UK Data Service

Powerful DDI-CDI Metadata – the how and the why?

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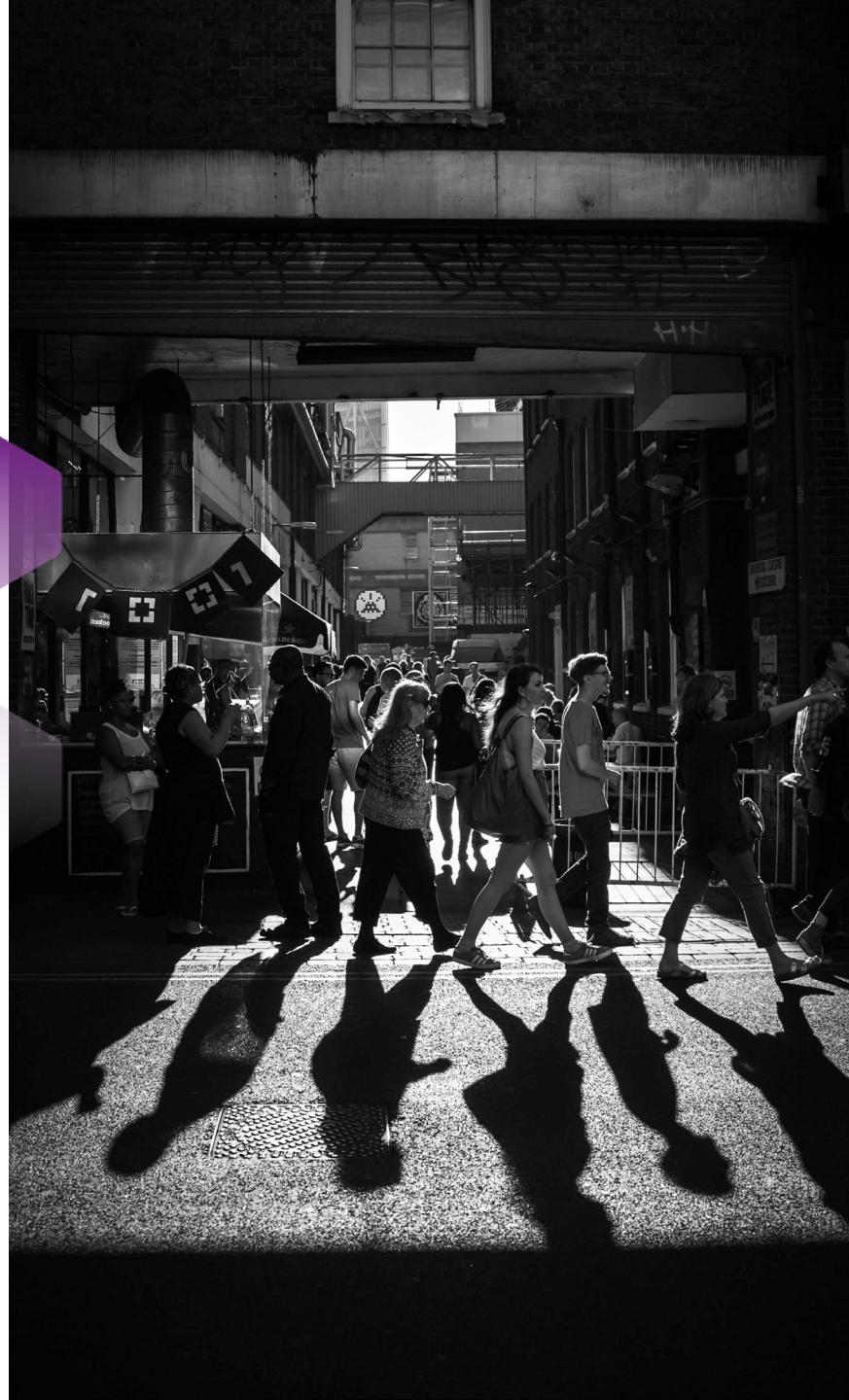
Ivan Evdokimov, Data Engineer
Jon Johnson, Closer



