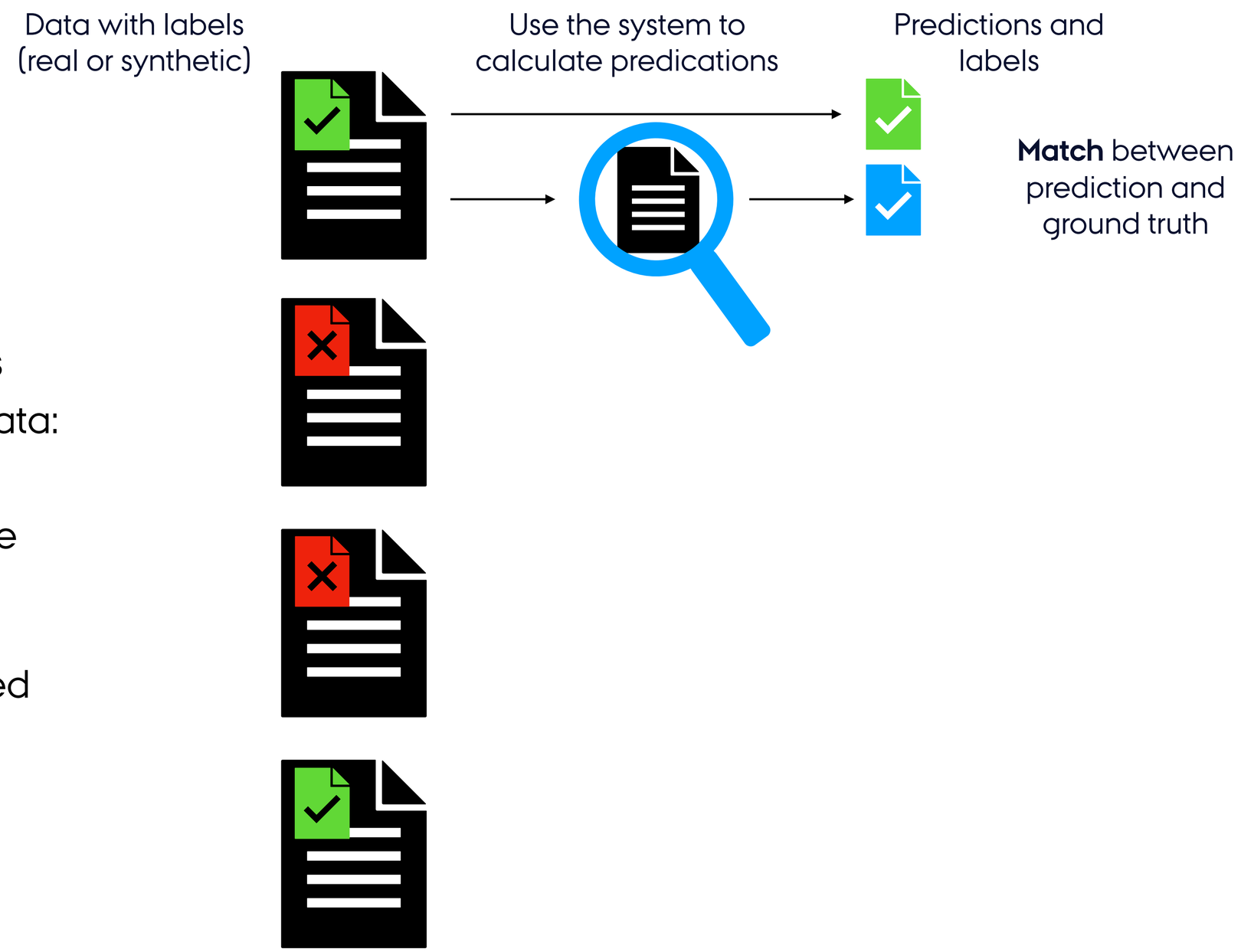

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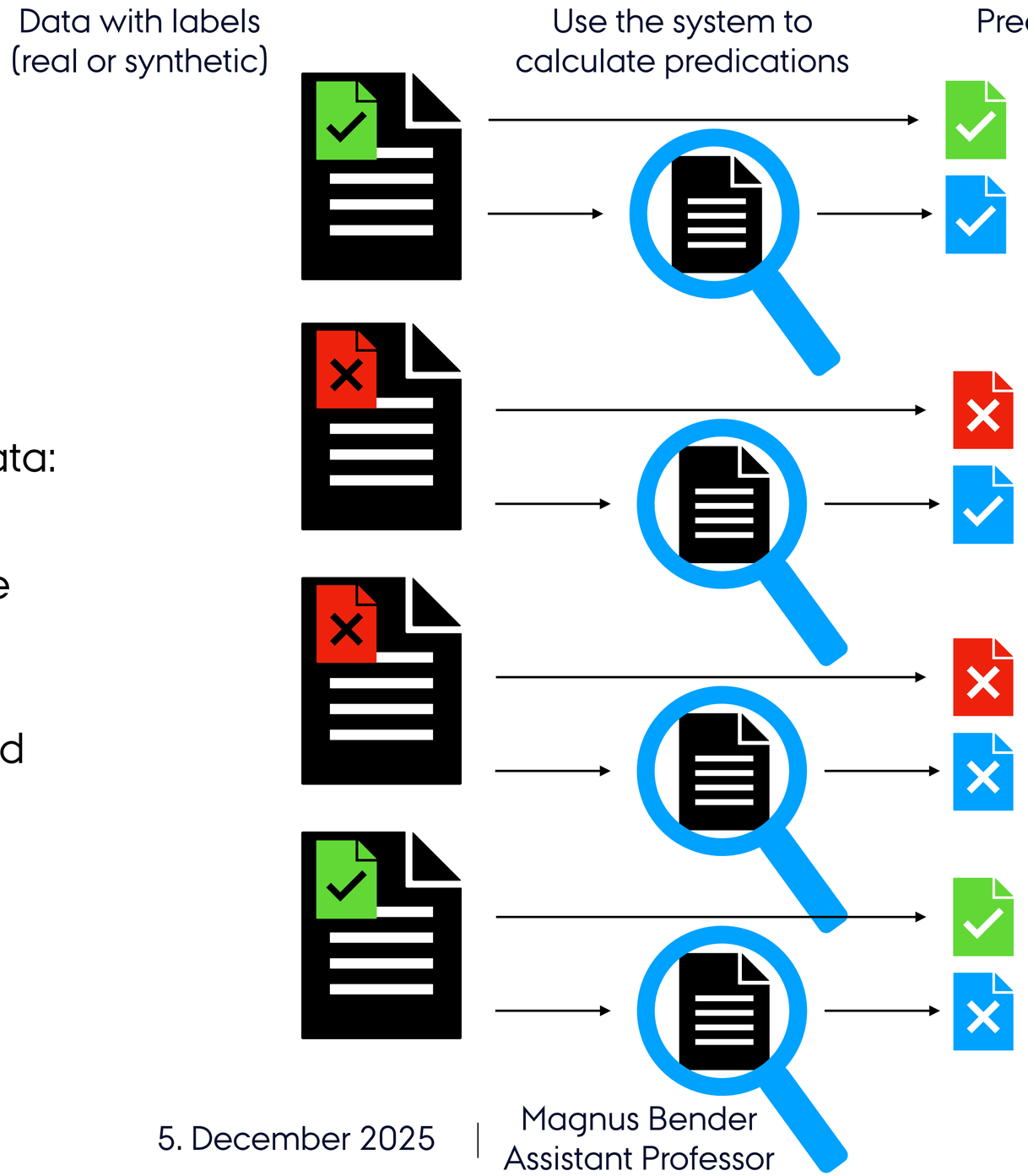

