

# Georeferencing: Theory and Challenges

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AAH-DARIAH-ARDC  
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Knowledge Exchange Session 2  
GeoHumanities

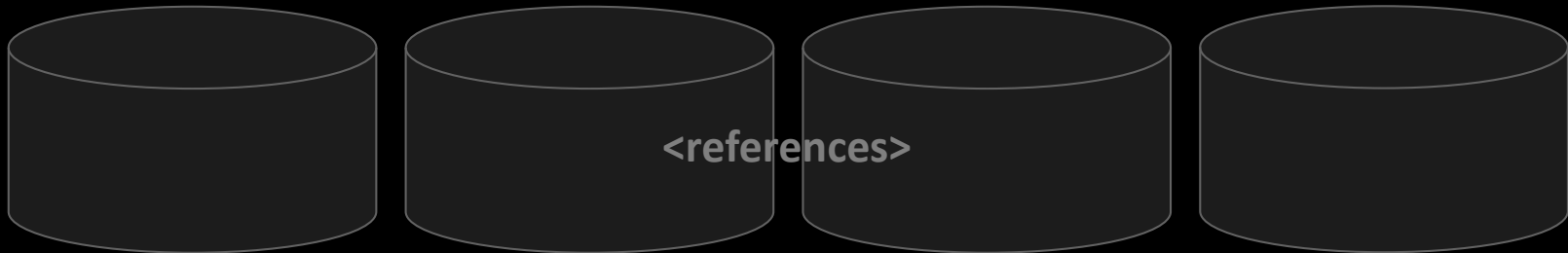
# Entities



# ST Representation



<algorithm>



*GIScience* is an information science

(Kemp, 2008)

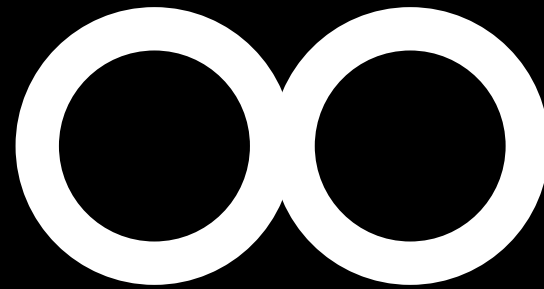
Refers to the scientific study of *geographic information* (GI)

Requires understanding of

- Fields of inquiry
- Knowledge creation methods
- Shared expertise across fields

(Duckham, 2017)

Epistemology  
Teleology



Perspectives

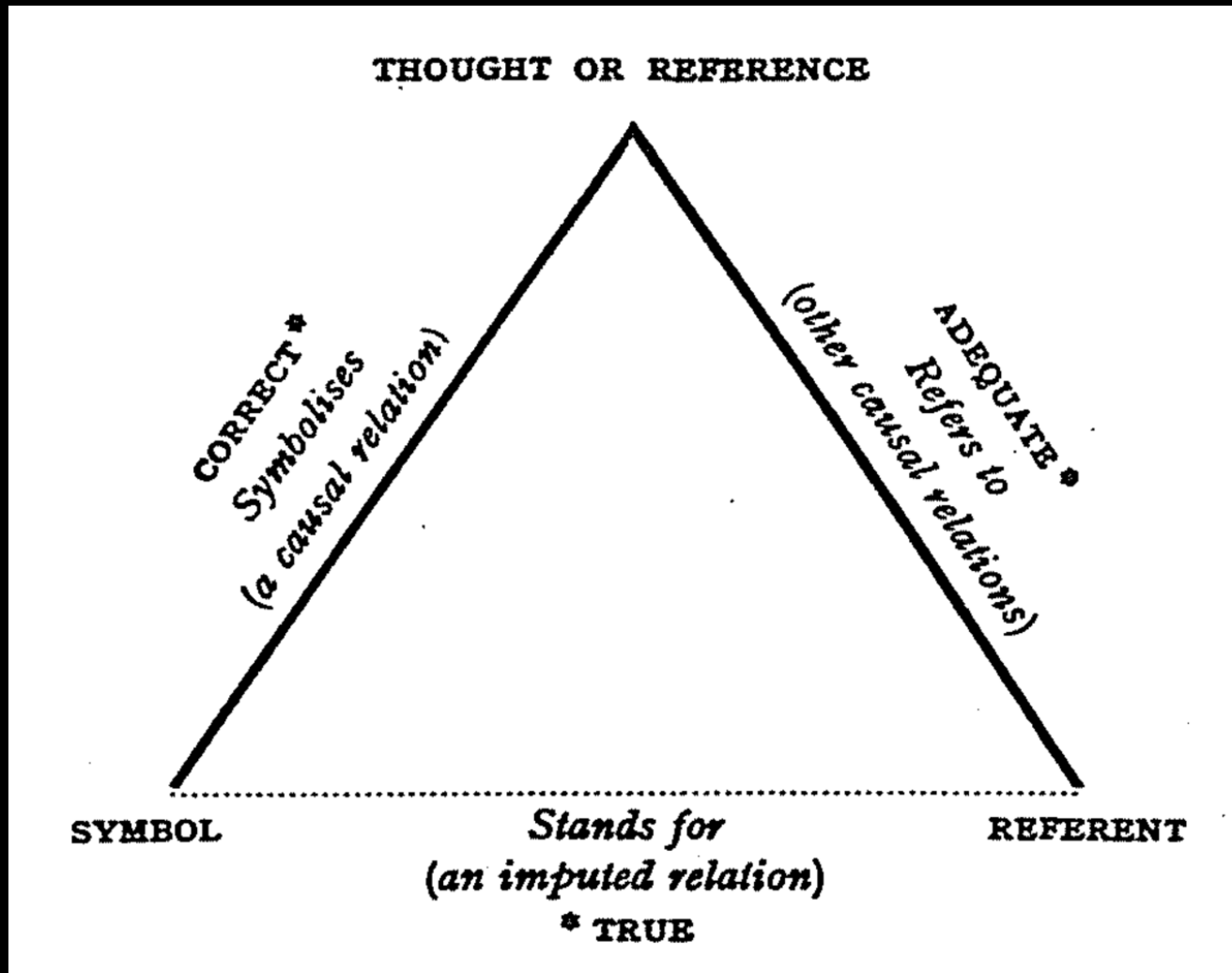
## Definition:

