Enabling a Data-informed Public Sector: An Introductory Course to BDTI Essentials

Session 3: Data Blending and Storage

Welcome!
The webinar will begin shortly.

DG CNECT
Directorate-General for Communications Networks, Content and Technology

DG DIGIT
Directorate-General for Digital Services

European Commission

Some housekeeping

- The Chat and Q&A widgets – **Bottom right of the screen**
- Please post session-related questions in **Q&A**
- The session will be recorded and available shortly after the end of the session on our website

Do

- Participate in the chat during the session
- Ask questions during the Q&A portion at the end
- Give feedback after the session
- Join the dedicated discussion board

Don't

- Self-promote
- Disrespect anyone

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Locate Chat and Q&A - Webex

Enabling a Data-informed Public Sector: An Introductory Course to BDTI Essentials

Session 3: Data Blending and Storage

Agenda

- Welcome [11:00-11:05]
- Session 2 Recap [11.05-11.15]
- Data blending and storage [11:15-12:00]
- Q&A [12:00-12:10]
- Wrap up [12:10 – 12:15]

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What is the Big Data Test Infrastructure (BDTI) ?

Not **only** for big data, for **public sector in general (open data)**

You have the key ingredients (datasets),
we equip you with the best **open-source tool**
to create amazing recipes for **public good.**

Six months free of charge service for EU public administrations *

Ready-to-use data analytics stack and support

Cloud platform based on open-source tools

* The cost of the pilot project must fit within the funding boundaries of the BDTI pilot budget

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Who is the Big Data Test Infrastructure (BDTI) for?

European Public Administrations
All European Public Administrations at **local, regional and national level** can independently apply for a BDTI pilot project

Ecosystem with academia and private sector
Academia, spin-off, startups can apply for pilot projects once there is a **clear collaboration** with a Public Administration which will be the main point of contact for the project (**Master/PhD, GovTech startups)**

Are you working for a public administration in need of infrastructure for data analytics?

https://big-data-test-infrastructure.ec.europa.eu/

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Open-source tools to support your data journey

100%

5. Decision-Making

1. Collection

4. Visualisation

Orchestration

Apache Airflow

2. Processing

3. Analysis

Metabase

Apache Superset

Development Environments

KNIME

jupyter

H2O.ai

R Studio

MINIO

Data Lake

OPENLINK VIRTUOSO UNIVERSAL SERVER

mongoDB

Database

elasticsearch

Apache Spark

Advanced Processing Engines

Use case:
"Identify Innovative Green Energy Projects from EU Universities"

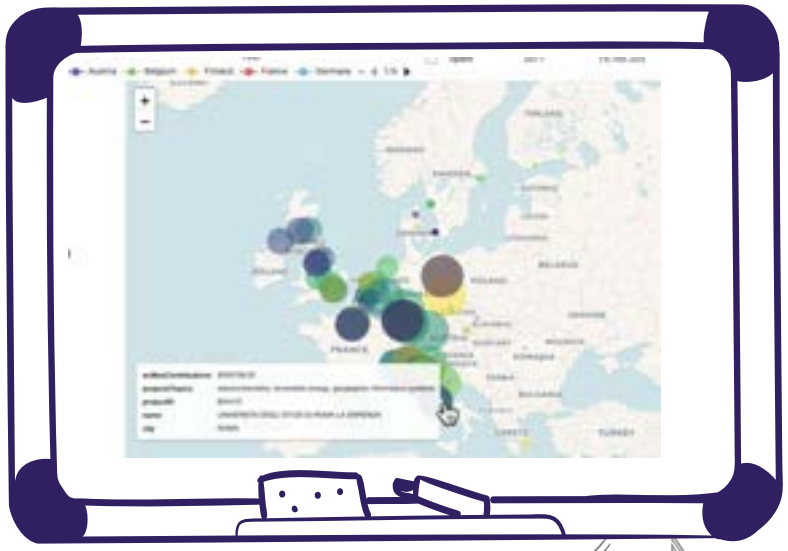
Zoi and her team, work in the **Educational Department of a highly polluted EU region.**

Their **purpose** is to identify potential ***"green energy partnerships"*** between EU universities to address pollution issues.

Zoi reached out the BDTI team to learn how to **connect the dots**, use the free BDTI playground to **create *insights*** and produce a ***report***, which can be **easily updated** when new data is available.

They found some interesting **open data:**

- **List of innovation *green energy* projects** across EU countries
- **CO2 emissions** of these countries



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Recap: Zoi Data Journey

https://code.europa.eu/bdti/bdti-essentials-course

Access the data from multiple sources

Merge the data and store it in the desired format (end of ETL process)

SESSION 1: Data Access and Exploration → **SESSION 2:** Data Cleaning and Transformation → **SESSION 3:** Data Blending and Storage → **SESSION 4:** Analytics: aggregation, visualisation, reporting → **SESSION 5:** Advanced Analytics

EU Open data portal:

data.europa.eu

Formats:
csv, Excel, JSON

Tools:

Open for Innovation KNIME

jupyter

RStudio

Clean and transform the data to the correct shape

Open for Innovation KNIME

Open for Innovation KNIME

Make sense of data, extract insights and visualise them in a report

Enhance analytics by gathering data from the internet

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Recap Session 2 –
Data Cleaning and Transformation

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Why Clean and Transform?

- The **core** of the data pipeline
- Data is rarely **clean**
  - Not useful data (columns/rows)
  - Duplicated data
  - Missing values
  - And more…
- Data not in the **correct shape**
  - **Extract** more information
  - Transform at cell or row **level**

Use Case

With an overview of the data, Zoi realises that it is not in the best shape to do an analysis, some columns are in the wrong format and she is also missing data.

In this session, she learned techniques **to clean and transform the data.**

Data Access → **Data Cleaning and Transformation** → Data Blending and Export → Analytics: aggregation, visualisation, reporting → Advanced Analytics

How?

Cleaning

Explore Data: make decisions according to objectives

Filter columns-rows: Remove what is not needed

Missing Values or Duplicates: decide how to handle them based on needs

From: 25 columns

Rows: 177834 | Columns: 25

#	RowID	projectID Number (inte...	projectAc... String	organisat... Number (inte...	vatNumber String	name String	shortName String	SME String
1	Row0	879926	EEN SACHSEN	999913831	?	INDUSTRIE-U...	IHK C	false
2	Row1	879926	EEN SACHSEN	994556036	DE176093942	ZTS-ZENTRU...	ZTS	true
3	Row2	879926	EEN SACHSEN	999797625	?	INDUSTRIE- U...	IHK DRESDEN	false
4	Row3	879926	EEN SACHSEN	999940409	?	HANDWERKS...	HWK DRESDEN	false
5	Row4	879926	EEN SACHSEN	999877844	DE140857609	TECHNISCHE...	?	false
6	Row5	879926	EEN SACHSEN	999914219	?	INDUSTRIE-U...	IHK-L	false
7	Row6	879926	EEN SACHSEN	969246408	?	HOCHSCHUL...	Hochschule Z...	false
8	Row7	879926	EEN SACHSEN	999917905	DE141484057	AGENTUR FU...	AGIL	false
9	Row8	740689	HEIMDALL	997710476	IT015032900...	CENTRO INTE...	FONDAZIONE...	false
10	Row9	740689	HEIMDALL	940057847	DK37222135	FREDERIKSB...	FBBR	false
11	Row10	740689	HEIMDALL	999703438	ESS0811001G	Departament ...	INT	false
12	Row11	740689	HEIMDALL	919049102	IT136697210...	ASSOCIAZIO...	?	false
13	Row12	740689	HEIMDALL	999778322	EL094149709	SPACE HELL...	SPACE HELL...	true
14	Row13	740689	HEIMDALL	999638739	ESG62616586	CENTRE TEC...	CTTC	false

To: 7 columns

Rows: 177834 | Columns: 7

#	RowID	projectID String	name String	activity... String	street String	postCo... String	city String	country String
1	Row0	879926	INDUSTRIE-UND H...	PUB	STRASSE DER ...	09111	CHEMNITZ	DE
2	Row1	879926	ZTS-ZENTRUM FUR...	OTH	INDUSTRIESTR...	01612	GLAUBITZ	DE
3	Row2	879926	INDUSTRIE- UND H...	PUB	LANGER WEG 4	01239	DRESDEN	DE
4	Row3	879926	HANDWERKSKAM...	PUB	AM LAGERPLA...	01099	DRESDEN	DE
5	Row4	879926	TECHNISCHE UNIV...	HES	STRASSE DER ...	09111	Chemnitz	DE
6	Row5	879926	INDUSTRIE-UND H...	PUB	GOERDELERRI...	04109	LEIPZIG	DE
7	Row6	879926	HOCHSCHULE ZITT...	HES	THEODOR-KOE...	02763	Zittau	DE
8	Row7	879926	AGENTUR FUR INN...	PRC	LESSINGSTRA...	04109	LEIPZIG	DE
9	Row8	740689	CENTRO INTERNAZ...	REC	VIA ARMANDO...	17100	SAVONA	IT
10	Row9	740689	FREDERIKSBORG B...	PRC	LOGISMOSE 3	3600	FREDERIKSSU...	DK
11	Row10	740689	Departament d'Inter...	PUB	Carrer Diputaci...	08009	Barcelona	ES
12	Row11	740689	ASSOCIAZIONE DE...	OTH	VIA BERNARDI...	00151	Roma	IT
13	Row12	740689	SPACE HELLAS AN...	PRC	MESSOGION A...	153 41	Aghia Paraske...	EL
14	Row13	740689	CENTRE TECNOLO...	REC	AVINGUDA CA...	08860	Castelldefels ...	ES

How?

Transformation

Explore Data: check data types, missing information

Change shape: Extract data and add columns

Modify data at a cell level: correct strings misspellings, group multiple titles.

From

projectID String	euroSciVocCode String	euroSciVocPath String	euroSciVocTitle String
869855	/29/101/555/1359	/social sciences/sociolog...	automation
869855	/25/63/399	/engineering and technol...	textiles
869855	/25/73/453/58525161	/engineering and technol...	sensors
869855	/25/73/453/459	/engineering and technol...	robotics
869855	/29/93/47293307	/social sciences/psychol...	ergonomics
870148	/25/63/409	/engineering and technol...	colors
883285	/21/33/121/44109686/5...	/medical and health scien...	ebola
883285	/21/33/137/133/9678651	/medical and health scien...	pandemics
883285	/21/33/121/44109686/7...	/medical and health scien...	influenza
883285	/29/91/523/1313	/social sciences/economy	employment

