Synthetic Data

IOM/Microsoft collaboration

Prepared by the Counter-Trafficking Data Collaborative (CTDC)

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IOM
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What are synthetic data?

- Synthetic data are **artificial data** generated from real data
- It cannot be linked back to the original data (including cases), so we can ensure data confidentiality and privacy.
- The statistical properties and relationships from the original data are preserved in synthetic data.
- The advantages of synthetic data over other forms of data are, e.g.,
  - **Aggregate data**: Researchers can no longer make connections between traits
    - Example: The Global Estimates of Modern Slavery
  - **K-anonymized data**: The redaction of outliers can lead to significant data loss
    - Example: CTDC data pre-2021

Example: Raw Data vs. K-anonymized Data

Raw Data

Anonymization

Gender	Age	isForcedLabour
Female	19	1
Male	18	1
Male	20	1
Male	37	
Female	35	
Female	31	

K-anonymized Data (*k* = 2)

Gender	AgeBroad	isForcedLabour	*k*
~~Female~~	~~18–20~~	~~1~~	~~1~~
Male	18–20	1	2
Male	18–20	1	2
~~Male~~	~~30–38~~		~~1~~
Female	30–38		2
Female	30–38		2

Example: Synthetic Data vs. K-anonymized Data

Synthetic Data ?

Gender	AgeBroad	isForcedLabour
Female		
	18–20	1
Male		
	30-38	
		1
Male	18–20	1
Male	18–20	1
Female	30–38	
Female	30–38	

K-anonymized Data (k = 2)

Gender	AgeBroad	isForcedLabour	*k*
~~Female~~	~~18–20~~	~~1~~	~~1~~
Male	18–20	1	2
Male	18–20	1	2
~~Male~~	~~30–38~~		~~1~~
Female	30–38		2
Female	30–38		2

**Both datasets are generated from the same raw data. For CTDC, k = 10.*

Overcoming challenges with synthetic data

Problem – Then

- CTDC's previous solution was **labour-intensive and partner reliant**
- K-anonymization results in the **loss** of potentially useful data
- Risk of **re-identification and reprisals**
- Market providers were **expensive**

Solution – Now

- Microsoft Research's solution **automatically** prevents the publication of rare attributes
- **Preserves** the statistical properties and relationships in the original data
- Differential privacy **guarantees against any privacy attacks**
- **Open-source**