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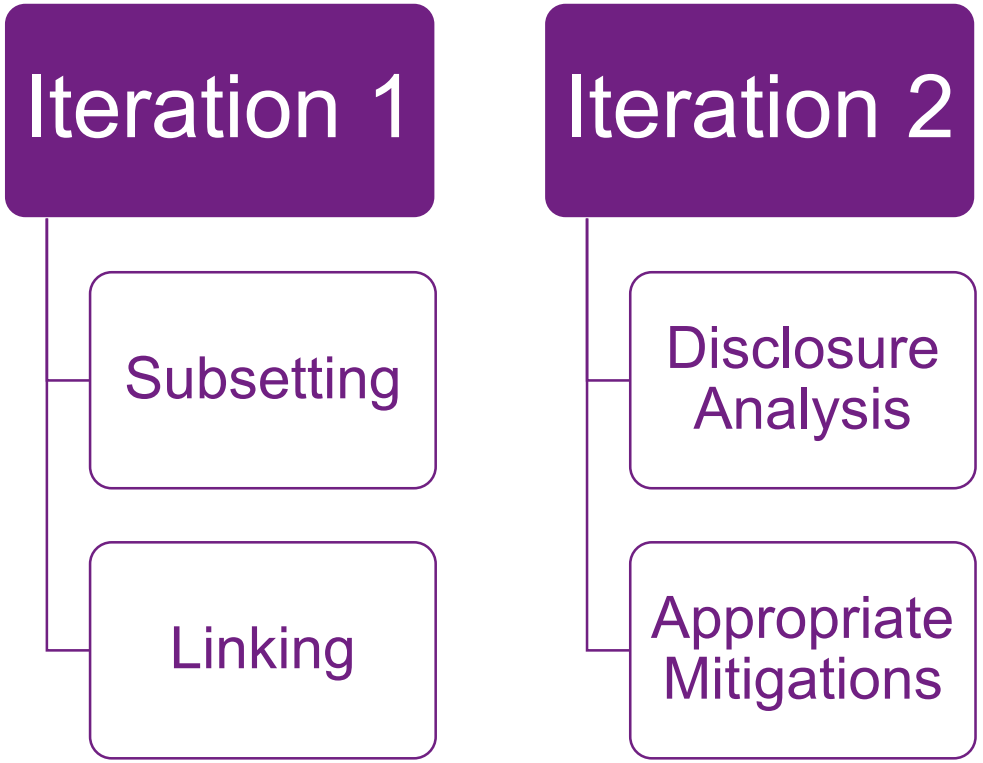
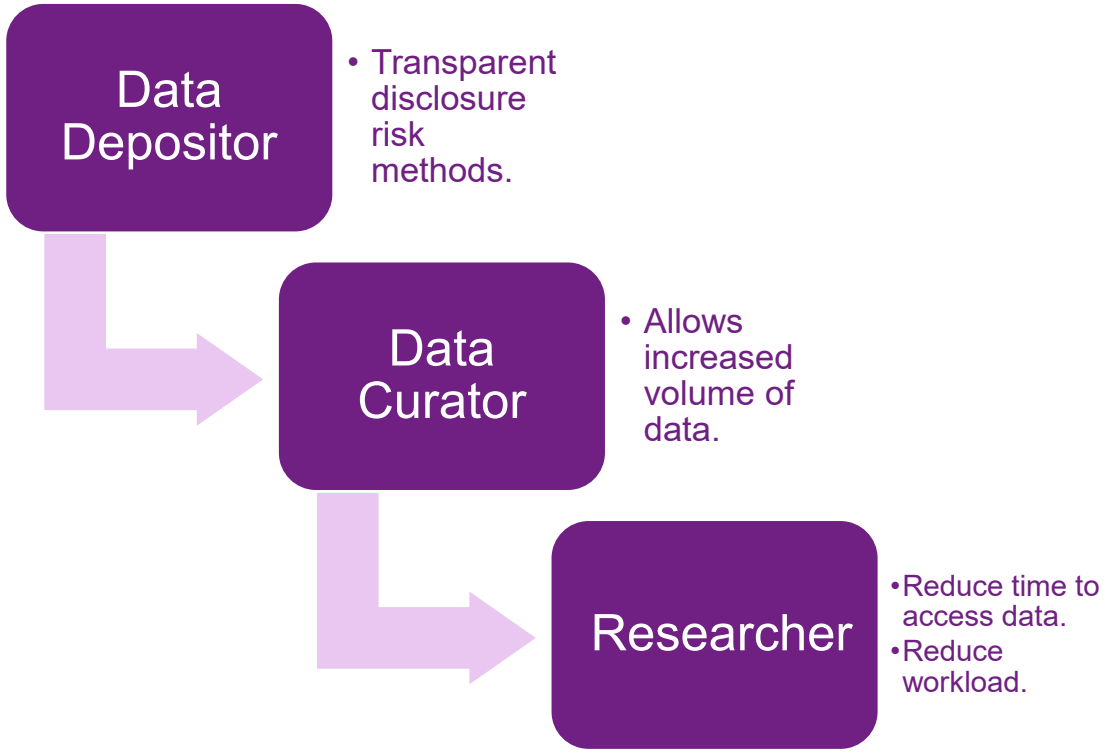
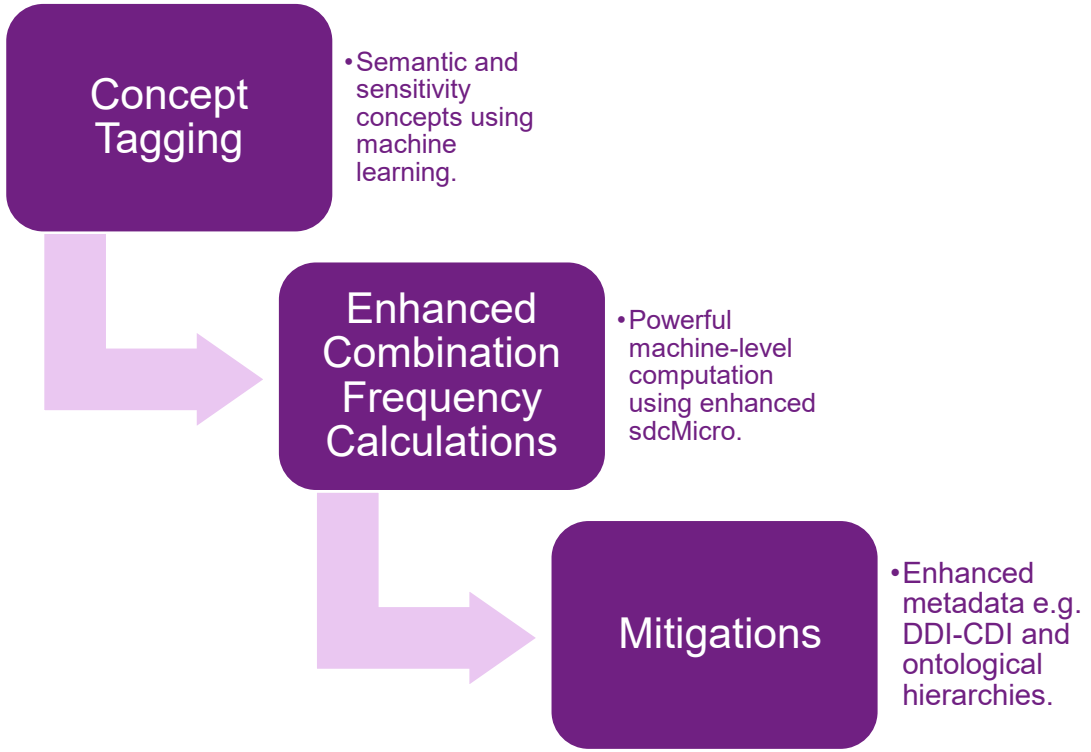
UKDS Data Product Builder



