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Beyond Scripting

A Beginner’s Guide to Accelerating Automation with Executables

www.mainanalytics.de

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…on a calm Friday afternoon

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...on a calm Friday afternoon

Colleague

Michel

Are you still working?

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Reference[1]

…on a calm Friday afternoon

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Are you still working?

… say no

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Are you still working?

Yes, sure.
How can I help you?

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Do you know how to easily merge PDFs?

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.. also, not many—just about ~1,000

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How can I help you?

… say **NO**

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… let me *think* one second about it…

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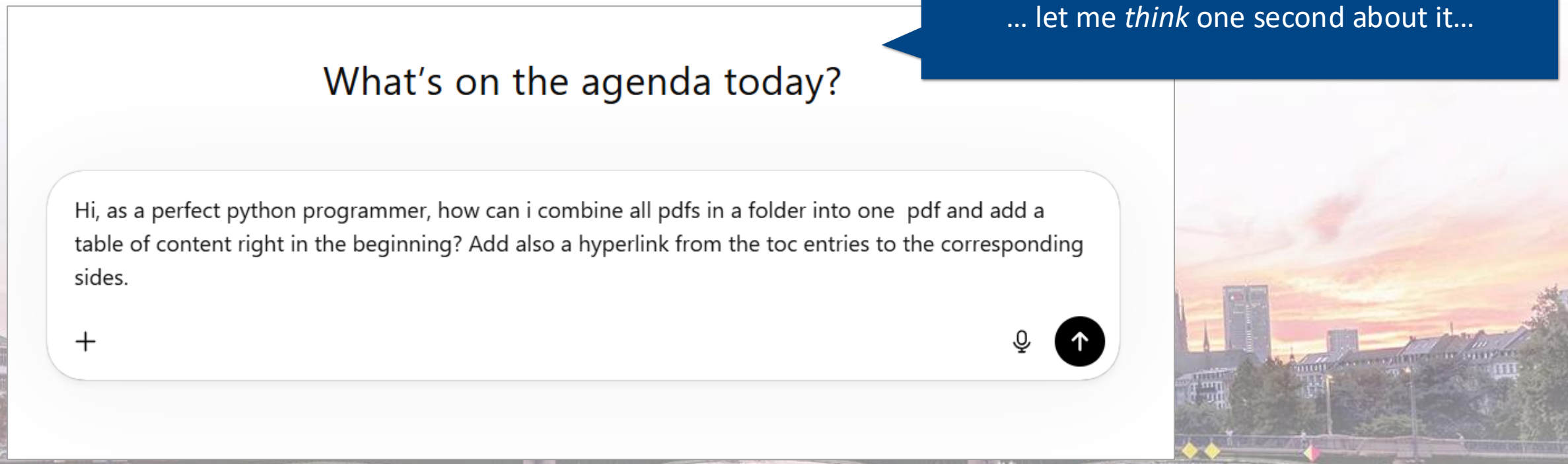
...so, what to do?



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…so, what to do?

You can absolutely do this in Python—but it's a bit more involved than just merging PDFs because:

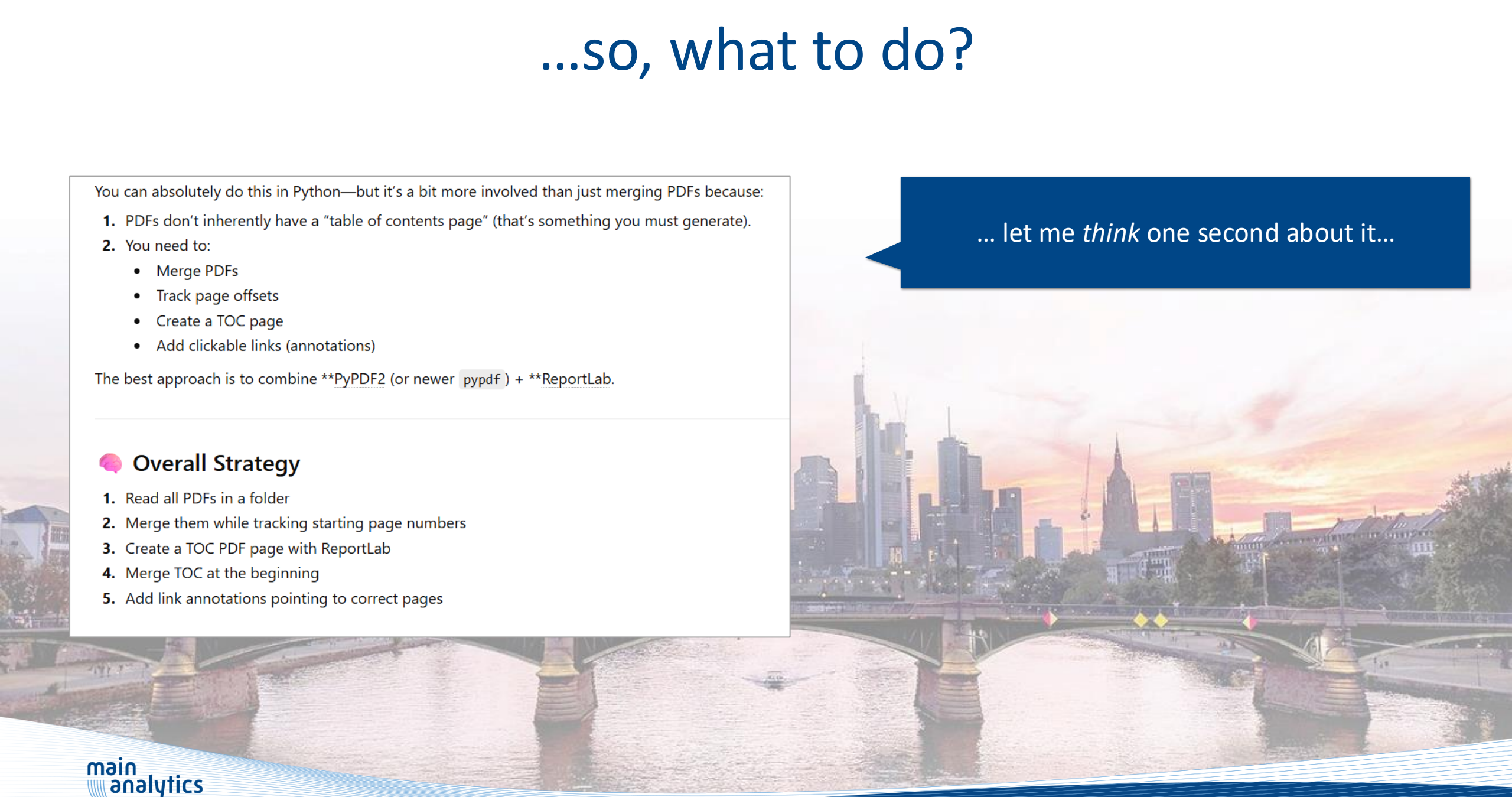
1. PDFs don't inherently have a "table of contents page" (that's something you must generate).
2. You need to:
   - Merge PDFs
   - Track page offsets
   - Create a TOC page
   - Add clickable links (annotations)

The best approach is to combine **PyPDF2 (or newer `pypdf`) + **ReportLab.

🧠 Overall Strategy

1. Read all PDFs in a folder
2. Merge them while tracking starting page numbers
3. Create a TOC PDF page with ReportLab
4. Merge TOC at the beginning
5. Add link annotations pointing to correct pages

