

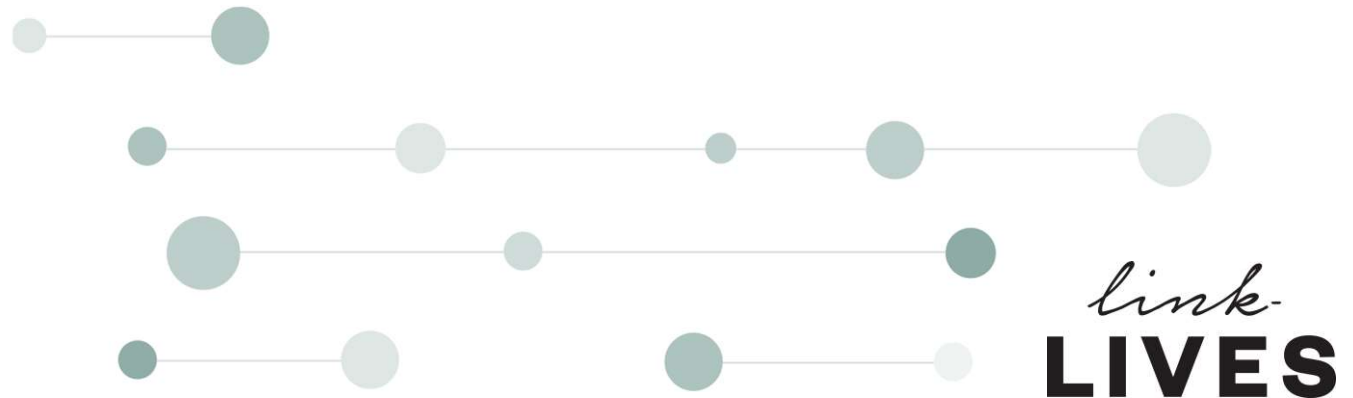


CARLSBERGFONDET



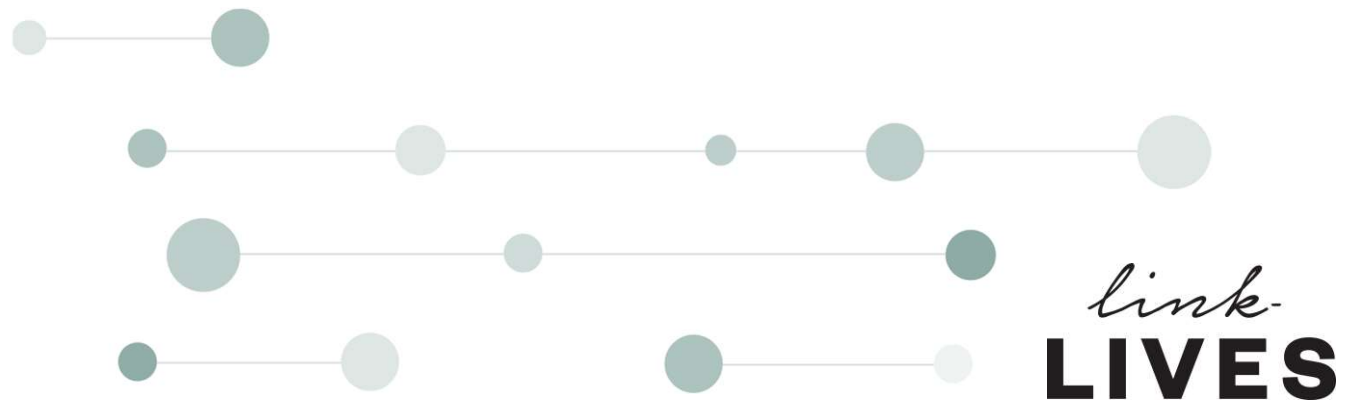
# Mapping populations past: The challenges of fitting Denmark's 19<sup>th</sup> century censuses to a map

Mads L. Perner, PhD fellow



# Outline

1. Background
  - The Link-Lives project
  - Data and life-courses
  - How do we link?
2. Mapping the census
  - DigDag and the Danish Demographic Database
  - Strategy and approach
  - Coverage
  - How we use the data
3. Current project: mapping Copenhagen



# What is Link-Lives?

A research project that aims to:

- Build life-courses (birth to burial) for all Danes 1787-1968
- Link historical register to the CPR (1968-now)

In order to do that:

- Understand and standardize the source material
- Mapping is part of that process



# What do we link?

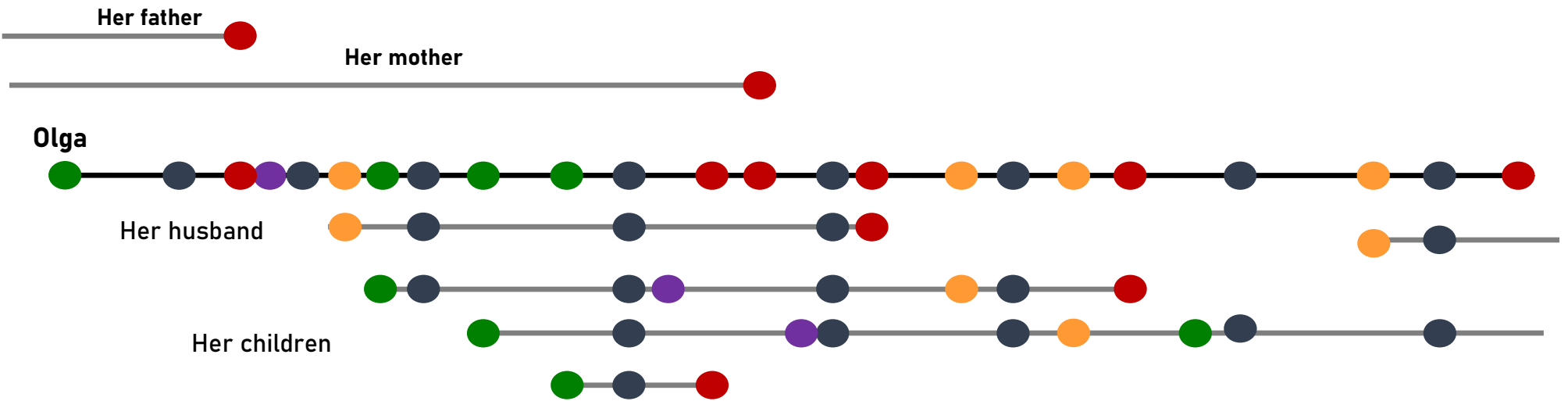
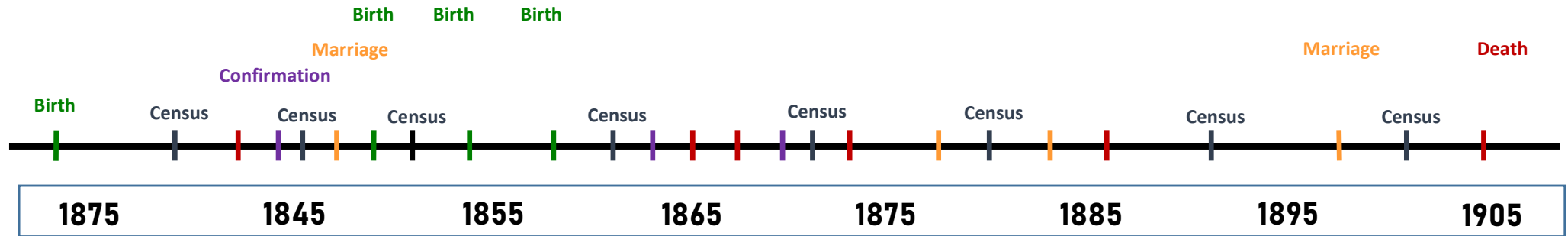
Sources to Danish population history were registered very thoroughly and are to a large extent complete and increasingly digitized.