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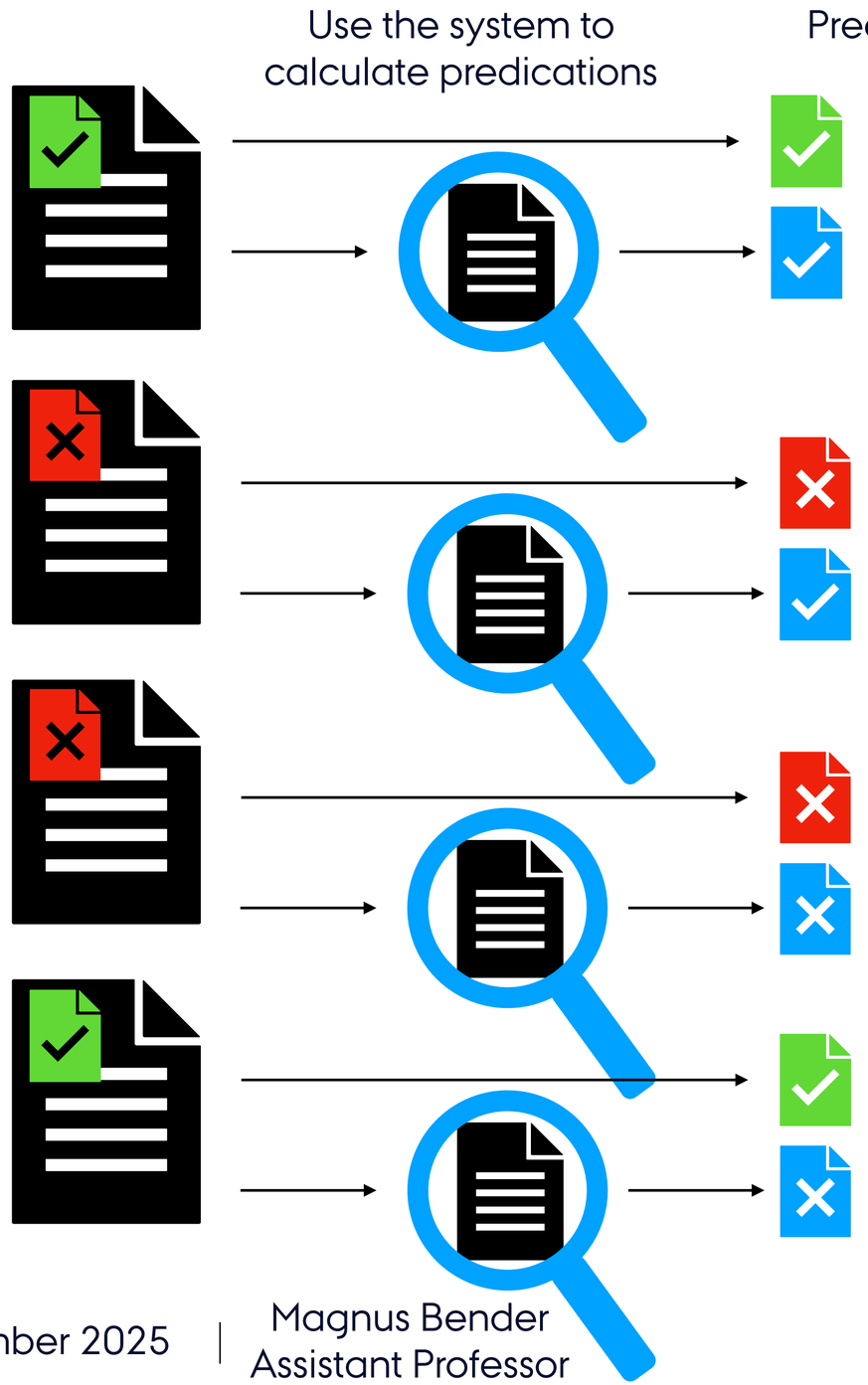

Accuracy: 50%

METRICS

		Prediction	
		Positive	**Negative**
Actual	**Positive**	True positive (tp)	False negative (fn)
	Negative	False positive (fp)	True negative (tn)

https://commons.wikimedia.org/wiki/File:Precisionrecall.svg

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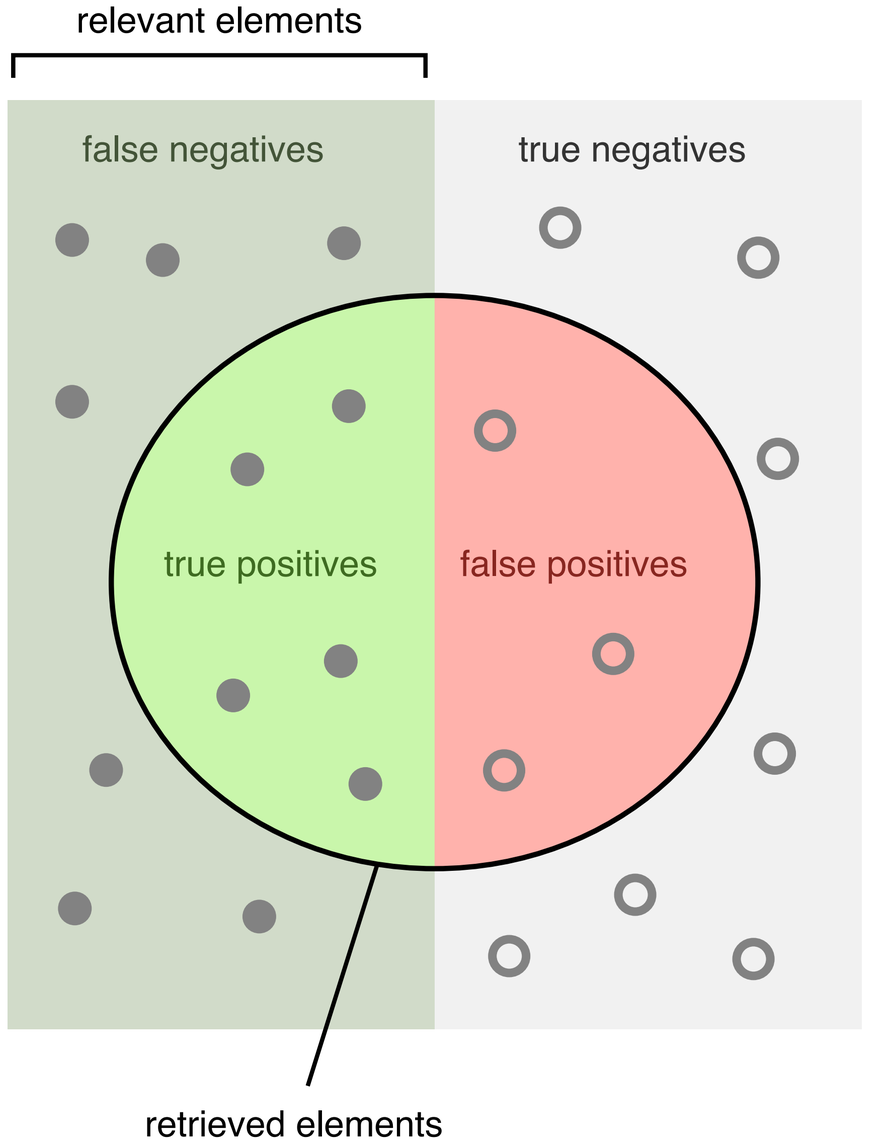

https://commons.wikimedia.org/wiki/File:Precisionrecall.svg
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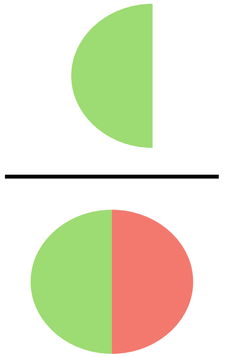
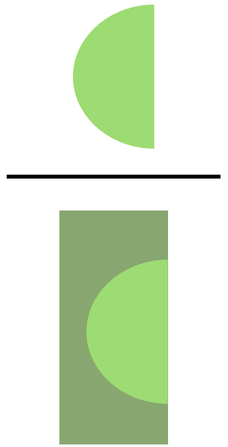
METRICS