The linking between an entity and a *spatial footprint*

Entity must have *spatial grounding*

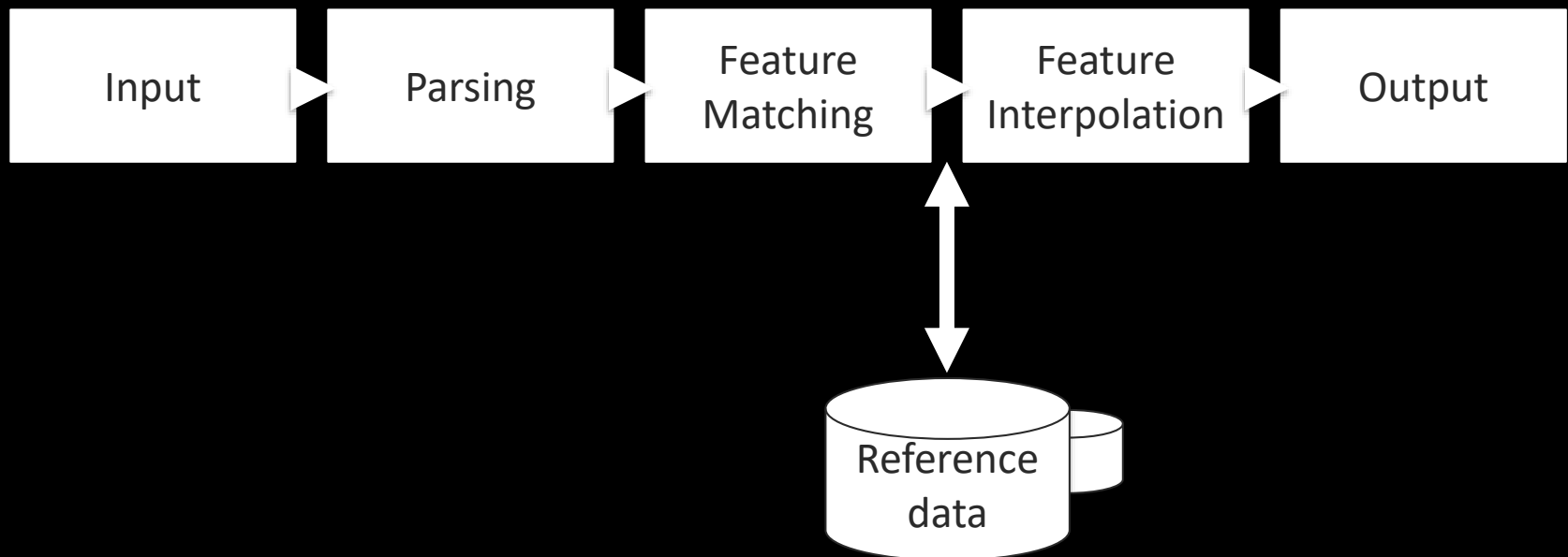
# Semiotics

Ogden and Richards (1923)