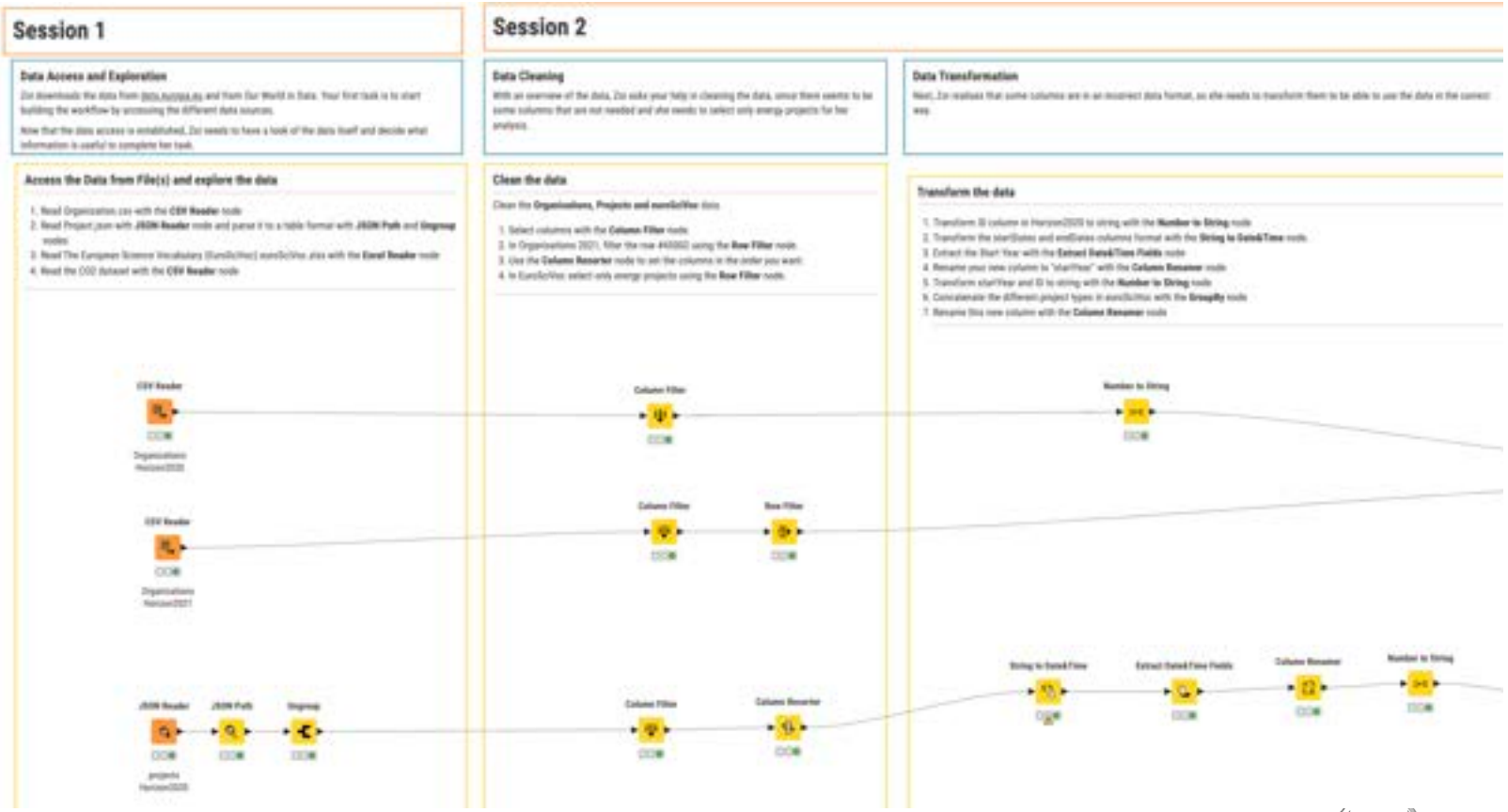
To

projectID String	projectsTopics String
101039110	energy conversion
101039446	energy and fuels
101039576	renewable energy
101039746	solar energy, energy conversion
101040341	geothermal energy
101040379	energy conversion
101040669	energy conversion
101040994	energy conversion
101041768	solar energy
101041809	solar energy
101042781	hydrogen energy

Session 2 Output: Workflow

- All these steps are in one single workflow that we can re-run and do it again!

https://code.europa.eu/bdti/bdti-essentials-course



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Exercise Review

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BDTI access refresh

To have access, public administrations need to ***apply on the official website***

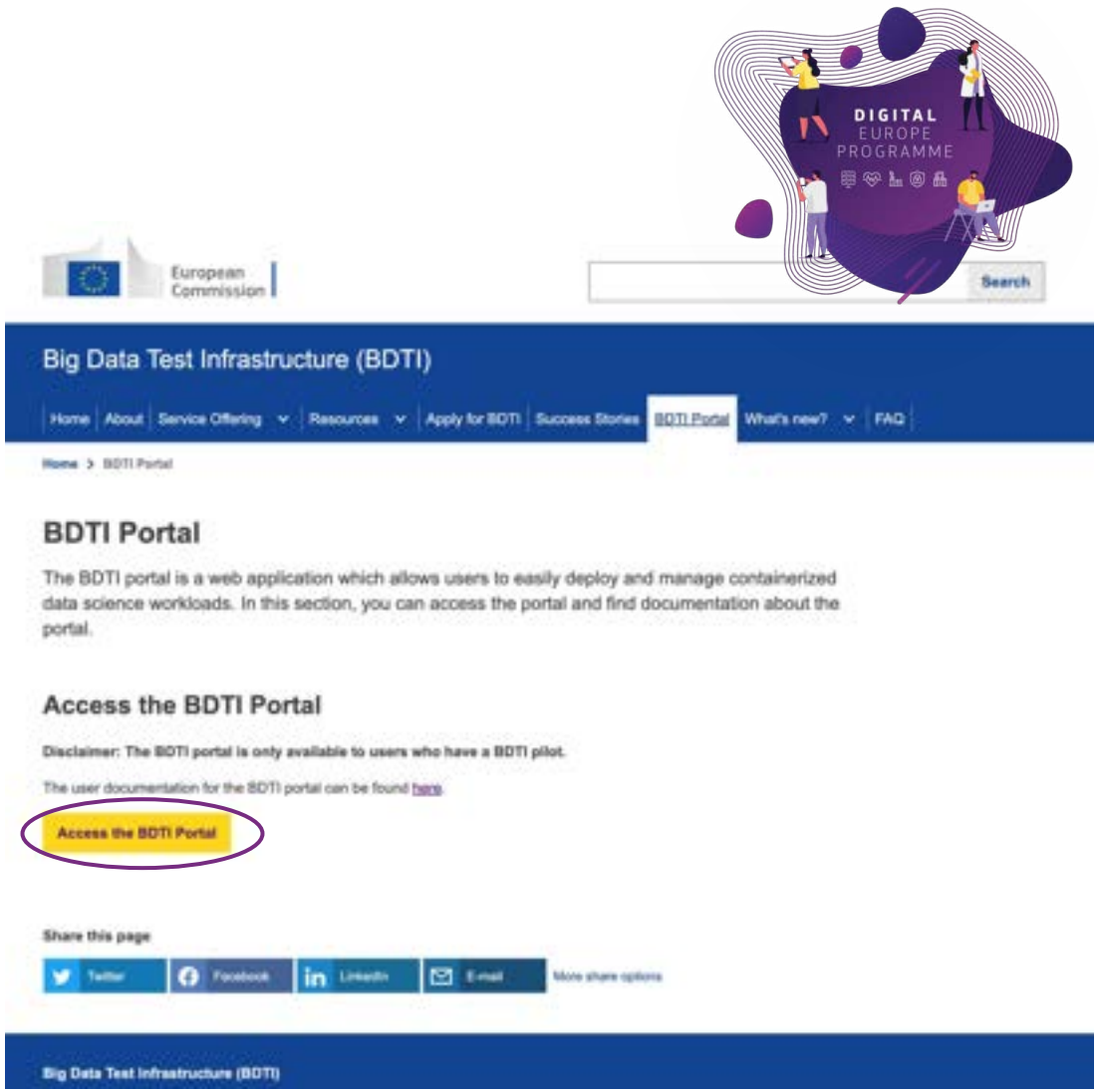
- https://big-data-test-infrastructure.ec.europa.eu/apply-bdti_en

Once you have access follow these steps:

Step 1 > Access the portal via the website

Step 2 > Navigate to the "Service Catalog" and launch the tools

Step 3 > Go to "My Services" and open the tool you created



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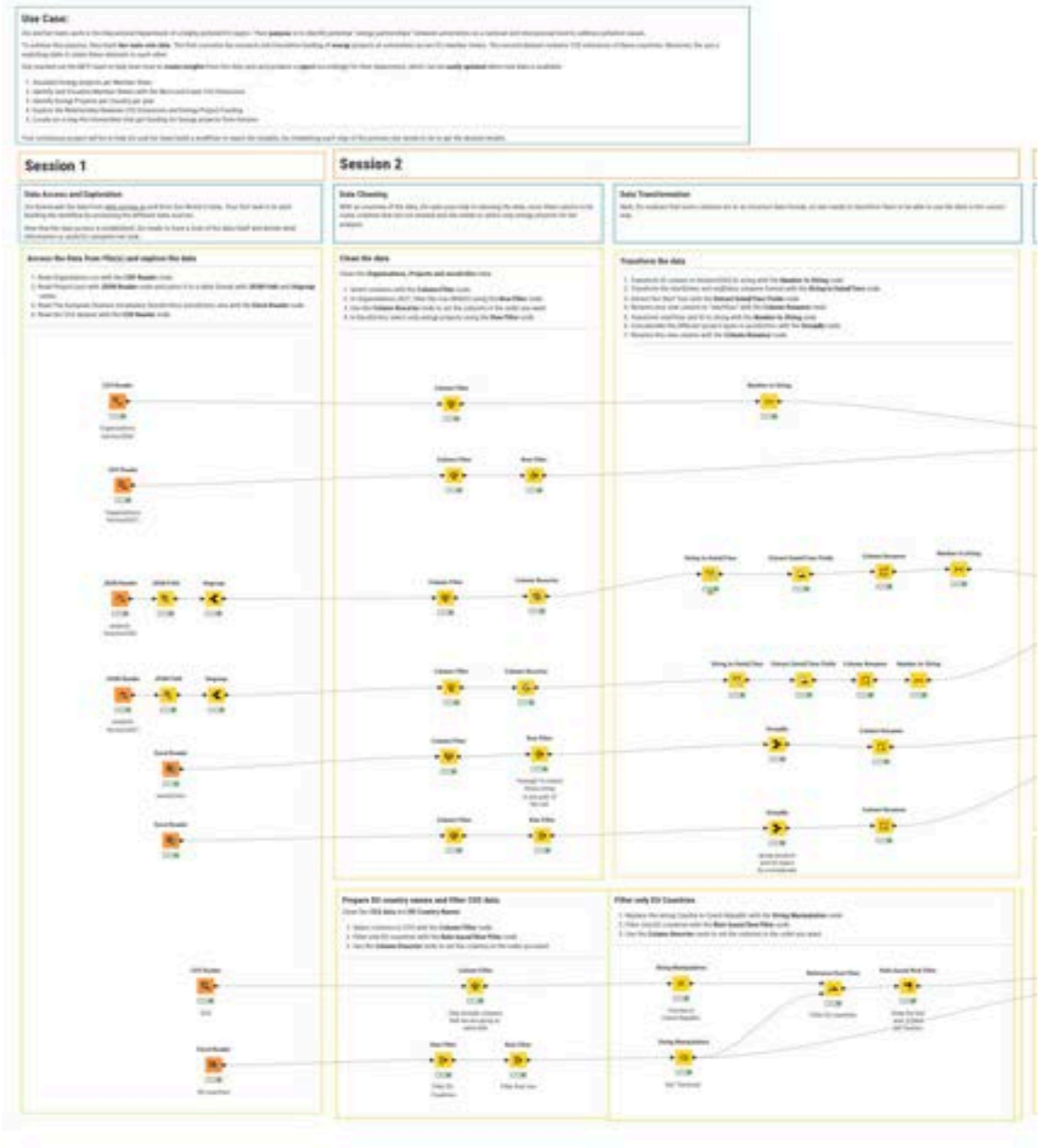
Exercise review



Session 3:
Data Blending and Storage

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Session 3: Data Blending and Storage

Session	Topic	Duration
Webinar 1	Data Access and Exploration	45 min
Webinar 2	Data Cleaning and Transformation	75 min
Webinar 3	**Data Blending and Storage**	**75 min**
Webinar 4	Analytics	75 min
Webinar 5	Advanced Module: Gathering Data from the Web and Geo Visualisation	75 min

- Slides, hands-on exercises, and solutions will be provided on the webinar
- Gitlab repository https://code.europa.eu/bdti/bdti-essentials-course

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Learning Outcomes

At the end of this session, you should be able to:

1. Sign in to the BDTI framework and initialise KNIME, PgAdmin, and PostgreSQL
2. Stack multiple tables
3. Join tables in multiple ways
4. Write data to various file formats
5. Store the data in a database

Open for Innovation KNIME

Data Access → Data Cleaning and Transformation → **Data Blending and Export** → Analytics: aggregation, visualisation, reporting → Advanced Analytics

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Data Blending

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Data Blending

Combine data from different sources and create a single table

1) **Stack** new data at the bottom of a table → same columns, **add rows**

2) **Join** information from tables by defining matching criteria → **add new columns**

Use Case

With the data cleaned and in the correct shape, we will now help Zoi to **merge** the different data sources, by stacking tables and matching or joining others to add the necessary columns.