Why?


Data Depositor
• Transparent disclosure risk methods.
Data Curator
• Allows increased volume of data.
Researcher
•Reduce time to access data.
•Reduce workload.

How?


Concept Tagging
•Semantic and sensitivity concepts using machine learning.
Enhanced Combination Frequency Calculations
•Powerful machine-level computation using enhanced sdcMicro.
Mitigations
•Enhanced metadata e.g. DDI-CDI and ontological hierarchies.

Concept Tagging

- Input features derived from:
  - Variable name.
  - Variable label.
  - Question text.
  - Variable group and subgroup.
- Multiple models:
  - Model per variable group, e.g., Standard Occupational Classification.
  - Sensitivity model.
- Machine Learning Methods:
  - FastAI: language based model.
  - SVM: Support Vector Machines.
  - KNN: K-Nearest Neighbour.

Enhanced Combination Frequency Calculations

- The existing tool we use is sdcMicro:
- GUI would not allow load of dataset as large as QLFS.
- With scripting – possible but quite slow.
- We have achieved 3-fold performance improvements by using C++ bitmask operations in place of the original R code.
- Makes real-time disclosure analysis feasible.

Enhanced Combination Frequency Calculations II

	A	B	C	fk
0	22	77	44	**3**
1	33	77	66	**1**
2	22	77	-9	**4**
3	22	77	55	**2**
4	33	77	44	**2**
5	33	77	44	**2**
6	11	88	-9	**1**
7	22	-9	44	**3**

Tested with the Quarterly Labour Force Survey
~96,000 rows.

10 key variables.

2-, 3- and 4-way combinations = 375 permutations
36 million rows in total.

~5s to compute the bitmasks*.

~15s to compute the fk frequency counts for all combinations*.
~240s to compute weighted Fk as well.

* Intel core i7-12700H, 32 GB.

Population-level Combination Frequencies

- Traditional Disclosure Risk Analysis (DRA) has relied on ‘data experts’.
- We’re currently exploring the feasibility of using Census aggregate data to inform automated DRA.
- Population-level combination frequencies can be checked when sample frequencies are low.
- Demo to illustrate this.

Mitigations

- Our Data Product Builder aims to offer metadata driven mitigations:
  - Top/Bottom coding examples:
    - Age top and bottom coding.
    - Salary top-coding.
  - Rebanding examples:
    - Broader geographical concept.
    - Broader occupation concept.
    - Broader ethnicity concept.

