Evaluating utility of subject headings in a data repository: A preliminary finding from a data search log and record classification

Presented by:
Mingfang Wu, Australian Research Data Commons
mingfang.wu@ardc.edu.au

Contributors:
Rowan Brownlee, Australian Research Data Commons
Ying-Hsang Liu, University of Southern Denmark
Jenny Xiuzhen Zhang, RMIT University, Australia

NKOS, 10 Sept. 2020

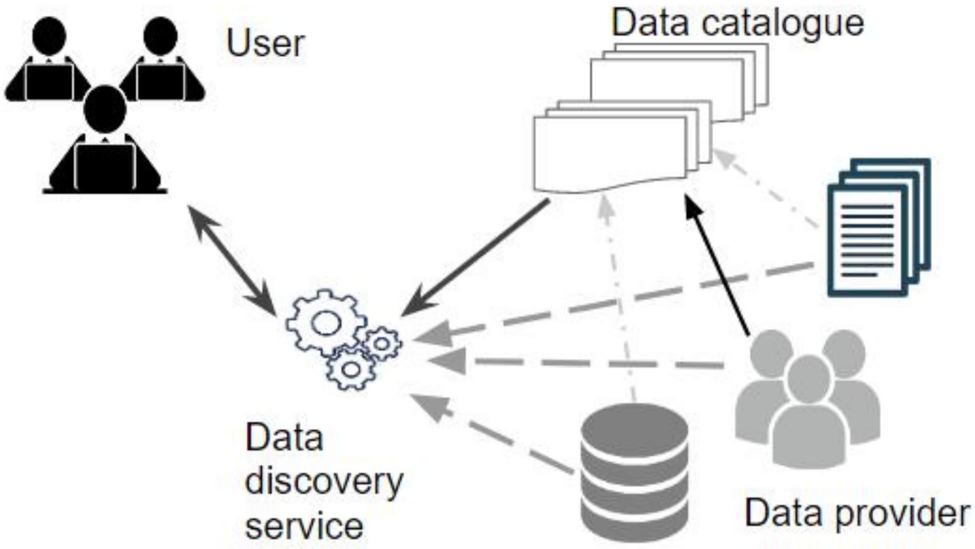
Outlines

- A background about the studied data catalogue: Research Data Australia

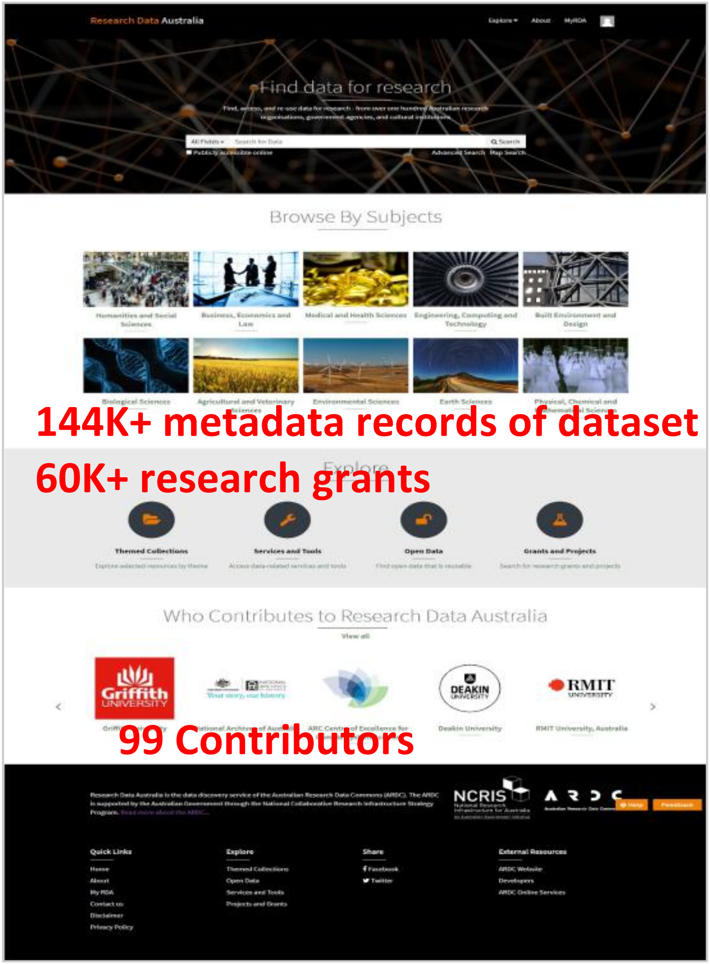
- Log analysis: the usage of subject headings

- Experiments on data record classification

- Future work



Research Data Australia - A National Data Catalogue



Research Data Australia

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Find, access, and re-use data for research - from over one hundred Australian research organisations, government agencies, and cultural institutions.

All Fields ▾ Search for Data 🔍 Search

□ Publicly accessible online

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Themed Collections — Explore selected resources by theme

Services and Tools — Access data-related services and tools

Open Data — Find open data that is reusable

Grants and Projects — Search for research grants and projects

Who Contributes to Research Data Australia

View all

Griffith University · National Archives of Australia · ARC Centre of Excellence for [illegible] · Deakin University · RMIT University, Australia

Research Data Australia is the data discovery service of the Australian Research Data Commons (ARDC). The ARDC is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy Program. Read more about the ARDC...

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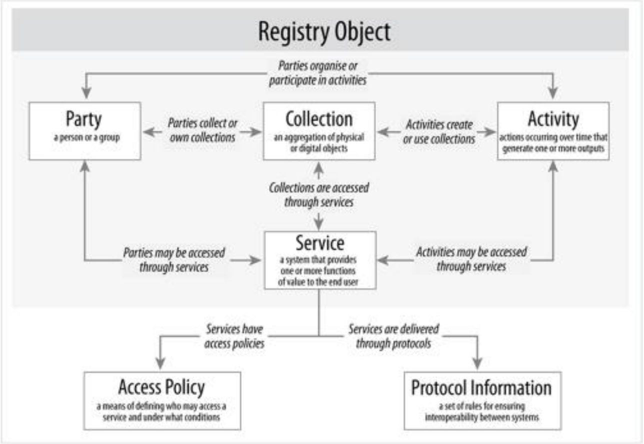
External Resources: ARDC Website, Developers, ARDC Online Services

144K+ metadata records of dataset

60K+ research grants

99 Contributors

Schema: The Registry Interchange Format - Collections and Services (RIF-CS, ISO 2146:2010)



Registry Object

Parties organise or participate in activities

Party — a person or a group

Parties collect or own collections

Collection — an aggregation of physical or digital objects

Activities create or use collections

Activity — actions occurring over time that generate one or more outputs

Collections are accessed through services

Parties may be accessed through services

Service — a system that provides one or more functions of value to the end user

Activities may be accessed through services

Services have access policies

Services are delivered through protocols

Access Policy — a means of defining who may access a service and under what conditions

Protocol Information — a set of rules for ensuring interoperability between systems