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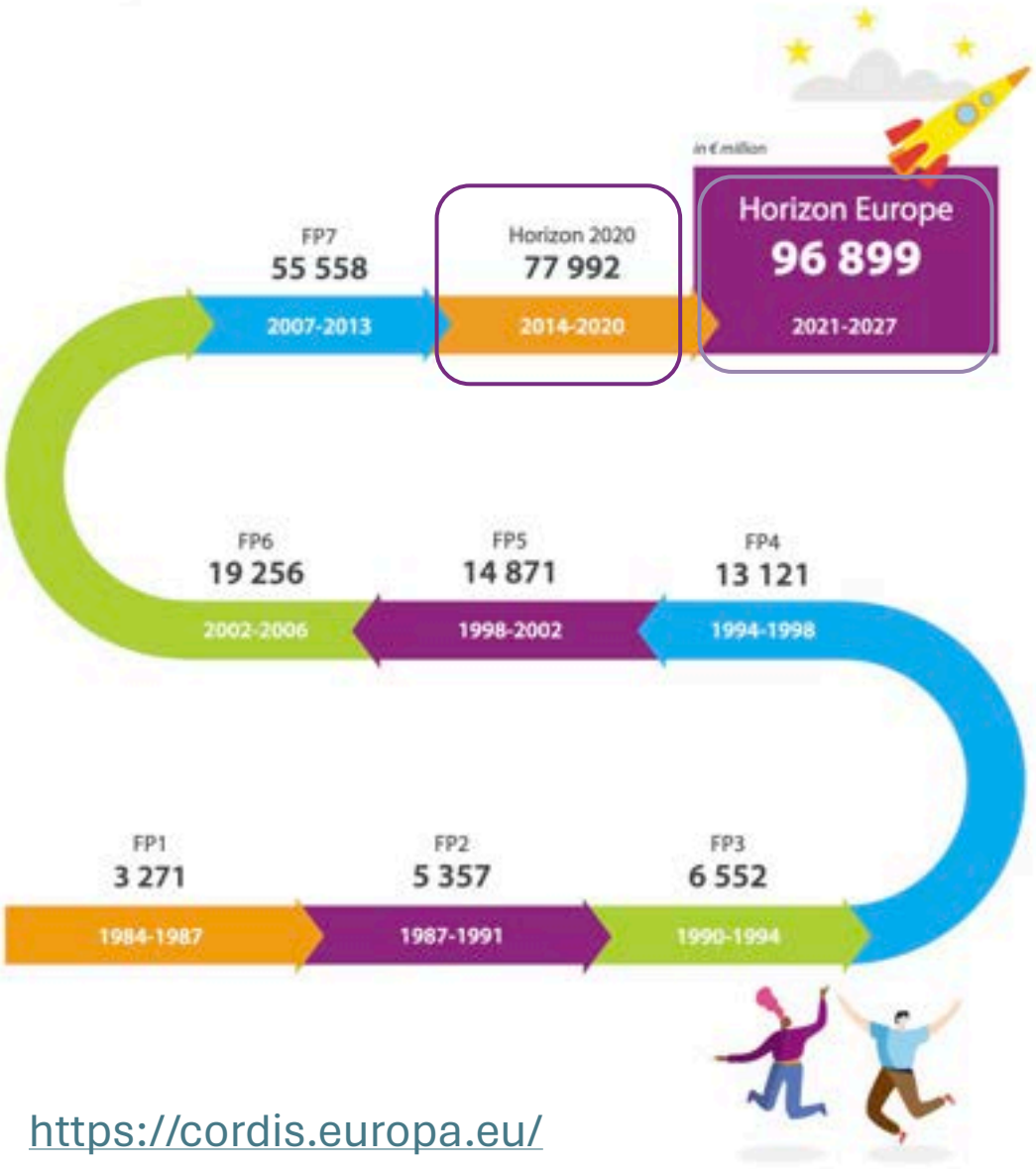
EVOLUTION OF THE R&I FRAMEWORK PROGRAMMES BUDGET

The EU budget has been significantly rising over time from EUR 3 271 million in FP1 to EUR 96 899 million today for Horizon Europe and Euratom. This illustrates the clear ambition of the EU for its main R&I funding instrument and increases relevance of science and technology in society to address our challenges.



https://cordis.europa.eu/

This budget compares favourably with the previous programme, Horizon 2020. In real terms, and excluding

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Data Blending

Stack

Stack new data at the bottom of a table -> same columns, **add rows**

Join

Join information from tables by defining matching criteria -> **add new columns**

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Stack data to add rows

Stack

Stack new data at the bottom of a table -> same columns, **add rows**

Table 1		
ID	Column 1	Column 2
Id-1		
Id-2		

Table 2		
ID	Column 1	Column 2
Id-3		
Id-4		

Result Table		
ID	Column 1	Column 2
Id-1		
Id-2		
Id-3		
Id-4		

EVOLUTION OF THE R&I FRAMEWORK PROGRAMMES BUDGET

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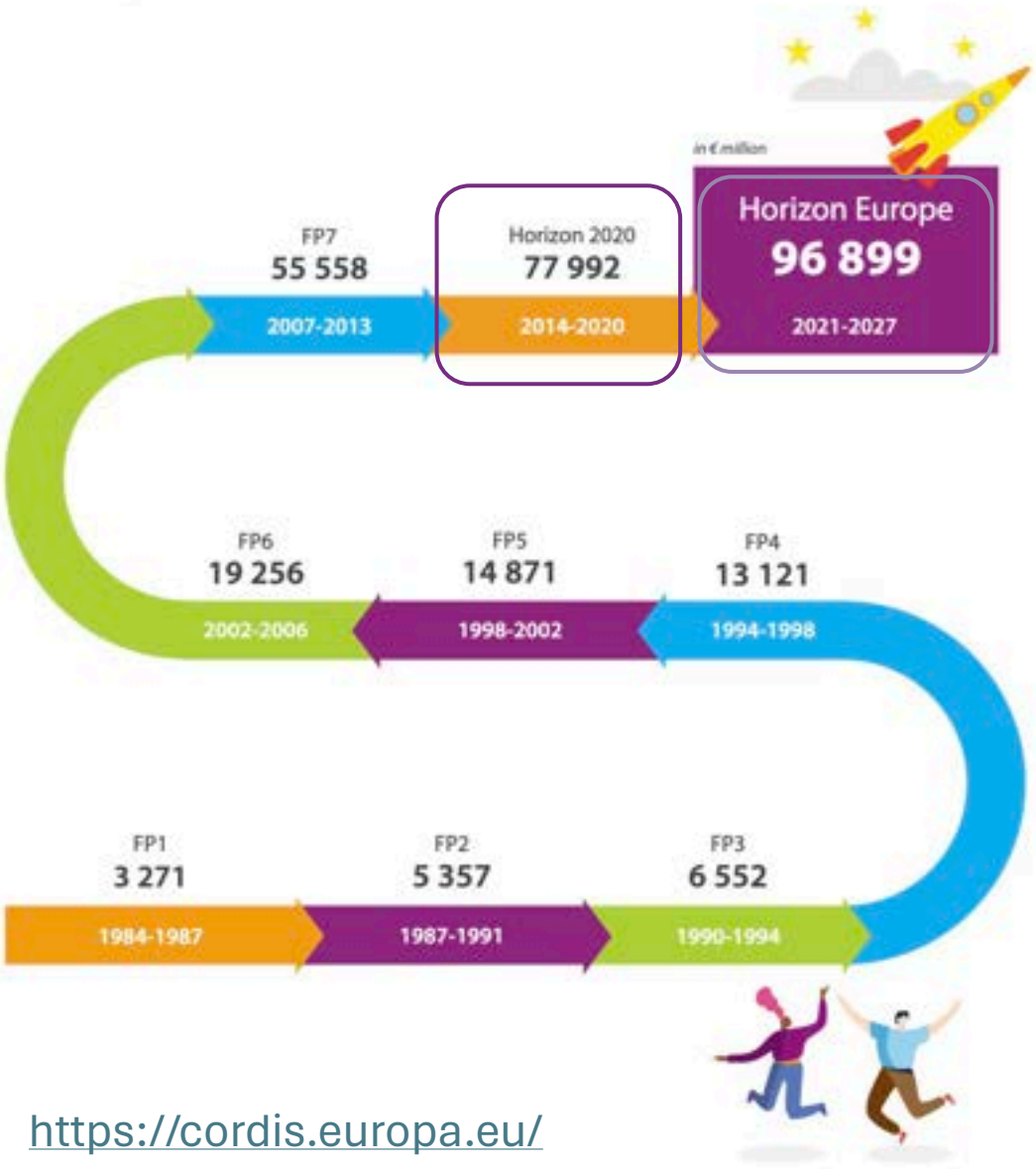

https://cordis.europa.eu/

This budget compares favourably with the previous programme, Horizon 2020. In real terms, and excluding

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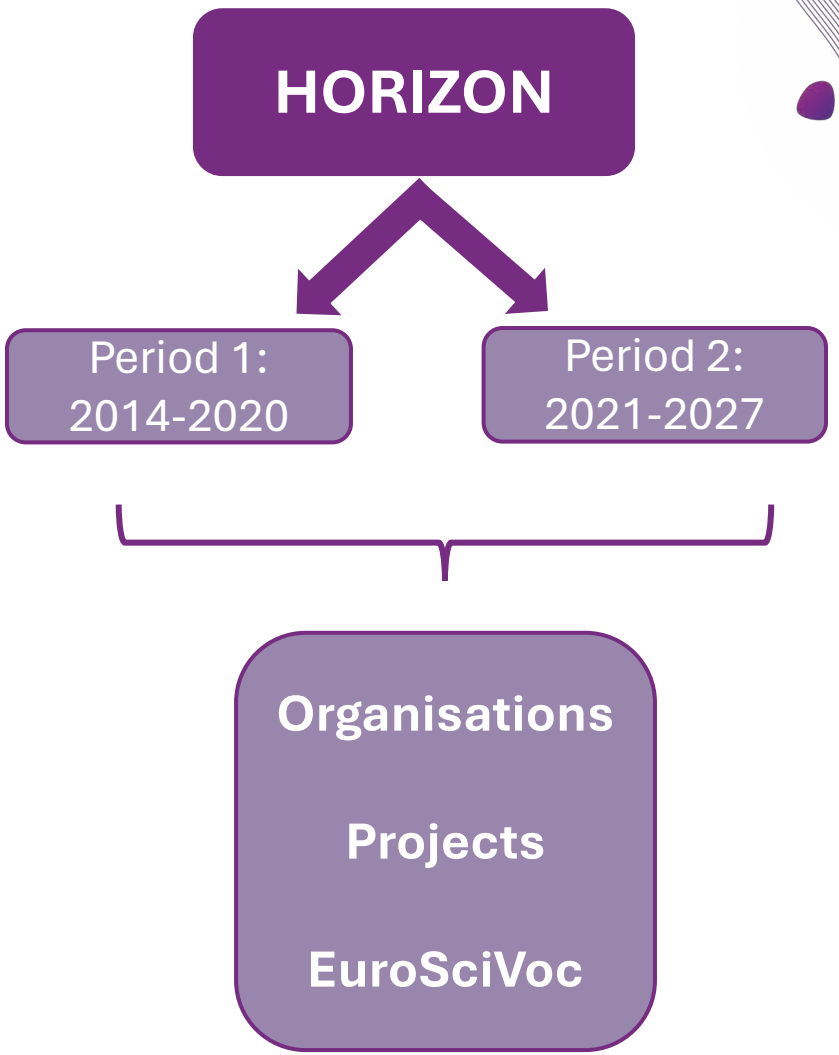
1) Why stack data?