Synthetic Data
Timeline and achievements

2017
CTDC launch

2019
TAT Accelerator program

2020
Published a paper with Microsoft Research on the privacy-preserving data solution

2021
Released the Global Synthetic Dataset

2022
Released the Global Victim-Perpetrator Synthetic Dataset

Synthetic Data
Tech Against Trafficking Accelerator Program

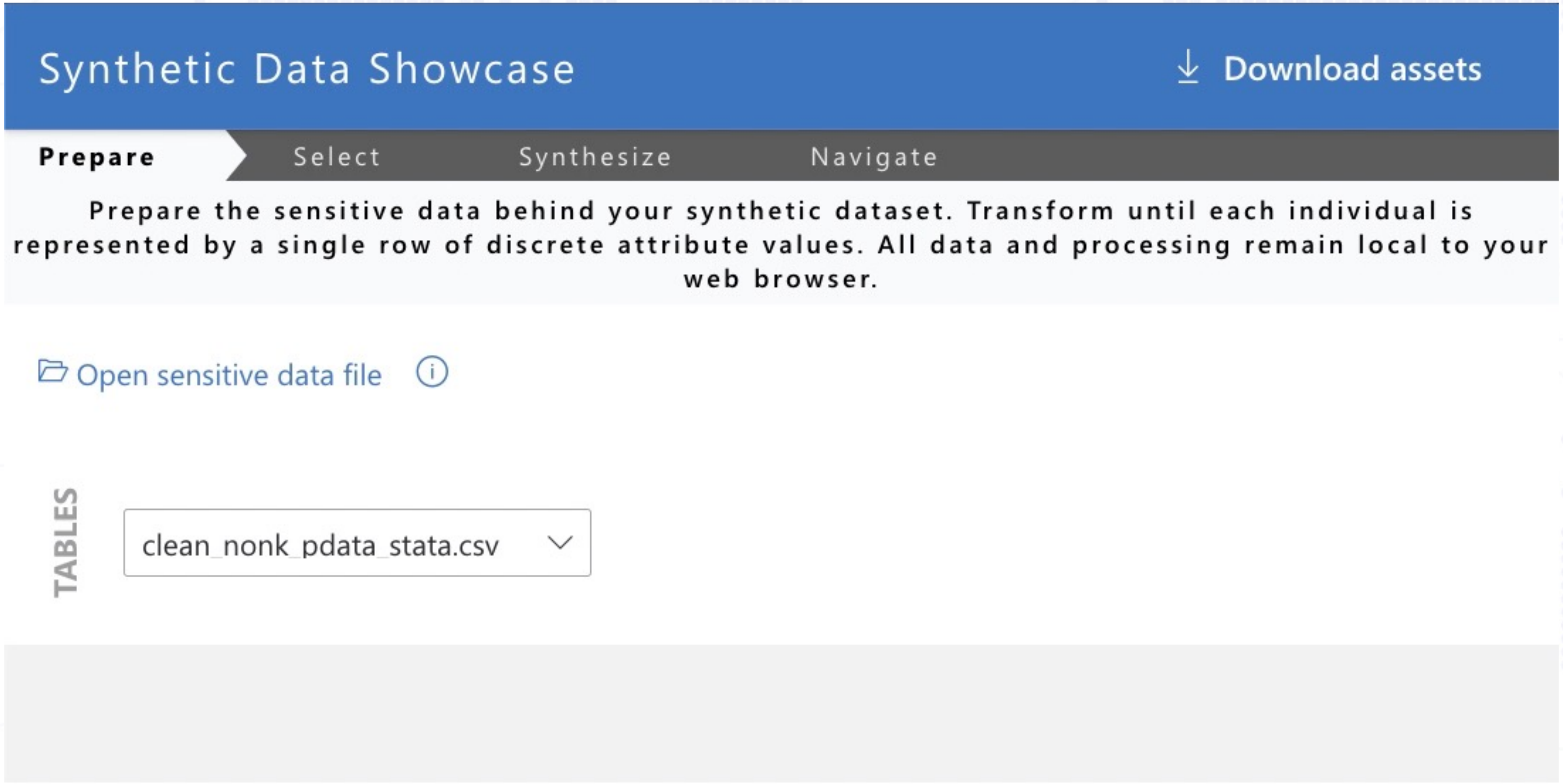
- Tech Against Trafficking invited IOM's CTDC to participate the 2019 Accelerator Program.
- The partnership focused on 3 workstreams:
  1. **Privacy-preserving mechanism**:
     Develop a solution for analyzing case data while protecting victim privacy.
  2. **Data standards:**
     Address data standards/consistency related to victim case management.
  3. **Stakeholder engagement:**
     Maximize utility and impact of the CTDC platform.
- IOM has benefitted from substantial in-kind support from Microsoft Research to support CTDC.

Microsoft Research’s Synthetic Data Showcase

- Synthetic Data Showcase can automatically generate 3 elements: i) a synthetic data, ii) aggregate data, and iii) data dashboards.
- The tool provides 2 approaches to create anonymous datasets: i) differential privacy and ii) k-anonymity.
- The tools are available with **command-line** options in Python/Rust or a locally run **web application** using Javascript and Web Assembly.