We base life-courses on:

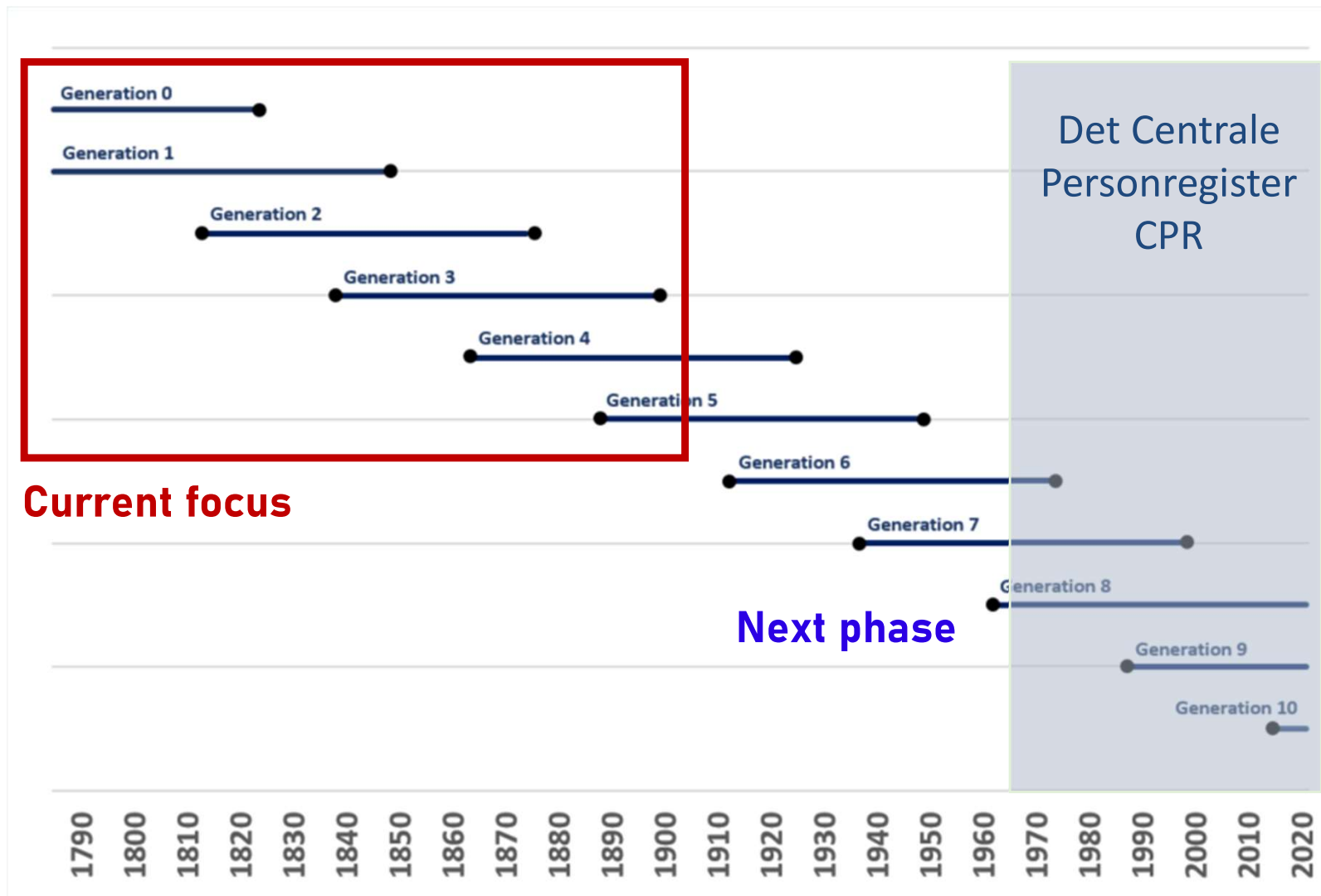
- Births ([transc. by Ancestry](#))
- Weddings ([Ancestry](#))
- Burials ([Ancestry/volunteers](#))
- Census counts ([Volunteers](#))