… let me *think* one second about it…



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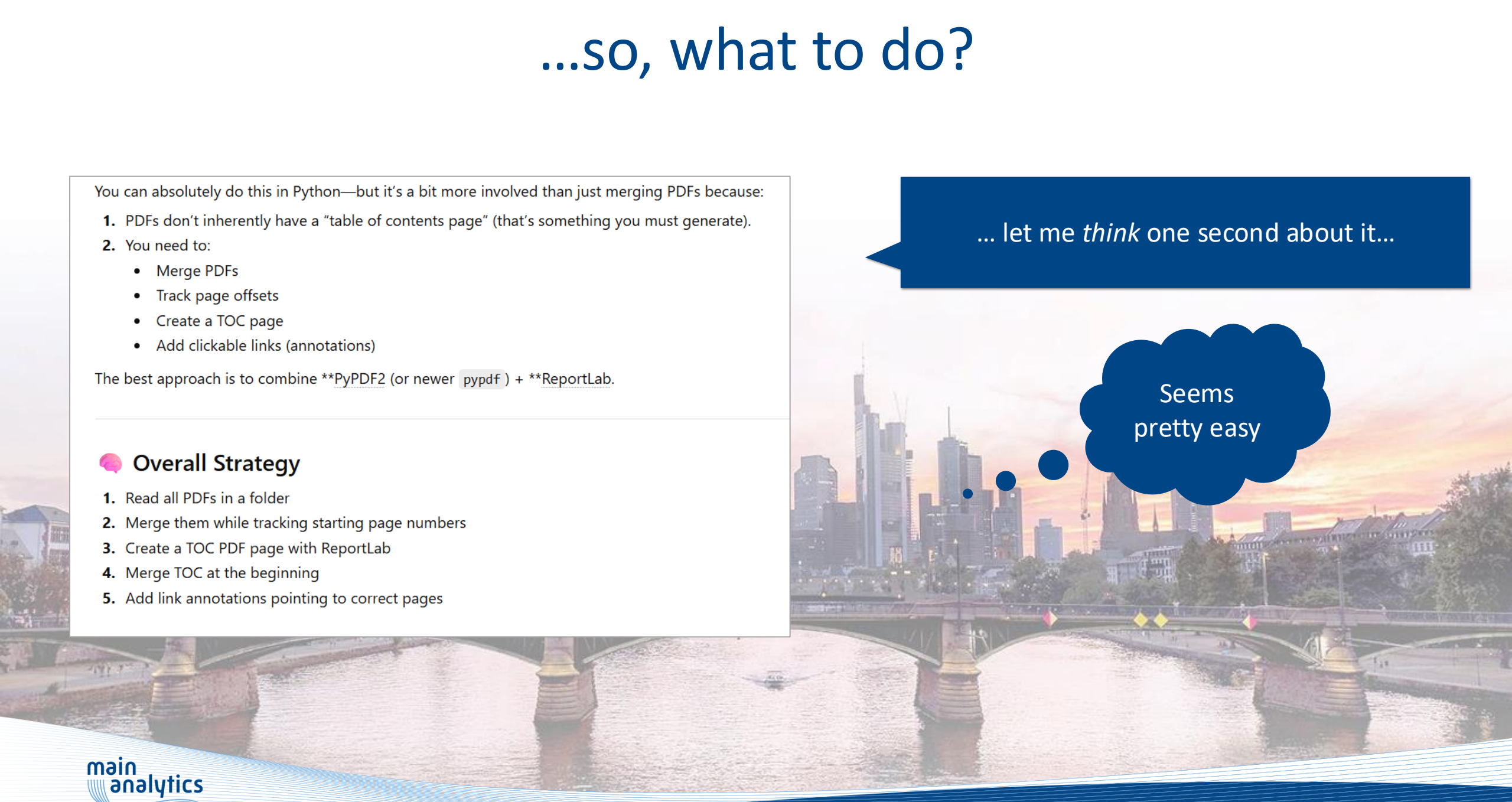
Seems pretty easy



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The solution (almost)...

✅ Full Working Example

Install dependencies:

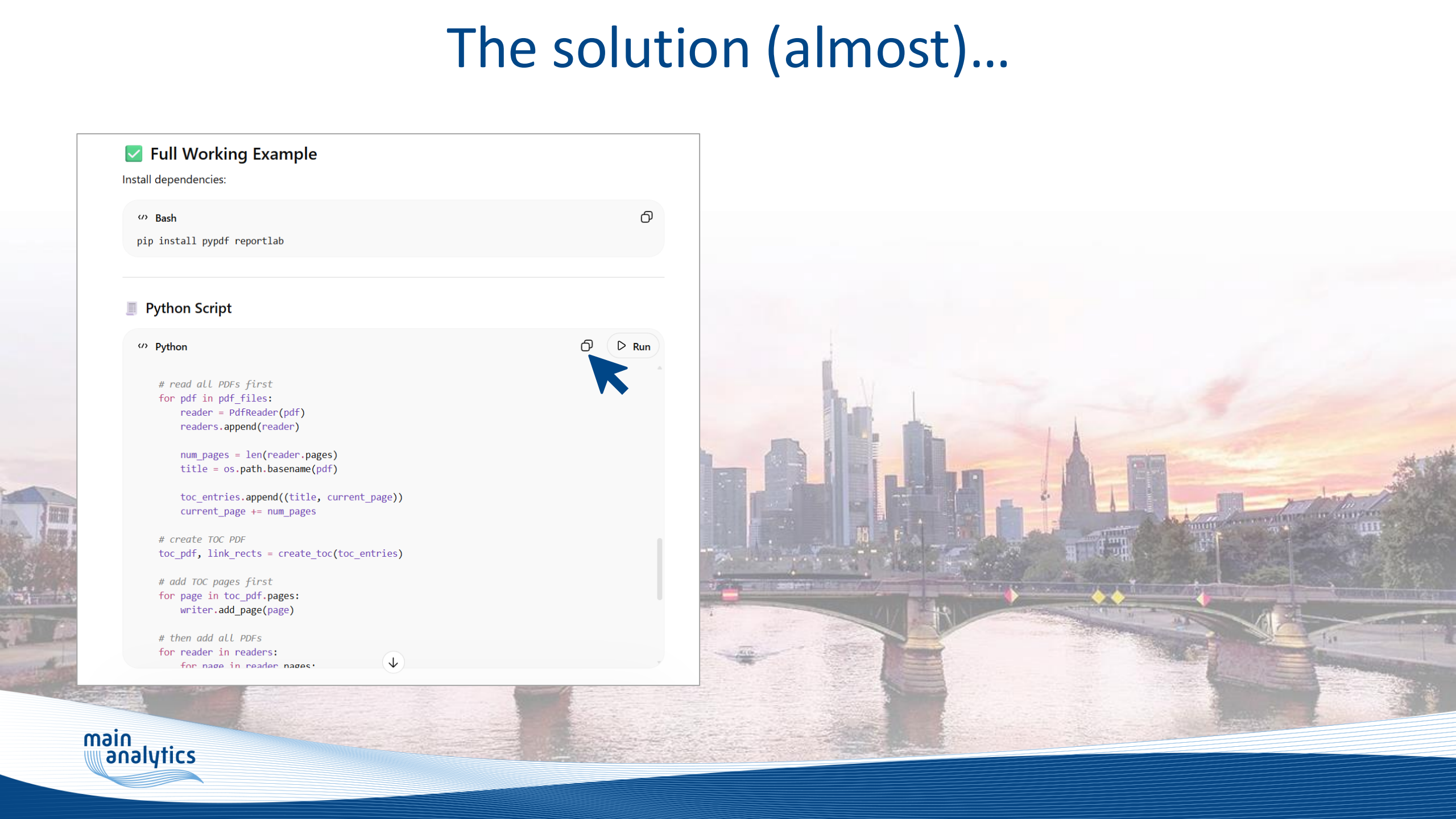
Bash

```
pip install pypdf reportlab
```

Python Script

Python Run

```
    # read all PDFs first
    for pdf in pdf_files:
        reader = PdfReader(pdf)
        readers.append(reader)

        num_pages = len(reader.pages)
        title = os.path.basename(pdf)

        toc_entries.append((title, current_page))
        current_page += num_pages

    # create TOC PDF
    toc_pdf, link_rects = create_toc(toc_entries)

    # add TOC pages first
    for page in toc_pdf.pages:
        writer.add_page(page)

    # then add all PDFs
    for reader in readers:
        for page in reader.pages:
```



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    # then add all PDFs
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        for page in reader.pages:
```

... the problem

- pdfs are on a sponsor's system
- only SAS is available

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The solution (for real) …

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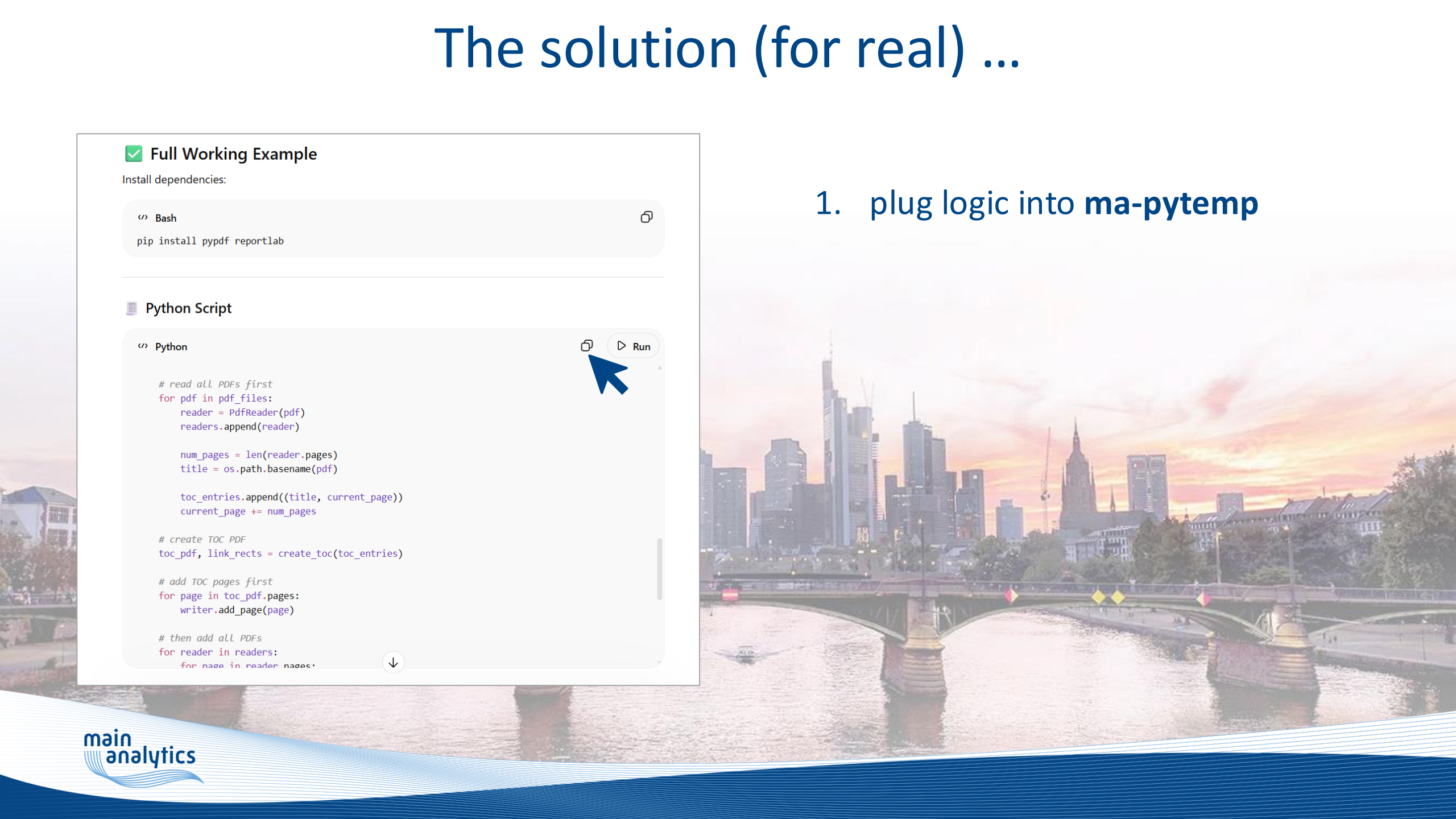
1. plug logic into **ma-pytemp**



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The solution (for real) …

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        for page in reader.pages:
```