Types of subject vocabularies

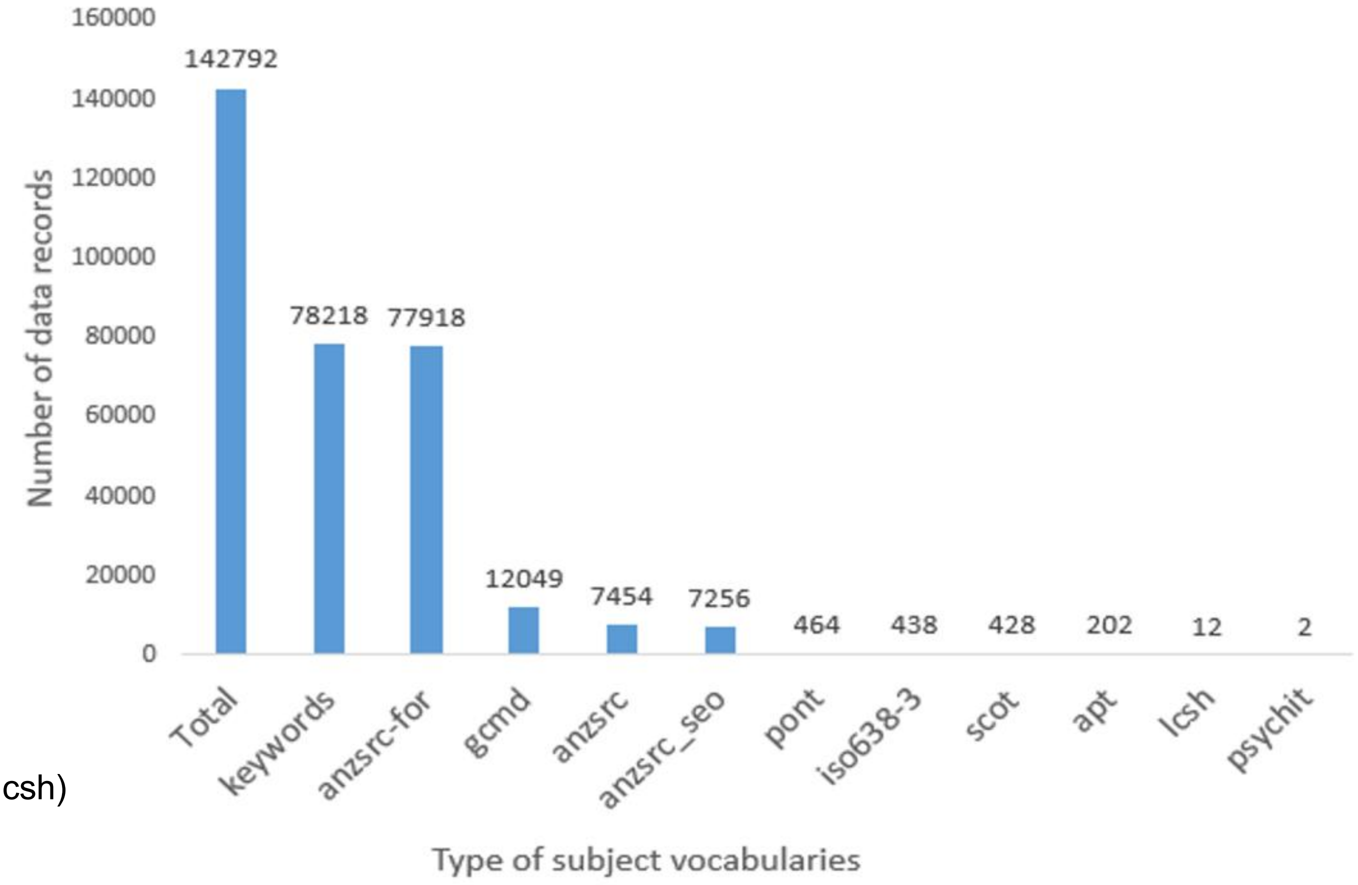
Anzsrc-for: The Australian and New Zealand Standard Research Classification (ANZSRC, fields of research)

Global change master directory (GCMD) keywords

Australian Pictorial Thesaurus (apt)

Thesaurus of Psychological Index Terms (psychit)

Library of Congress Subject Headings (lcsh)

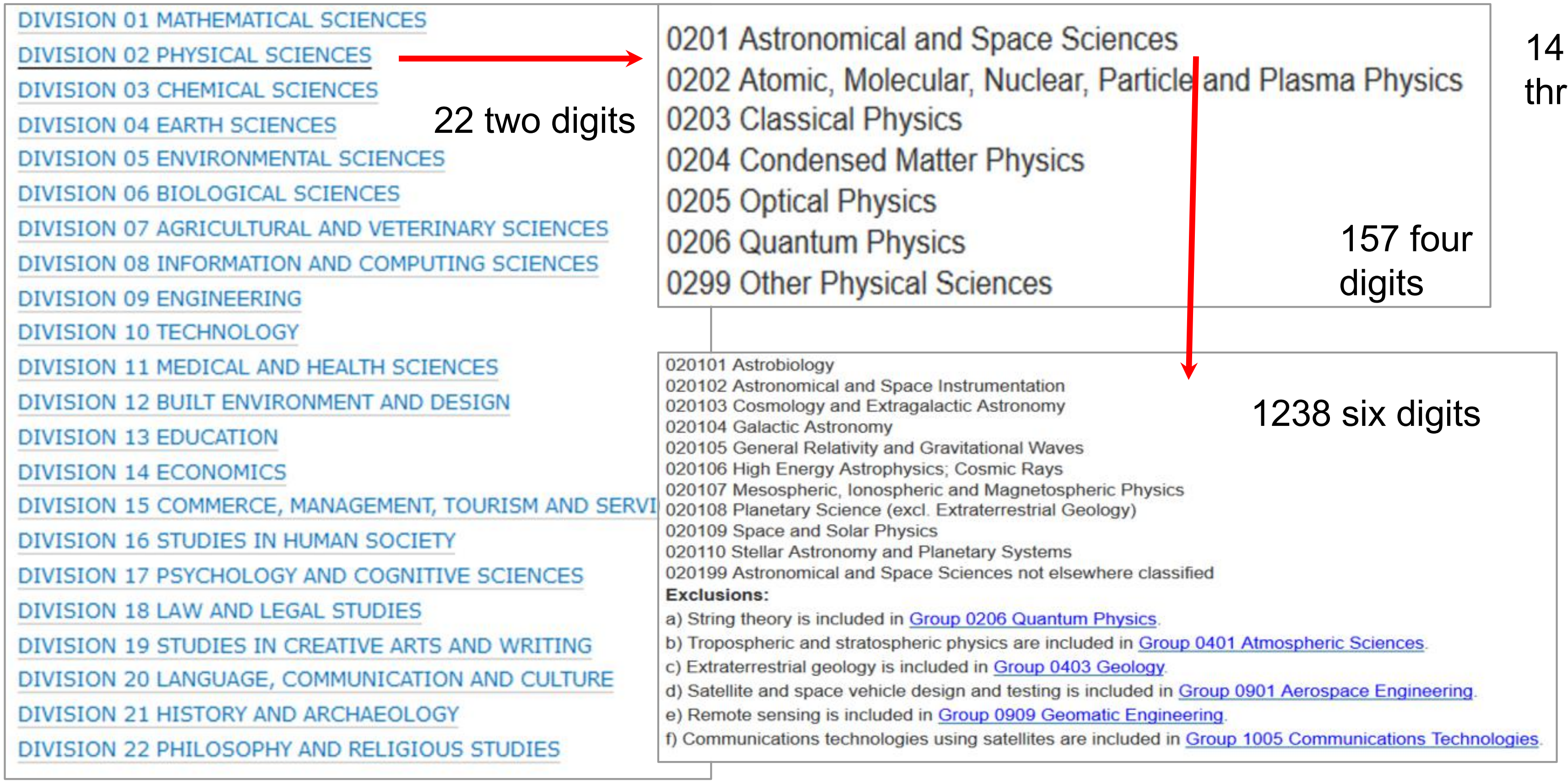


Anzsrc-for: The Australian and New Zealand Standard Research Classification - Fields of Research

- ANZSRC ensures that R&D statistics collected are useful to governments, educational institutions, international organisations, scientific, professional or business organisations, business enterprises, community groups and private individuals in Australia and New Zealand.