- To combine two or more tables/ datasets with the **same structure** but different data, thus, **add rows.**
  - Example: Horizon from 2 periods that contain data for different years



1) Stack data: add rows

Horizon data from different periods:

Organisations

Rows: 177834 | Columns: 7

#	RowID	projectID String	name String	activityTy... String	street String	postCode String	city String	country String
1	Row0	879926	INDUSTRIE-U...	PUB	STRASSE DE...	09111	CHEMNITZ	DE
2	Row1	879926	ZTS-ZENTRU...	OTH	INDUSTRIEST...	01612	GLAUBITZ	DE
3	Row2	879926	INDUSTRIE- U...	PUB	LANGER WEG...	01239	DRESDEN	DE
4	Row3	879926	HANDWERKS...	PUB	AM LAGERPL...	01099	DRESDEN	DE
5	Row4	879926	TECHNISCHE...	HES	STRASSE DE...	09111	Chemnitz	DE
6	Row5	879926	INDUSTRIE-U...	PUB	GOERDELERR...	04109	LEIPZIG	DE
7	Row6	879926	HOCHSCHUL...	HES	THEODOR-KO...	02763	Zittau	DE
8	Row7	879926	AGENTUR FU...	PRC	LESSINGSTR...	04109	LEIPZIG	DE
9	Row8	740689	CENTRO INT...	REC	VIA ARMAND...	17100	SAVONA	IT
10	Row9	740689	FREDERIKSB...	PRC	LOGISMOSE 3	3600	FREDERIKSS...	DK
11	Row...	740689	Departament ...	PUB	Carrer Diputa...	08009	Barcelona	ES
12	Row...	740689	ASSOCIAZIO...	OTH	VIA BERNAR...	00151	Roma	IT
13	Row...	740689	SPACE HELL...	PRC	MESSOGION ...	153 41	Aghia Parask...	EL

Rows: 55994 | Columns: 7

#	RowID	projectID String	name String	activityType String	street String	postCode String	city String	country String
1	Row0	101091483	LA PALMA RES...	PRC	CALLE EL CAST...	38787	Santa Cruz De L...	ES
2	Row1	101091483	GEOLOGIAN TU...	REC	VUORIMIEHENT...	02151	Espoo	FI
3	Row2	101091483	INTERNATIONA...	OTH	RUE VAUTIER 54	1000	Bruxelles / Brus...	BE
4	Row3	101091483	PROMAN MAN...	PRC	WEINGARTENS...	2214	Auersthal	AT
5	Row4	101091483	ALDA - ASSOCI...	OTH	PLACE DES OR...	67000	Strasbourg	FR
6	Row5	101091483	REGIONE EMILI...	PUB	VIALE ALDO MO...	40127	Bologna	IT
7	Row6	101091483	TELOS ALEFF L...	PRC	36 ERITH HIGH ...	DA8 1QY	ERITH	UK
8	Row7	101091483	PETRONAVIT AS	PRC	STOKKAHAGEN...	4022	Stavanger	NO
9	Row8	101091483	MACCABE DUR...	PRC	20 FITZWILLIA...	D02YV58	DUBLIN 2	IE
10	Row9	101091483	GENERATOR BE...	PRC	QUINTA DA GA...	2560629	LISBOA	PT
11	Row...	101091483	ISTITUTO SUPE...	REC	VIA VITALIANO ...	00144	Roma	IT
12	Row...	101091483	GEOLOGIA E GE...	PRC	RUA CUNHA JU...	4250-186	Porto	PT

Period 1: 2014- 2020
Rows: 177834
Number of Columns: 7

Period 2: 2021-2027
Rows: 55994
Number of Columns: 7

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1) Stack data: add rows

Horizon data from different periods:

Projects

Rows: 35386 | Columns: 7

#	RowID	ids String	startDates Local Date	endDates Local Date	ecMaxContri... Number (double)	totalCosts Number (double)	objectives String	startYear String
1	Row...	879926	2020-01-01	2021-12-31	125,559	125,560	The aim of the pr...	2020
2	Row...	740689	2017-05-01	2021-01-31	7,836,370.63	8,585,414.19	The project aims ...	2017
3	Row...	730082	2016-11-01	2019-04-30	1,500,000	1,850,000	E2mC aims at de...	2016
4	Row...	101023342	2021-06-01	2024-11-30	3,755,470.75	5,214,286.25	Sustainability in c...	2021
5	Row...	831993	2019-01-01	2021-12-31	796,056.25	796,056.25	New technologie...	2019
6	Row...	641451	2015-01-01	2016-12-31	999,653.25	1,323,315	GEO-VISION is an...	2015
7	Row...	731665	2017-01-01	2018-12-31	1,498,857.5	1,498,857.5	The objective of t...	2017
8	Row...	653866	2015-06-01	2017-11-30	1,990,114.25	2,018,034.75	This proposal se...	2015
9	Row...	770037	2017-11-01	2019-10-31	2,003,918.75	2,003,918.75	Since 2015, migr...	2017
10	Row...	636906	2015-02-01	2017-01-31	610,013.75	792,938.75	The worldwide ec...	2015
11	Row...	825132	2019-01-01	2022-10-31	5,121,692.5	5,121,692.5	Current industrial...	2019
12	Row...	780785	2018-01-01	2021-12-31	2,940,920	3,877,451.43	Micro-ROS will be...	2018
13	Row...	952633	2020-11-01	2023-10-31	4,480,308.75	4,480,308.75	Despite the evide...	2020

Rows: 9000 | Columns: 7

#	RowID	ids String	startDates Local Date	endDates Local Date	ecMaxContri... Number (double)	totalCosts Number (double)	objectives String	startYear String
1	Row...	101091483	2023-01-01	2025-12-31	2,291,975	2,291,975	CIRAN will develo...	2023
2	Row...	101058526	2022-04-01	2025-03-31	3,998,440	3,998,440	The introduction ...	2022
3	Row...	101058362	2022-12-01	2026-05-31	4,645,639	6,762,123.75	Each year the EU ...	2022
4	Row...	101060504	2022-09-01	2025-08-31	2,499,951	2,499,951	Europe's regional ...	2022
5	Row...	101080025	2022-10-01	2025-09-30	2,486,150	2,507,255	Housing policy in...	2022
6	Row...	101121171	2023-08-01	2024-07-31	910,986.65	0	SHIELD4CROWD ...	2023
7	Row...	101070085	2022-09-01	2024-08-31	4,293,263.5	4,293,263.75	The BAMBAM pr...	2022
8	Row...	101059425	2022-10-01	2026-09-30	2,999,605	2,999,609.38	Secure attachme...	2022
9	Row...	101120323	2023-10-01	2026-09-30	2,908,625	3,550,250	Procedural Knowl...	2023
10	Row...	101082630	2022-11-01	2024-10-31	2,334,143.75	2,959,812.5	'On B2B and B2C...	2022
11	Row...	101091967	2023-01-01	2026-12-31	6,584,313.5	8,829,675	Buildings are res...	2023
12	Row...	101094391	2023-01-01	2025-12-31	999,235	999,235	Building Gender+ ...	2023
13	Row...	101111996	2023-09-01	2027-02-28	4,683,365.49	4,683,365.49	The general obje...	2023

Period 1: 2014- 2020
Rows: 35386
Columns: 7

Period 2: 2021-2027
Rows: 9000
Columns: 7

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1) Stack data: add rows

Horizon data from different periods:

euroSciVoc

Rows: 2461 | Columns: 2

#	RowID	projectID String	projectsTopics String
1	Row0	101000158	renewable energy
2	Row1	101000470	renewable energy
3	Row2	101000496	energy and fuels
4	Row3	101000612	energy and fuels
5	Row4	101000785	geothermal energy
6	Row5	101000828	hydrogen energy
7	Row6	101000832	renewable energy
8	Row7	101000987	energy and fuels
9	Row8	101001078	energy and fuels
10	Row9	101001081	renewable energy
11	Row...	101001514	energy conversion
12	Row...	101001626	energy conversion

Period 1: 2014- 2020
Rows: 2461
Columns: 2

Rows: 470 | Columns: 2

#	RowID	projectID String	projectsTopics String
1	Row0	101039110	energy conversion
2	Row1	101039446	energy and fuels
3	Row2	101039576	renewable energy
4	Row3	101039746	solar energy, energy conversion
5	Row4	101040341	geothermal energy
6	Row5	101040379	energy conversion
7	Row6	101040669	energy conversion
8	Row7	101040994	energy conversion
9	Row8	101041768	solar energy
10	Row9	101041809	solar energy
11	Row...	101042781	hydrogen energy

Period 2: 2021-2027
Rows: 470
Columns: 2

Stack in the different BDTI tools (add rows)

SQL

```
SELECT * FROM table1
UNION ALL
SELECT * FROM table2;
```

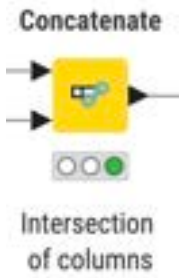
R

```
library(dplyr)
df1 <- read.csv('table1.csv')
df2 <- read.csv('table2.csv')
combined_df <- bind_rows(df1, df2)
```

PYTHON

```
import pandas as pd
df1 = pd.read_csv('table1.csv')
df2 = pd.read_csv('table2.csv')
combined_df = pd.concat([df1, df2], ignore_index=True)
```

KNIME



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1) How to stack data?

Steps:

1. Identify matching columns

2. Decide how to combine columns

3. Decide on how to handle duplicate row ids

1) Stack data: add rows

Period 1

Rows: 177834 | Columns: 7

#	RowID	projectID String	name String	activityTy... String
1	Row0	879926	INDUSTRIE-U...	PUB
2	Row1	879926	ZTS-ZENTRU...	OTH
3	Row2	879926	INDUSTRIE- U...	PUB
4	Row3	879926	HANDWERKS...	PUB
5	Row4	879926	TECHNISCHE...	HES
6	Row5	879926	INDUSTRIE-U...	PUB

Period 2

Rows: 55994 | Columns: 7

#	RowID	projectID String	name String	activityType String
1	Row0	101091483	LA PALMA RES...	PRC
2	Row1	101091483	GEOLOGIAN TU...	REC
3	Row2	101091483	INTERNATIONA...	OTH
4	Row3	101091483	PROMAN MAN...	PRC
5	Row4	101091483	ALDA - ASSOCI...	OTH

Rows: 233828 | Columns: 7

#	RowID	projectID String	name String	activityType String
1	Row0	879926	INDUSTRIE-UND HANDELSKAMME...	PUB
2	Row1	879926	ZTS-ZENTRUM FUR TECHNOLOGIE...	OTH
3	Row2	879926	INDUSTRIE- UND HANDELSKAMME...	PUB
4	Row3	879926	HANDWERKSKAMMER DRESDEN	PUB
5	Row4	879926	TECHNISCHE UNIVERSITAET CHEM...	HES
6	Row5	879926	INDUSTRIE-UND HANDELSKAMME...	PUB
7	Row6	879926	HOCHSCHULE ZITTAU/GOERLITZ	HES
8	Row7	879926	AGENTUR FUR INNOVATIONSFORD...	PRC
9	Row8	740689	CENTRO INTERNAZIONALE IN MON...	REC
10	Row9	740689	FREDERIKSBORG BRAND OG REDNI...	PRC
11	Row10	740689	Departament d'Interior - Generalitat ...	PUB

One table with shared columns and more rows

1) Summary: Why stack data?

- To combine two or more tables/ datasets with the same structure but different data, thus, add rows.

- Some tools call it UNION, others Concatenate. In the end, they all add rows, remember to be mindful of the **operation**.