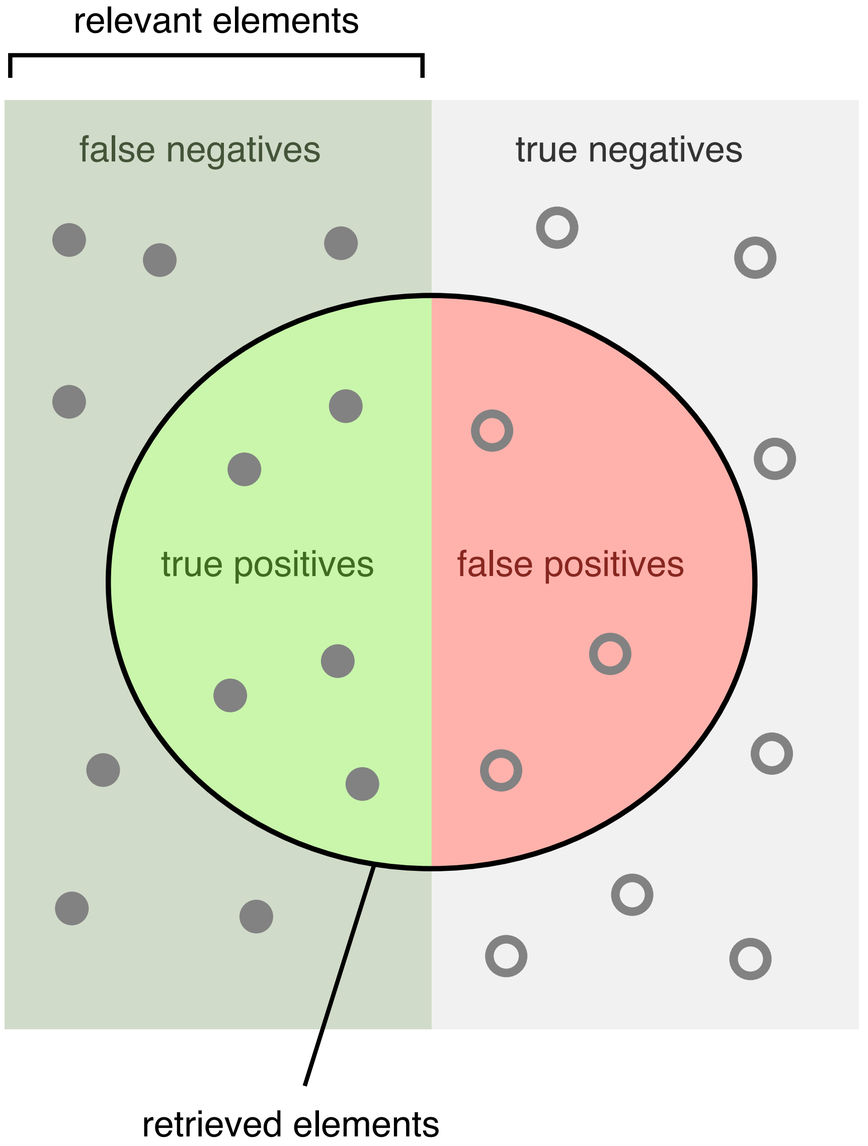
How many retrieved items are relevant?

Precision = 

How many relevant items are retrieved?

Recall = 

```
sklearn.metrics.precision_score()
sklearn.metrics.recall_score()
sklearn.metrics.precision_recall_fscore_support()
```



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AN EXEMPLARY MINI PROJECT

- Data generation, app, and validation
- Archive export for WISEflow

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THE USE-CASE: SALUTATION ANALYSIS

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  - Language (English, Danish, ...)
  - Level of formality (Formal, Informal, ...)
  - Time of day (Morning, Evening, ...)

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  1. Generate synthetic data using OpenAI API: `Magnus_Recap/data_generation/generate.ipynb`

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  2. Create a simple app: `Magnus_Recap/final_project/app.py`
  3. Provide an evaluation (validation): `Magnus_Recap/final_project/validate.ipynb`

DATA GENERATION

DATA GENERATION

```
language = ["Danish", "English", "German", "Norwegian", "Swiss German", "French"]
formality = ["very formal", "formal", "informal", "partner"]
time_of_day = ["morning", "mid day", "evening", "night"]
```

DATA GENERATION

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language = ["Danish", "English", "German", "Norwegian", "Swiss German", "French"]
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time_of_day = ["morning", "mid day", "evening", "night"]

def generate(language:str, formality:str, time_of_day:str) -> str:
  prompt = "Please generate a short salutation  ..."
  prompt += "Language: {language}, Formality: {formality}, Time of day: {time_of_day}"

  completion = client.chat.completions.create(
    model="gpt-5-nano",
    messages=[{"role":"user", "content" : prompt}]
  )
  return completion.choices[0].message.content
```

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for i in range(100):
  salutation = generate(random.choice(language),
    random.choice(formality), random.choice(time_of_day))
```

Generate 100 examples based on random selections of language, formality, and time of day.

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for i in range(100):
  salutation = generate(random.choice(language),
    random.choice(formality), random.choice(time_of_day))
  # write to json file -> the 'salutation' and the values for:
  #   language, formality, time_of_day
```

Generate 100 examples based on random selections of language, formality, and time of day.

RESULT: SYNTHETIC DATA


```
[
  {
    "parameters": {
      "language": "English",
      "formality": "very formal",
      "time_of_day": "mid day"
    },
    "salutation": "Good afternoon, Sir."
  },
  {
    "parameters": {
      "language": "French",
      "formality": "very formal",
      "time_of_day": "morning"
    },
    "salutation": "Bonjour, Monsieur."
  },
  ...
]
```

RESULT: SYNTHETIC DATA

- We know for each item:


```
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  {
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    "parameters": {
      "language": "French",
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    },
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  },
  ...
]
```

RESULT: SYNTHETIC DATA

- We know for each item:
  - The used parameters
    - Won't be visible to the app
    - Are the ground truth to compare to later

```
[
  {
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  },
  ...
]
```

RESULT: SYNTHETIC DATA

- We know for each item:
  - The used parameters
    - Won't be visible to the app
    - Are the ground truth to compare to later
  - The generated salutation
    - Inputs for our app as test cases
    - Are used as basis to compare with the estimates/ predictions of our app