- ANZSRC-FoR include major fields and related sub-fields of research and emerging areas of study investigated by businesses, universities, tertiary institutions, national research institutions and other organisations.

Anzsrc-for: The Australian and New Zealand Standard Research Classification - Fields of Research)



- DIVISION 01 MATHEMATICAL SCIENCES
- DIVISION 02 PHYSICAL SCIENCES
- DIVISION 03 CHEMICAL SCIENCES
- DIVISION 04 EARTH SCIENCES
- DIVISION 05 ENVIRONMENTAL SCIENCES
- DIVISION 06 BIOLOGICAL SCIENCES
- DIVISION 07 AGRICULTURAL AND VETERINARY SCIENCES
- DIVISION 08 INFORMATION AND COMPUTING SCIENCES
- DIVISION 09 ENGINEERING
- DIVISION 10 TECHNOLOGY
- DIVISION 11 MEDICAL AND HEALTH SCIENCES
- DIVISION 12 BUILT ENVIRONMENT AND DESIGN
- DIVISION 13 EDUCATION
- DIVISION 14 ECONOMICS
- DIVISION 15 COMMERCE, MANAGEMENT, TOURISM AND SERVI
- DIVISION 16 STUDIES IN HUMAN SOCIETY
- DIVISION 17 PSYCHOLOGY AND COGNITIVE SCIENCES
- DIVISION 18 LAW AND LEGAL STUDIES
- DIVISION 19 STUDIES IN CREATIVE ARTS AND WRITING
- DIVISION 20 LANGUAGE, COMMUNICATION AND CULTURE
- DIVISION 21 HISTORY AND ARCHAEOLOGY
- DIVISION 22 PHILOSOPHY AND RELIGIOUS STUDIES

22 two digits

- 0201 Astronomical and Space Sciences
- 0202 Atomic, Molecular, Nuclear, Particle and Plasma Physics
- 0203 Classical Physics
- 0204 Condensed Matter Physics
- 0205 Optical Physics
- 0206 Quantum Physics
- 0299 Other Physical Sciences

157 four digits

1417 terms in three layers

- 020101 Astrobiology
- 020102 Astronomical and Space Instrumentation
- 020103 Cosmology and Extragalactic Astronomy
- 020104 Galactic Astronomy
- 020105 General Relativity and Gravitational Waves
- 020106 High Energy Astrophysics; Cosmic Rays
- 020107 Mesospheric, Ionospheric and Magnetospheric Physics
- 020108 Planetary Science (excl. Extraterrestrial Geology)
- 020109 Space and Solar Physics
- 020110 Stellar Astronomy and Planetary Systems
- 020199 Astronomical and Space Sciences not elsewhere classified

Exclusions:

a) String theory is included in Group 0206 Quantum Physics.

b) Tropospheric and stratospheric physics are included in Group 0401 Atmospheric Sciences.

c) Extraterrestrial geology is included in Group 0403 Geology.

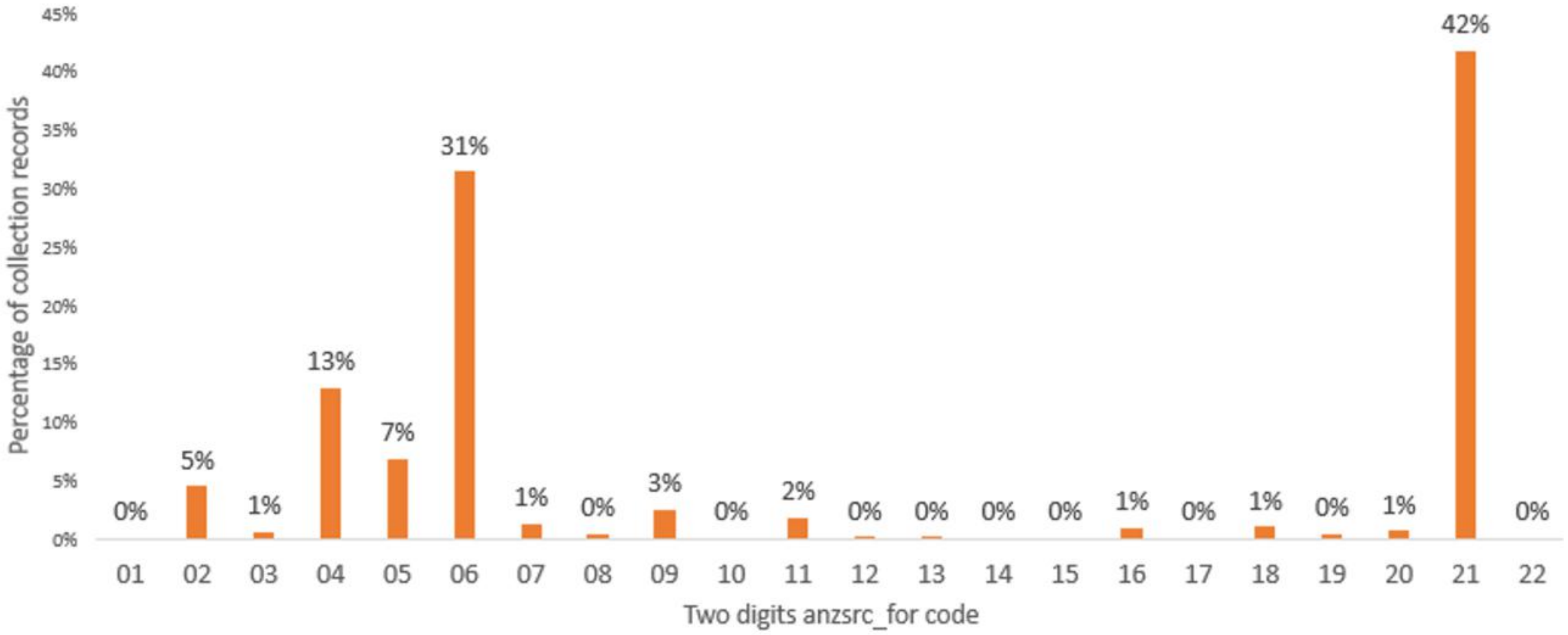
d) Satellite and space vehicle design and testing is included in Group 0901 Aerospace Engineering.

e) Remote sensing is included in Group 0909 Geomatic Engineering.

f) Communications technologies using satellites are included in Group 1005 Communications Technologies.