# Example of a life-course



# Historical records to modern registers

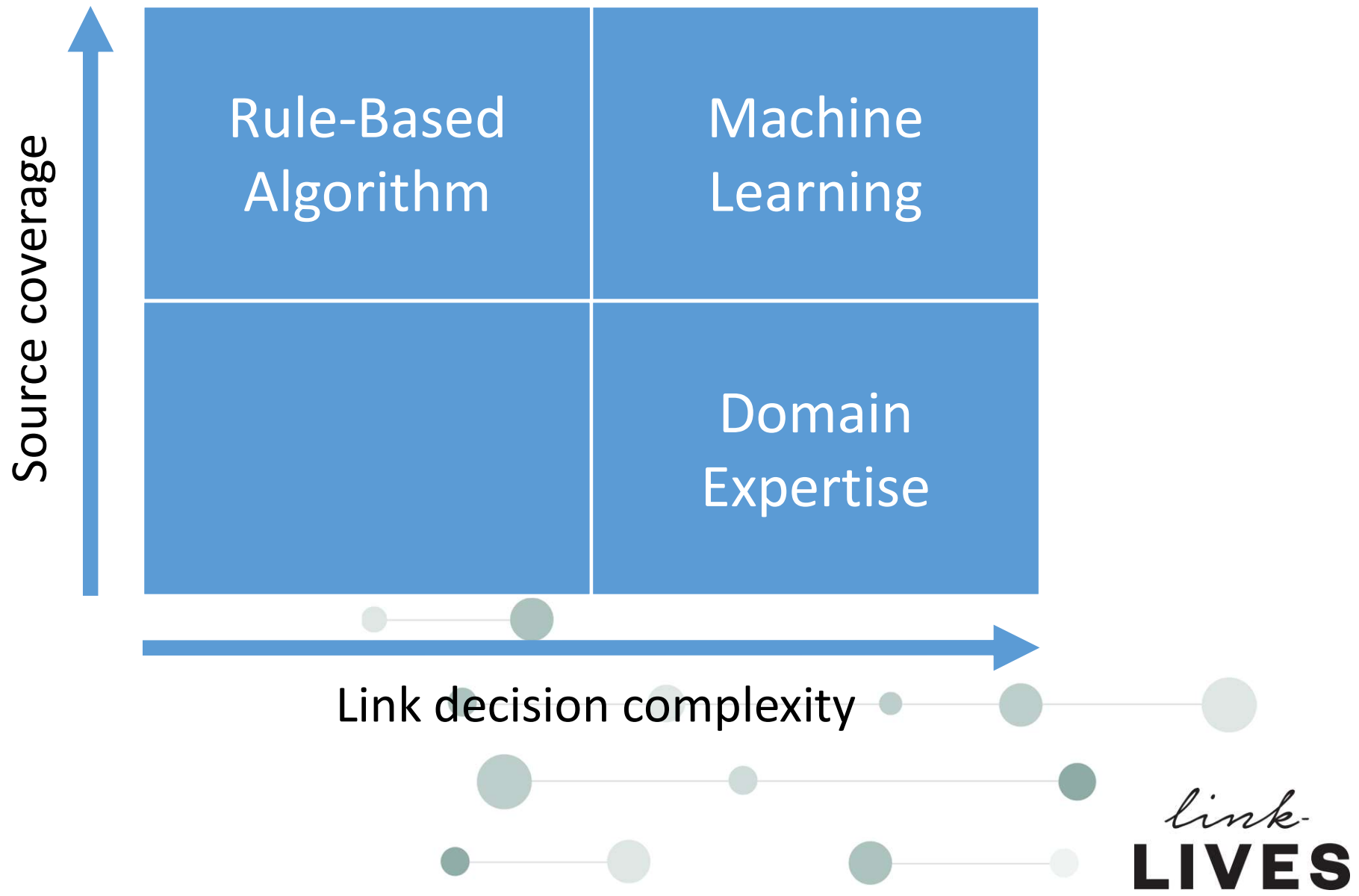


Current focus

Next phase

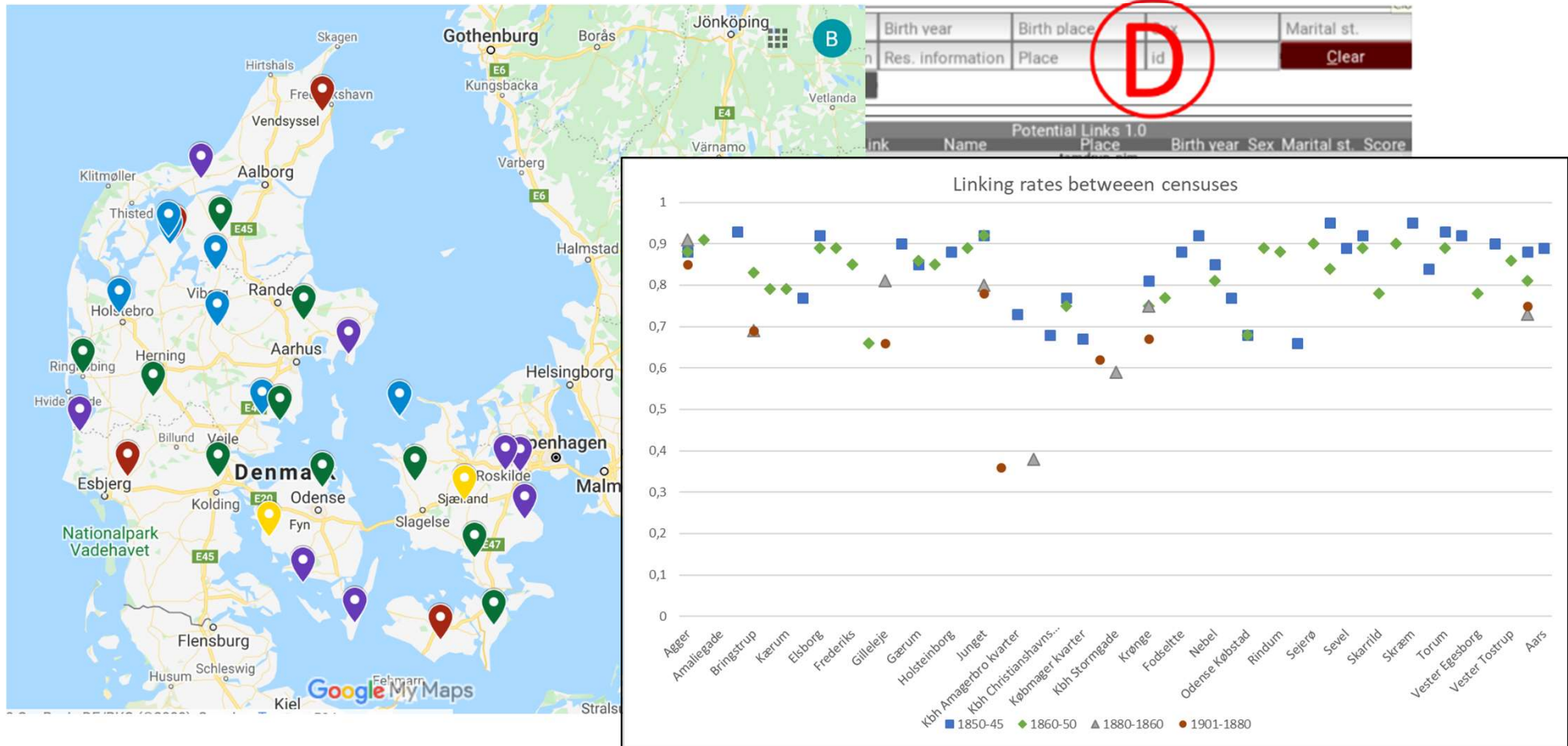
Det Centrale  
Personregister  
CPR

# How do we link?



# Domain expert hand linkage

Our homemade linking software ALA:





# Rule-based linking

source1

Id	Sex	Age	Name
1	M	20	Jens Jensen
2	M	45	Klavs Hansen
3	K	3	Hanne Fisker
4	M	45	Jørgen

source2

Id	Sex	Age	Name
1	M	20	Jens Jensen
2	M	21	Klavs Hansen
3	K	3	Hanne
4	M	45	Jørgen
5	K	47	Jørgen Slot
6	M	18	Jens Jørgen

Sex = m (same sex)  
Age = [18,22]  
(age±2)

Name Birth place ↔ Name Birth place

1	M	20	Jens Jensen
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1	M	20	Jens Jensen
2	M	21	Klavs Jensen
6	M	18	Jens Jørgensen

Scores

0.0	◀ 1. Link
0.11	
0.18	

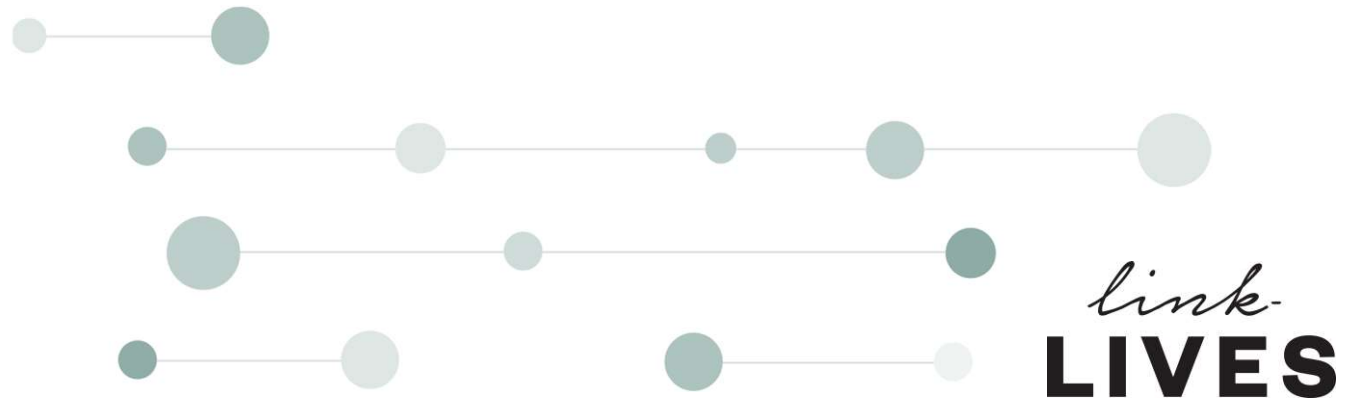
# Status of our links

We currently have:

- Tens of thousands of hand-linked life-courses (very reliable)
- Millions of rule-based life-courses (less reliable)

Current work focuses on:

- Better use of personal relations in linkage
- Applications of various machine learning models



# The Danish Demographic Database

A coordinated effort to transcribe Danish population data with the help of volunteers since 1992.

More than 21 million person appearances transcribed from the Danish census 1787-1940 (per dec. 2019).

A screenshot of the 'Dansk Demografisk Database' website. The page title is 'Dansk Demografisk Database' and it is part of 'Rigsarkivet'. The navigation menu includes 'Forside', 'Folketaellinger', 'Kirkebøger', 'Andre databaser', 'Deltag', 'Oversigt', and 'Kontakt'. The main content area is titled 'Søg efter person - Simple søgning'. It features a search form with sections for 'Bopælsoplysninger' (Residence information) and 'Personoplysninger' (Personal information). The 'Bopælsoplysninger' section includes dropdown menus for 'Amt' (County), 'Herred' (Parish), and 'Sogn' (Parish), and text input fields for 'KI Pnr' and 'Stednavn' (Place name). The 'Personoplysninger' section includes a text input field for 'Navn' (Name) and a dropdown for 'FT år' (Year of birth). There are 'Søg' and 'FORTRYD' buttons at the bottom. On the right side, there is a 'Søgetips' (Search tips) section with a question mark icon and a list of search options like 'Generelt om søgningen', 'Visning af herreder og sogne', etc.