1. plug logic into **ma-pytemp**
2. build **executable** and deploy

ma_pdf-compiler.exe

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…1 hour later

You’re the best

I created this executable:
path/to/**ma_pdf-compiler.exe**

just click on it

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Reference[1]

… on a beautiful Friday evening

Executables – What and Why?

self-sustained programs	no further dependencies no installation
unlocking the power of	high-level languages libraries rest of the world
for all environments	GxP SCE
complexity overhead	develop build deploy
abstract complexity	standardize template prebuild focus on automation

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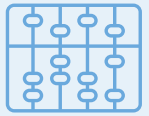
Executables – What?

Simple answer

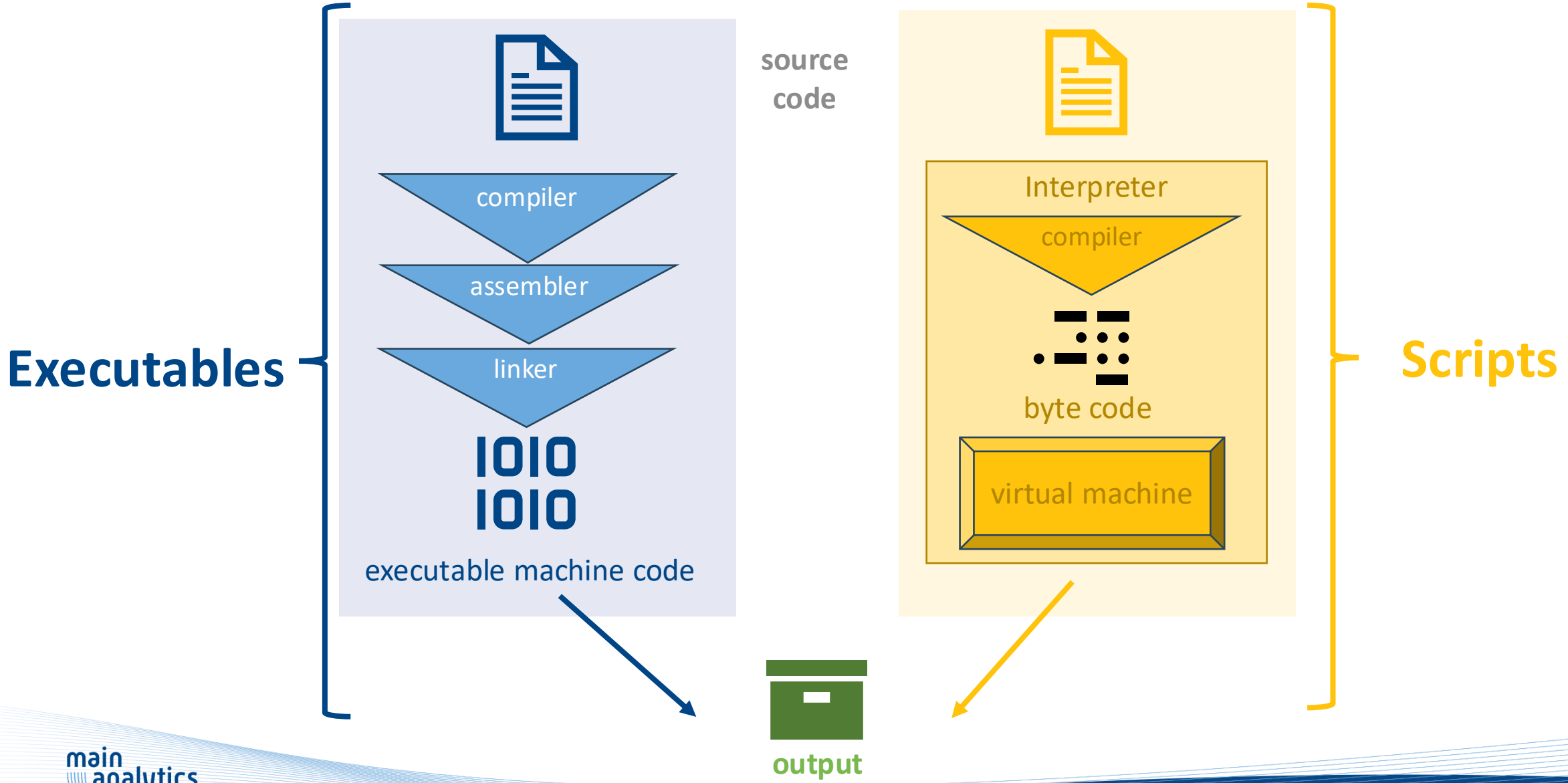
- .exe
- “click and play”



Detailed Answer

- program without needing further compilation
- **machine code** specific to CPU architecture operation system
- **deliverable** of software engineering

Executables vs. Scripts



Executables – Why?

- Many common languages are interpreted
  Java, Python, R, C#,…
- Require “extra” software -> often not available

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Why not using what is already available?

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- Many common languages are interpreted
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- Require “extra” software -> often not available

Why not using what is already available?

→ unleash the internet

→ unleash AI

Challenges of Executables

Programming language	Dependency management	User Interface (Framework)	Adaptivity
Hard coded resources	Robustness	Error & Exception handling	IO
User feedback	Logging	Unit Testing	Validation
Version control	Build	Building machine vs. target machine	Deployment