1238 six digits

Number of records per anzsrc-for two digits



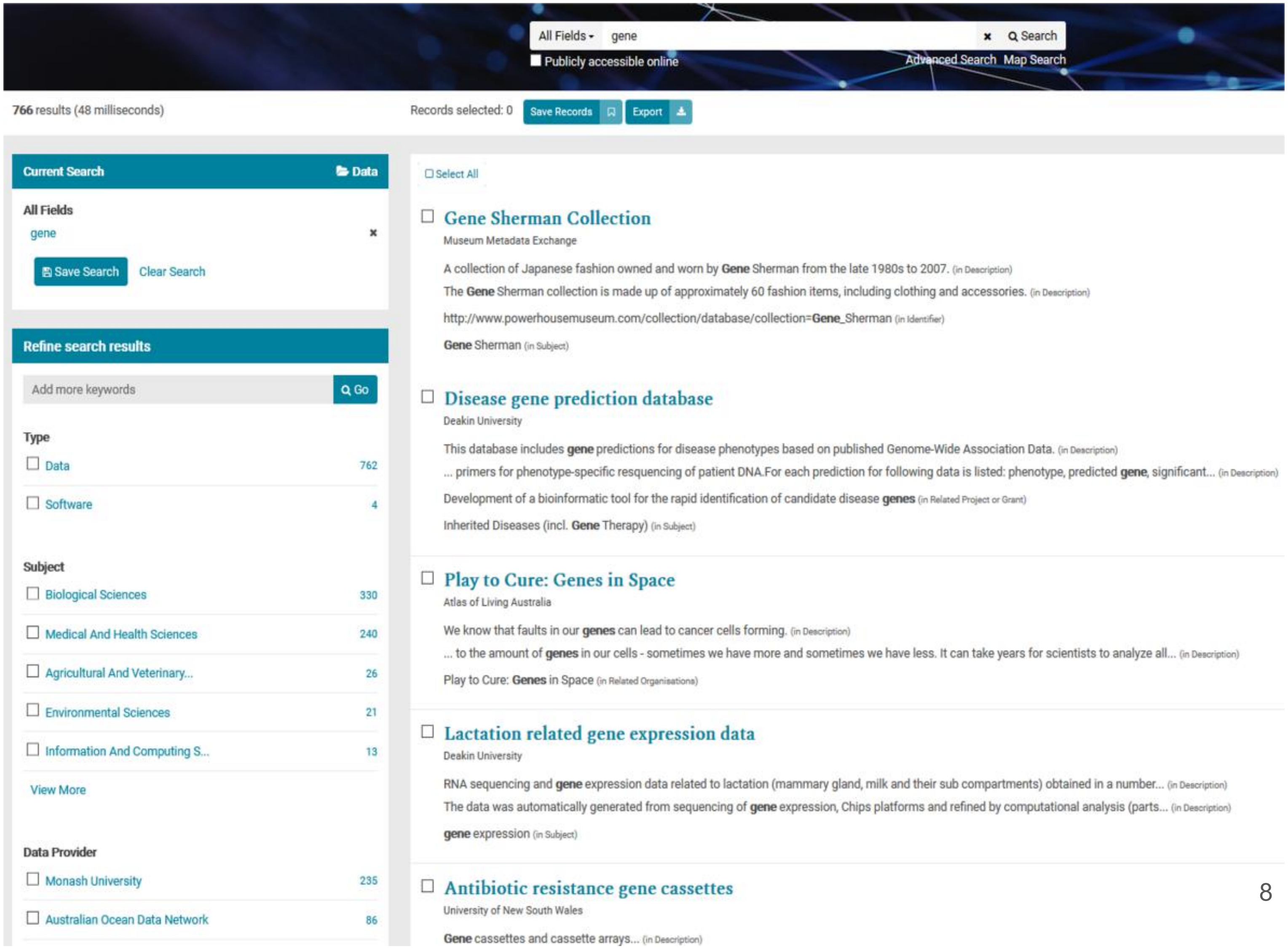
04: Earth Sciences

06: Biological Sciences

21: History and Archaeology

Search interface

All text strings (including subject headings) are indexed.



766 results (48 milliseconds)

Records selected: 0 Save Records Export

Current Search Data

All Fields

gene ×

Save Search Clear Search

Refine search results

Add more keywords Go

Type

□ Data	762
□ Software	4

Subject

□ Biological Sciences	330
□ Medical And Health Sciences	240
□ Agricultural And Veterinary...	26
□ Environmental Sciences	21
□ Information And Computing S...	13

View More

Data Provider

□ Monash University	235
□ Australian Ocean Data Network	86

□ Select All

□ **Gene Sherman Collection**

Museum Metadata Exchange

A collection of Japanese fashion owned and worn by **Gene** Sherman from the late 1980s to 2007. (in Description)

The **Gene** Sherman collection is made up of approximately 60 fashion items, including clothing and accessories. (in Description)

http://www.powerhousemuseum.com/collection/database/collection=**Gene**_Sherman (in Identifier)

Gene Sherman (in Subject)

□ **Disease gene prediction database**

Deakin University

This database includes **gene** predictions for disease phenotypes based on published Genome-Wide Association Data. (in Description)

... primers for phenotype-specific resquencing of patient DNA.For each prediction for following data is listed: phenotype, predicted **gene**, significant... (in Description)

Development of a bioinformatic tool for the rapid identification of candidate disease **genes** (in Related Project or Grant)

Inherited Diseases (incl. **Gene** Therapy) (in Subject)

□ **Play to Cure: Genes in Space**

Atlas of Living Australia

We know that faults in our **genes** can lead to cancer cells forming. (in Description)

... to the amount of **genes** in our cells - sometimes we have more and sometimes we have less. It can take years for scientists to analyze all... (in Description)

Play to Cure: **Genes** in Space (in Related Organisations)

□ **Lactation related gene expression data**

Deakin University

RNA sequencing and **gene** expression data related to lactation (mammary gland, milk and their sub compartments) obtained in a number... (in Description)

The data was automatically generated from sequencing of **gene** expression, Chips platforms and refined by computational analysis (parts... (in Description)

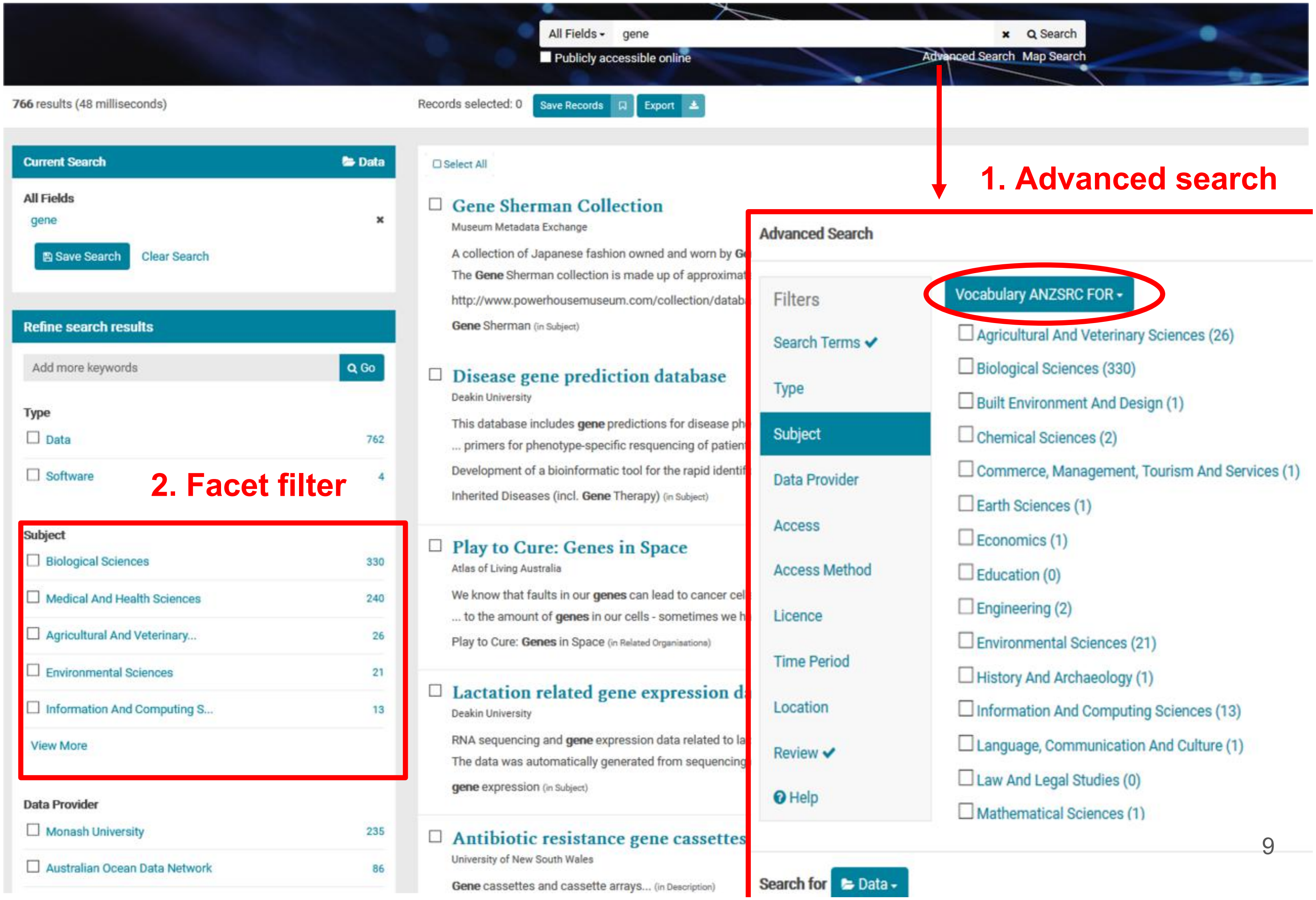
gene expression (in Subject)