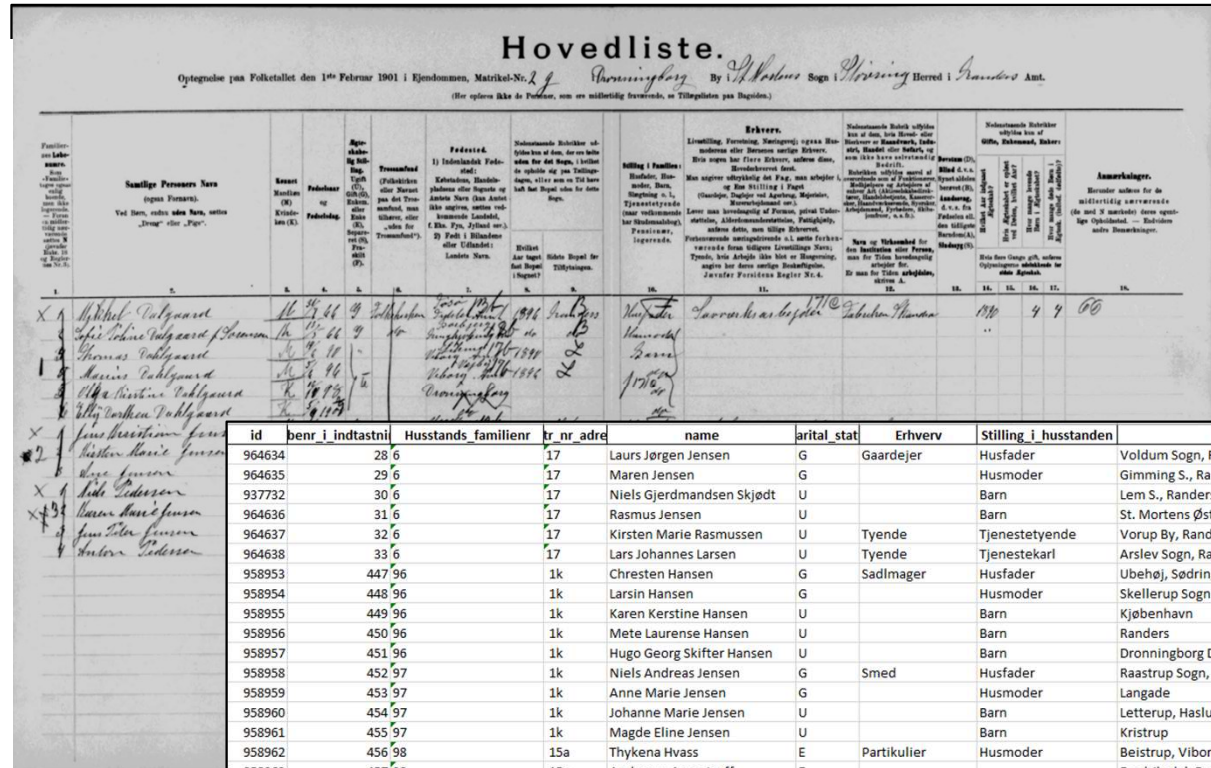
# The Danish Demographic Database

The following census years are 100% transcribed:  
1787, 1801, 1840, 1845,  
1850, 1860, 1880, 1901.

They contain:

Name, age, position in household, birthplace (from 1845), occupation.

A very rich dataset which can be used to answer a wide range of question in history, demography and other fields



id	benr i indtastni	Husstands familiernr	tr nr	adre	name	arital_stat	Erhverv	Stilling i husstanden	birth_place
964634	28	6	17		Laurs Jørgen Jensen	G	Gaardejer	Husfader	Voldum Sogn, Randers A.
964635	29	6	17		Maren Jensen	G		Husmoder	Gimming S., Randers A.
937732	30	6	17		Niels Gjerdmansden Skjødt	U		Barn	Lem S., Randers A.
964636	31	6	17		Rasmus Jensen	U		Barn	St. Mortens Østre Landsogn, Randers Amt
964637	32	6	17		Kirsten Marie Rasmussen	U	Tyende	Tjenestetyende	Vorup By, Randers Amt
964638	33	6	17		Lars Johannes Larsen	U	Tyende	Tjenestekarl	Arslev Sogn, Randers Amt
958953	447	96	1k		Chresten Hansen	G	Sadlmager	Husfader	Ubehøj, Sødring Sogn
958954	448	96	1k		Larsin Hansen	G		Husmoder	Skellerup Sogn
958955	449	96	1k		Karen Kerstine Hansen	U		Barn	Kjøbenhavn
958956	450	96	1k		Mete Laurensen Hansen	U		Barn	Randers
958957	451	96	1k		Hugo Georg Skifter Hansen	U		Barn	Dronningborg Distrikt
958958	452	97	1k		Niels Andreas Jensen	G	Smed	Husfader	Raastrup Sogn, Ringkjøbing Amt
958959	453	97	1k		Anne Marie Jensen	G		Husmoder	Langgade
958960	454	97	1k		Johanne Marie Jensen	U		Barn	Letterup, Haslund Sogn
958961	455	97	1k		Magde Eline Jensen	U		Barn	Kristrup
958962	456	98	15a		Thykena Hvass	E	Partikulier	Husmoder	Beistrup, Viborg Amt
958963	457	98	15a		Andrea v. Arenstorff	E		Husmoder	Fredriksdal, Randers Amt
958964	458	98	15a		Thykinde Hvass	U		Husmoder	Fredriksdal, Randers Amt
958965	459	99	14a		Andreas Nielsen Steensen	G	HandelsGartner	Familiefader	Vejlby Sogn, Aarhus Amt
958966	460	99	14a		Eise Kirstine Steensen	G		Husmoder	Randers
958967	461	99	14a		Gerda Steensen	U		Datter	Rolighed
958968	462	99	14a		Poula Steensen	U		Datter	Rolighed
958969	463	99	14a		Pouline Simonsen	E		Aftektkone	Randers
958970	464	99	14a		Agnes Lene Nielsen	U		Tjenestepige	Udbyneder Sogn, Randers Amt
958971	465	99	14a		Jørgen Mogensen	U		Elev	Randers
958972	466	100	13h		Chr. Hansen	G		Husfader	Højberg Sogn, Viborg Amt
958973	467	100	13h		Johanne Stiksen	G		Husmoder	Vinderslev Sogn, Viborg Amt
958974	468	100	13h		Hans Hansen	U		Søn	Højberg Sogn, Viborg Amt
958975	469	100	13h		Laurits Hansen	U		Søn	Kjellerup, Viborg Amt
958976	470	100	13h		Jacob Hansen	U		Søn	Kjellerup, Viborg Amt
958977	471	100	13h		Katrine Hansen	U		Datter	Thorning Sogn, Viborg Amt
958978	472	100	13h		Theodor Mathiasen	G		Husfader	Højberg Sogn, Viborg Amt

# Geography in the Danish Demographic Database

On paper, the geography of the census has been standardized according to Trap 5 (1953-72)

In practice, it is unclear exactly how this was carried out.