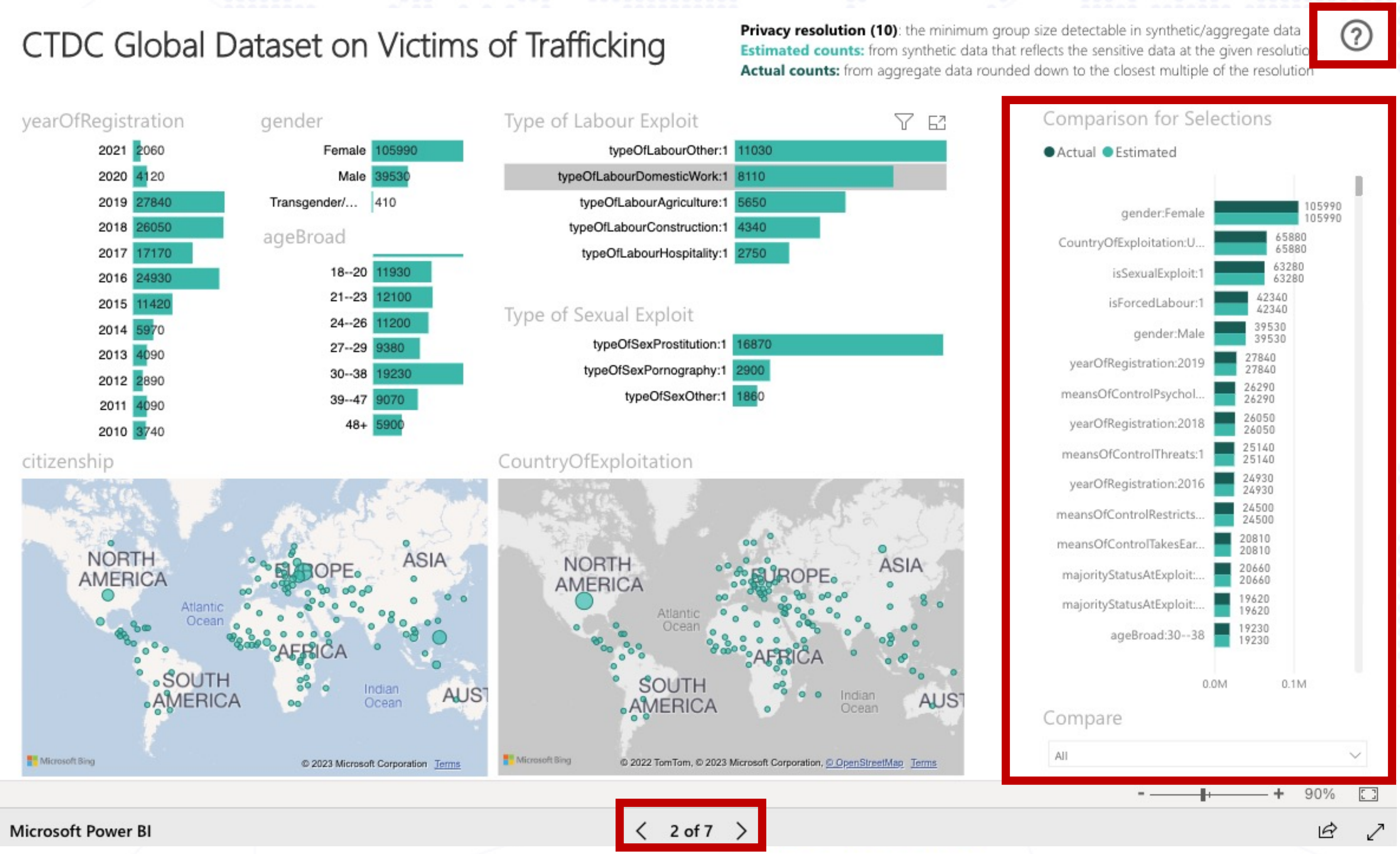
Prepare → Select → Synthesize → Navigate

Synthetic Data Showcase
Free-to-use web application



Global Synthetic Dataset (2021)