□ **Antibiotic resistance gene cassettes**

University of New South Wales

Gene cassettes and cassette arrays... (in Description)

Subject headings



1. Advanced search

2. Facet filter

All Fields ▾ gene ✖ Search

□ Publicly accessible online

Advanced Search Map Search

766 results (48 milliseconds)

Records selected: 0 Save Records Export

Current Search Data

All Fields

gene ✖

Save Search Clear Search

Refine search results

Add more keywords Go

Type

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http://www.powerhousemuseum.com/collection/datab

Gene Sherman (in Subject)

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Advanced Search

Filters

Search Terms ✓

Type

Subject

Data Provider

Access

Access Method

Licence

Time Period

Location

Review ✓

Help

Vocabulary ANZSRC FOR ▾

□ Agricultural And Veterinary Sciences (26)

□ Biological Sciences (330)

□ Built Environment And Design (1)

□ Chemical Sciences (2)

□ Commerce, Management, Tourism And Services (1)

□ Earth Sciences (1)

□ Economics (1)

□ Education (0)

□ Engineering (2)

□ Environmental Sciences (21)

□ History And Archaeology (1)

□ Information And Computing Sciences (13)

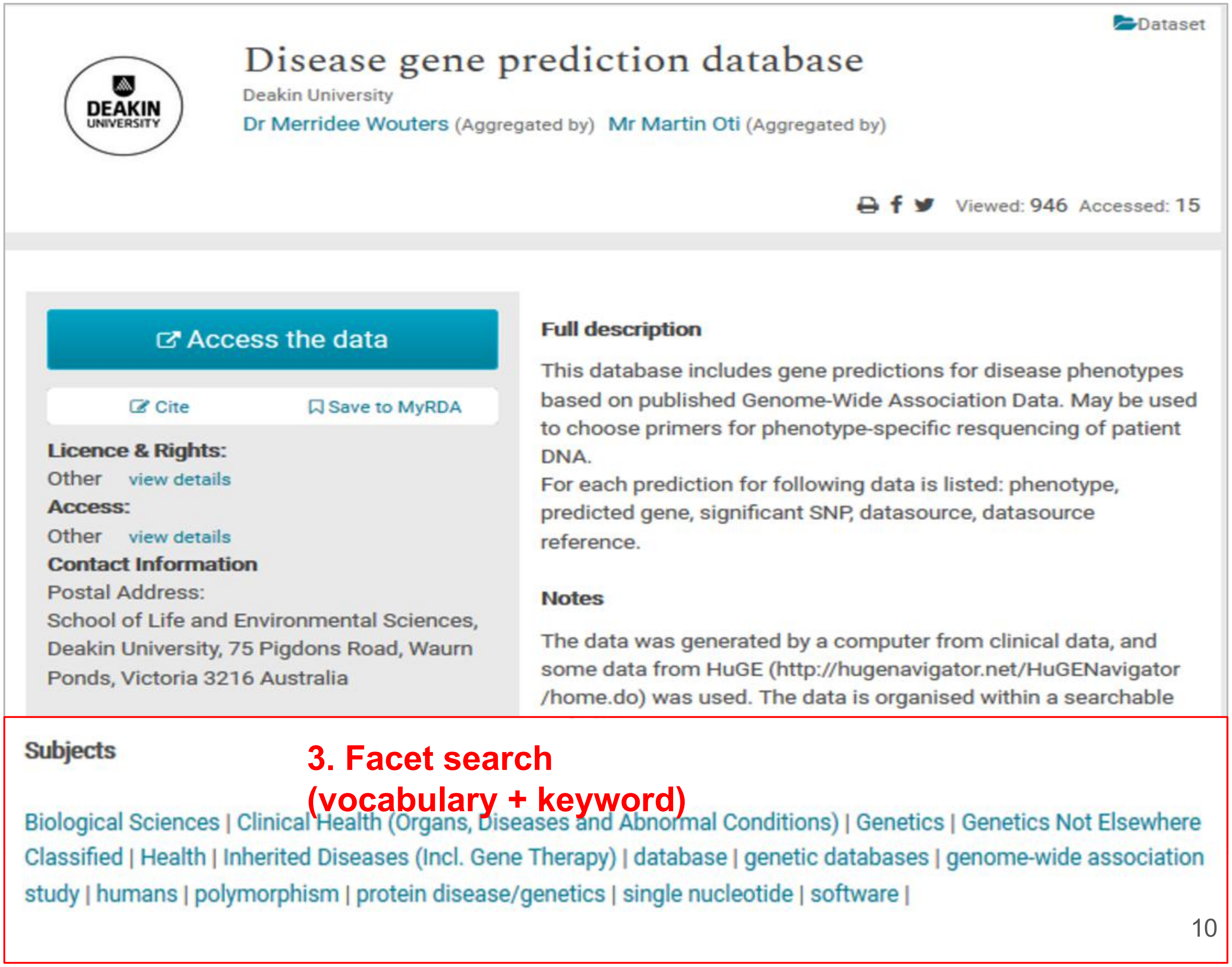
□ Language, Communication And Culture (1)

□ Law And Legal Studies (0)

□ Mathematical Sciences (1)

Search for Data ▾

Record view



Disease gene prediction database

Deakin University

Dr Merridee Wouters (Aggregated by) Mr Martin Oti (Aggregated by)

Viewed: 946 Accessed: 15

Licence & Rights:

Other view details

Access:

Other view details

Contact Information

Postal Address:
School of Life and Environmental Sciences,
Deakin University, 75 Pigdons Road, Waurn
Ponds, Victoria 3216 Australia

Full description

This database includes gene predictions for disease phenotypes based on published Genome-Wide Association Data. May be used to choose primers for phenotype-specific resquencing of patient DNA.
For each prediction for following data is listed: phenotype, predicted gene, significant SNP, datasource, datasource reference.