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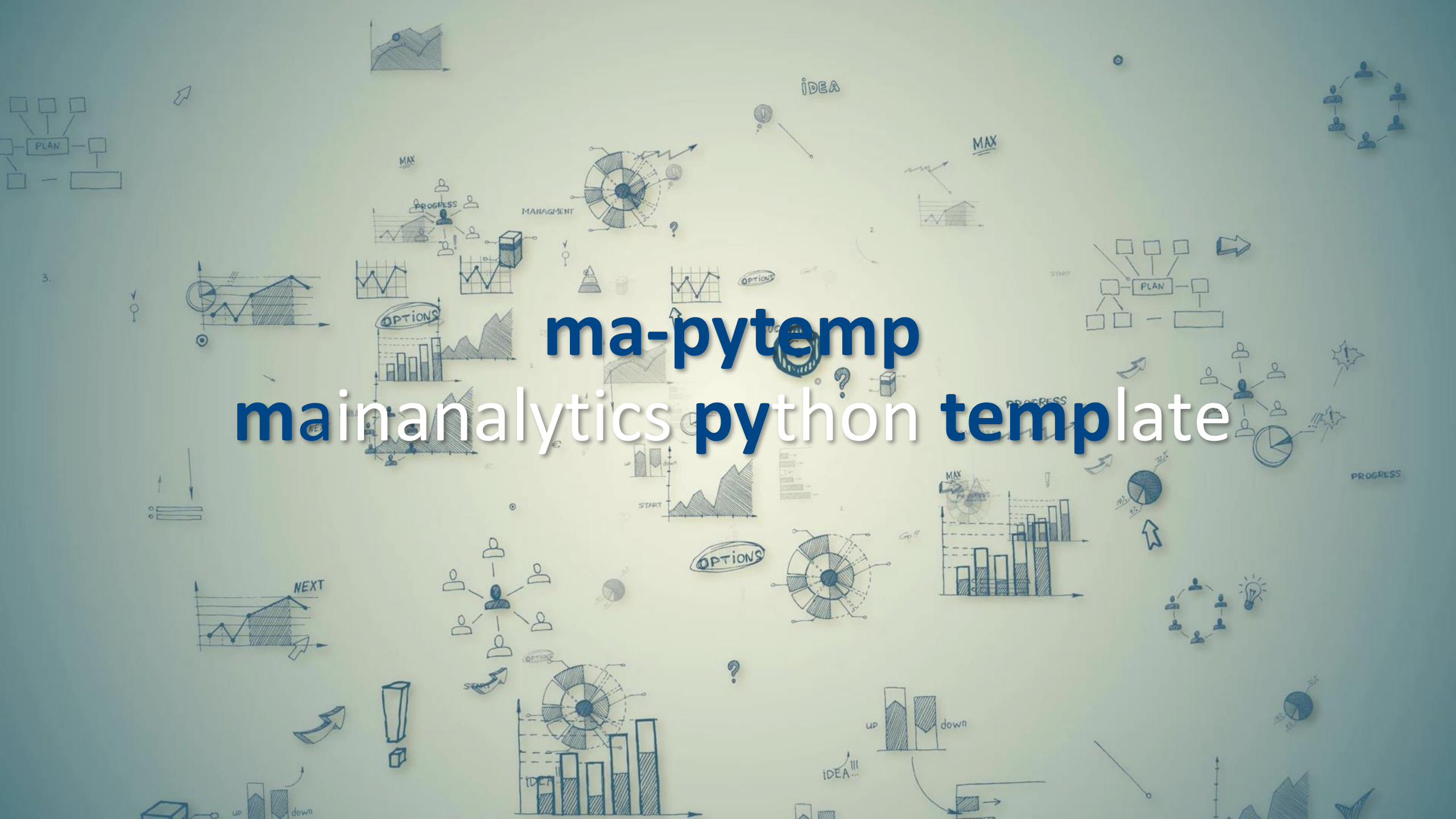
Executables as Tools in Statistical Programming

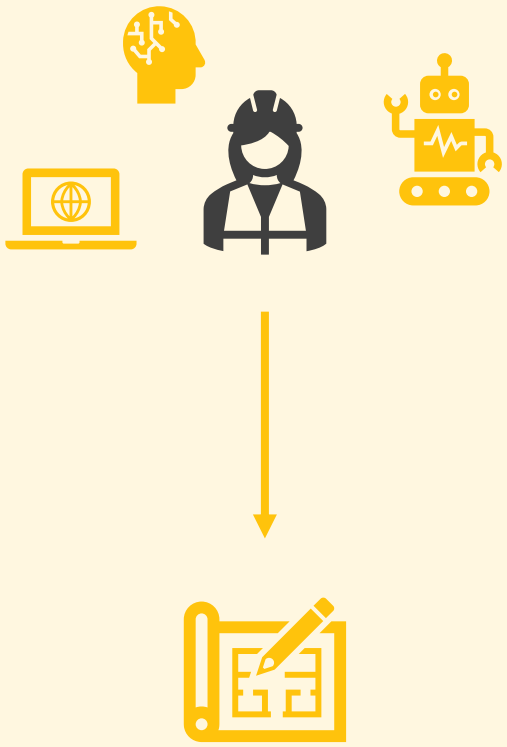
powerful and modern
even for GxP environments

high **development complexity**
for the “box” around although
core logic often **simple**