```
[
  {
    "parameters": {
      "language": "English",
      "formality": "very formal",
      "time_of_day": "mid day"
    },
    "salutation": "Good afternoon, Sir."
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    "parameters": {
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  ...
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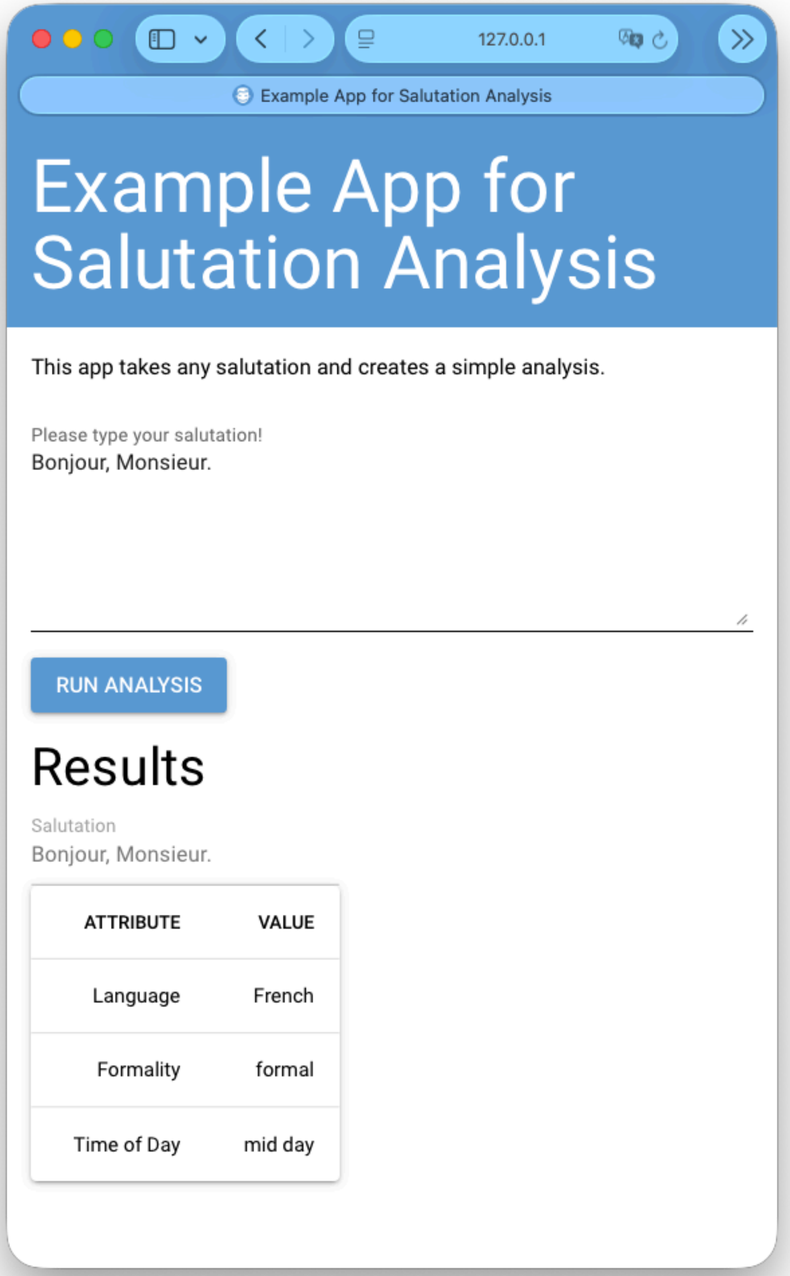
```

AN APP

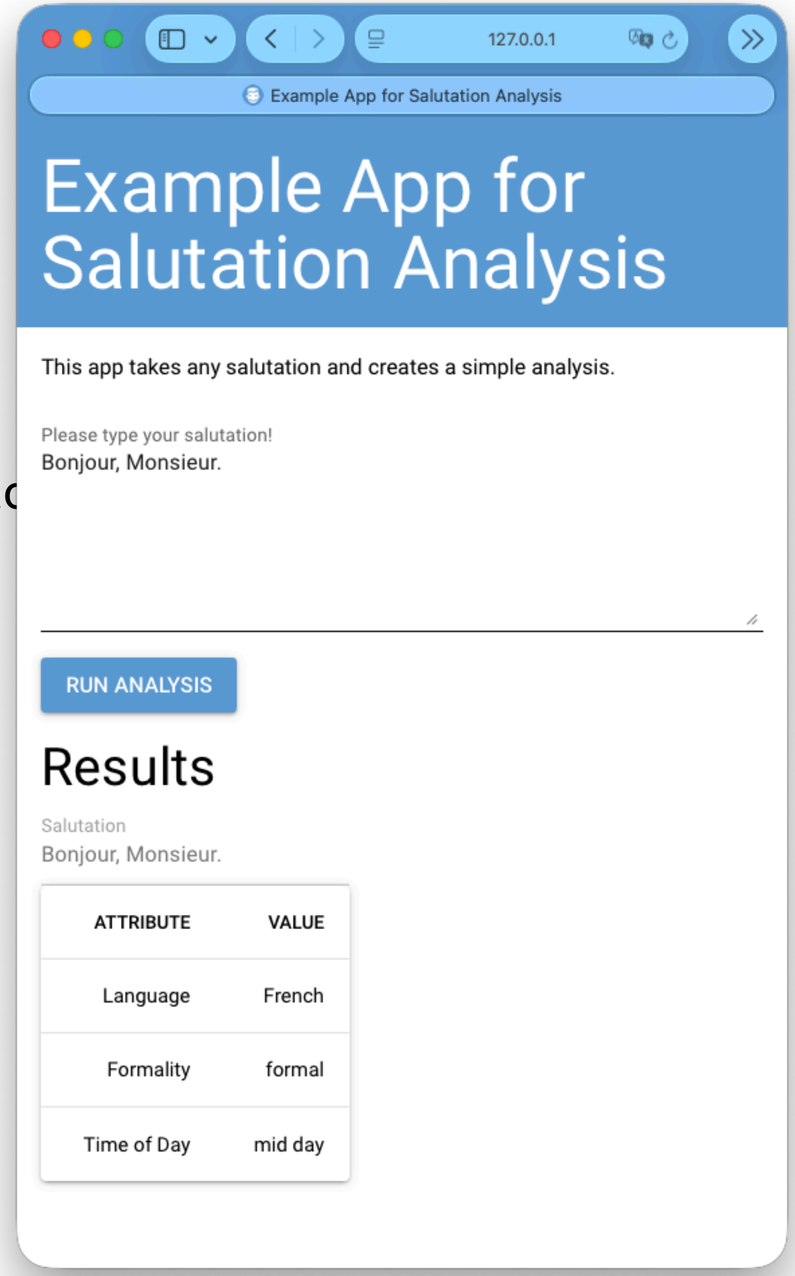

127.0.0.1
Example App for Salutation Analysis
Example App for Salutation Analysis
This app takes any salutation and creates a simple analysis.
Please type your salutation!
Bonjour, Monsieur.
RUN ANALYSIS
Results
Salutation
Bonjour, Monsieur.
ATTRIBUTE
VALUE
Language
French
Formality
formal
Time of Day
mid day

AN APP

- Two files:

AN APP

- Two files:
  - `salutation_analysis.py`
    - Contains the actual analysis process:
    - ```
      async def analyze_salutation(salutation:str) -> Salutatio
          response = await client.responses.parse(
            model="gpt-5-nano",
            ...
            text_format=SalutationAnalysis
          )
          return response.output_parsed
      ```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            ...
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          )
          return response.output_parsed
      ```
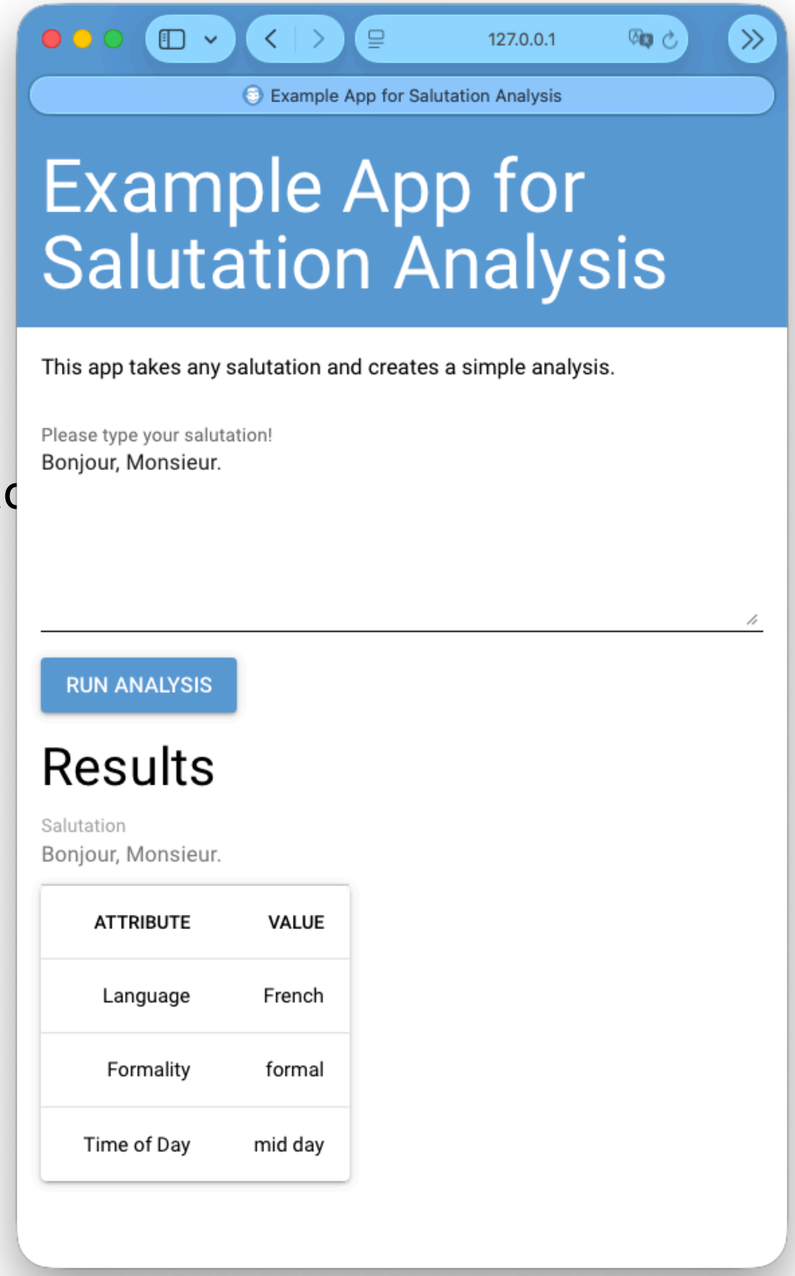
  - `app.py`
    - Contains the NiceGUI interfaces and functions
    - ```
      from salutation_analysis import analyze_salutation

      analysis = await analyze_salutation(salutation)
      ```



VALIDATION

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Use the same actual analysis process as the app (`analyze_salutation` function).