# Georeferencing process

## General components (Goldberg, 2017)





# Example input

## 1. Text

### Character

- a) Structured (e.g. address)
- b) Unstructured (e.g. toponym)

### Integer

- c) Structured (e.g. joining IDs)

## 2. Raster

- d) Grid (e.g. image transformation)

# a) Address geocoding

Assigning an address a spatial footprint

Input: **Text (char, structured)**

Example: *“64 Lincoln Ave Melbourne Australia”*

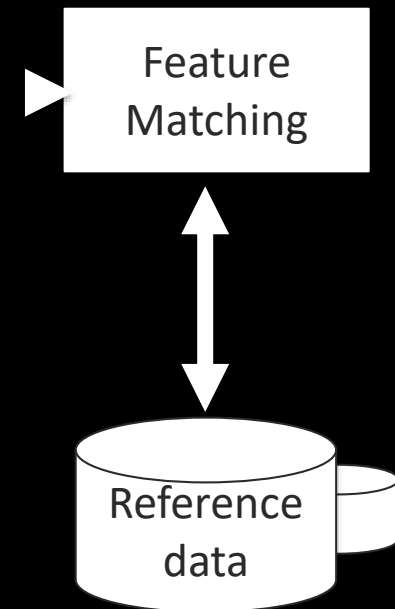
Goldberg, Wilson, and Knoblock (2007); Hill (2006)

# a) Address geocoding

## Reference data:

- Address file
  - G-NAF Live
  - G-NAF Open (3 months)

<https://www.pdma.com.au/products/g-naf>



# a) Example geocoding levels

## Address Input

## Geocoding Output

*“64 Lincoln Ave Melbourne Australia”*

 Point

*“Lincoln Ave Melbourne Australia”*

 Line

*“Melbourne Australia”*

 Polygon

*“Australia”*

 Polygon

# But existing tools are a black box

Google  
Bing  
Mapbox  
PSMA  
Gisgraphy  
HERE  
Geocode.xyz  
LocationIQ  
Tomtom  
Geocode.farm  
Yahoo BOSS  
geocode.earth  
SmartyStreets  
...



**Feature matching algorithm?**  
**Reference datasets?**

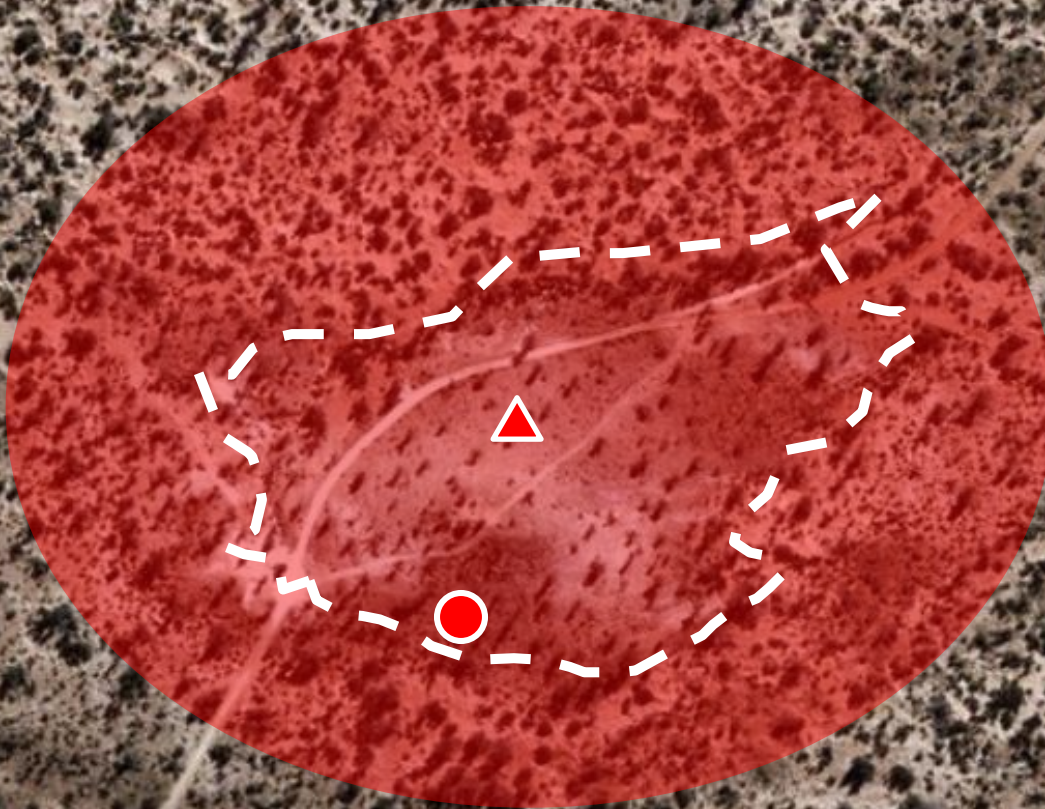
Digital methods –

How do we know that one approach is appropriate for another's purpose?