Notes

The data was generated by a computer from clinical data, and some data from HuGE (http://hugenavigator.net/HuGENavigator /home.do) was used. The data is organised within a searchable

Subjects

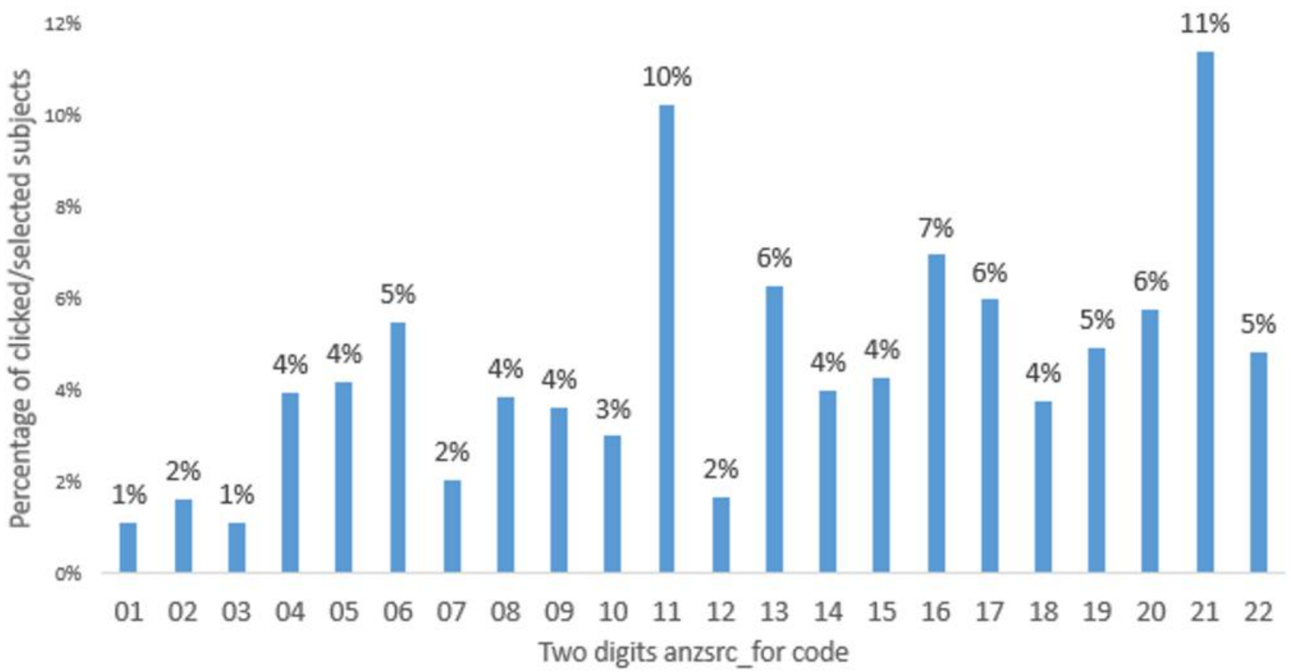
3. Facet search (vocabulary + keyword)

Biological Sciences | Clinical Health (Organs, Diseases and Abnormal Conditions) | Genetics | Genetics Not Elsewhere Classified | Health | Inherited Diseases (Incl. Gene Therapy) | database | genetic databases | genome-wide association study | humans | polymorphism | protein disease/genetics | single nucleotide | software |

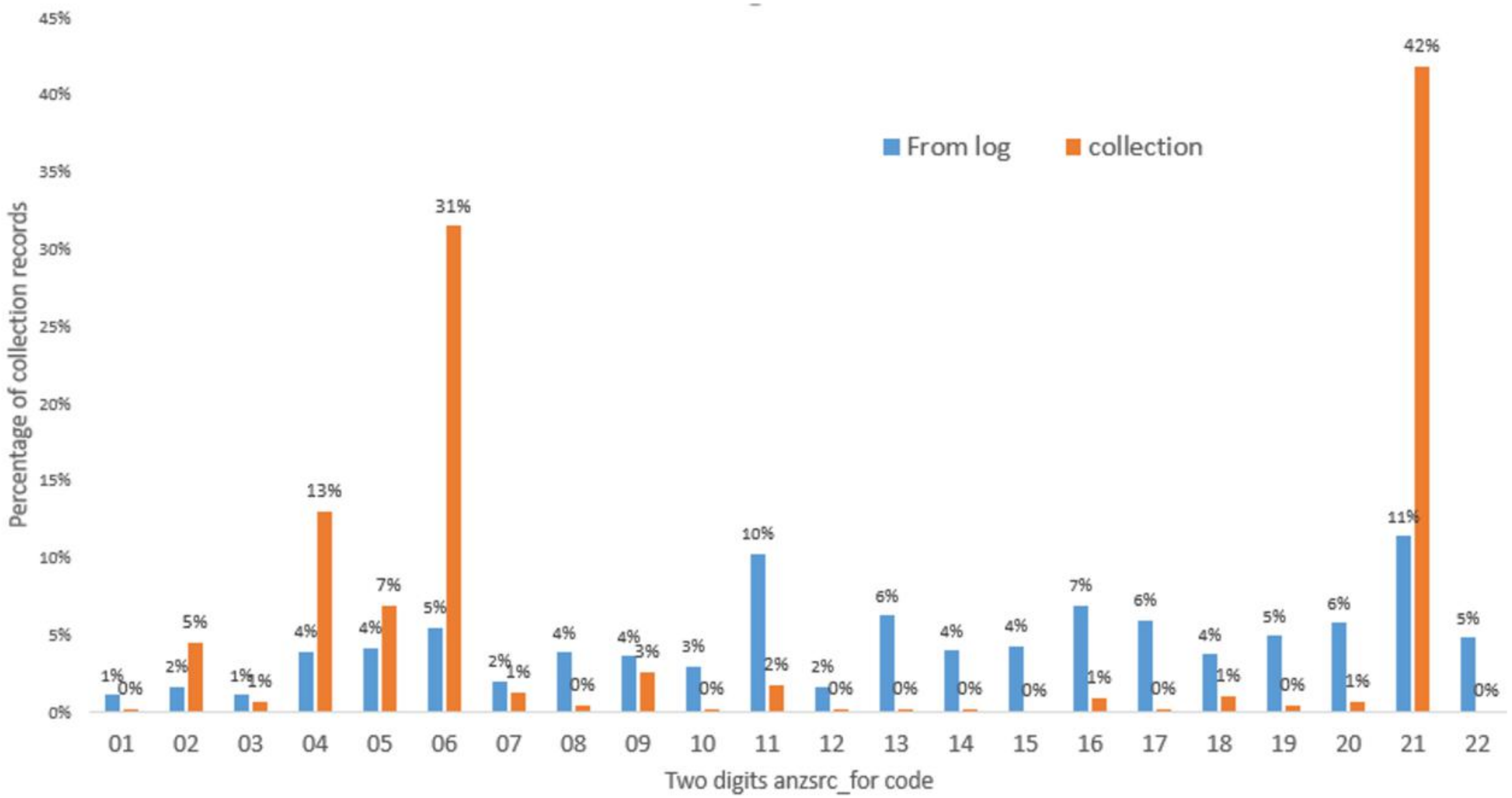
Log analysis: the usage of subject headings