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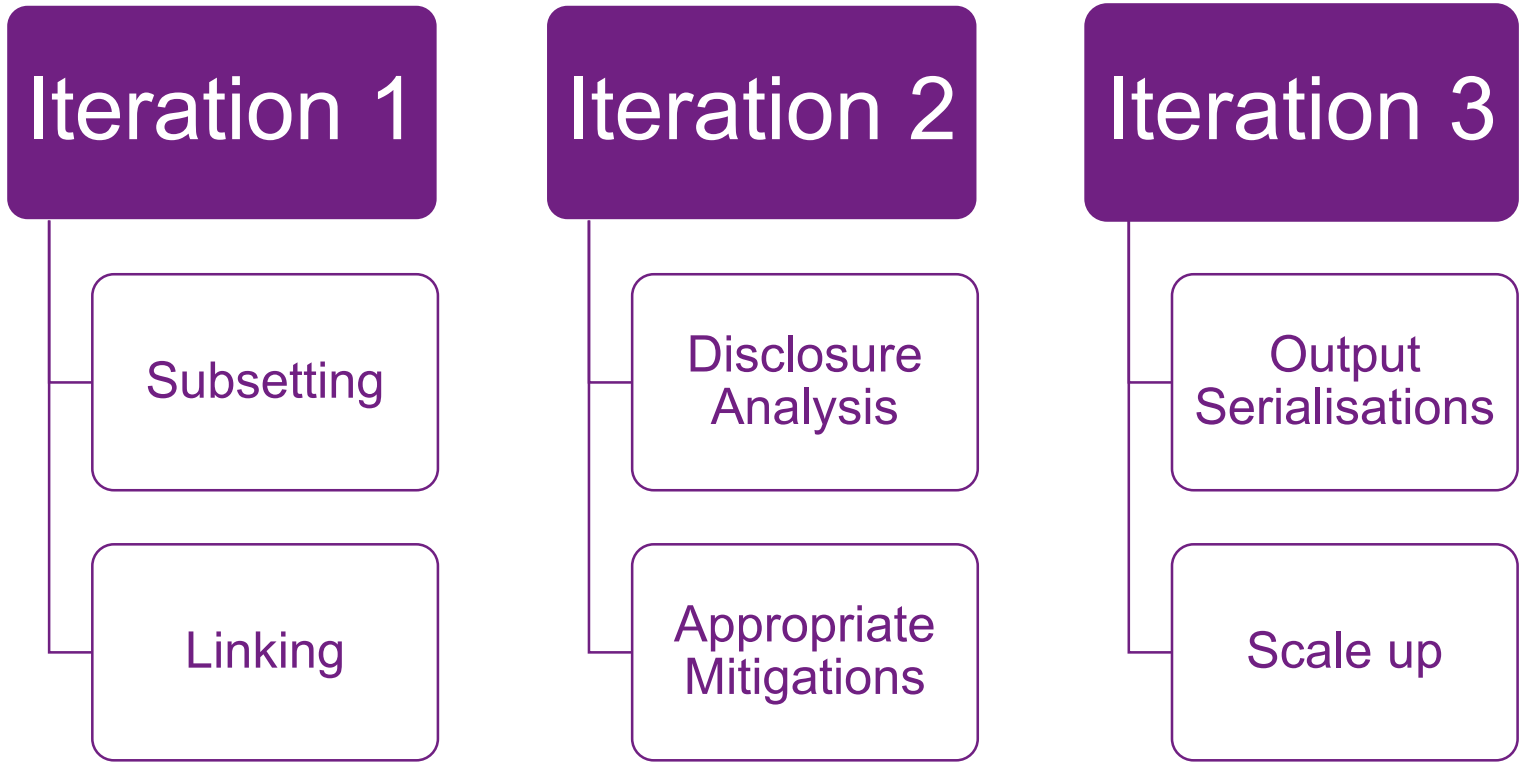
DEMO

UKDS Data Product Builder cont..



Any questions?