ma-pytemp
mainanalytics python template

ma-pytemp: Idea

ma-pytemp: Idea



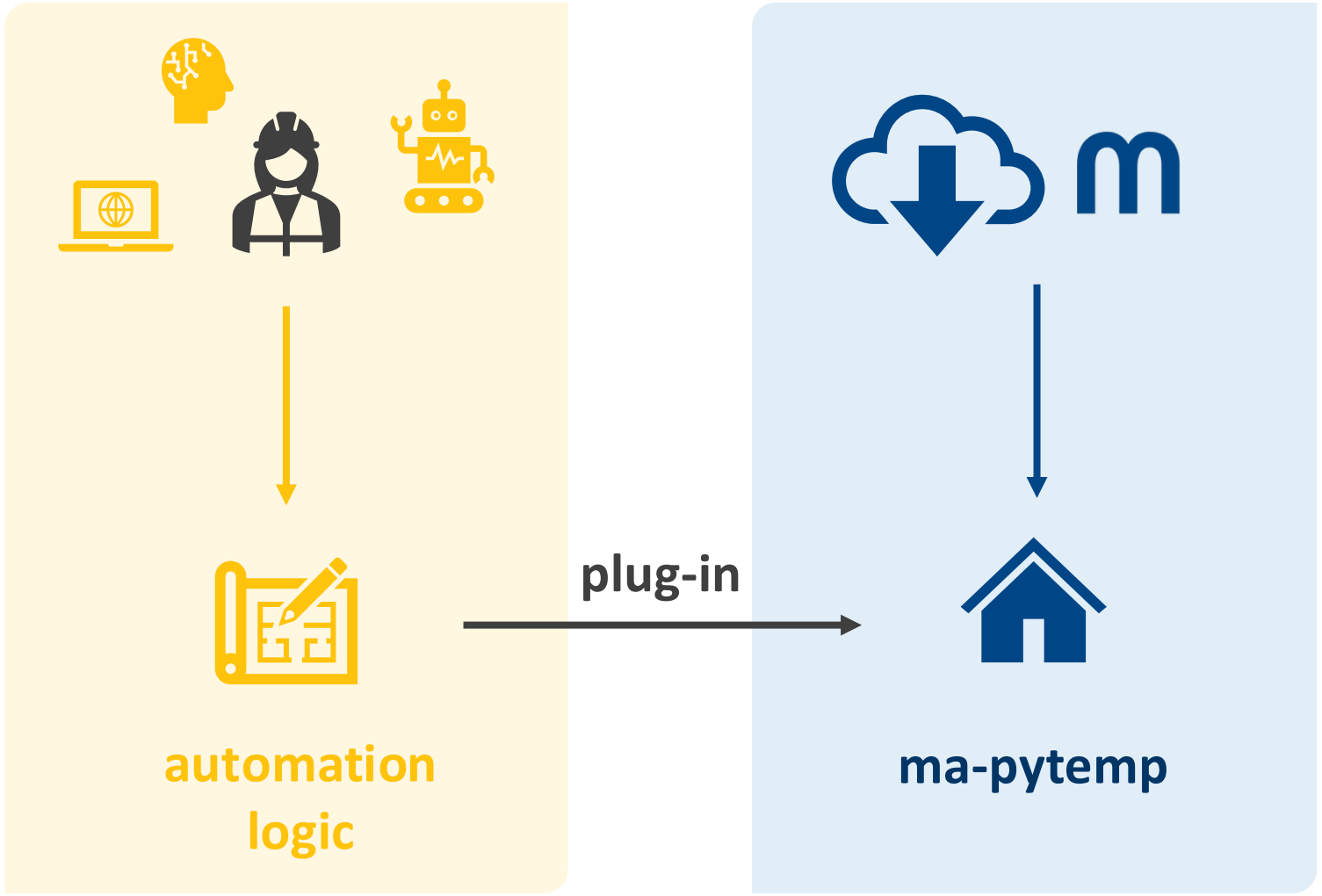
→ **search for solutions**

- Libraries
- Repos
- Internet

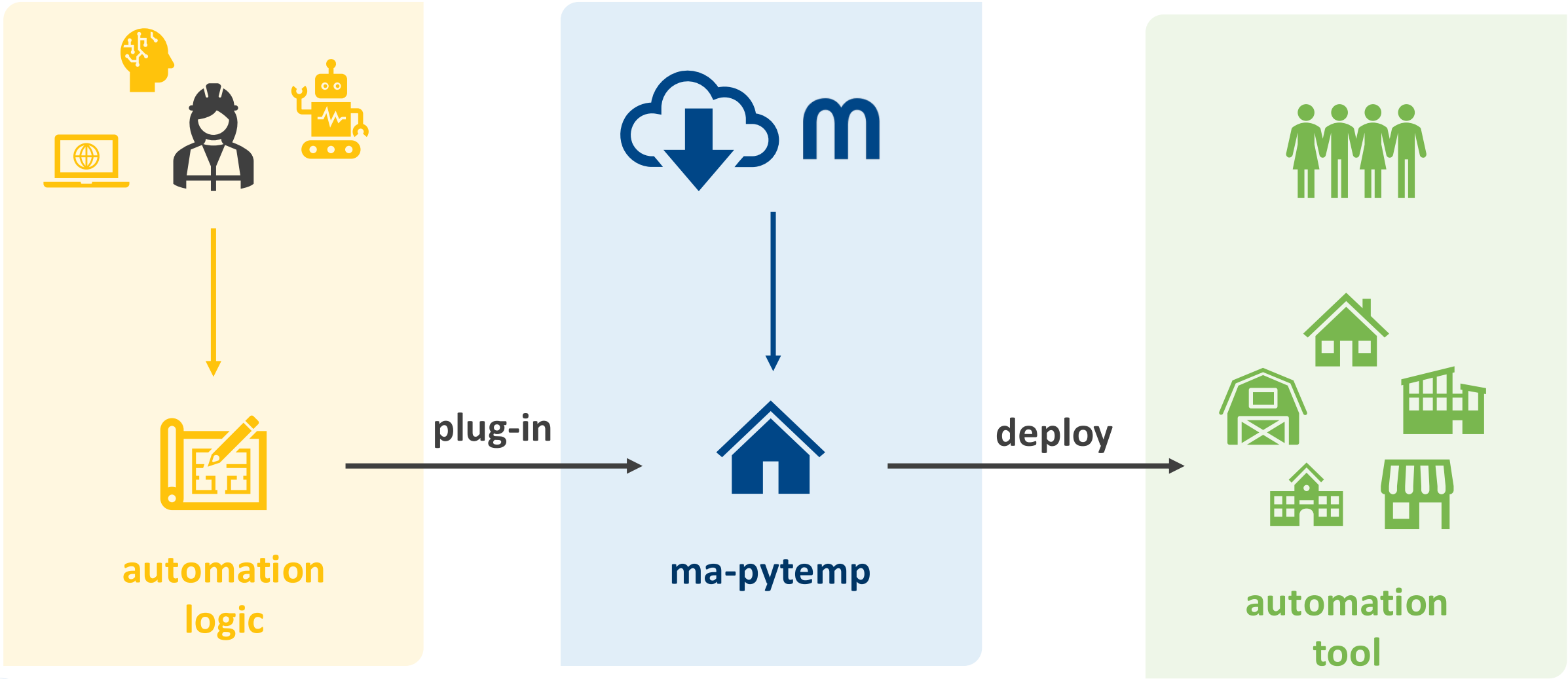
→ **Vibe-coding**

→ **Use your own skills**

ma-pytemp: Idea



ma-pytemp: Idea



ma-pytemp: Features

Key features	Python
	Dependency & Project Management
	GUI Framework
	Structured architecture
	Logging
	Adaptability
	Validation
	CICD

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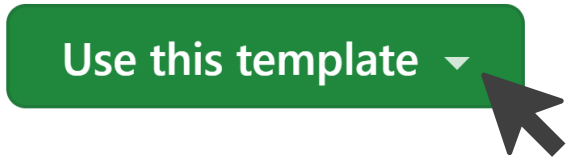
More features

- Template git repository
- Version control
- Documentation
- Basic code quality
- Customization
- .ico creation
- multi-threading
- …

how to use ma-pytemp?

1



https://github.com/mainanalytics

how to use ma-pytemp?

1

Use this template

https://github.com/mainanalytics

2

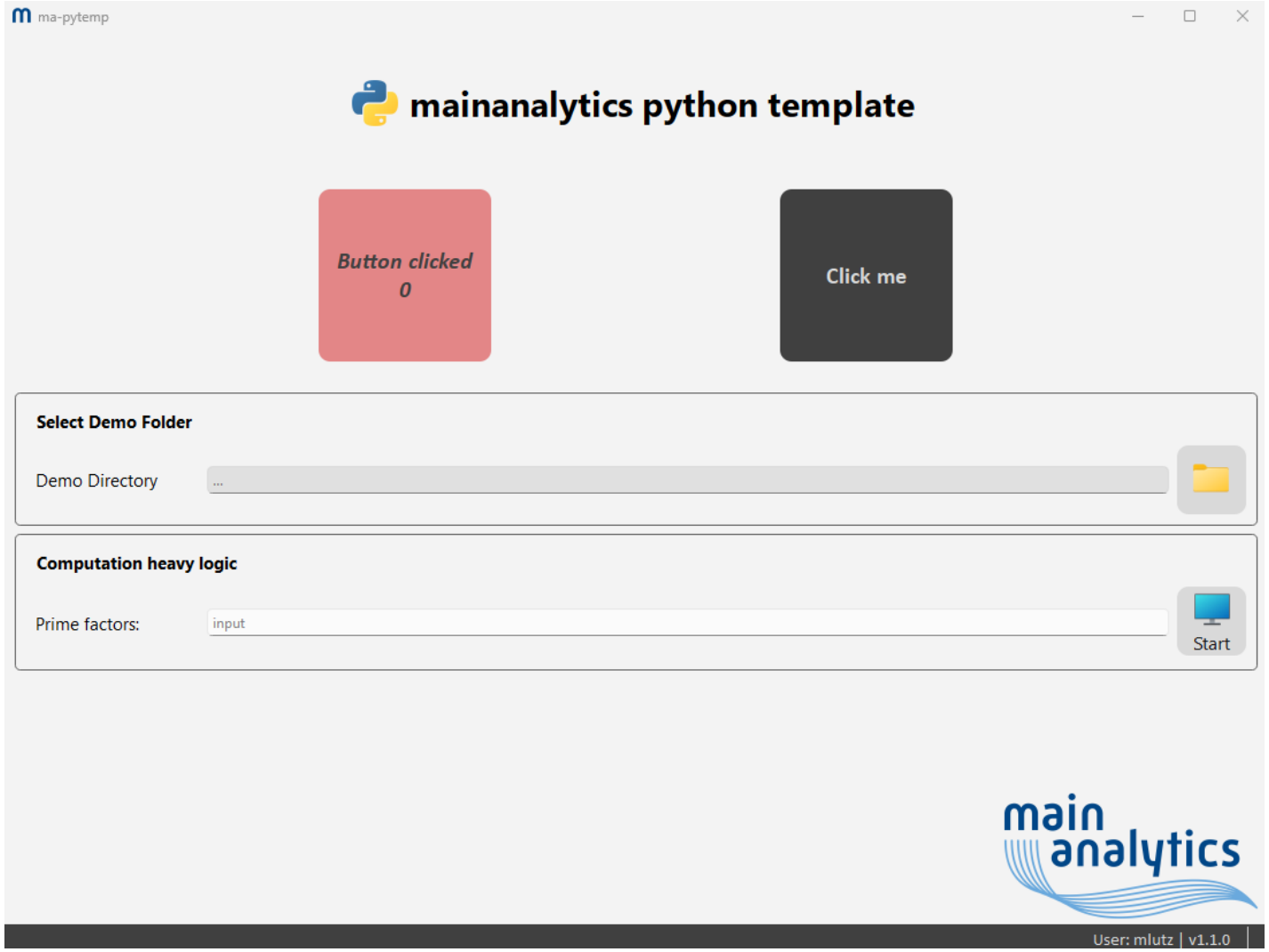
Poetry

initialize project
create VENV
install dependencies
...