You can download data, codebook, and data dictionary

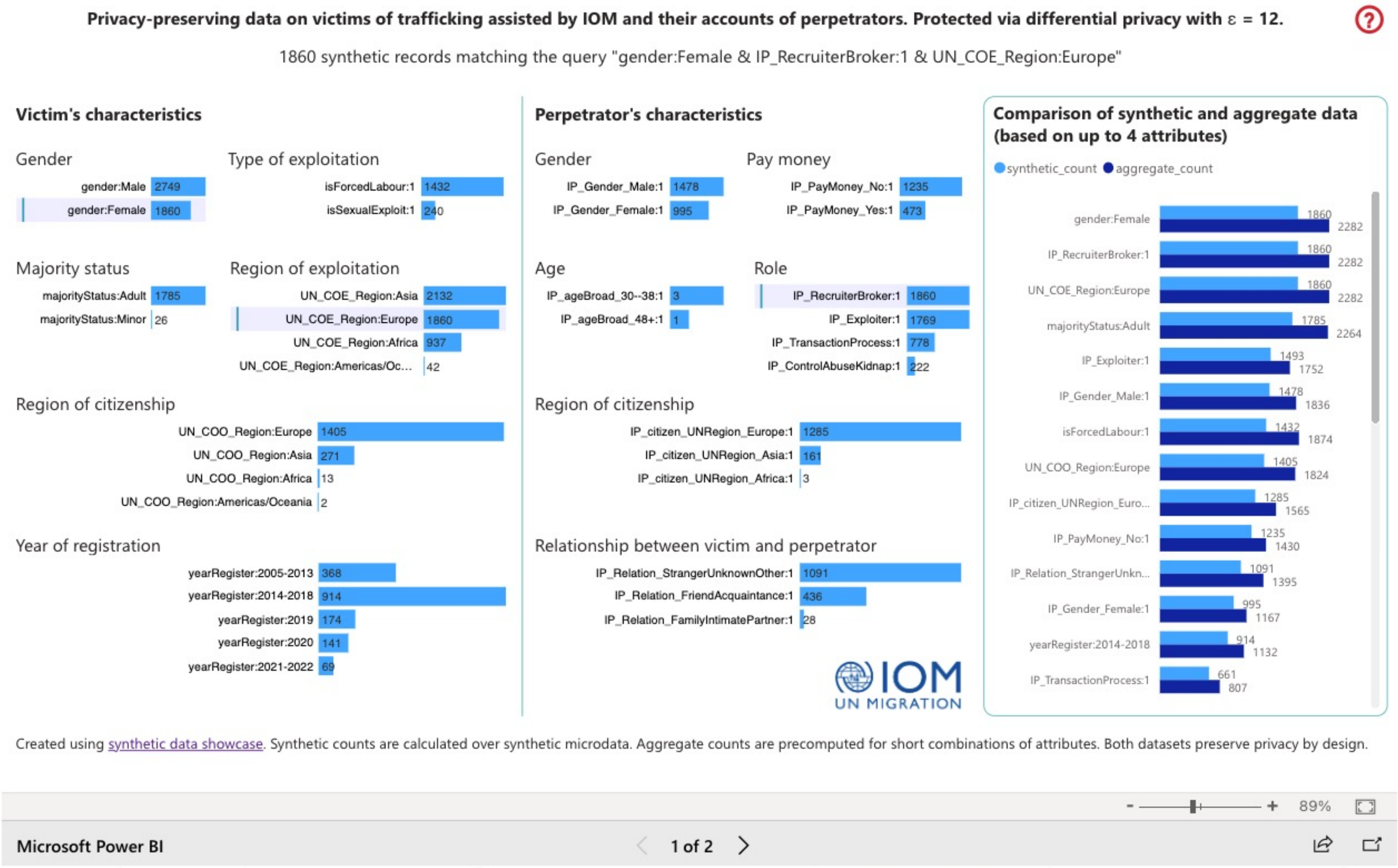


Victim's characteristics, e.g.,

- Country of exploitation
- Citizenship
- Type of trafficking, labour exploit, sexual exploit
- Means of control
- Trafficking duration
- and more…