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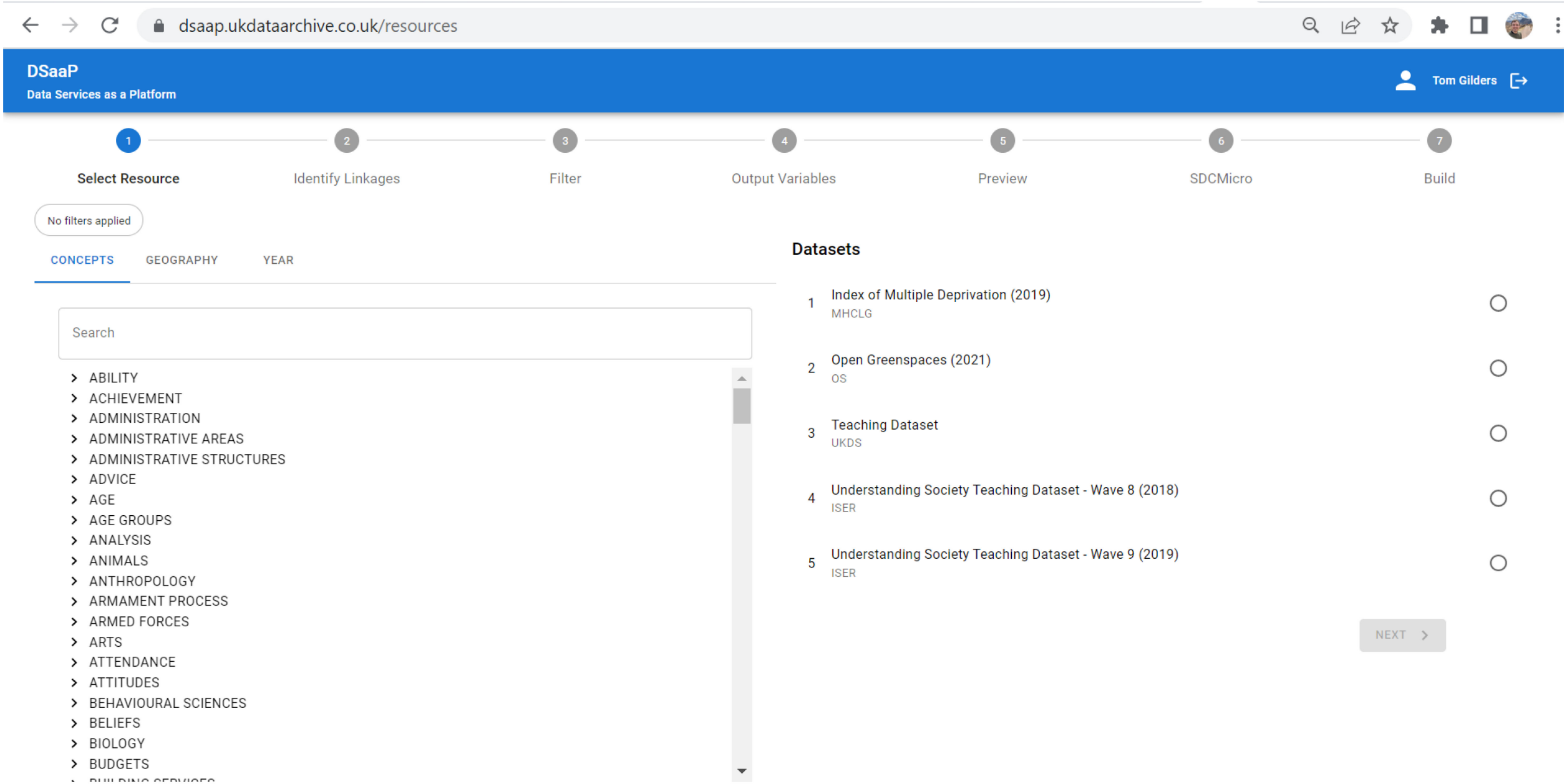
Thank you.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Tom Gilders
1
Select Resource
2
Identify Linkages
3
Filter
4
Output Variables
5
Preview
6
SDCMicro
7
Build
No filters applied
CONCEPTS
GEOGRAPHY
YEAR
Search
ABILITY
ACHIEVEMENT
ADMINISTRATION
ADMINISTRATIVE AREAS
ADMINISTRATIVE STRUCTURES
ADVICE
AGE
AGE GROUPS
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ARMAMENT PROCESS
ARMED FORCES
ARTS
ATTENDANCE
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BEHAVIOURAL SCIENCES
BELIEFS
BIOLOGY
BUDGETS
Datasets
1 Index of Multiple Deprivation (2019)
MHCLG
2 Open Greenspaces (2021)
OS
3 Teaching Dataset
UKDS
4 Understanding Society Teaching Dataset - Wave 8 (2018)
ISER
5 Understanding Society Teaching Dataset - Wave 9 (2019)
ISER
NEXT

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No filters applied

CONCEPTS | GEOGRAPHY | YEAR

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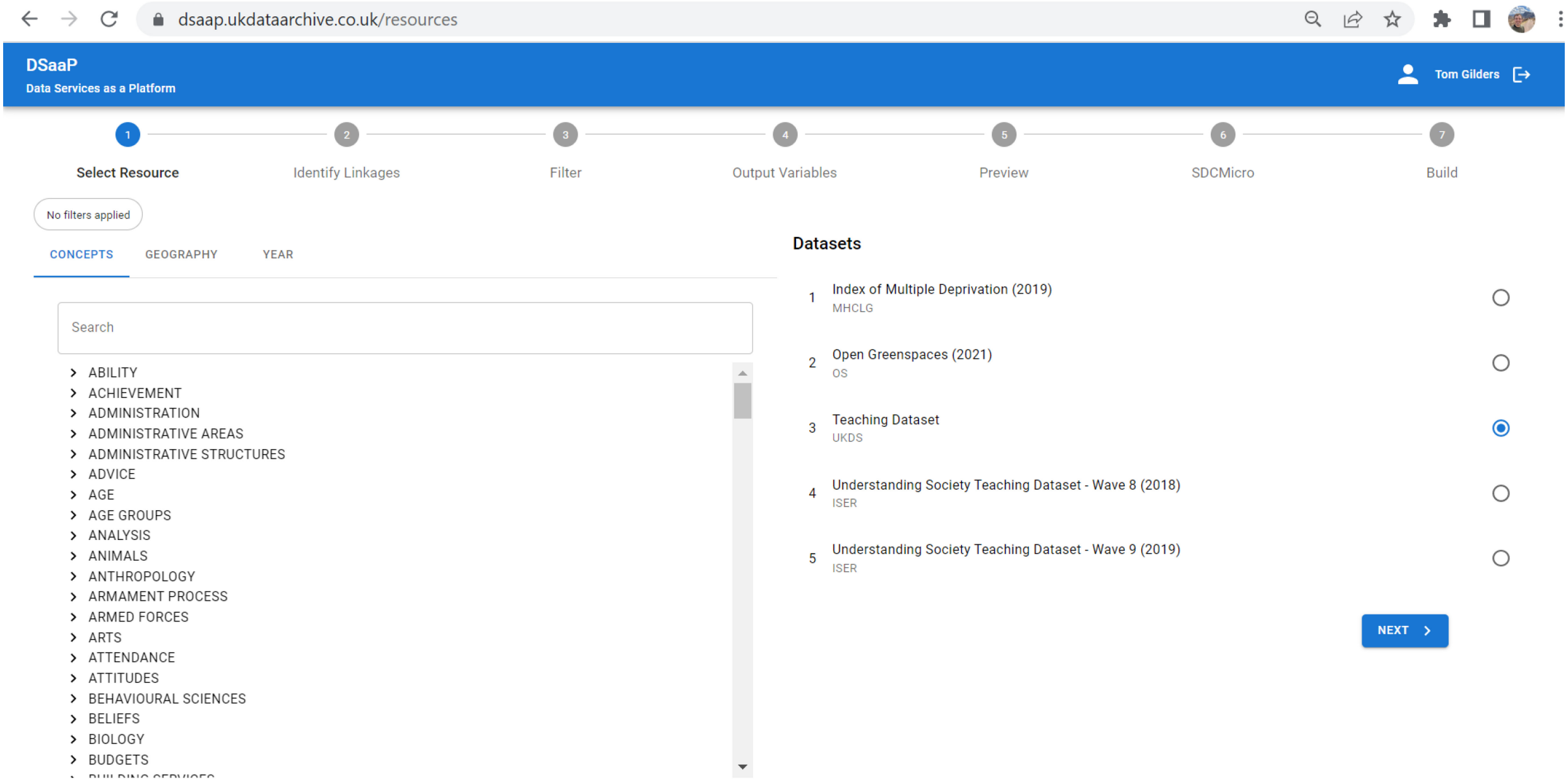
2. Open Greenspaces (2021) — OS
3. Teaching Dataset — UKDS
4. Understanding Society Teaching Dataset - Wave 8 (2018) — ISER
5. Understanding Society Teaching Dataset - Wave 9 (2019) — ISER