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Data Blending

Stack

Stack new data at the bottom of a table -> same columns, **add rows**

Join

Join information from tables by defining matching criteria -> **add new columns**

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2) Why join?

- Situation: When we have information from different tables with different structures, but they share the **main category** (Projects in our case).

- Action: **add columns** from different tables/ data sets together.

- Goal: To **enrich** the information about the **main category.**

Join data to add columns

Table 1		
ID	Column 1	Column 2
Id-1		
Id-2		

Table 2		
ID	Column 3	Column 4
Id-1		
Id-2		

Result Table				
ID	Column 1	Column 2	Column 3	Column 4
Id-1				
Id-2				

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2) What do we join?

Two tables: we join a "left table" and a "right table" on a Key

- Left table: first dataset in the join operation.
- Right table: second dataset in the join operation.

Key:

- Key: The **common** column(s) used to match rows between the left and right tables.

2) Joining Columns of Data

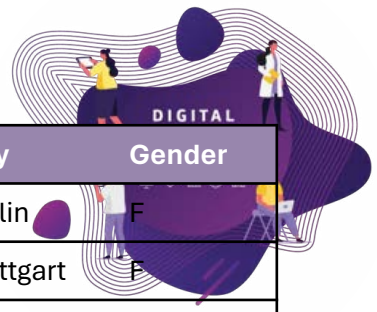
- We want to have all the information **together**
- We need a **common** column to join the data – normally “Key” or “ID”

ID	Item	Cost
Id-1	Table	50
Id-2	Couch	100

ID	Store Type	City
Id-1	Onsite	NY
Id-2	Online	NY

ID	Item	Cost	Store Type	City
Id-1	Table	50	Onsite	NY
Id-2	Couch	100	Online	NY

2) Types of Joins



Left Table

Key	OrderDate	OrderID
22	2019-09-23	#23444
24	2019-09-30	#23457
15	2019-10-07	#28985
10	2019-10-13	#29999

Right Table

Key	DoB	City	Gender
17	1974-02-23	Berlin	F
65	2001-05-25	Stuttgart	F
35	1988-08-05	Cologne	M
15	1983-07-20	Hamburg	M
10	1993-01-13	Berlin	M

Join by Key

Inner Join

Key	OrderDate	OrderID	DoB	City	Gender
15	2019-10-07	#28985	1983-07-20	Hamburg	M
10	2091-10-13	#29999	1993-01-13	Berlin	M

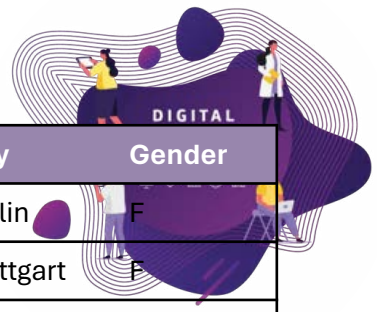
Left Outer Join

Key	OrderDate	OrderID	DoB	City	Gender
22	2019-09-23	#23444	?	?	?
24	2019-09-30	#23457	?	?	?
15	2019-10-07	#28985	1983-07-20	Hamburg	M
10	2019-10-13	#29999	1993-01-13	Berlin	M

Right Outer Join

Key	OrderDate	OrderID	DoB	City	Gender
17	?	?	1974-02-23	Berlin	F
65	?	?	2001-05-25	Stuttgart	F
35	?	?	1988-08-05	Cologne	M
15	2019-10-07	#28985	1983-07-20	Hamburg	M
10	2019-10-13	#29999	1993-01-13	Berlin	M

2) Joining Columns of Data



Key	OrderDate	OrderID
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24	2019-09-30	#23457
15	2019-10-07	#28985
10	2091-10-13	#29999

Left Table

Key	DoB	City	Gender
17	1974-02-23	Berlin	F
65	2001-05-25	Stuttgart	F
35	1988-08-05	Cologne	M
15	1983-07-20	Hamburg	M
10	1993-01-13	Berlin	M

Right Table

Join by Key

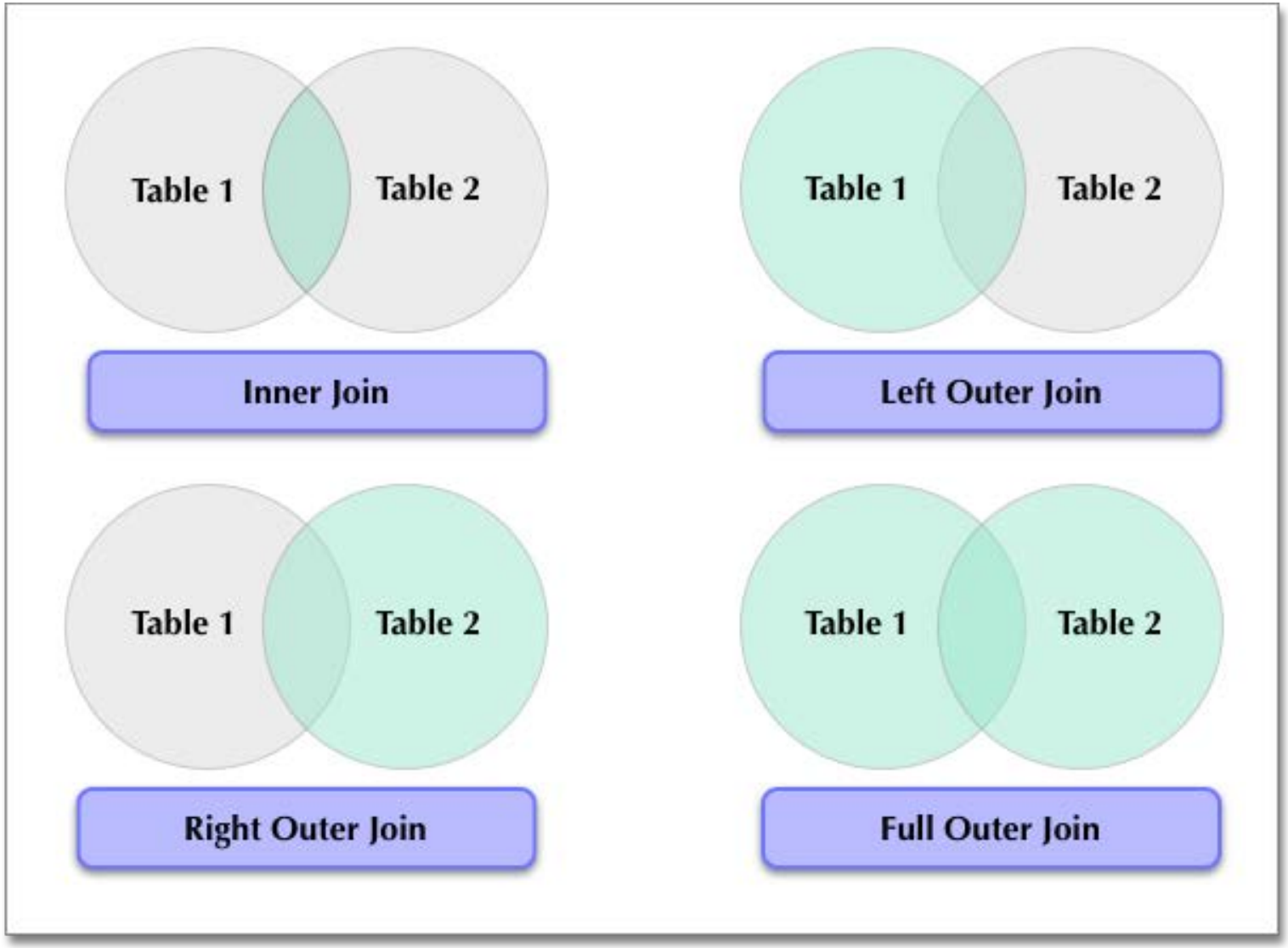
Full outer Join

Key	OrderDate	OrderID	DoB	City	Gender
17	?	?	1974-02-23	Berlin	F
65	?	?	2001-05-25	Stuttgart	F
35	?	?	1988-08-05	Cologne	M
15	2019-10-07	#28985	1983-07-20	Hamburg	M
10	2091-10-13	#29999	1993-01-13	Berlin	M
22	2019-09-23	#23444	?	?	?
24	2019-09-30	#23457	?	?	?

Missing values in the left table

Missing values in the right table

What types of join can we implement?



2) How to join?

Steps:

1. Choose **matching** column (key) from left and right table

2. **Decide** which information to keep (type of join)

2) What do we join? Horizon Data

Rows: 44386 | Columns: 7

#	RowID	ids	startDates	endDates	ecMaxContri...	totalCosts	objectives	startYear
		String	Local Date	Local Date	Number (double)	Number (double)	String	String
1	Row...	879926	2020-01-01	2021-12-31	125,559	125,560	The aim of the pr...	2020
2	Row...	740689	2017-05-01	2021-01-31	7,836,370.63	8,585,414.19	The project aims ...	2017
3	Row...	730082	2016-11-01	2019-04-30	1,500,000	1,850,000	E2mC aims at de...	2016
4	Row...	101023342	2021-06-01	2024-11-30	3,755,470.75	5,214,286.25	Sustainability in c...	2021
5	Row...	831993	2019-01-01	2021-12-31	796,056.25	796,056.25	New technologie...	2019
6	Row...	641451	2015-01-01	2016-12-31	999,653.25	1,323,315	GEO-VISION is an...	2015
7	Row...	731665	2017-01-01	2018-12-31	1,498,857.5	1,498,857.5	The objective of t...	2017
8	Row...	653866	2015-06-01	2017-11-30	1,990,114.25	2,018,034.75	This proposal se...	2015
9	Row...	770037	2017-11-01	2019-10-31	2,003,918.75	2,003,918.75	Since 2015, migr...	2017
10	Row...	636906	2015-02-01	2017-01-31	610,013.75	792,938.75	The worldwide ec...	2015

Rows: 233828 | Columns: 7

#	RowID	projectID	name	activityType	street	postCode	city	country
		String	String	String	String	String	String	String
1	Row0	879926	INDUSTRIE-UND ...	PUB	STRASSE DER N...	09111	CHEMNITZ	DE
2	Row1	879926	ZTS-ZENTRUM F...	OTH	INDUSTRIESTRA...	01612	GLAUBITZ	DE
3	Row2	879926	INDUSTRIE- UND ...	PUB	LANGER WEG 4	01239	DRESDEN	DE
4	Row3	879926	HANDWERKSKA...	PUB	AM LAGERPLATZ...	01099	DRESDEN	DE
5	Row4	879926	TECHNISCHE UN...	HES	STRASSE DER N...	09111	Chemnitz	DE
6	Row5	879926	INDUSTRIE-UND ...	PUB	GOERDELERRING...	04109	LEIPZIG	DE
7	Row6	879926	HOCHSCHULE ZI...	HES	THEODOR-KOER...	02763	Zittau	DE
8	Row7	879926	AGENTUR FUR IN...	PRC	LESSINGSTRASS...	04109	LEIPZIG	DE
9	Row8	740689	CENTRO INTERN...	REC	VIA ARMANDO M...	17100	SAVONA	IT