Global Victim-Perpetrator Synthetic Dataset (2023)

You can download data, codebook, and data dictionary



Perpetrator' characteristics, e.g.,

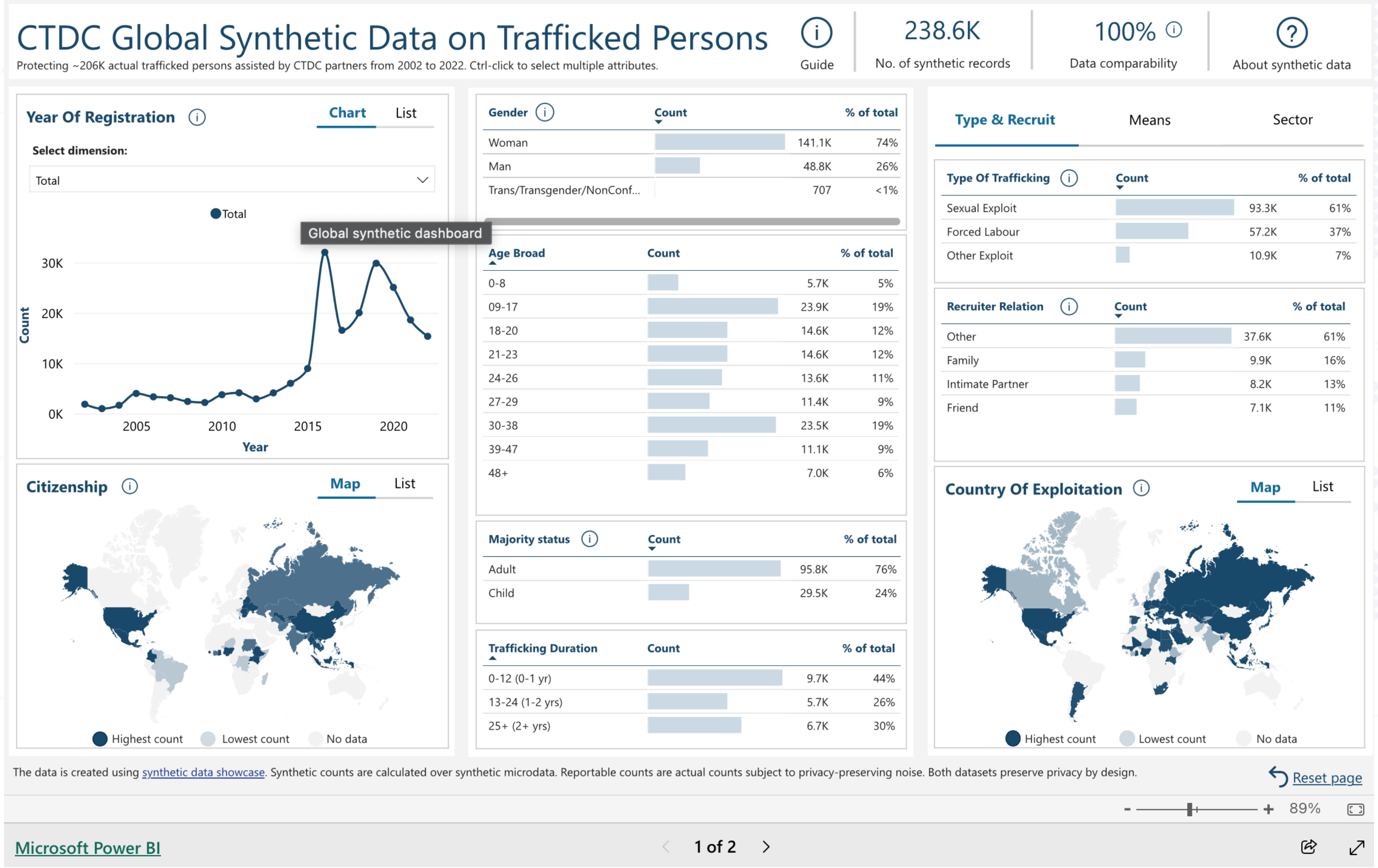
- Role
- Region of citizenship
- Victim-perpetrator relationship
- Pay money