# Location vs place

How might this place be represented?

What else might we need to consider?



Observatory Hill, SA

## b) Toponym resolution

Assigning a toponym (place name) a spatial footprint

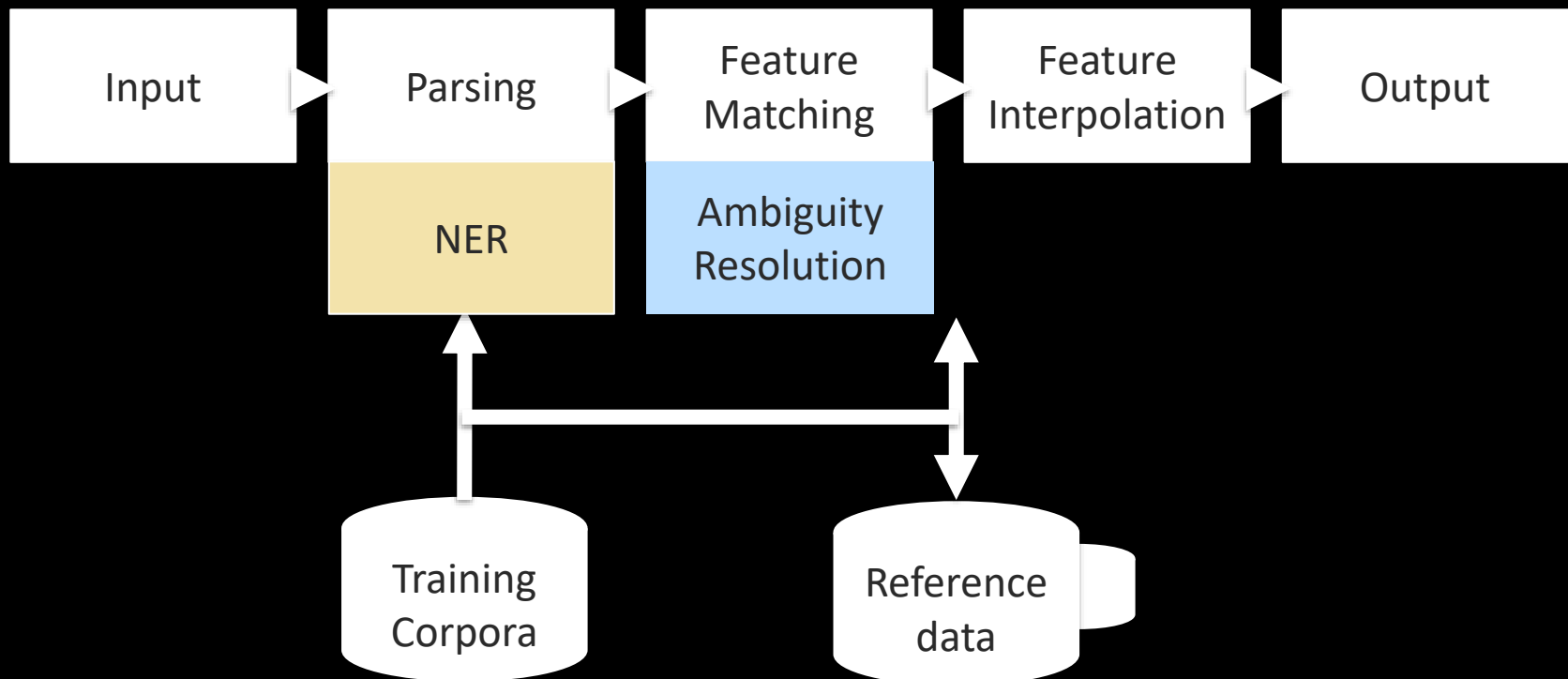
Input: **Text (char, unstructured)**

Example: *“Lake Macquarie”*



# b) Toponym resolution

Adapted from Goldberg (2017)



# b) Toponym example

Place description: NSW 1881 Census

Source: <http://hccda.ada.edu.au/>



Topographic?

Country?

DAD

Select NER Tool:

- DBpedia Spotlight
- Stanford NLP
- NLTK (GMB)
- SpaCy
- OpeNER?
- SyntaxNet/Parsey?