Left Table: Projects

Right Table: Organisations

Join by ID

Inner Join

Rows: 233828 | Columns: 13

#	RowID	pro...	name	activit...	street	post...	city	coun...	startDates	endDates	ecMaxCon...	totalCosts	objectives	startYear
		String	String	String	String	String	String	String	Local Date	Local Date	Number (doubl...	Number (doubl...	String	String
1	Row...	879926	INDUSTRIE-UN...	PUB	STRASSE DER ...	09111	CHEMNITZ	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
2	Row...	879926	ZTS-ZENTRUM...	OTH	INDUSTRIESTR...	01612	GLAUBITZ	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
3	Row...	879926	INDUSTRIE- U...	PUB	LANGER WEG 4	01239	DRESDEN	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
4	Row...	879926	HANDWERKSK...	PUB	AM LAGERPLA...	01099	DRESDEN	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
5	Row...	879926	TECHNISCHE ...	HES	STRASSE DER ...	09111	Chemnitz	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
6	Row...	879926	INDUSTRIE-UN...	PUB	GOERDELERRI...	04109	LEIPZIG	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
7	Row...	879926	HOCHSCHULE ...	HES	THEODOR-KOE...	02763	Zittau	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
8	Row...	879926	AGENTUR FUR...	PRC	LESSINGSTRA...	04109	LEIPZIG	DE	2020-01-01	2021-12-31	125,559	125,560	The aim of the ...	2020
9	Row...	740689	CENTRO INTE...	REC	VIA ARMANDO...	17100	SAVONA	IT	2017-05-01	2021-01-31	7,836,370.63	8,585,414.19	The project ai...	2017
10	Row...	740689	FREDERIKSBO...	PRC	LOGISMOSE 3	3600	FREDERIKSSU...	DK	2017-05-01	2021-01-31	7,836,370.63	8,585,414.19	The project ai...	2017

Join in the different BDTI tools (add columns)

SQL

```
SELECT table1.*, table2.column_name
FROM table1
JOIN table2 ON table1.id = table2.id;
```

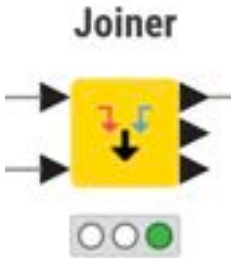
R

```
library(dplyr)
df1 <- read.csv('table1.csv')
df2 <- read.csv('table2.csv')
merged_df <- inner_join(df1, df2, by = "id")
```

PYTHON

```
import pandas as pd
df1 = pd.read_csv('table1.csv')
df2 = pd.read_csv('table2.csv')
merged_df = pd.merge(df1, df2, on='id', how='inner')
```

KNIME



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2) Joining relationships

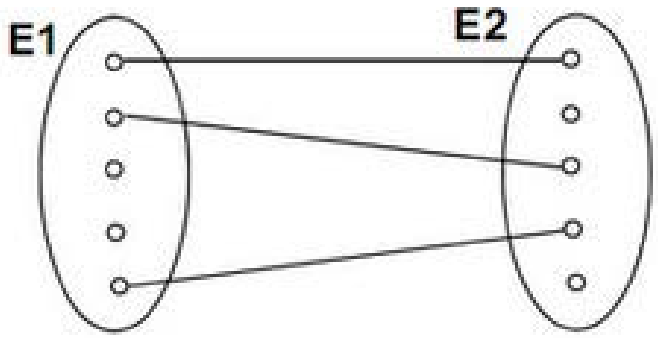
ProjectID
Project 1
Project 2
Project 3
Project 4

Organisations
A
B
C
D
E
F
G

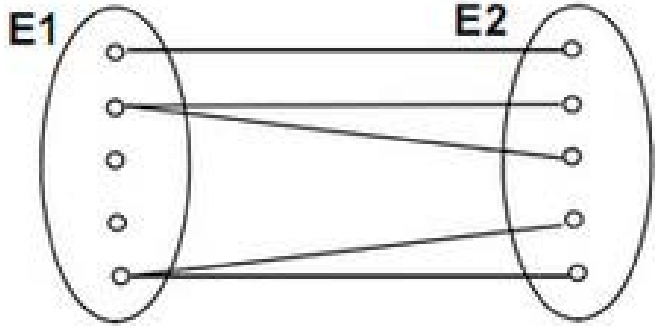
1 to many

2) Joining relationships

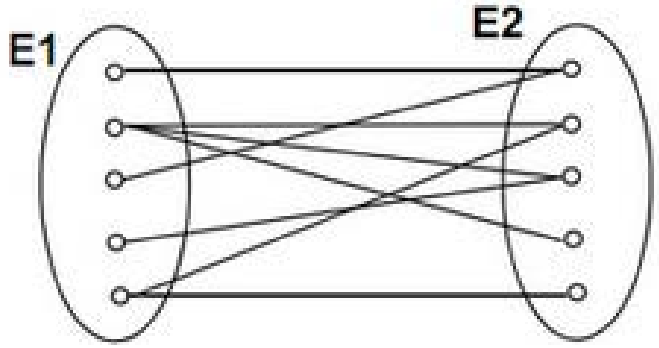
One to one
1:1



One to many
1:M



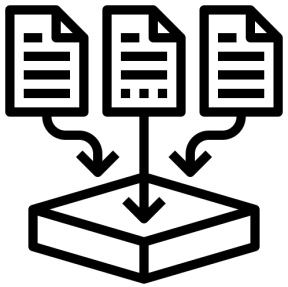
Many to many
M:N



Summary: **Data Blending**

From multiple data files (8)

- Organisations 20-21
- Projects 20-21
- EuroSciVoc 20-21
- CO2
- EU Country Names



To a **single** data file with all the information!

Data Export and Storage

Data Export and Storage

1. Export the data to store it in different file formats: CSV, Excel, JSON.

2. **Scalability**, when things gets **bigger**, and we have too much data is better to use Databases

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1) Export in different file formats

- End of ETL process, we can export the final files in the format that is more convenient for us.
- Export the data to store it or continue the computation somewhere else
- In Zoi's case, she will export all the Horizon data into a CSV file

2) Export and storage in databases

- **Scalability**, when things gets bigger, and we have too much data is better to use Databases

- Facilitates seamless transfer of data across platforms and applications.

- Ensures compatibility and accessibility of data for various analytical and storage needs.

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2) Data Export and Storage in BDTI

Where can we store the data in **BDTI**?

- *PostgreSQL: object-relational database*
- **PGAdmin:** is the administration and development platform for PostgreSQL

- MongoDB: relational NoSQL database (JSON objects)

- MinIO: S3-compatible object storage

2) Data Export and Storage in BDTI

In the BDTI framework, we can connect the tools!

- KNIME for Analytics process
- PgAdmin-SQL to Store and manage the data

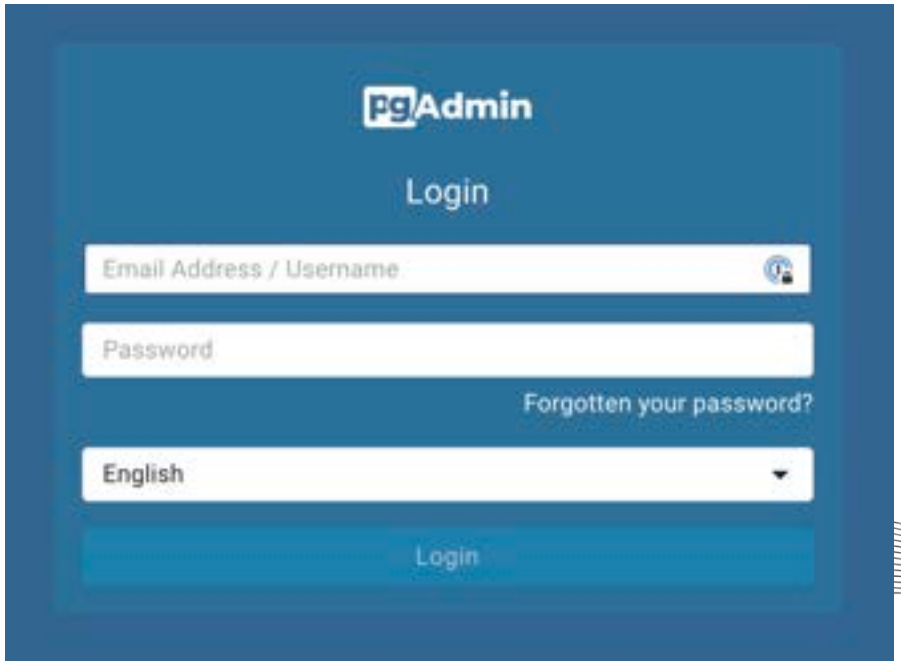
Working with Databases in BDTI

How to initialise a SQL database in BDTI?

- Step 1 > Access the portal via the website

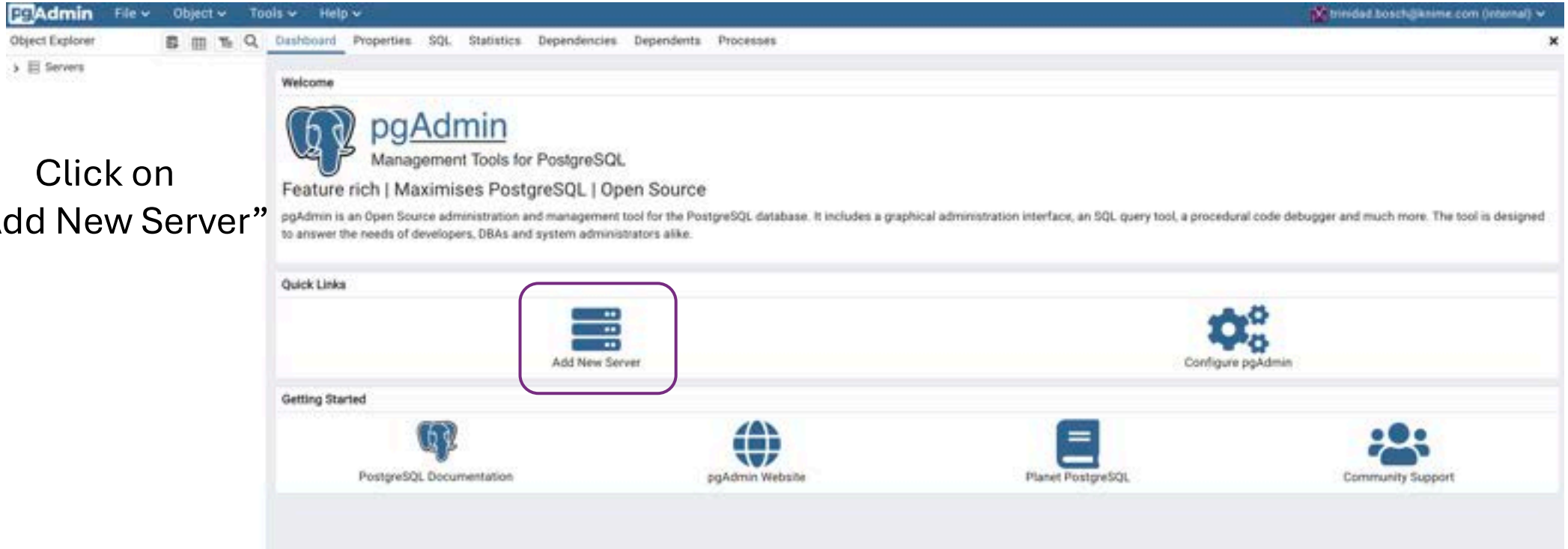
- Step 2 > Navigate to the "Service Catalog" and launch
  a) PostgreSQL instance
  b) PgAdmin instance

- Step 3 > Go to "My Services" and open **PgAdmin**
  a) Input your credentials (password in “My Data”)



Configure your database

1) Click on "Add New Server"



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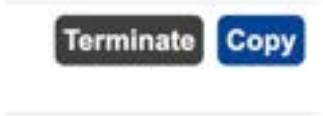
Configure your database