Victim's characteristics, e.g.,

- Type of exploitation
- Region of exploitation and citizenship

Global Synthetic Dataset (2024)

You can download data, codebook, and data dictionary



Protecting over 206K actual trafficked persons assisted by CTDC partners from 2002 to 2022 via differential privacy.

Synthetic Data
Relevance to stakeholders

- More data (that are published safely) can enable more effective research and scalable responses.
- Victim-perpetrator relationships and victims' characteristics can help advance the understanding of risk factors for vulnerability.
- The technology can be used by any stakeholder who wants to collect and publish sensitive data while protecting individual privacy.
- Synthetic data, if well used, can strengthen the evidence base on human trafficking and help address this grave human rights violation.

Want to know more?

- Take this free and self-paced e-learning course on "Standardized Human Trafficking Survivor Data Management"
- Visit the CTDC website
- 🚨 Read/consult this joint IOM-UNODC report (2023), "Leveraging Administrative Data to Strengthen the Response to TIP (ICSTIP)" and guidance

Appendix: Different forms of data

Type	Definition
Raw data	Data collected on *data subjects* and **not processed**.
Partially de-identified data	Data **modified only marginally** by removing direct identifiers (e.g., name, ID number, IP address).
Aggregate data	Data combined and presented in a **summarized format** in the form of statistics, etc. (e.g., Global Estimates 2022).
K-anonymized data	Data modified by removing direct identifiers, **reducing details** (e.g., 23 becomes 18–24), and **redacted outliers** (e.g., $k = 10$).
Synthetic data	Data that are **artificially created** rather than obtained through direct measurement, but the statistical properties and relationships from the original data are preserved.

Appendix: Synthesizing data with full k-anonymity (Microsoft)

Step 1

	ATTRIBUTES/COLUMNS			
row ID	A	B	C	D
1	a1	b1	c1	d1
2	a2	b2	c1	d1
3	a1	b2	c2	d1
4	a2	b1	c1	d2
5	a2	b2	c3	d1
6	a1	b1	c3	d1
7	a1	b2	c1	d2

value of attribute	freq.	rel. freq.	cumu. freq.	RAND [0,1]
a1	4	0.25	0.25	0.1
b1	3	0.19	0.50	
c1	4	0.25	0.69	
d1	5	0.31	0.94	
total	16			

new1	a1			

Step 2

	ATTRIBUTES/COLUMNS			
ID	A	B	C	D
1	a1	b1	c1	d1
3	a1	b2	c2	d1
6	a1	b1	c3	d1
7	a1	b2	c1	d2

value of attribute	freq.	rel. freq.	cum. freq.	RAND [0,1]
b1	2	0.29	0.29	
c1	2	0.29	0.57	0.6
d1	3	0.43	1	
total	7			

new1	a1		c1	

Step 3

	ATTRIBUTES/COLUMNS			
ID	A	B	C	D
1	a1	b1	c1	d1
7	a1	b2	c1	d2

value of attribute	freq.	rel. freq.	cumu. freq.	RAND [0,1]
b1	1	0.5	0.5	
d1	1	0.5	1	0.75
total	2			

new1	a1		c1	d1

Step 4

	ATTRIBUTES/COLUMNS			
ID	A	B	C	D
1	a1	b1	c1	d1

We could not include attribute B

new1	a1	NULL	c1	d1
new2	NULL	b1	c1	d1

* "freq." stands for frequency. "rel." stands for relative. "cumu." stands for cumulative.