- C:\Users\mlutz> cd ma-pytemp
- C:\Users\mlutz> poetry install

User Interface

Graphical User Interface

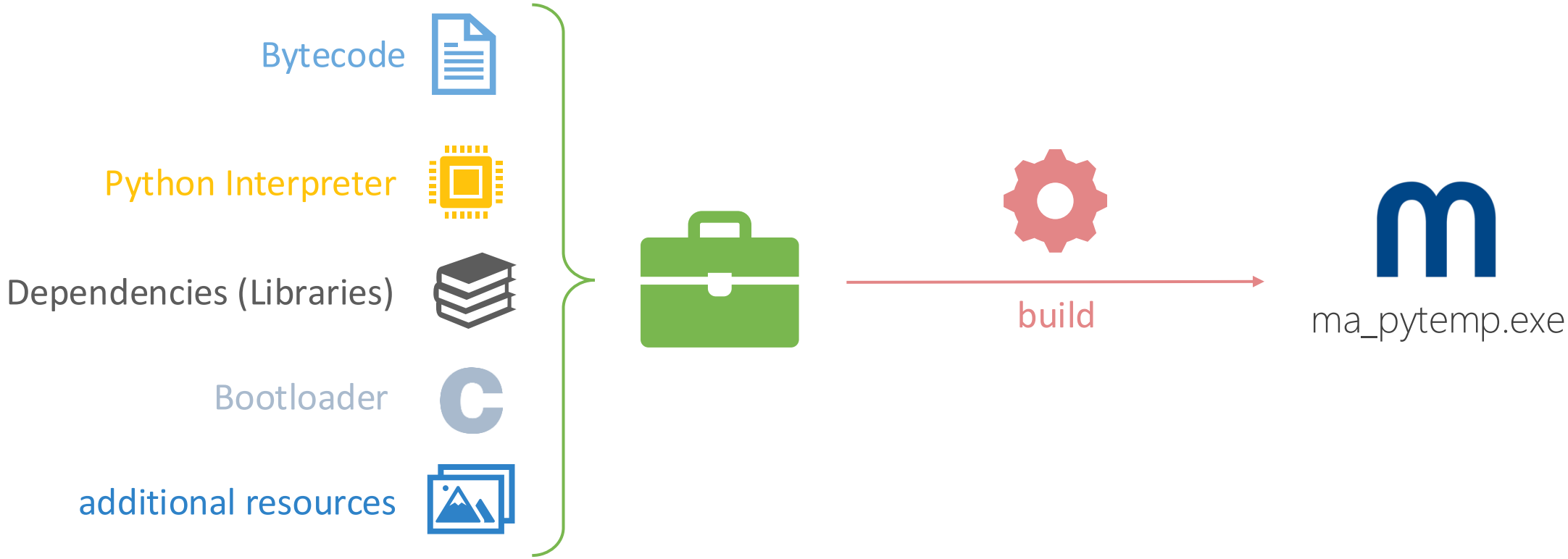


Build

build

creating the executable

I'm packing my suitcase



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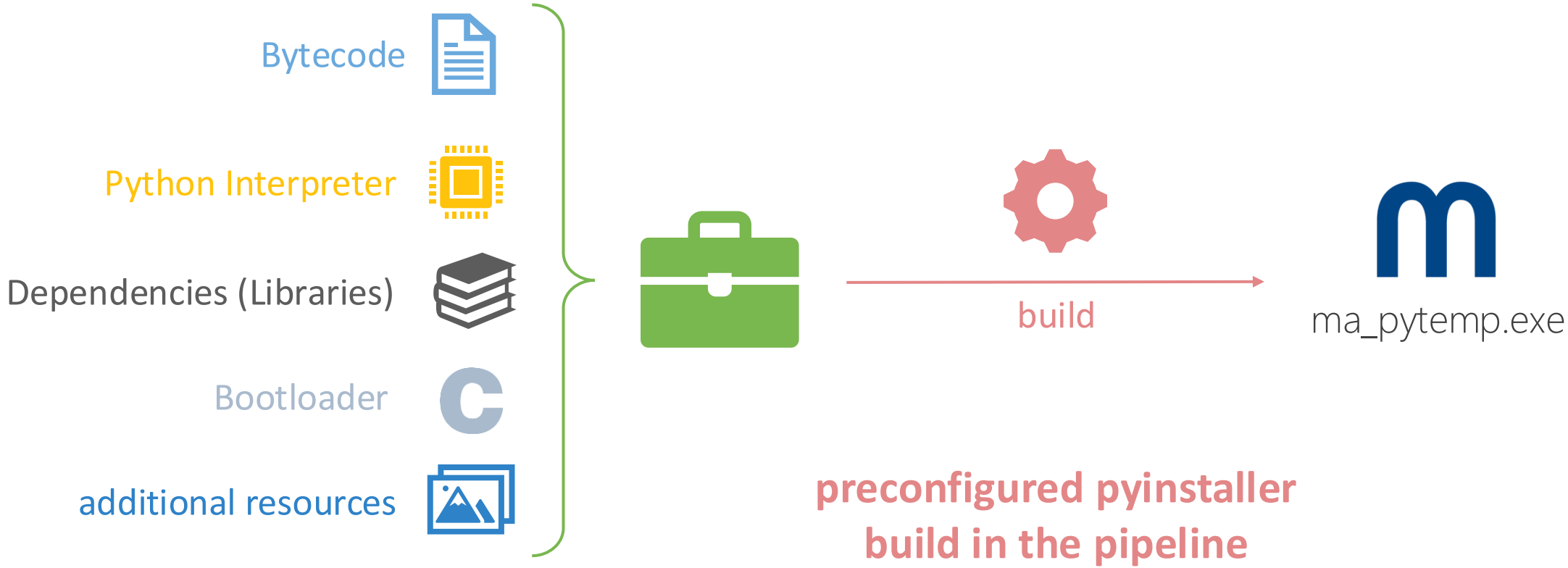


preconfigured pyinstaller build in the pipeline

Deployment

ma-pytemp: Deployment

predefined CICD workflow

pytest

Ruff

Pylint

Star your Python code!

ma-pytemp: Workflow

Workflow file for this run

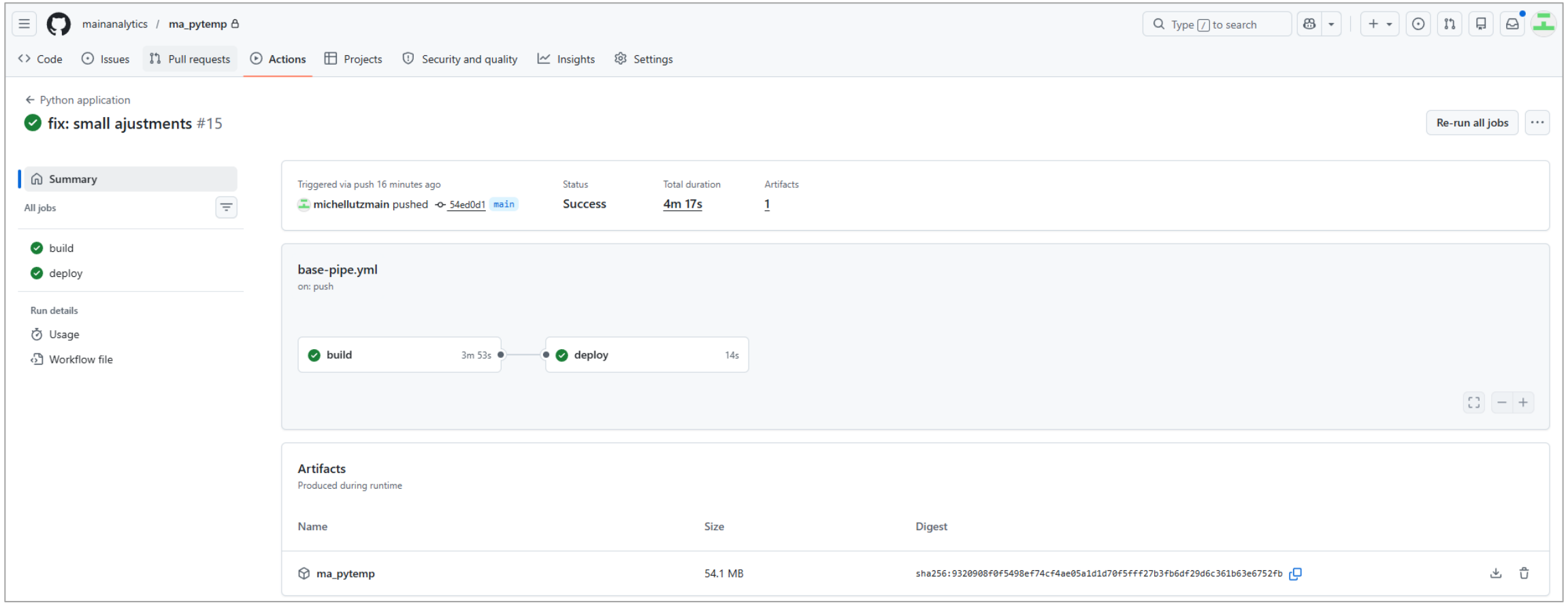
.github/workflows/base-pipe.yml at 84d487c

```yaml
# This workflow will install Python dependencies, run tests and lint with a single version of Python
# For more information see: https://docs.github.com/en/actions/automating-builds-and-tests/building-and-testing-python

name: Python application

on:
  push:
    branches:
      - main
      - dev
  pull_request:
    branches:
      - main
      - dev

permissions:
  contents: read

jobs:
  build:
    strategy:
      fail-fast: false

    runs-on: windows-latest

    steps:
    - name: Checkout code
      uses: actions/checkout@v5

    - name: Set up Python 3.13.12
      uses: actions/setup-python@v6
      with:
        python-version: "3.13.12"


    - name: Install poetry
      run: |
        python -m ensurepip
        python -m pip install --upgrade pip
        python -m pip install poetry
```

[Workflow runs · mainanalytics/ma_pytemp]

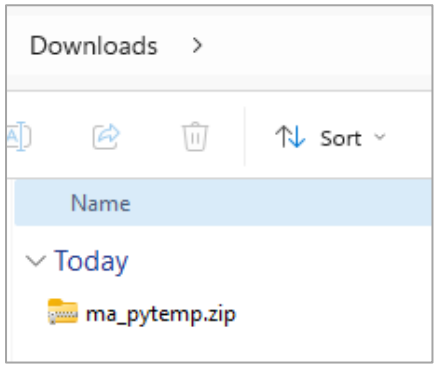
```yaml
    - name: Install dependencies with Poetry
      run:  poetry install --with dev

    - name: Set PYTHONPATH to include the source directory
      run: echo "PYTHONPATH=$PWD/src/ma_pytemp" >> $GITHUB_ENV

    - name: Formatter
      run: poetry run ruff format

    - name: Lint with pylint (fail on warnings/errors)
      run: poetry run pylint src/

    - name: Unit Test and report creation
      run: poetry run pytest

    - name: Build executable
      run: poetry run pyinstaller -y main_standard.spec

    # Upload the compiled executable
    - name: Upload artifacts
      uses: actions/upload-artifact@v7
      with:
        name: ma_pytemp
        path: |
          dist/
          config/
          validation_report/
        retention-days: 10

    # Show artifact id and store in enviroment variable
    - name: Output artifact ID
      run:  |
        echo 'artefact_id=${{ steps.artifact-upload-step.outputs.artifact-id }}' >> $GITHUB_ENV
        echo 'Artifact ID is ${{ steps.artifact-upload-step.outputs.artifact-id }}'

  deploy:
    runs-on: windows-latest
    needs: build

    steps:
    - name: Download artifact
      uses: actions/download-artifact@v7
      with:
        name: ma_pytemp
        path: /opt

    - name: List Artifacts
      run: ls /opt
```