As a result, however, the geography of DDD is somewhat anachronistic: each census contains entities (parishes) that did not exist at the time.

Further, DDD has no identifier for the same parish across the censuses.



# DigDag: the backbone of Danish historical GIS

DigDag is the “digitale atlas over Danmarks historisk-administrative geografi”.

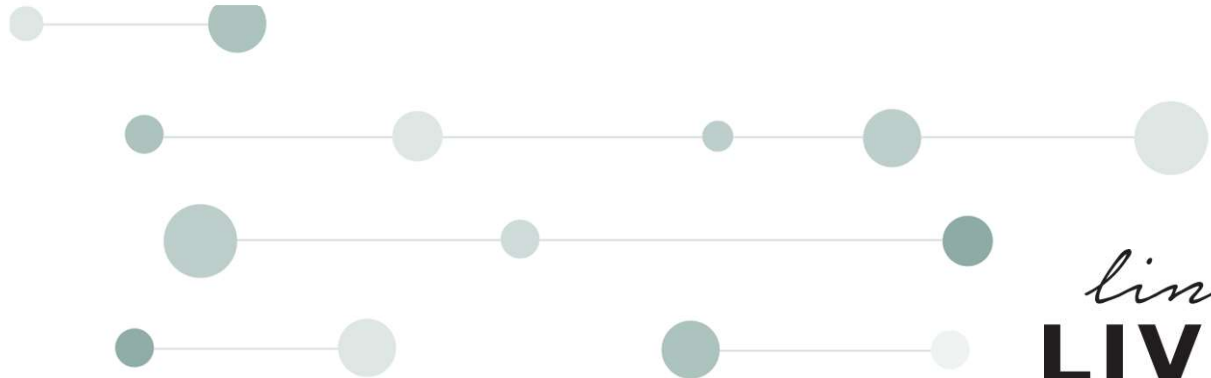
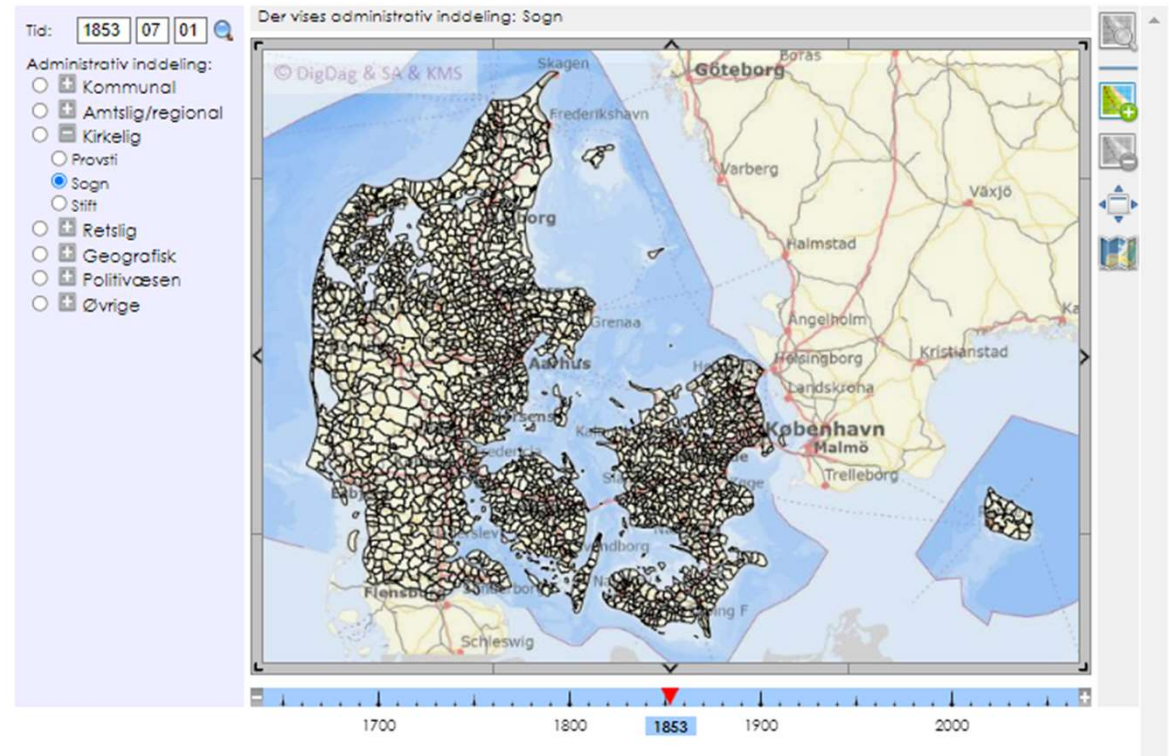
It contains most geographical units used at some point in Denmark in amazing temporal detail.

We use it as a “ground truth” of what the administrative geography looked like at the time of each census.

Units we use:

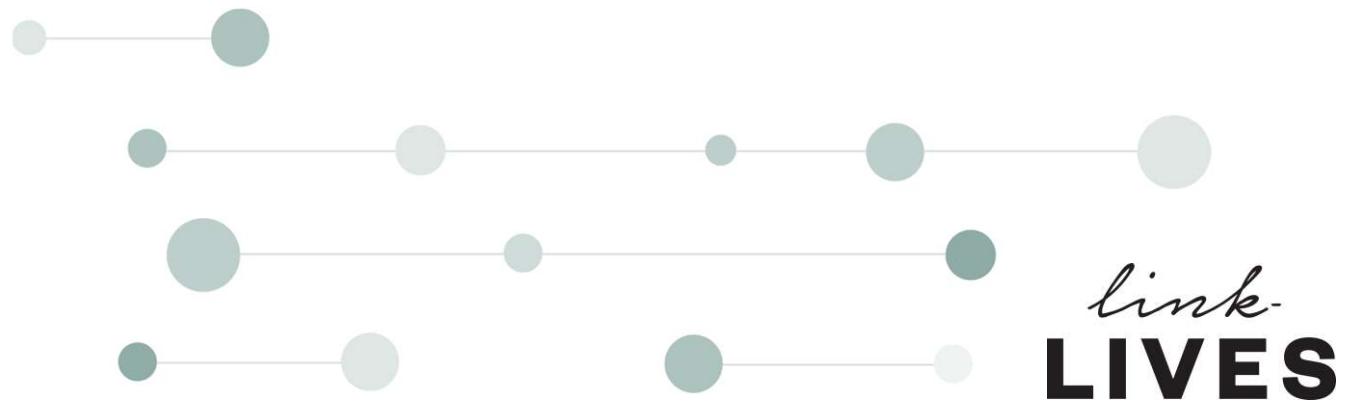
- Parish (sogn)
- Town (købstad)
- Shire (herred)
- County (amt)

Almindeligt kort ↗



# A plethora of geographies at play

- The legal, matricular geography (represented by DigDag)
- The parochial geography as practised by the census counters
- Organization of the archive
- Processing of the material at digitization and transcription
- Post-transcription standardization



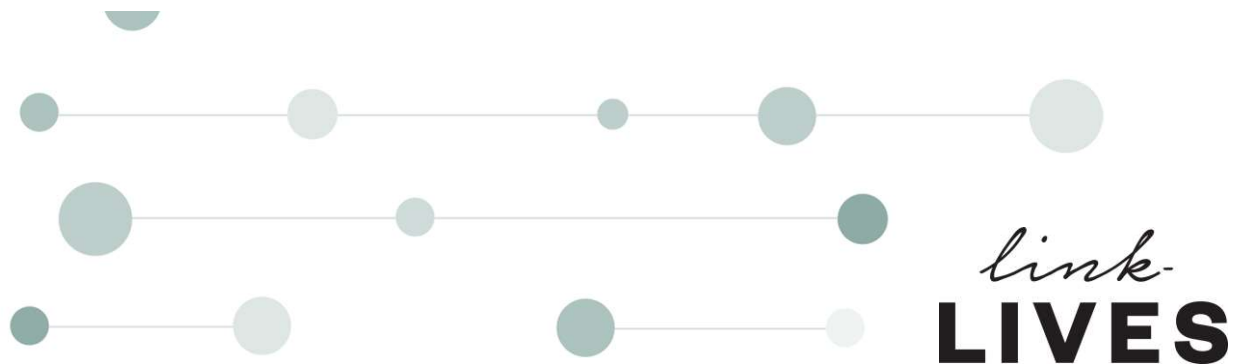
# Strategy

We aimed to fit the units from Danish Demographic Database to DigDag while preserving as much detail as possible for each census year (one vector layer per census).

In most cases this was a straightforward parish to parish link.

Some general issues:

- Sub-parish entities (villages, farms, cadasters) are difficult to work with in the DDD data.
- In and around towns, the census often distinguishes between the town itself and the town's rural district. These had to be separated using different DigDag units.
- The census tends to treat some settlements as towns even though they were not technically towns – as thus do not exist in the administrative geography!



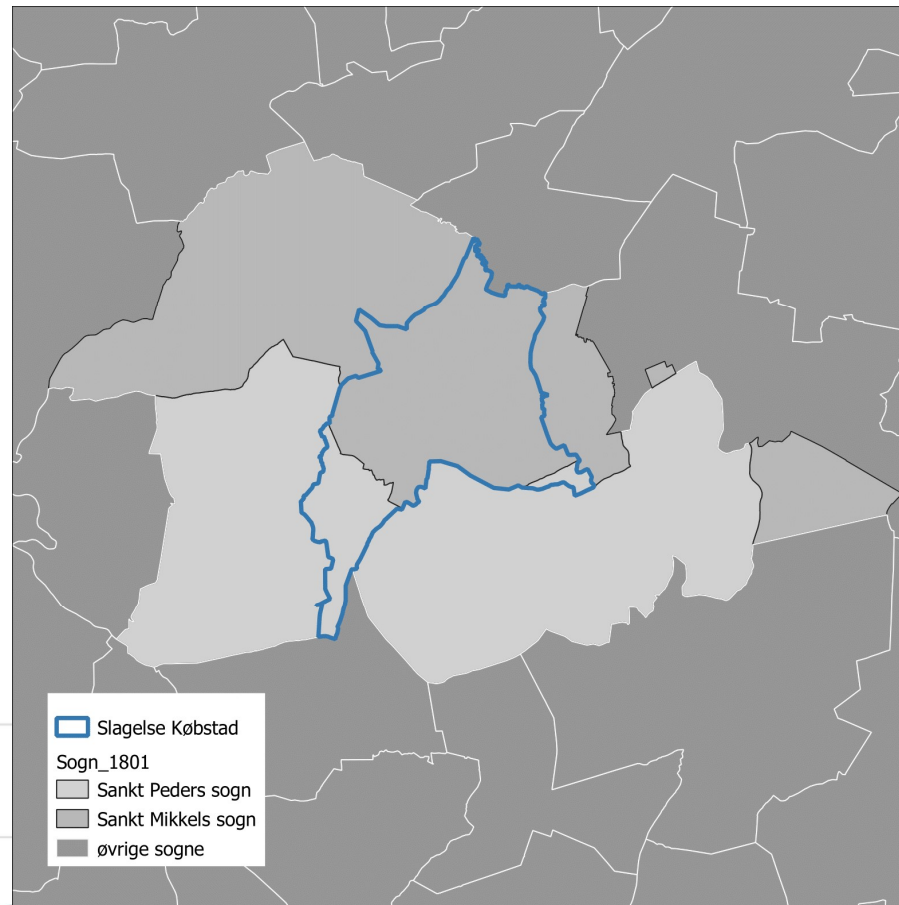


# Linking geographies – step 1

We tailor-fit a vector layer to each census using DigDag.