Embracing a north-eastern portion of the county of Northumberland Commencing on the south side of the south channel of the River Hunter at a point where the Waratah Coal Company's railway meets it bounded thence by that railway south-westerly crossing the Great Northern Railway to the centre of the road dividing H. Dangar's thirty-nine acres thirty-two perches from J. Moore's thirty-nine acres thence by a line southerly along the centre of that road to the centre of the cross road forming the southern boundaries of H. Dangar's and J. Moore's lands aforesaid thence by a line to the centre of the road dividing A. Brown's two acres one rood one perch and L. B. Winship's two acres two roods thirty-two perches from A. Brown's four acres three roods eighteen perches and M. Fenwick's one acre thirty-seven perches thence by a line along the centre of that road southerly to a point due east from the south-east corner of M. Fenwick's one acre thirty-seven perches aforesaid thence by a line bearing south about one hundred chains thence by a line bearing east to the south-west corner of the Australian Agricultural Company's grant of two thousand acres by that boundary easterly to a north-western boundary of the Municipality of Newcastle as defined by proclamation dated the seventh of June eighteen hundred and fifty-nine and published in the Government Gazette of the eighth of June in the same year thence by that boundary bearing south twenty-seven degrees west to the north-western extremity of a south-western boundary line of that borough thence by a line bearing east twenty-seven degrees south to the sea thence by the sea southerly to Kahibah at the entrance of Lake Macquarie thence by that entrance being the south boundary of that village westerly to Lake Macquarie thence by part of the eastern the northern and part of the western shores of that lake northerly westerly and southerly to Dora Creek thence by that creek upwards to its source in the Sugar-loaf Range thence by that range northerly to the south boundary of the parish of Stockrington thence by that boundary and the south boundary of Scott's eleven hundred and eighty acres Minmi and the south boundary of W. C. Wentworth's six hundred and forty acres and the south boundary of A. W. Scott's five hundred and ninety-eight acres to the south-east corner of the last mentioned land thence by the east boundary of A. Scott's five hundred and ninety-eight acres southerly and part of the south boundary of W. C. Wentworth's

Admin or  
Topographic?

tinker.edu.au

# b) Toponym resolution

## Reference data:

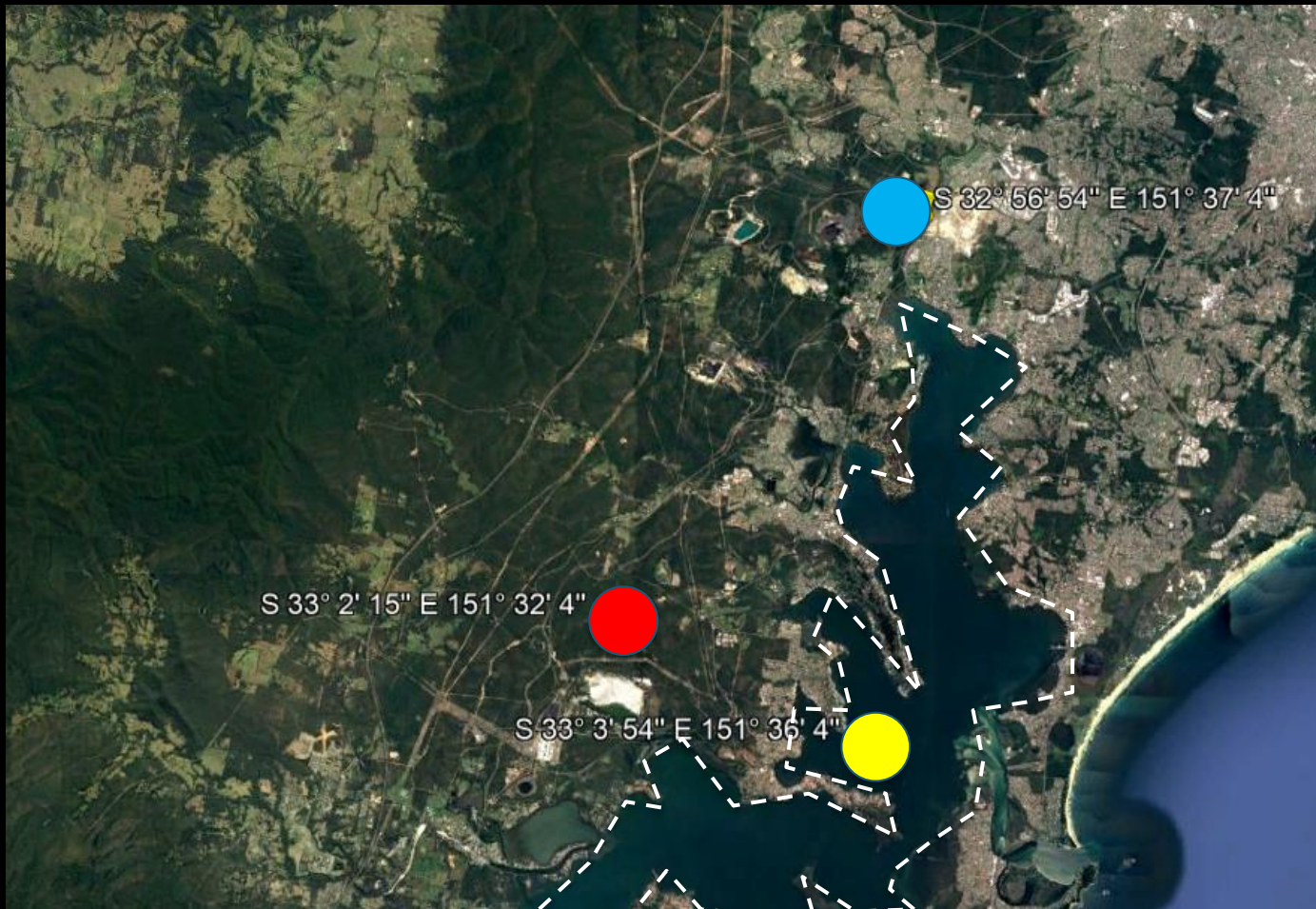
- Gazetteers
  - National (e.g. GA)
  - State (e.g. VICNAMES)
- Other
  - GeoNames (<http://www.geonames.org/>)
  - DBpedia (<https://wiki.dbpedia.org/>)
  - ANPS (<http://www.anps.org.au/>)
  - ...