```
from salutation_analysis import analyze_salutation
```

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```python
from salutation_analysis import analyze_salutation

async def single_validation(data_item:dict[str,dict[str,str]|str]) -> tuple[str, str]:
  sal, par = data_item['salutation'], data_item['parameters']
  analysis = await analyze_salutation(sal)

  ground_truth = par['language'], par['formality'], par['time_of_day']
  estimates = analysis.language, analysis.formality, analysis.time_of_day

  return ground_truth, estimates
```

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  estimates = analysis.language, analysis.formality, analysis.time_of_day

  return ground_truth, estimates

await single_validation({
  "parameters": {"language": "English","formality": "informal","time_of_day": "evening" },
  "salutation": "Hey, good evening!"
})
```

VALIDATION

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from salutation_analysis import analyze_salutation

async def single_validation(data_item:dict[str,dict[str,str]|str]) -> tuple[str, str]:
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  ground_truth = par['language'], par['formality'], par['time_of_day']
  estimates = analysis.language, analysis.formality, analysis.time_of_day

  return ground_truth, estimates

await single_validation({
  "parameters": {"language": "English","formality": "informal","time_of_day": "evening" },
  "salutation": "Hey, good evening!"
})
# (('English', 'informal', 'evening'), ('English', 'informal', 'evening'))
```

SOME SCORES

```
import json
from sklearn.metrics import classification_report
```

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```
import json
from sklearn.metrics import classification_report

t_e = []
for d_i in json.load(open(
    "../data_generation/synthetic-data.json"
  )):
  gt, es = await single_validation(d_i)
  t_e.append((ft, es))
```

SOME SCORES

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from sklearn.metrics import classification_report

t_e = []
for d_i in json.load(open(
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classification_report(
  [value for v in t_e for value in v[0]], # ground truth values
  [value for v in t_e for value in v[1]], # estimated values
)
```