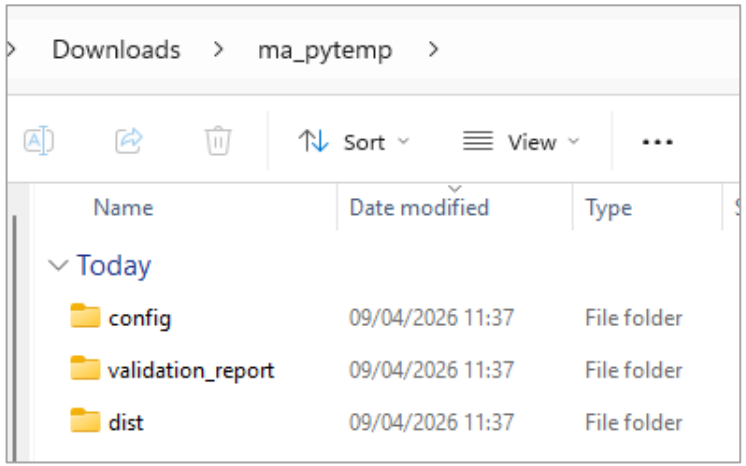
ma-pytemp: Deployment

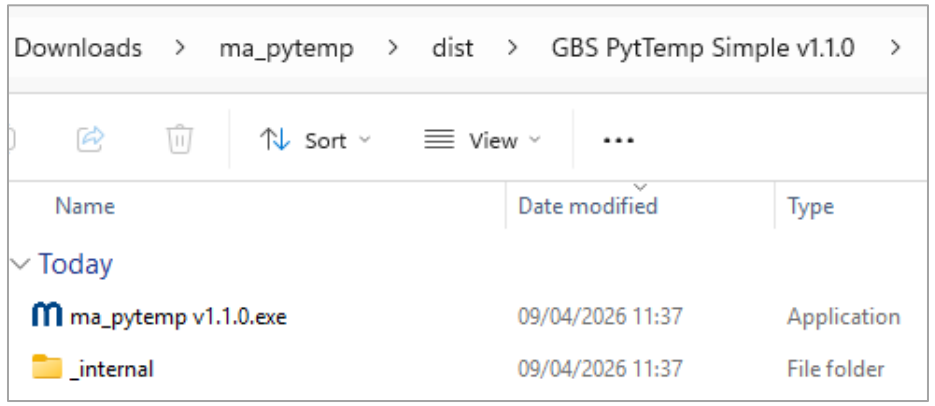


ma-pytemp: Artifact

artifact is a .zip folder

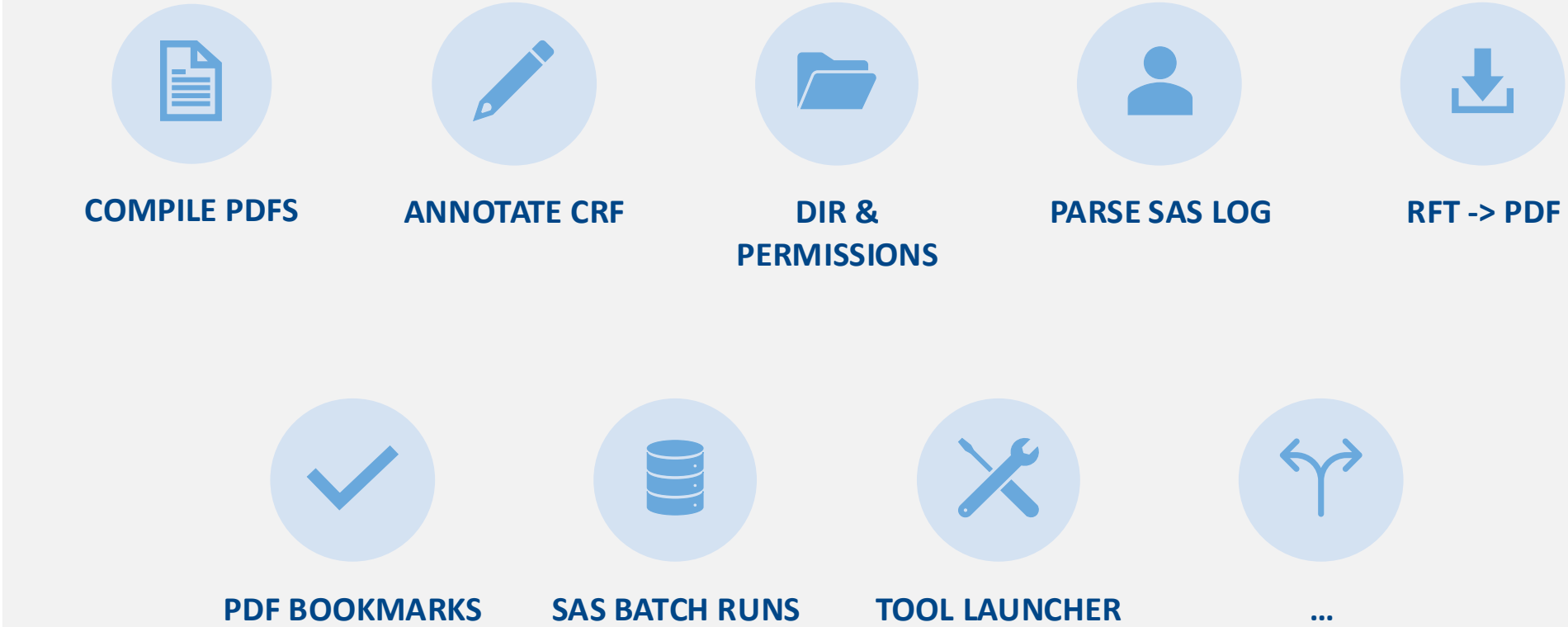







into production

into production



CRF Bookmarks

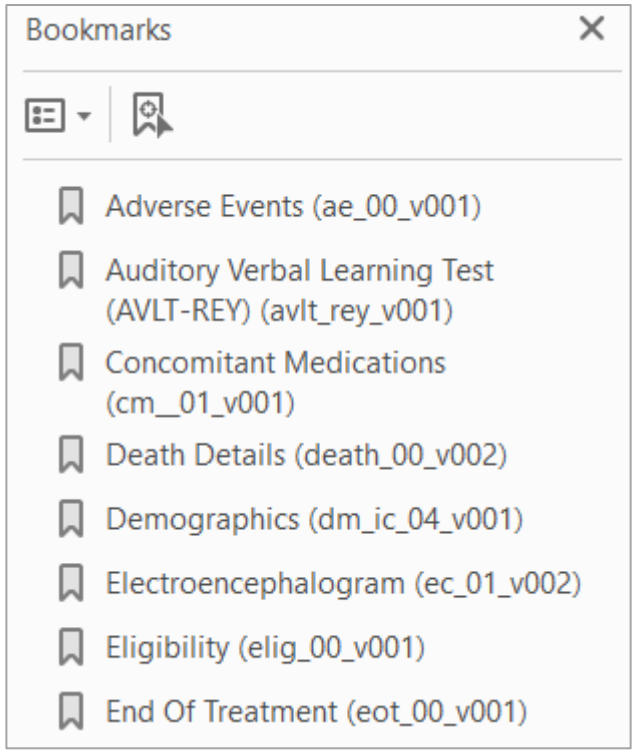
Situation

- a software provider cannot extract CRFs with bookmarks by form and visit
- >> 20 studies
- unclear when or even if this will be fixed

Current solution

- TDMs create bookmarks by hand
- painful and error prone

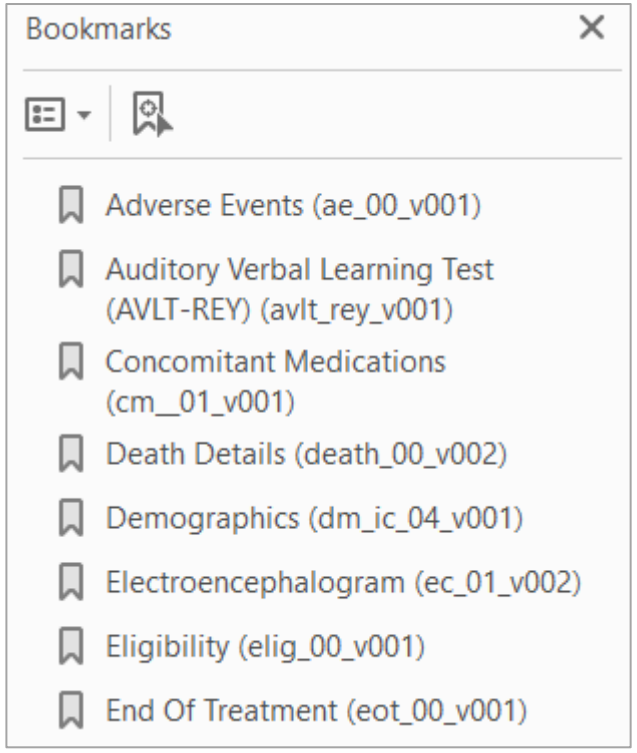
CRF Bookmarks



- first level bookmarks <form_label> (<form_name>)
- no visit information
- Study Definition Specs (SDS) contains visit information