NEXT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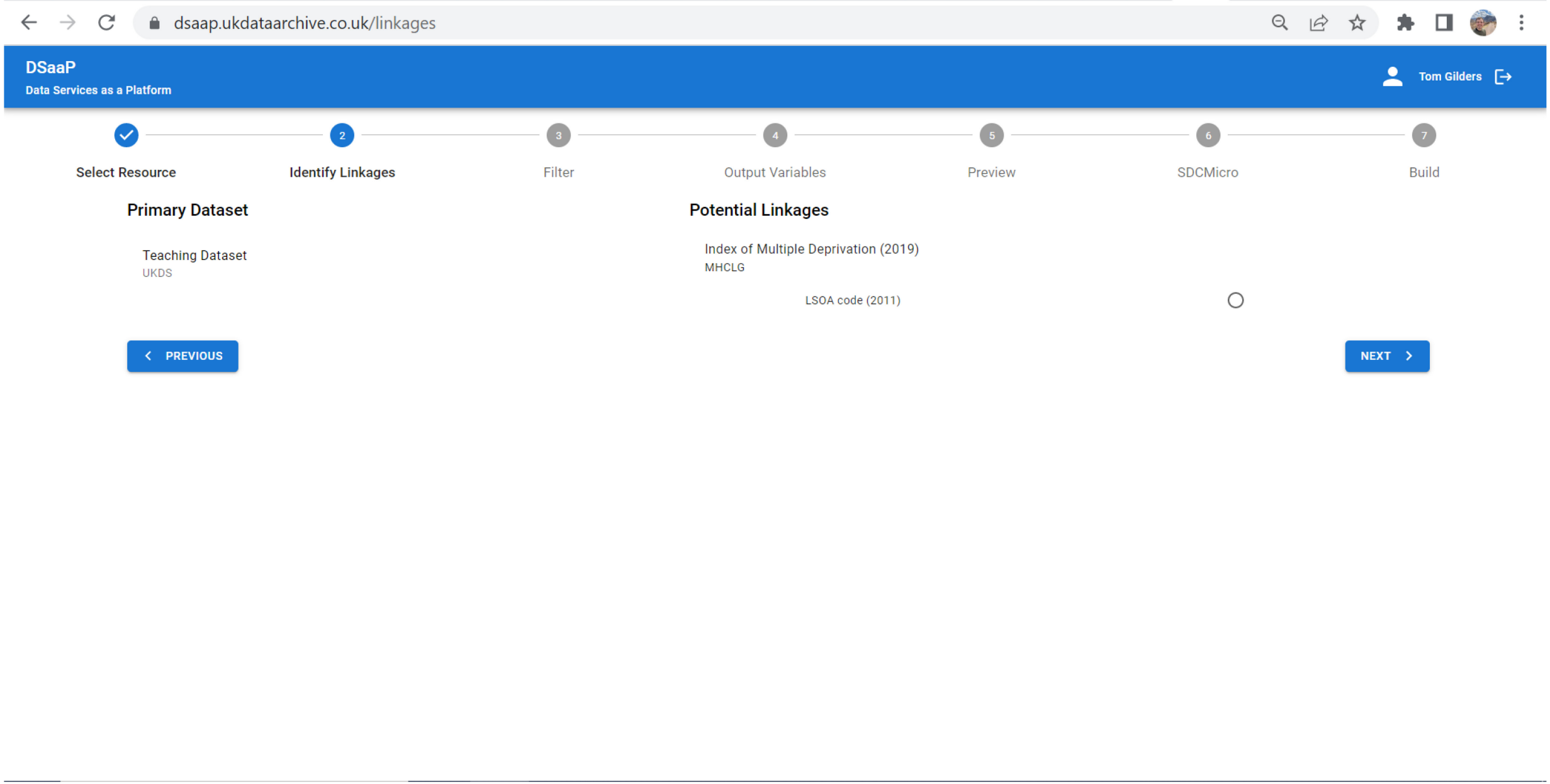
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Potential Linkages
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LSOA code (2011)
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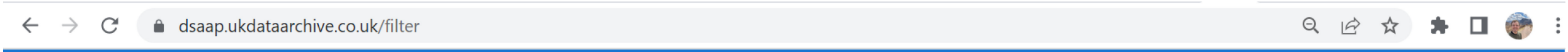