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classification_report(
  [value for v in t_e for value in v[0]], # ground
  [value for v in t_e for value in v[1]], # estima
)
```

	precision	recall	f1-score	support
Danish	0.79	0.92	0.85	12
English	1.00	1.00	1.00	17
French	1.00	1.00	1.00	18
German	1.00	1.00	1.00	18
Norwegian	0.91	0.77	0.83	13
Swiss German	1.00	1.00	1.00	22
evening	0.70	1.00	0.82	21
formal	0.26	0.73	0.39	15
informal	0.96	0.96	0.96	28
mid day	0.88	1.00	0.93	28
morning	1.00	0.86	0.93	29
night	1.00	0.59	0.74	22
partner	1.00	0.39	0.56	28
very formal	0.68	0.45	0.54	29
accuracy			0.82	300
macro avg	0.87	0.83	0.83	300
weighted avg	0.88	0.82	0.82	300

FREQUENT ERRORS

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- Language
  - *truth → estimate (count)*
  - Norwegian → Danish (3)
  - Danish → Norwegian (1)

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- Language
  - *truth → estimate (count)*
  - Norwegian → Danish (3)
  - Danish → Norwegian (1)
- Time of Day
  - night → evening (9)
  - morning → mid day (4)

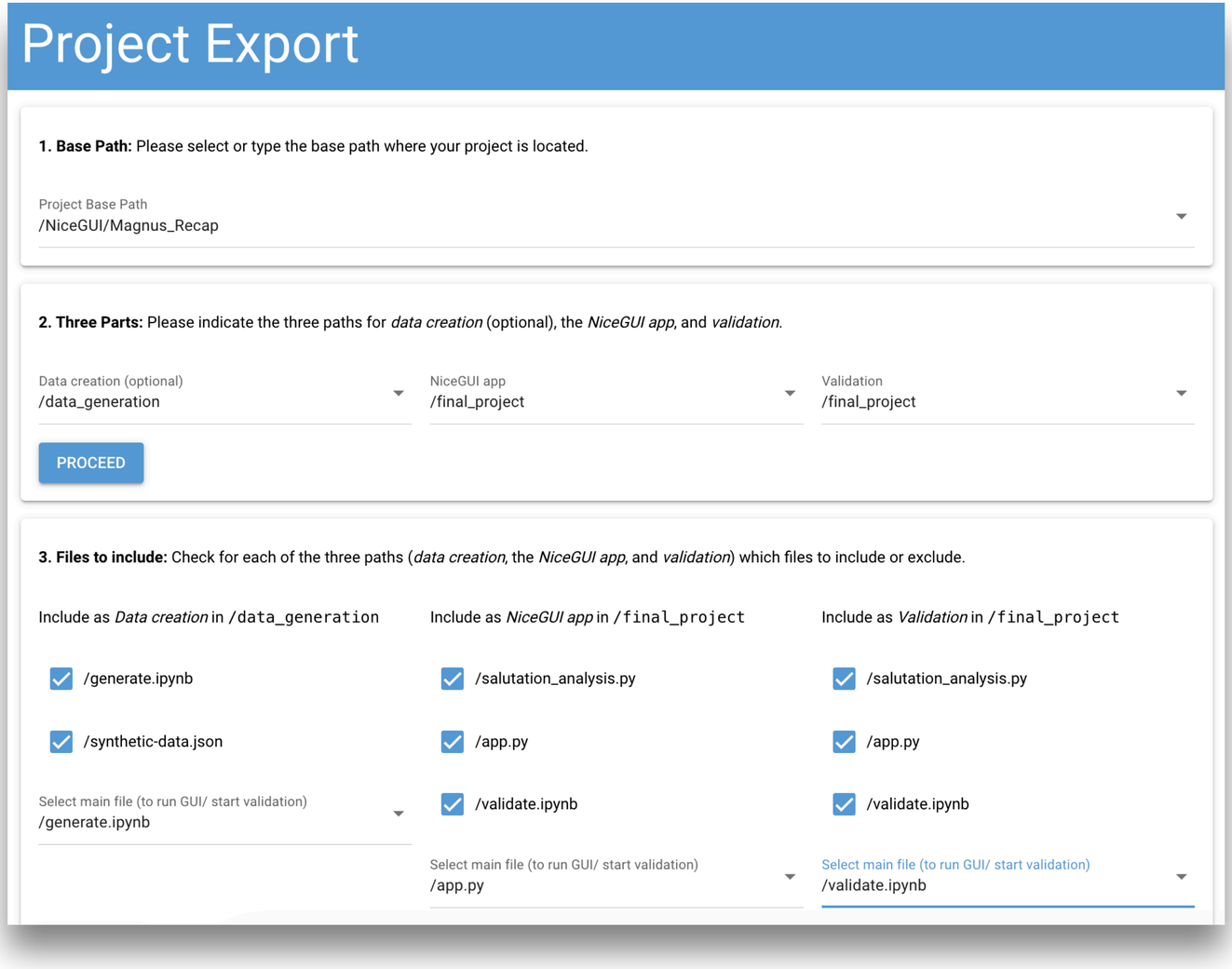
FREQUENT ERRORS

- Language
  - *truth → estimate (count)*
  - Norwegian → Danish (3)
  - Danish → Norwegian (1)
- Time of Day