CRF Bookmarks

crf_raw.pdf



sds.xlsx

Form Label	Form Name	Running Records	Screening		Baseline
		Running Records	Screening 1	Screening 2	Baseline
Adverse Events	ae_00_v001	X			
Concomitant Medications	cm__01_v001	X			
Death Details	death_00_v002	X			
Electroencephalogram	ec_01_v002	X			
Exposure	exp_000	X			
Injection Site Reactions	inj_site_00_v001	X			
Demographics	dm_ic_04_v001		X		
Eligibility	elig_00_v001		X		
Informed Consent	ic_01_v001		X		
Medical History	mh_00_v001		X		
Vital Signs (Weight, Height And Temperature)	vs_wgh_hgt_temp_000		X		
Ophthalmic Examination	opth_exm_v001		X	X	X
Auditory Verbal Learning Test (AVLT-REY)	avlt_rey_v001			X	
Vital Signs (Temperature)	vs_temp_000			X	
Patient Health Questionnaire-9 (PHQ-9)	phq_9_v001				X
Satisfaction With Life Survey (SWLS)	swls_000				X
Hamilton Depression Rating Scale - 17 (HAMD-17)	hamd_17_00_v001				X
Vital Signs (Weight And Temperature)	vs_wgh_temp_000				X
Patient Summary	pat_sum_000				
End Of Treatment	eot_00_v001				

CRF Bookmarks

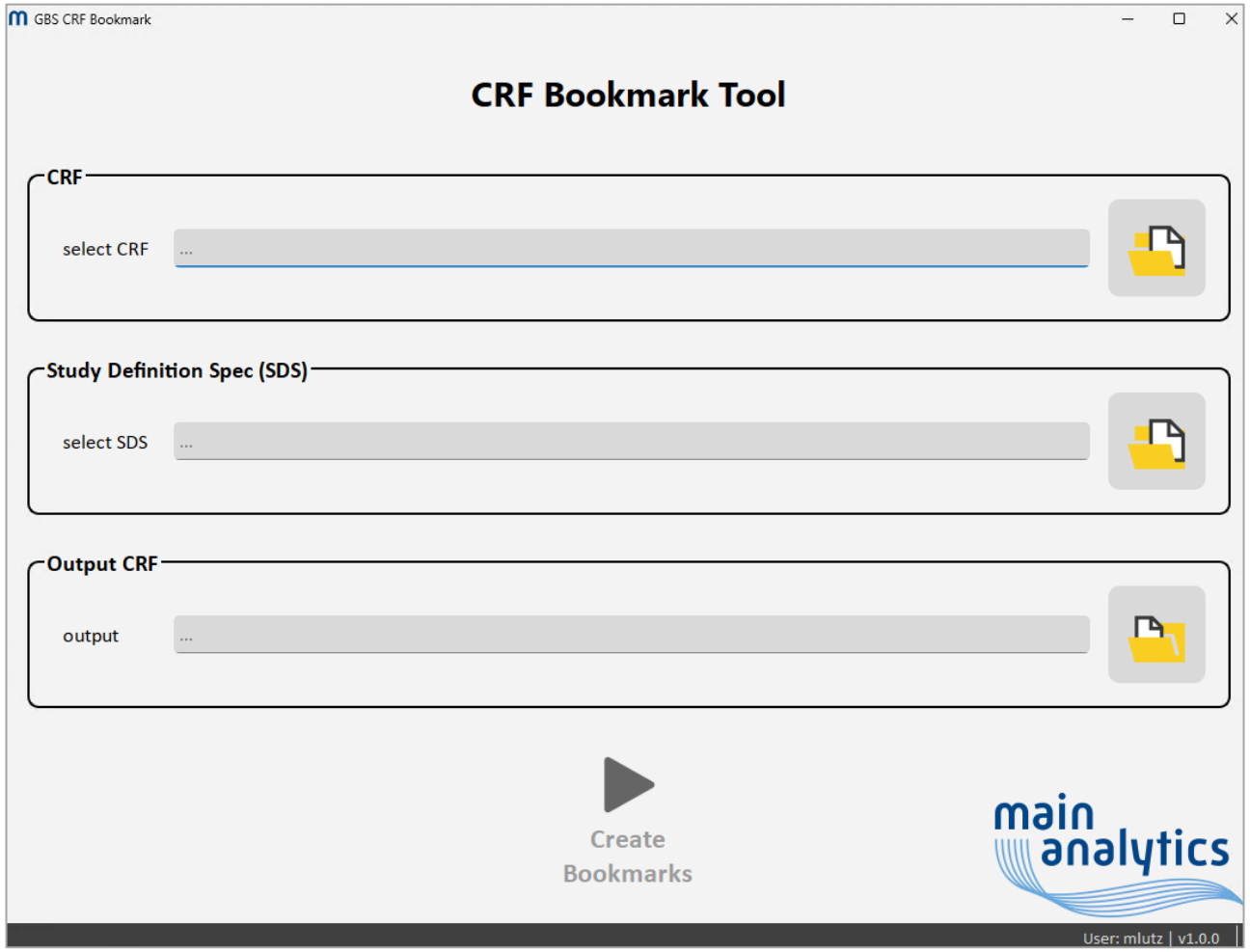
Solution

1. Read in crf_raw.pdf with pymupdf
2. Extract input bookmarks
3. Read in sds.xlsx with pandas
4. Match Form Label and Form Names from original bookmarks with sds
5. Create new bookmarks
   - by Form
   - by Visit
6. Save new file

Deployment

1. Plug logic into **ma_pytemp**
2. Add 3 IO Buttons
3. Add Start button

Example: CRF Bookmarks



Executables – What and Why?

self-sustained programs	no further dependencies no installation
unlocking the power of	high-level languages libraries rest of the world
for all environments	GxP SCE
complexity overhead	develop build deploy
abstract complexity	standardize template prebuild focus on automation

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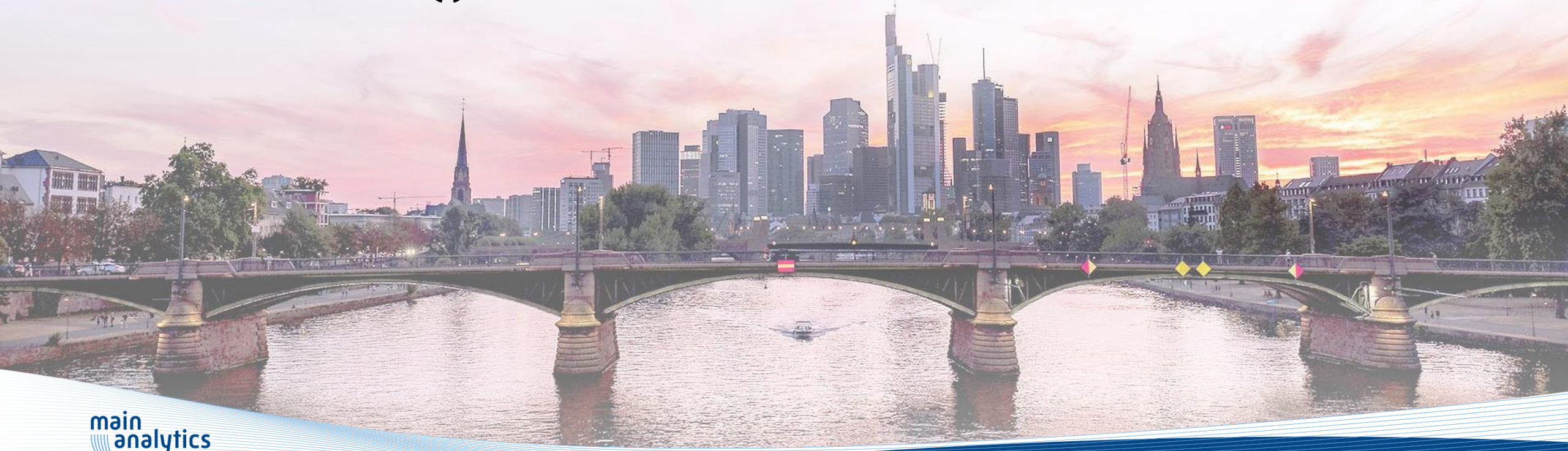
give it a try

https://github.com/mainanalytics/ma_pytemp



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References

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