# Multiple candidates

*“Lake Macquarie” – “Awaba”*

What ST representation?

Base layer: Google Earth (2019)



<http://www.geonames.org/search.html?q=lake+macquarie&country=AU>

# Ambiguity resolution ST

The process of identifying a single spatial footprint from multiple candidates

This process can be assisted using:

- Confidence scores
- Ontologies
- ST extents
- Previous research (feedback)

# Context is critical

## NER and chunking

*“Kahibah at the entrance of ... Lake Macquarie ... thence by”*



Topological relations



*Places can change...*

The Electoral District of Kahibah was created in 1894 ...

It was abolished in 1920 with the introduction of proportional representation.

It was recreated in 1927.

It was abolished and partly replaced by Waratah in 1930.

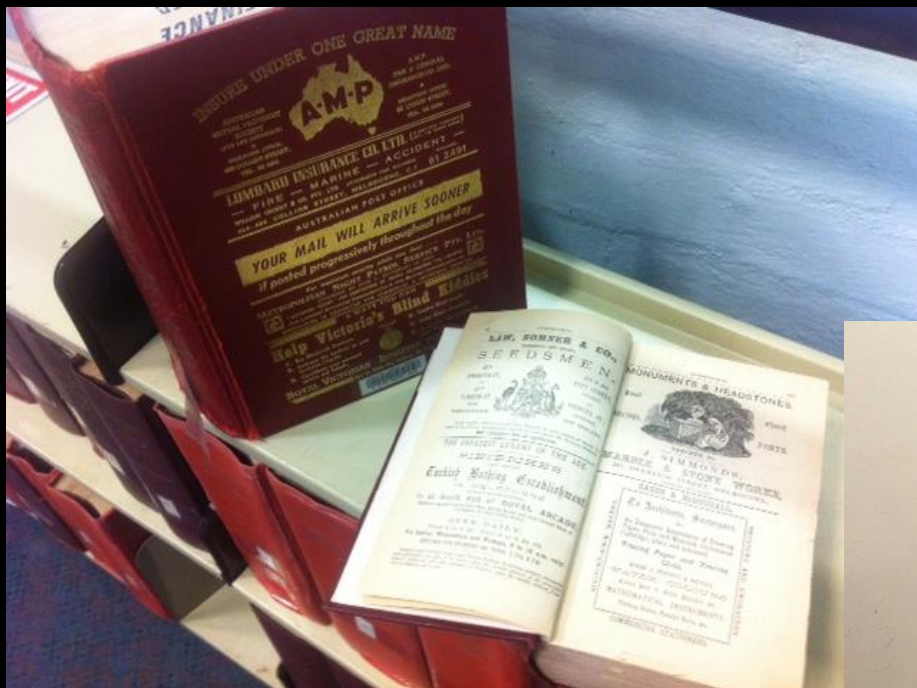
It was recreated in 1950

It was abolished again in 1971 and replaced by Charlestown.