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7. Build

Teaching Dataset
UKDS

LSOA code (2011)

Index of Multiple Deprivation (2019)
MHCLG

Case count: 9261

Variable id	Variable label	Source dataset	Variable type
soc103d	Industry class in main job (3 digits)	TD_1	Scale
gor	Government Office Region (2 and 3 combined)	TD_1	Nominal
sex	Sex of respondent	TD_1	Nominal
weight	Person weight 2018	TD_1	Scale
age_band5	Age Band (5 years)	TD_1	Nominal
soc104d	Industry class in main job (4 digits)	TD_1	Nominal
lsoa	Lower-level Super Output Area	TD_1	Nominal

Rows per page: 100 1–8 of 8

Selected filter variable	Filter to apply
No rows	

Rows per page: 100 0–0 of 0

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Teaching Dataset
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LSOA code (2011)

Index of Multiple Deprivation (2019)
MHCLG

Case count: 9261

	Variable id	Variable label	Source dataset
☐	age_band5	Age Band (5 years)	TD_1
☐	gor	Government Office Region (2 and 3 combined)	TD_1
☐	int_date	Date of interview	TD_1
☐	int_type	Type of Interview	TD_1
☐	lsoa	Lower-level Super Output Area	TD_1
☐	pid	Person Identifier	TD_1
☐	sex	Sex of respondent	TD_1

1 row selected

Rows per page: 100 1–12 of 12

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UKDS

LSOA code (2011)

Index of Multiple Deprivation (2019)
MHCLG

Case count: 9261

	Variable id	Variable label	Source dataset
☑	pid	Person Identifier	TD_1
☑	sex	Sex of respondent	TD_1
☑	soc103d	Industry class in main job (3 digits)	TD_1
☑	soc104d	Industry class in main job (4 digits)	TD_1
☑	weight	Person weight 2018	TD_1
☑	dec_dv	Index of Multiple Deprivation (IMD) Decile	IMD
☐	lsoa	LSOA code (2011)	IMD

10 rows selected

Rows per page: 100 1–12 of 12

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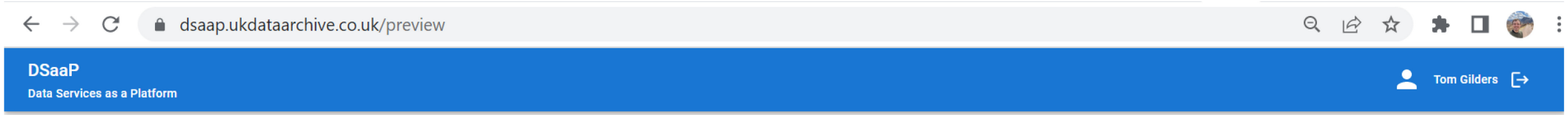

TD_1_pid	TD_1_gor	TD_1_int_date	TD_1_sex	TD_1_int_type	TD_1_weight	TD_1_age_band5	TD_1_soc104d	TD_1_soc103d	IMD_dec_dv
10001	4	4012015	1	1	548	5	1122	112	9
1000501	4	18012015	1	1	953	0	7113	711	3
1001201	5	25012015	2	1	530	6	1131	113	10
1002101	8	29032015	2	1	694	6	-9	-9	8
1003201	1	15022015	2	1	529	4	9274	927	1
1004801	4	22032015	1	1	553	10	2471	247	1
1005801	6	4012015	1	2	690	7	7123	712	6
100602	10	29032015	1	1	764	1	9120	912	6
1006501	8	25012015	2	2	1130	9	3417	341	2
100702	2	15032015	1	2	674	4	8212	821	7

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Select Resource ✓ — Identify Linkages ✓ — Filter ✓ — Output Variables ✓ — Preview ✓ — SDCMicro 6 — Build 7

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LSOA code (2011)

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Computing Combined Key Variable Frequency Counts...