  - night → evening (9)
  - morning → mid day (4)

- Formality
  - very formal → formal (16)
  - partner → formal (14)
  - formal → very formal (3)
  - partner → very formal (3)
  - informal → formal (1)
  - formal → informal (1)

EXPORT APP

- Exemplary export of salutation app on uCloud.



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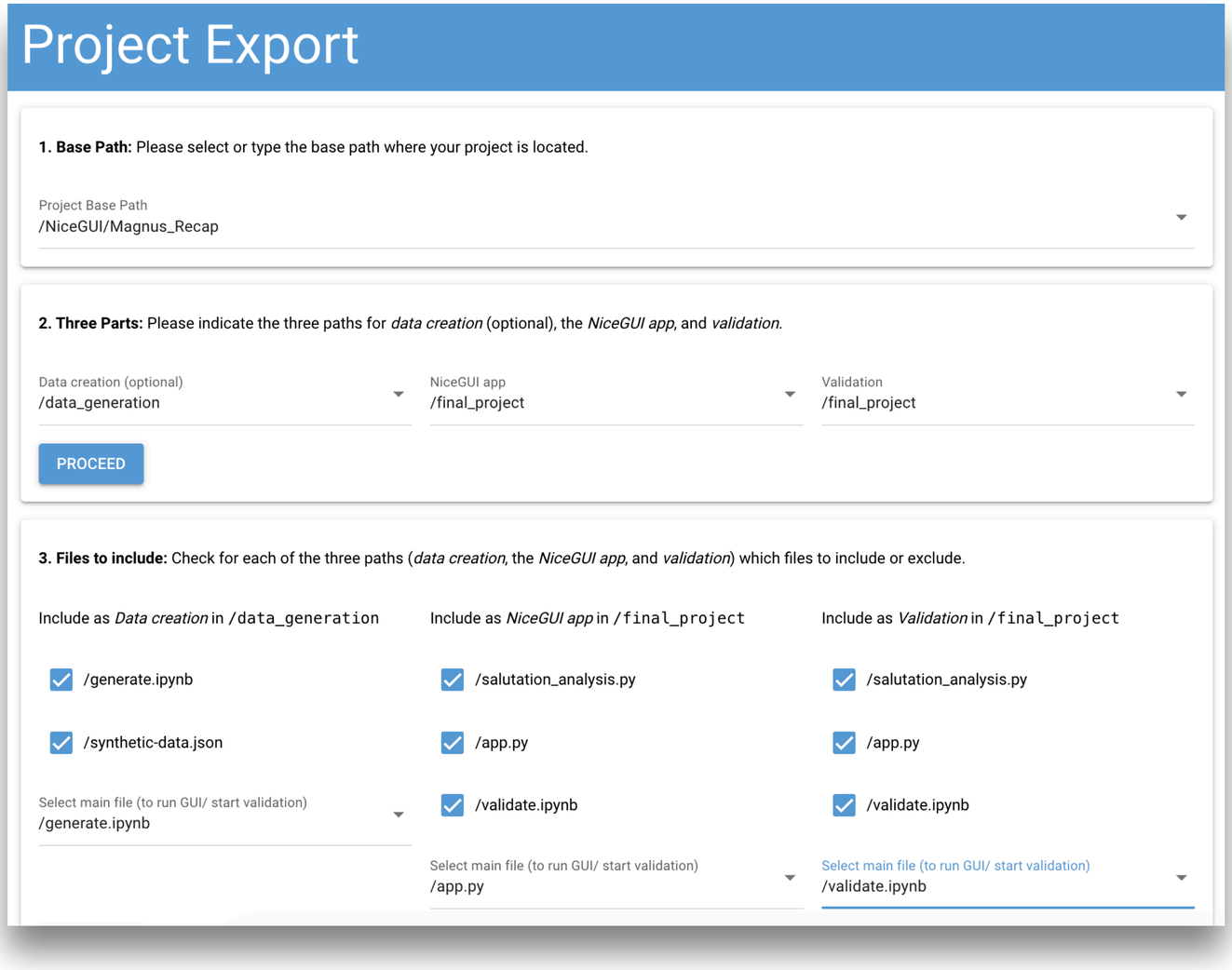
- Exemplary export of salutation app on uCloud.
- Salutation app has only two folders:



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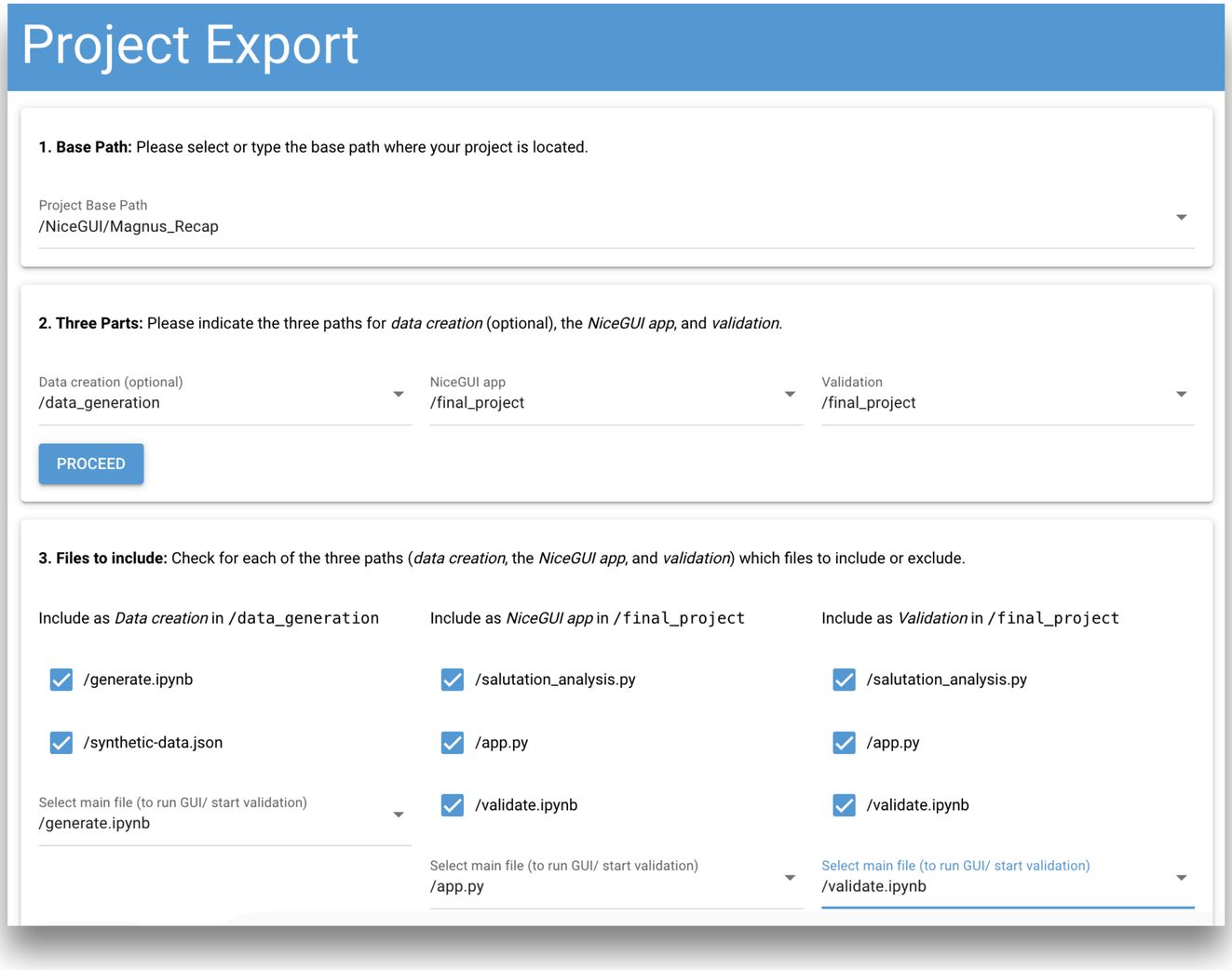
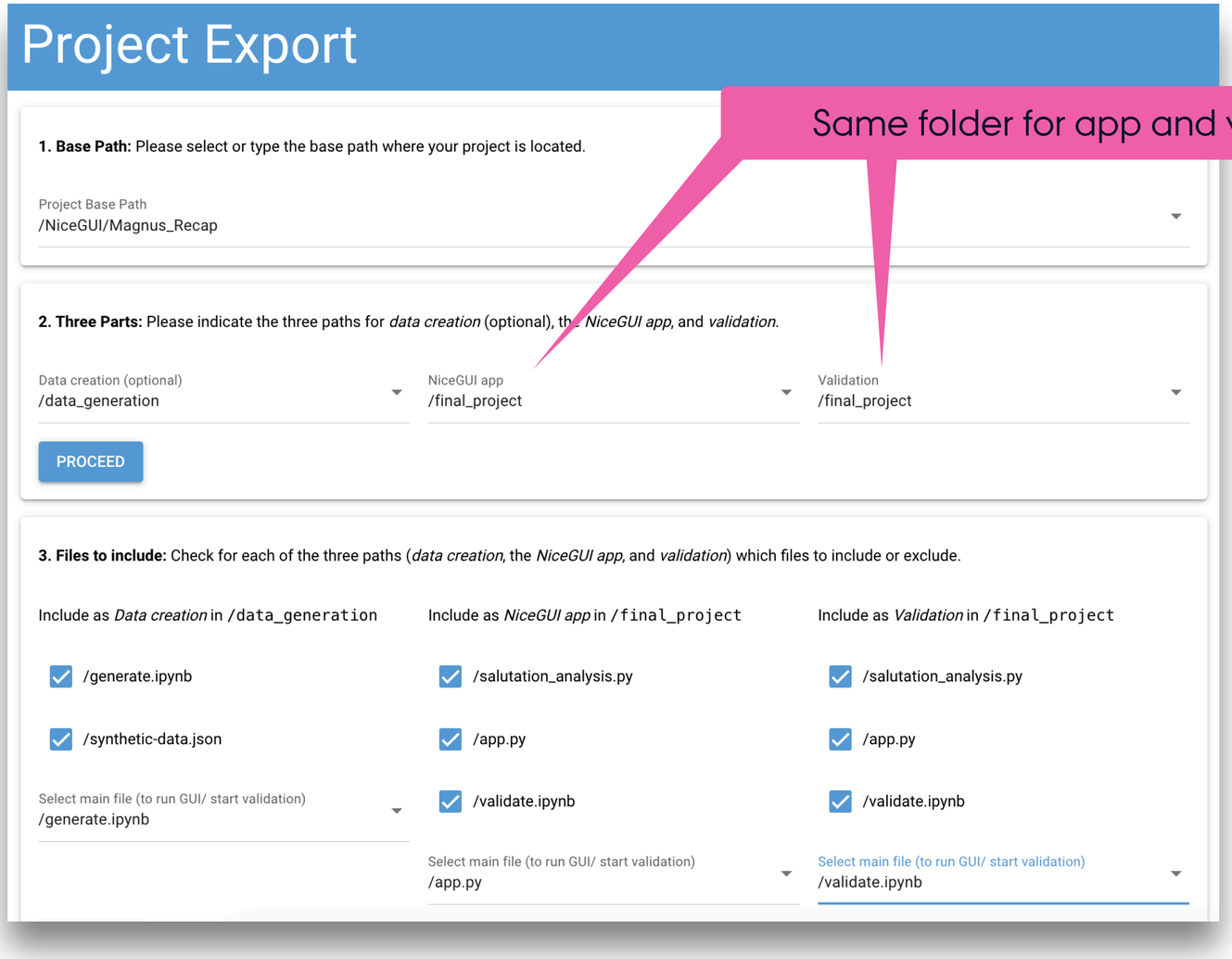
- Salutation app has only two folders:
  - `data_generation`
    - Data and generation notebook



EXPORT APP

- Exemplary export of salutation app on uCloud.
- Salutation app has only two folders:
  - `data_generation`
    - Data and generation notebook
  - `final_project`
    - App and validation code



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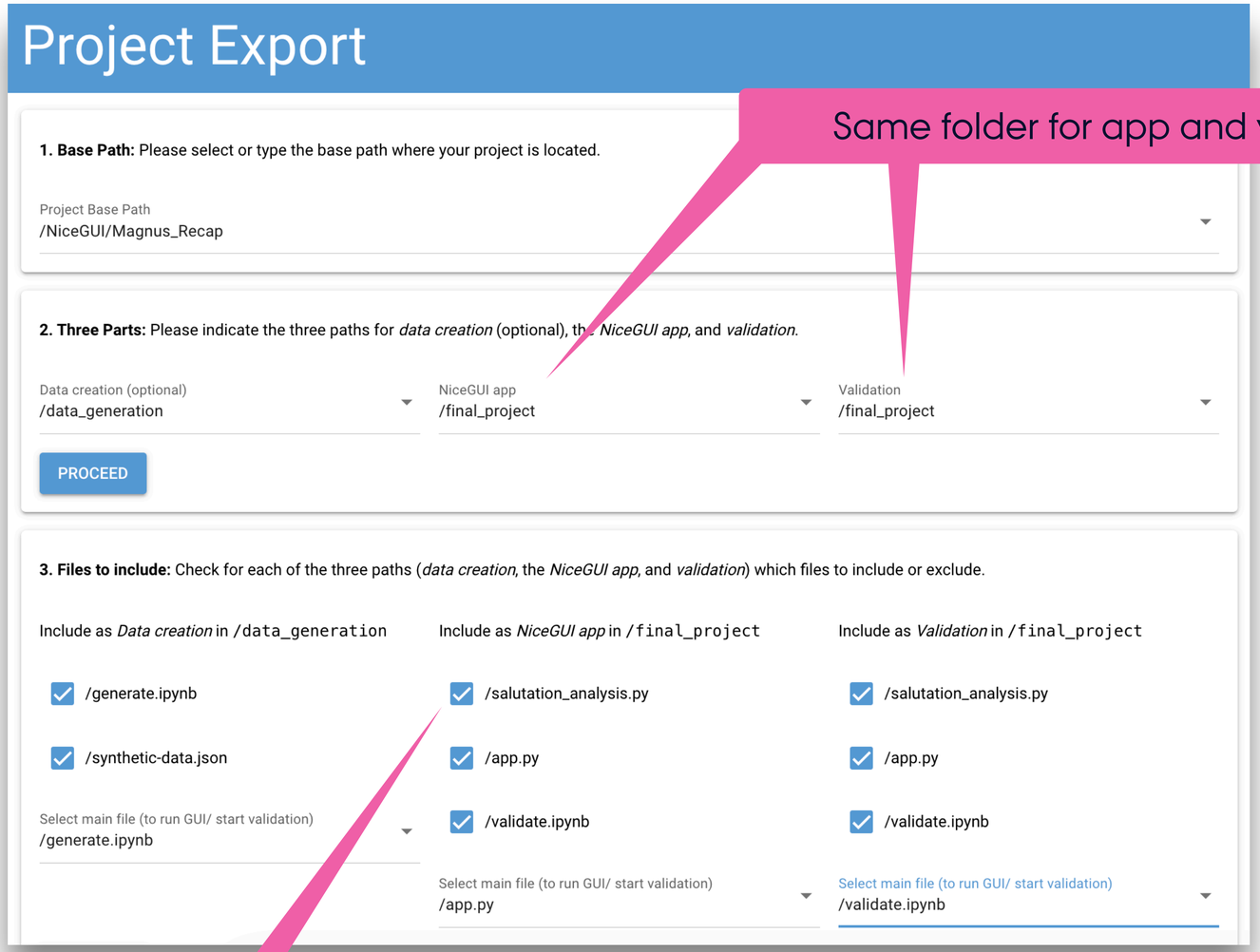
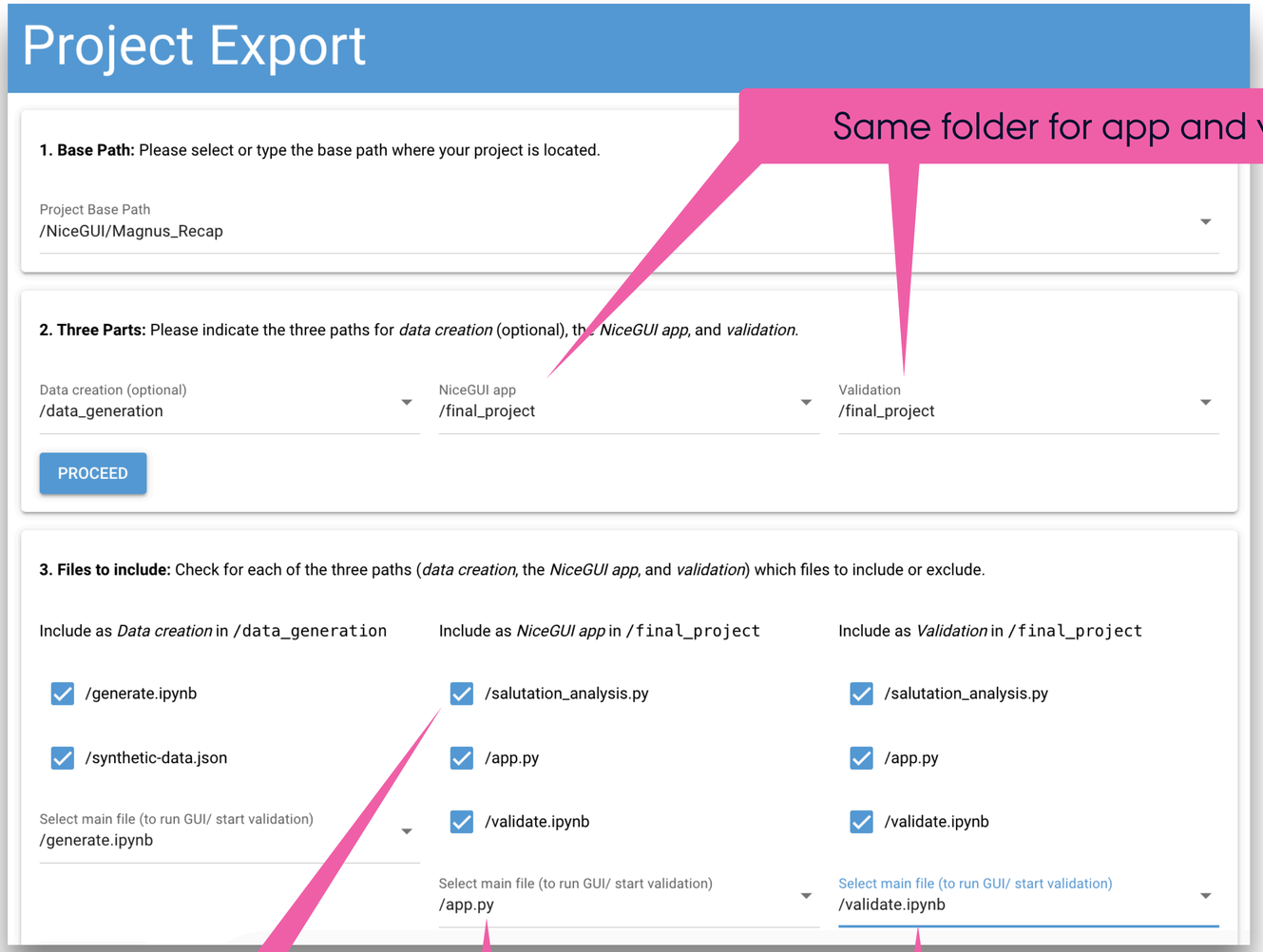


Same folder for app and validation

Python script containing analysis code is used by app and validation

EXPORT APP

- Exemplary export of salutation app on uCloud.
- Salutation app has only two folders:
  - `data_generation`
    - Data and generation notebook
  - `final_project`
    - App and validation code



Same folder for app and validation

Python script containing analysis code is used by app and validation

Different main files for app and validation

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- Each validation will be different!
  - Depending on the use-case, you need to evaluate in different settings and need different approaches to be able to calculate scores.
  - Don’t worry about the actual values of your scores, we do not grade based on them!

TEACHING EVALUATION

AARHUS BSS
DEPARTMENT OF MANAGEMENT
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5. December 2025

Magnus Bender
Assistant Professor

TEACHING EVALUATION

Thank you for your feedback and comments!

AARHUS BSS
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  - Nice ideas like 1-1 consultations with us
- Coding and technical skills
  - Difficult to change: Right now the aim is that you have to program something
  - Consider while revising course description
  - More classic/ detailed „Introduction to programming“ difficulty to fully fit in

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