Source: DBpedia.org

# Historical challenges

Source: <http://www.kingston.vic.gov.au/library>



Sands & McDougall Directories

## What about bias?



Yellow Pages

Source: <http://www.abc.net.au/news>

External world knowledge cannot be derived from linguistic principles alone

Leidner (2017)



# Thought experiment

Imagine we had a complete repository of  
reference data

for the entire world...

for all time...

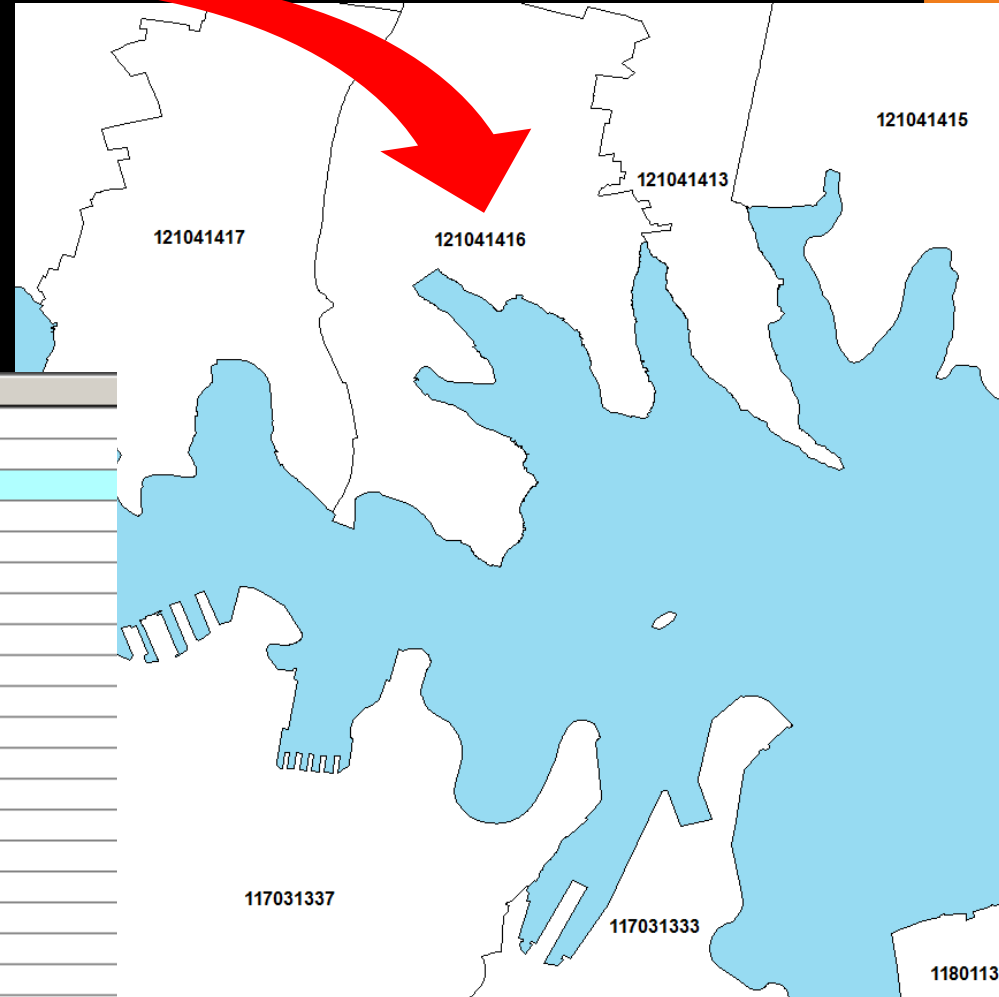
Could we identify a location?

Could we identify a place?