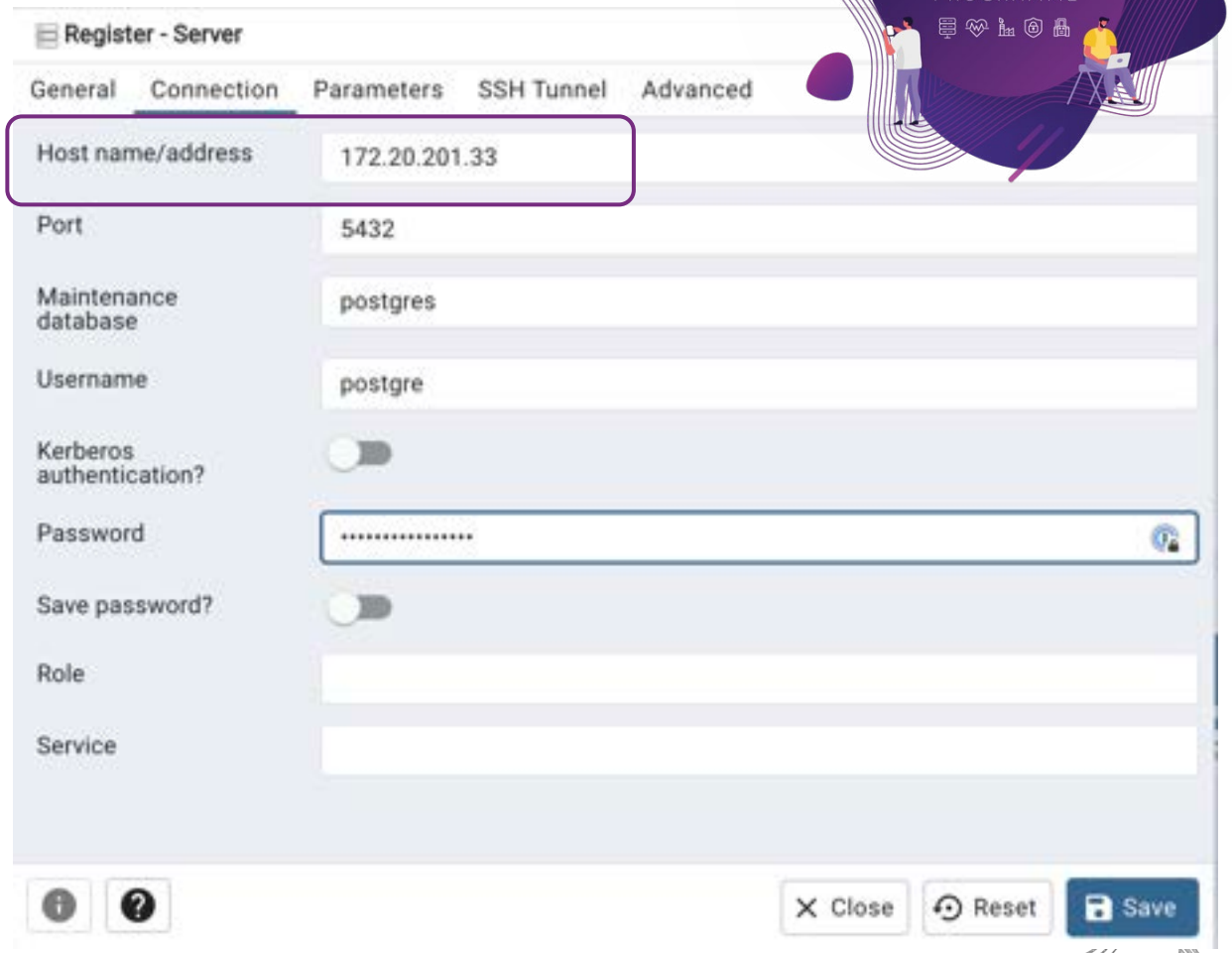
2) A configuration window will open, go to “Connection”:

- Host name/address → this information is in *My Services* under your **“PostgreSQL”** *instance*. Copy the host address by clicking on the related *Copy* button.



- This information is the same to use in “General” under *Name*

- Password: the postgresSQL password saved in *My Services*



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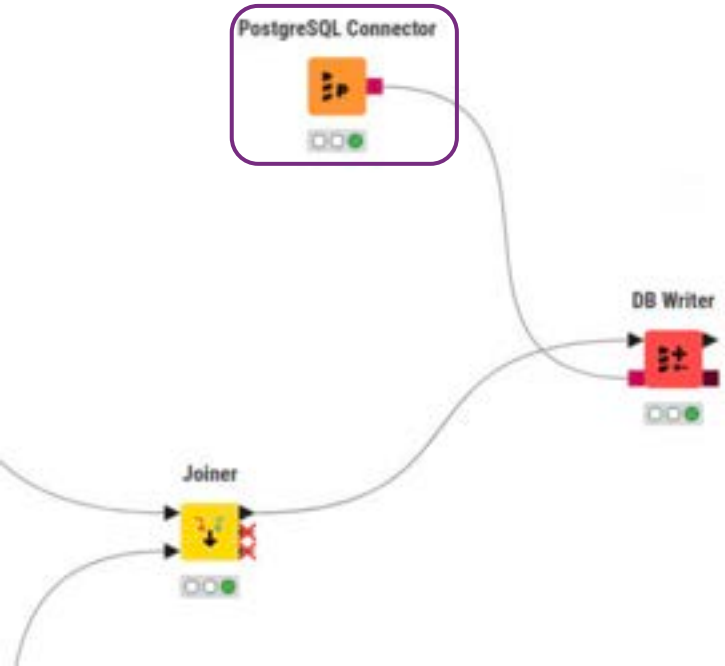
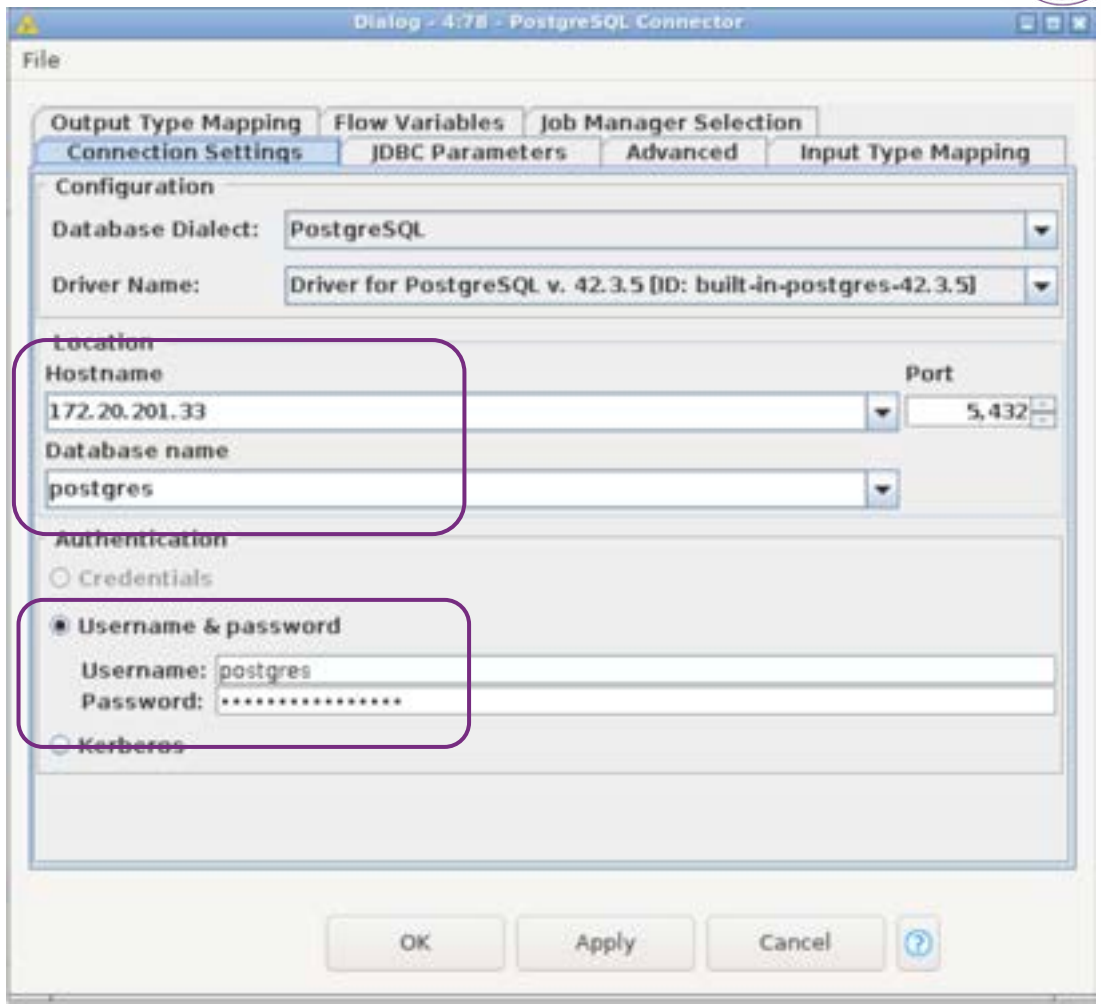
Connect the tools

In your KNIME instance, add the following nodes after the last join operation:

- **“PostgreSQL Connector”**
  - Add your database credentials

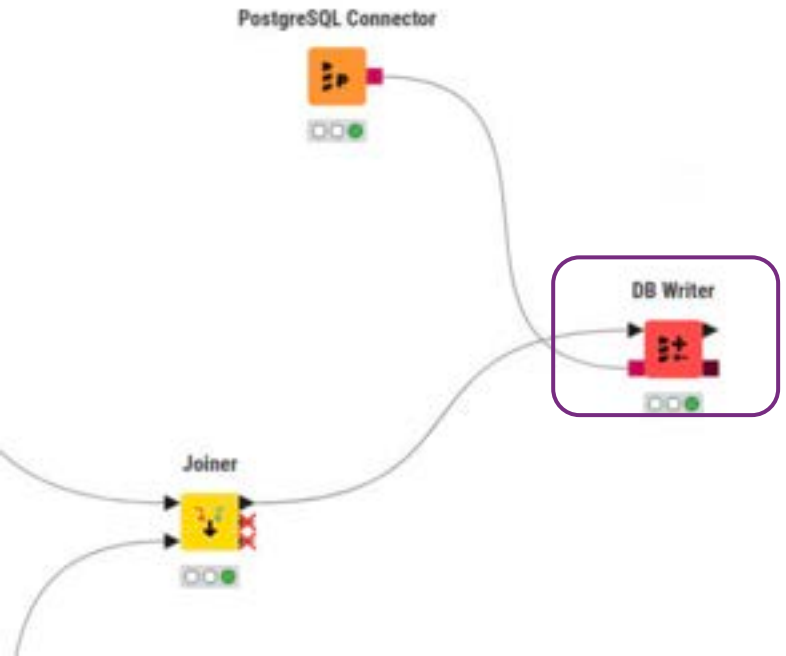


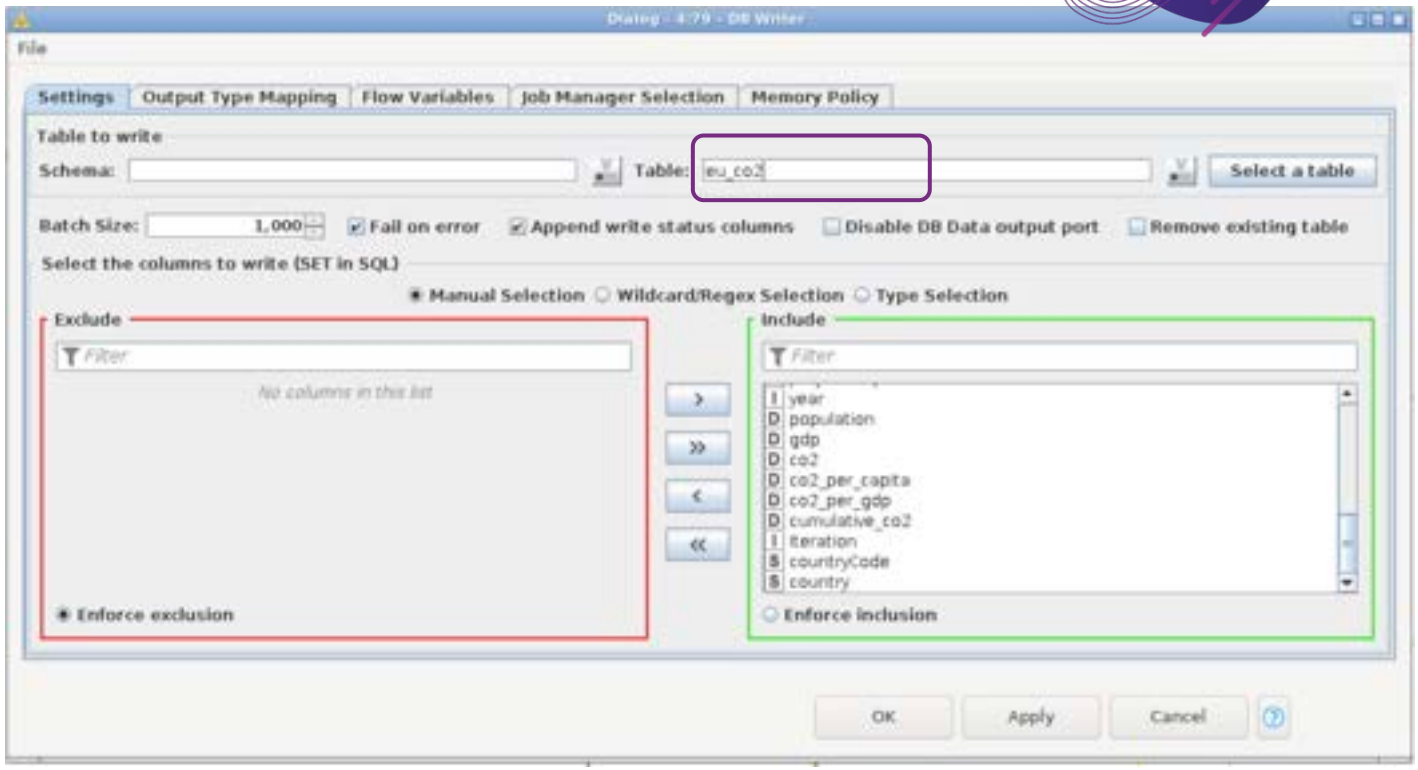


Connect the tools

In your KNIME instance add the following nodes after the last join operation:

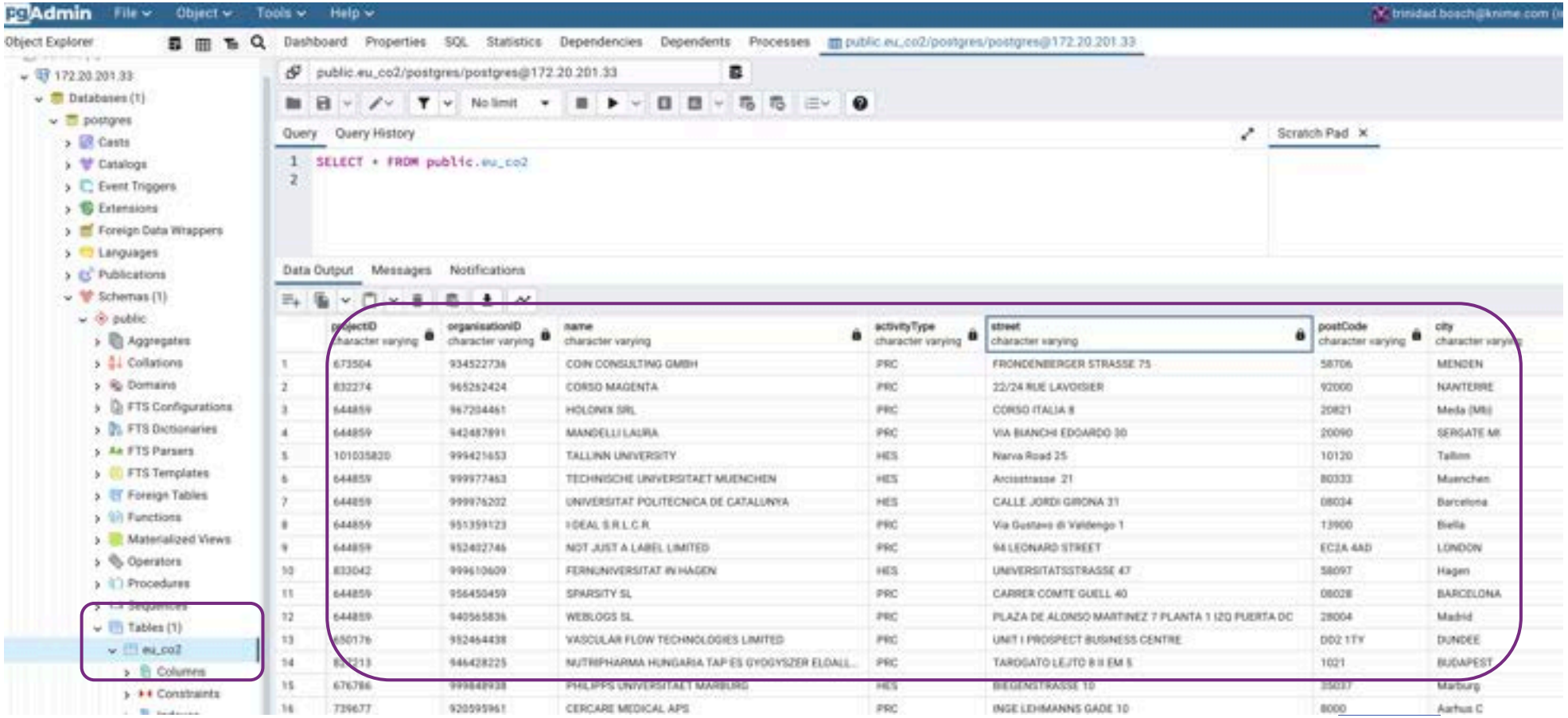
- **“DB Writer”**
  - Give your data a name
  - Choose columns to include





Connect the tools

Now, you have created a table in your database with all the data you have manipulated!



Apply queries to validate your data

postgres/postgres@172.20.201.33

No limit

Query | Query History

```
/*
SELECT * FROM public.eu_co2;
*/

/*
SELECT COUNT(DISTINCT country) AS unique_country_count
FROM public.eu_co2;
*/

SELECT country, COUNT(*) AS country_count
FROM public.eu_co2
GROUP BY country;
```

Data Output | Messages | Notifications

	country character varying	country_count bigint
1	Austria	6012
2	Belgium	10330
3	Bulgaria	968
4	Croatia	857
5	Cyprus	1193
6	Czech Republic	2283
7	Denmark	4987
8	Estonia	1011
9	Finland	4296
10	France	20542
11	Germany	24994
12	Greece	7110
13	Hungary	1657
14	Ireland	3568
15	Italy	20483
16	Latvia	586

Here we have the count of countries in our data

Summary

Now you should be able to:

1. Sign in to the BDTI framework and initialise KNIME, PgAdmin, and PostgreSQL
2. Stack multiple tables
3. Join tables in multiple ways
4. Write data to various file formats
5. Store the data in a database

Data Access → Data Cleaning and Transformation → **Data Blending and Export** → Analytics: aggregation, visualisation, reporting → Advanced Analytics

Next session:

Data Access → Data Cleaning and Transformation → Data Blending and Export → **Analytics: aggregation, visualisation, reporting** → Advanced Analytics

Apache Superset™

Open for Innovation KNIME

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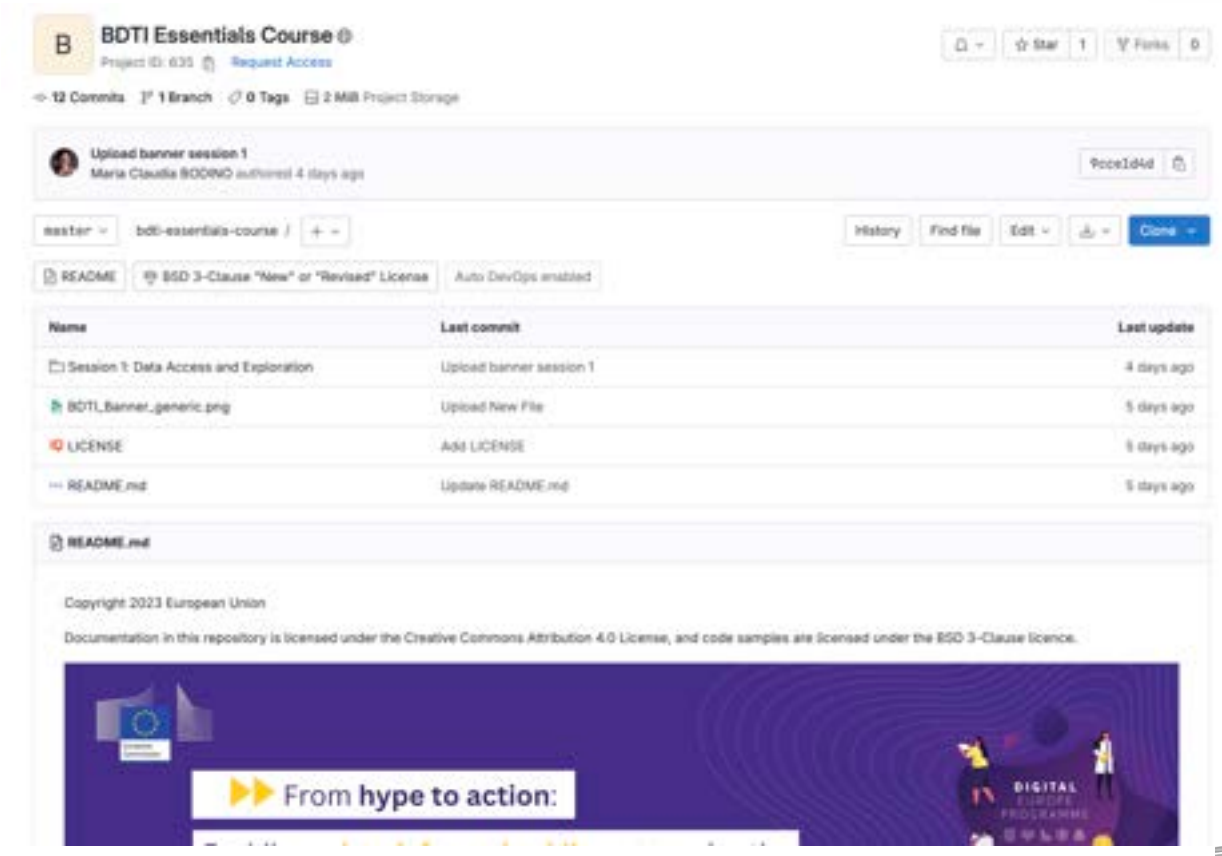
Practice, practice and practice!

- Slides, hands-on exercises, and solutions will be provided on the webinar Gitlab repository

https://code.europa.eu/bdti/bdti-essentials-course



Practice, practice and practice!

- Slides, hands-on exercises, and solutions will be provided on the webinar Gitlab repository

https://code.europa.eu/bdti/bdti-essentials-course

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Q&A

Your BDTI journey starts here

Congrats! You are on the first step to data-driven innovation.

BDTI Essentials Course

Brainstorm your data project

Apply for BDTI Pilot-light process

https://big-data-test-infrastructure.ec.europa.eu/apply-bdti_en

Course discussion board

joinup

Interoperable Europe | Interoperability Solutions | Support Centre

Big Data Test Infrastructure (BDTI)

Leave this solution

eGovernment Topics: Open Source Software

About | Members | Discussions | BDTI Newsletter | Overview

BDTI Essentials Course Discussion Board

Unlike (3) | Translate

Kim Gillick Published on: 24/01/2024 Last update: 26/01/2024 Discussion

Welcome!

Here, you can ask questions and discuss topics related to the BDTI Essentials Online Course. The board is moderated by the BDTI team, so your questions will be answered quickly. We also encourage members to discuss and help each other where possible to build a collaborative space and rewarding community.

Helpful links

Get in touch and follow the BDTI activities

Are you working for a public administration in need of infrastructure for data analytics?

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