- Transaction log: one year (2019) of activities recorded from the RDA catalogue
- About 2 million entries/activities, 63% from Australia
- About 496,739 sessions (with 30 minutes duration from the same IP address)
- 37,056 sessions have at least a search event (keyword search, advanced search, subject (factet) filter, subject search
- 4668 (12.6%) of search sessions involved filters/search with the anzsrc-for subjects, only 45 (0.1%) with gcmd subject

Subject usages per anzsrc-for two digits code



Subject distribution among clicks and the collection



Log analysis: the usage of subject headings

- There is less bias in user’s behaviour of applying subject headings, compared to the content bias toward a few subject headings.
- However, this log shows low usage of subject headings
- Exploring causes
    - Further log analysis, e.g. correlation between subject usage and
        - query types
        - domain knowledge
        - search quality
    - Interface design
    - At the record level: only half of the indexed records have anzsrc-for codes

Machine learning for record classification

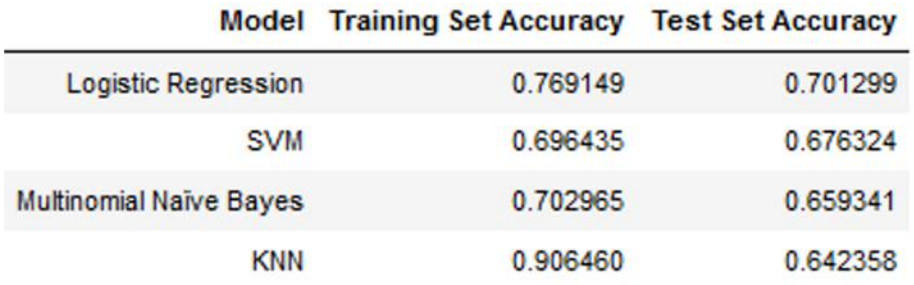
- Assign anzsrc-for code to unlabelled records automatically
  - Aim to improve search experience for both human and machine
  - Understand domain coverage of the collection

- Train models, three components are essential for the training:
  - Labels - anzsrc-for code
  - Classifier - four supervised machine learning methods:
    - multinomial logistic regression (MLR), multinomial naive bayes (MNB), K Nearest Neighbors (KNN), Support Vector Machine (SVM)
  - Data - (~78k) records with anzsrc-for code
    - Split into two sets: training set, test set

- Apply model(s)/best prediction to unlabelled records

Record classification with anzsrc-for code

- Use 77918 records that have an anzsrc-for code for training models
- Step by step: first the top two digits, then move down to four, six digits
- Four models: multinomial logistic regression (MLR), multinomial naive bayes (MNB), K Nearest Neighbors (KNN), Support Vector Machine (SVM)

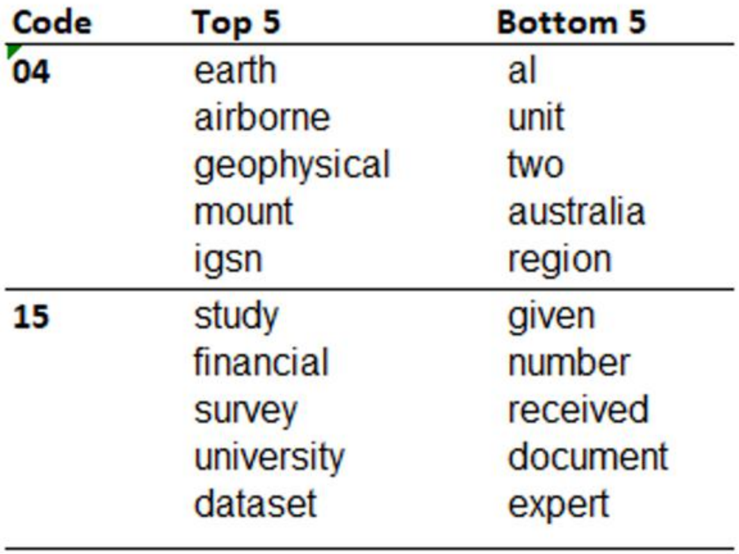


Model	Training Set Accuracy	Test Set Accuracy
Logistic Regression	0.769149	0.701299
SVM	0.696435	0.676324
Multinomial Naïve Bayes	0.702965	0.659341
KNN	0.906460	0.642358

Acknowledgement:
Adapted the code from Miguel Frenandez Zafra

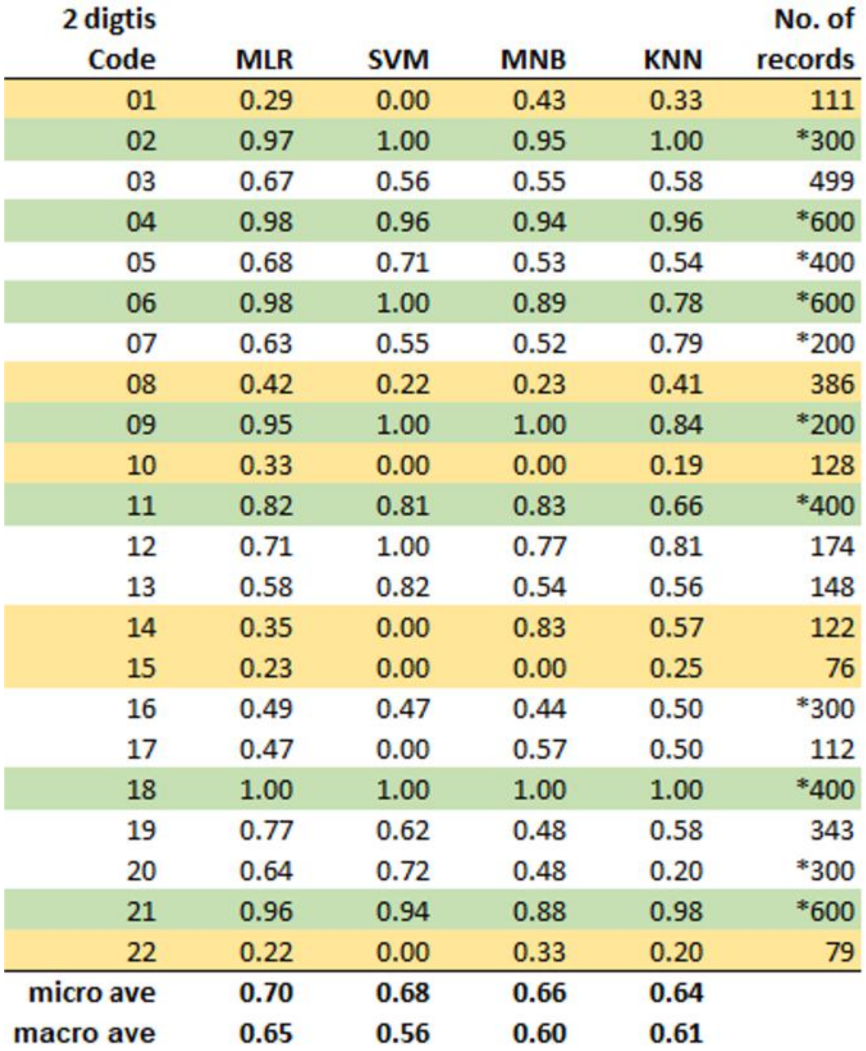
Performance per category

Most correlated unigrams:



Code	Top 5	Bottom 5
04	earth	al
	airborne	unit
	geophysical	two
	mount	australia
	igsn	region
15	study	given
	financial	number
	survey	received
	university	document
	dataset	expert

04: Earth Science
15: Commerce, Management, Tourism and Services

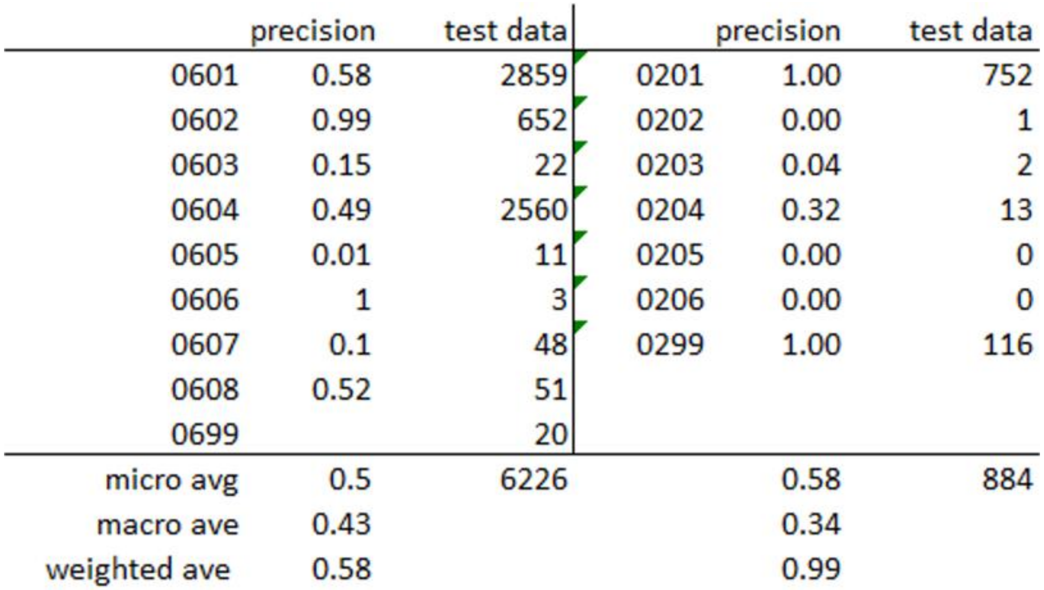


2 digtis Code	MLR	SVM	MNB	KNN	No. of records
01	0.29	0.00	0.43	0.33	111
02	0.97	1.00	0.95	1.00	*300
03	0.67	0.56	0.55	0.58	499
04	0.98	0.96	0.94	0.96	*600
05	0.68	0.71	0.53	0.54	*400
06	0.98	1.00	0.89	0.78	*600
07	0.63	0.55	0.52	0.79	*200
08	0.42	0.22	0.23	0.41	386
09	0.95	1.00	1.00	0.84	*200
10	0.33	0.00	0.00	0.19	128
11	0.82	0.81	0.83	0.66	*400
12	0.71	1.00	0.77	0.81	174
13	0.58	0.82	0.54	0.56	148
14	0.35	0.00	0.83	0.57	122
15	0.23	0.00	0.00	0.25	76
16	0.49	0.47	0.44	0.50	*300
17	0.47	0.00	0.57	0.50	112
18	1.00	1.00	1.00	1.00	*400
19	0.77	0.62	0.48	0.58	343
20	0.64	0.72	0.48	0.20	*300
21	0.96	0.94	0.88	0.98	*600
22	0.22	0.00	0.33	0.20	79
micro ave	**0.70**	**0.68**	**0.66**	**0.64**	
macro ave	**0.65**	**0.56**	**0.60**	**0.61**	

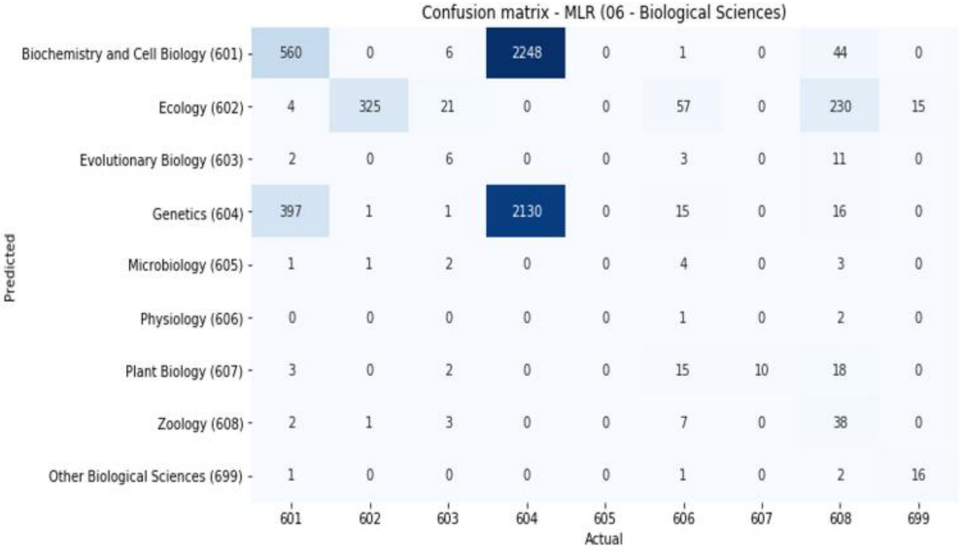
Examples of classification within two-digits code

Method: MLR
06: Biological Sciences (41505 records)
02: Physical Sciences (3533 records)

06: 17268 records (out of 41505) have both 0601 and 0604 labels



	precision	test data		precision	test data
0601	0.58	2859	0201	1.00	752
0602	0.99	652	0202	0.00	1
0603	0.15	22	0203	0.04	2
0604	0.49	2560	0204	0.32	13
0605	0.01	11	0205	0.00	0
0606	1	3	0206	0.00	0
0607	0.1	48	0299	1.00	116
0608	0.52	51			
0699		20			
micro avg	0.5	6226		0.58	884
macro ave	0.43			0.34	
weighted ave	0.58			0.99	



Confusion matrix - MLR (06 - Biological Sciences)

Predicted \ Actual	601	602	603	604	605	606	607	608	699
Biochemistry and Cell Biology (601)	560	0	6	2248	0	1	0	44	0
Ecology (602)	4	325	21	0	0	57	0	230	15
Evolutionary Biology (603)	2	0	6	0	0	3	0	11	0
Genetics (604)	397	1	1	2130	0	15	0	16	0
Microbiology (605)	1	1	2	0	0	4	0	3	0
Physiology (606)	0	0	0	0	0	1	0	2	0
Plant Biology (607)	3	0	2	0	0	15	10	18	0
Zoology (608)	2	1	3	0	0	7	0	38	0
Other Biological Sciences (699)	1	0	0	0	0	1	0	2	16

Discussion and future work

- User behaviour:
  - Evidence that subject headings are used
    - Why and why not
  - Low usage of subject headings from this log collection
    - Is this unique to this data catalogue and interface?

  Log analysis + survey and interview

- Collection characteristics:
  - Large proportion of records from the catalogue without a “standard” vocabulary for the subject headings a known issue
  - Those with subject headings are biased toward a few categories
    - Encourage underrepresented subject areas to publish and share data
  - Record classification works for some categories
    - Explore correlation, improvement

Thanks!