...Mitigations

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LSOA code (2011)

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Combined Key Variable Frequency Counts

No Violations

Contributing variable	Number of levels	Lowest sample frequency
TD_1_age_band5	11	689
TD_1_sex	2	4325
TD_1_gor	10	462
IMD_dec_dv	10	826

Violations

Contributing variable	Number of levels	Lowest sample frequency	Lowest combination population frequency	Available mitigation	New lowest sample frequency	New lowest combination population frequency	
TD_1_soc104d	307	1	1	Banding: SOC2010 unit group → SOC2010 minor group	6	5	ACCEPT

Teaching Dataset
UKDS

LSOA code (2011)

Index of Multiple Deprivation (2019)
MHCLG

Combined Key Variable Frequency Counts

No Violations

Contributing variable	Number of levels	Lowest sample frequency
TD_1_age_band5	11	689
TD_1_sex	2	4325
TD_1_gor	10	462
IMD_dec_dv	10	826

Mitigated violations

Contributing variable	Number of levels	Lowest sample frequency	Lowest combination population frequency	Accepted mitigation	
TD_1_soc104d	307	6	5	Banding: SOC2010 unit group → SOC2010 minor group	UNDO

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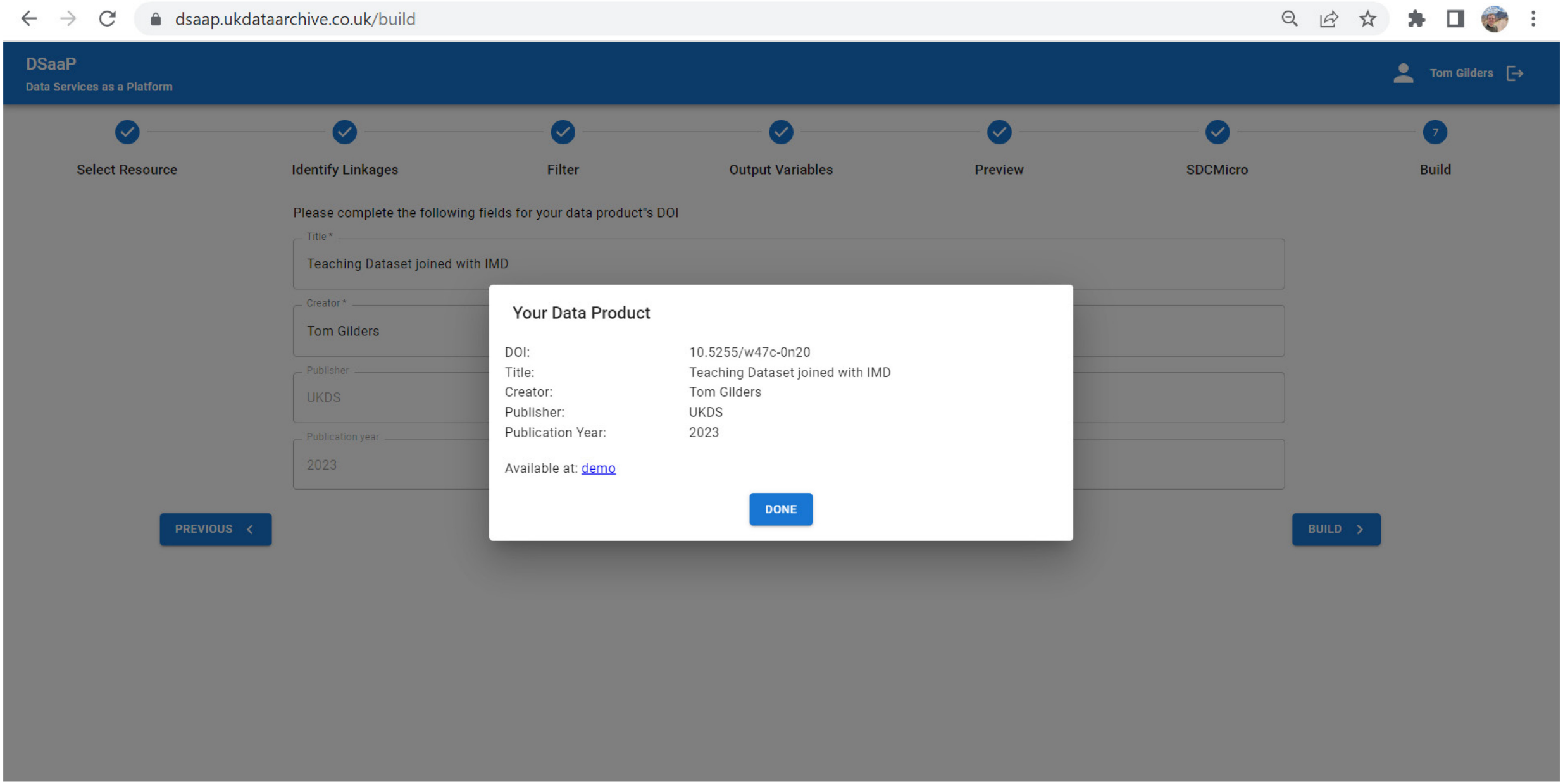
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