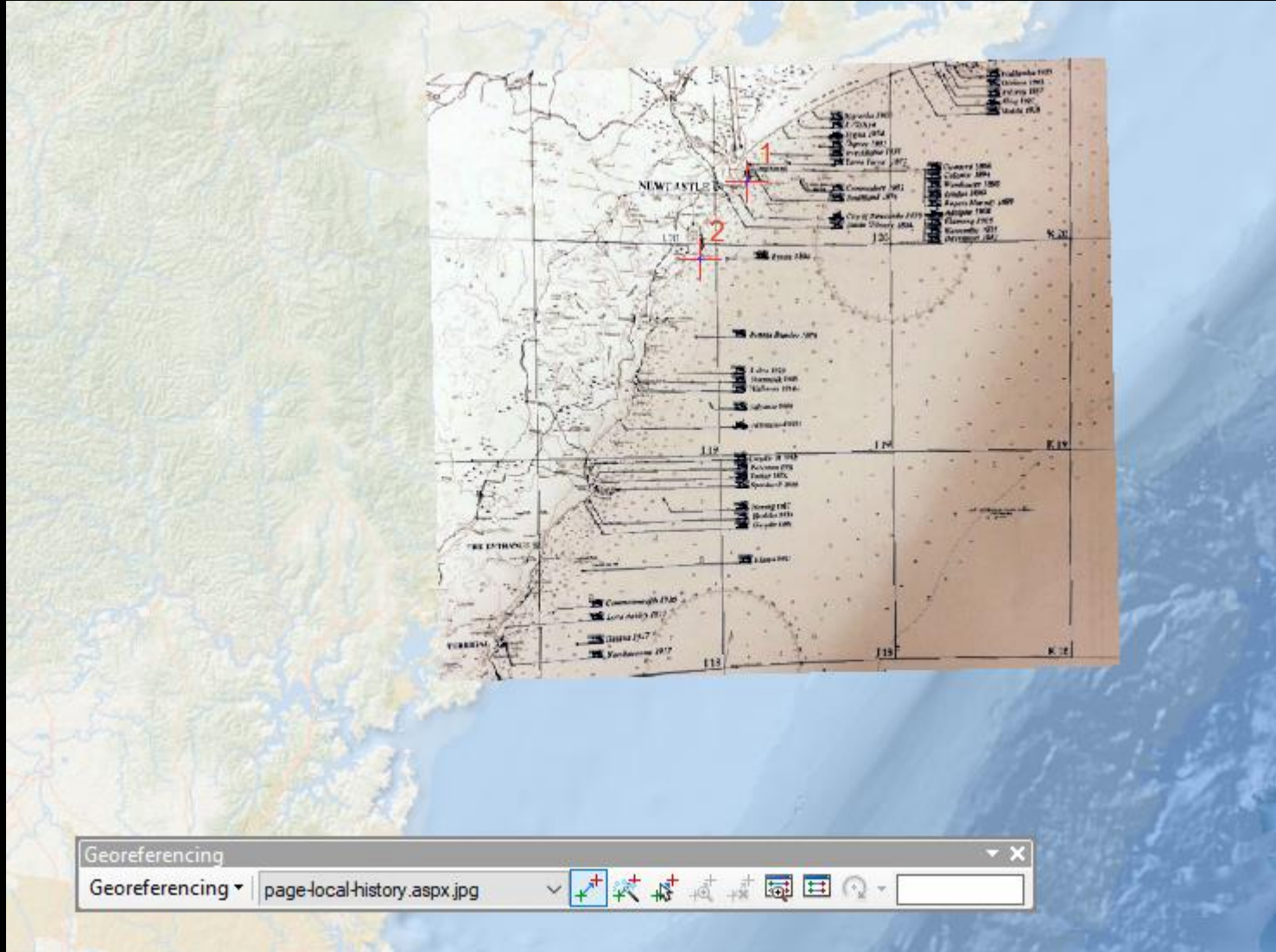
# c) Joining IDs

ABS SA2 Boundaries 2016

FID	Shape	SA2_MAIN16	SA2_5DIG16	SA2_NAME16
433	Polygon	121041414	11414	Crows Nest - Waverton
434	Polygon	121041415	11415	Mosman
435	Polygon	121041416	11416	Neutral Bay - Kirribilli
436	Polygon	121041417	11417	North Sydney - Lavender Bay
437	Polygon	122011418	11418	Balgowlah - Clontarf - Seaforth
438	Polygon	122011419	11419	Manly - Fairlight
439	Polygon	122021420	11420	Avalon - Palm Beach
440	Polygon	122021421	11421	Bayview - Elanora Heights
441	Polygon	122021422	11422	Newport - Bilgola
442	Polygon	122021423	11423	Warriewood - Mona Vale
443	Polygon	122031424	11424	Beacon Hill - Narraweena
444	Polygon	122031425	11425	Cromer
445	Polygon	122031426	11426	Dee Why - North Curl Curl
446	Polygon	122031427	11427	Forestville - Killarney Heights
447	Polygon	122031428	11428	Frenchs Forest - Belrose
448	Polygon	122031429	11429	Freshwater - Brookvale
449	Polygon	122031430	11430	Manly Vale - Allambie Heights
450	Polygon	122031431	11431	Narrabeen - Collaroy
451	Polygon	122031432	11432	Terrey Hills - Duffys Forest
452	Polygon	123011433	11433	Camden - Ellis Lane



# d) Image transformation



<http://desktop.arcgis.com/en/arcmap/10.3/manage-data/raster-and-images/fundamentals-for-georeferencing-a-raster-dataset.htm>

# Thank you

Steve Bennett, Steve McEachern, Steve Cassidy, Rob Hutton and members of the HASS DeVL team

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