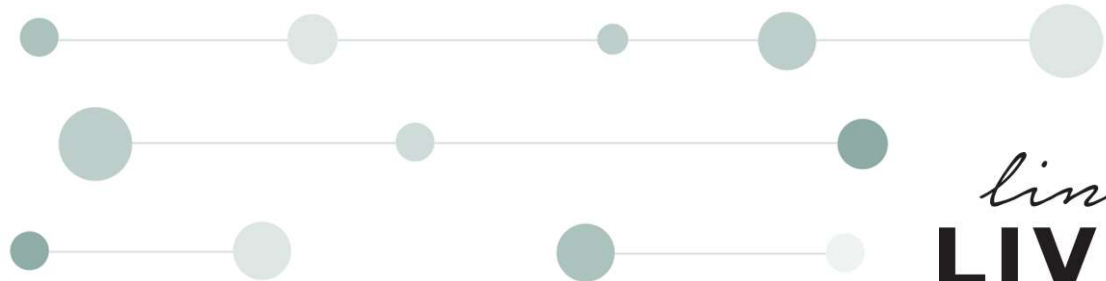
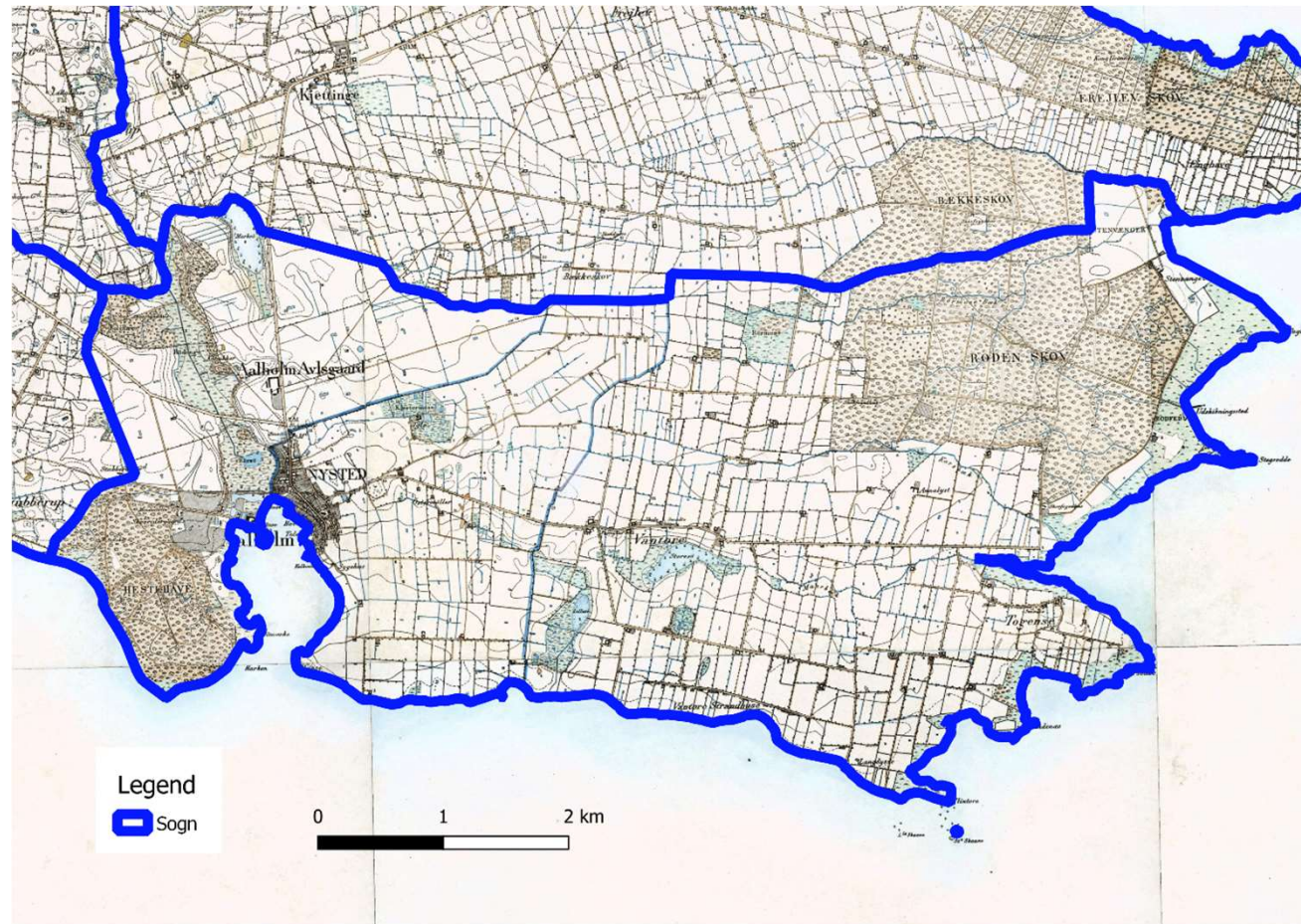
This involved inspecting the DigDag units in comparison to DDD units, particularly around towns, to assure the right level of detail.

Some towns have a rural district, others do not.



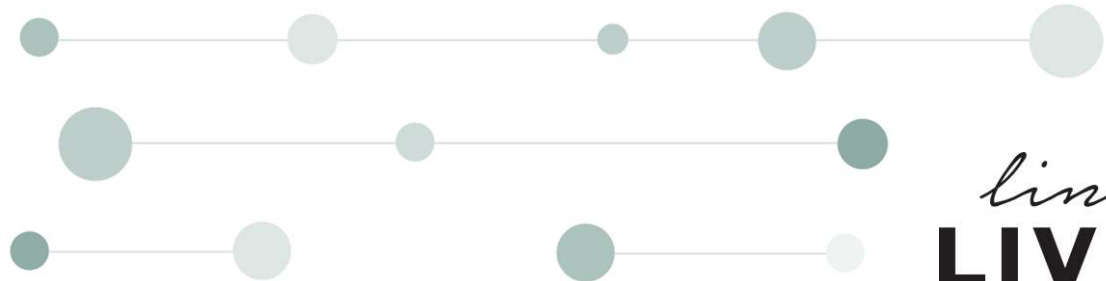
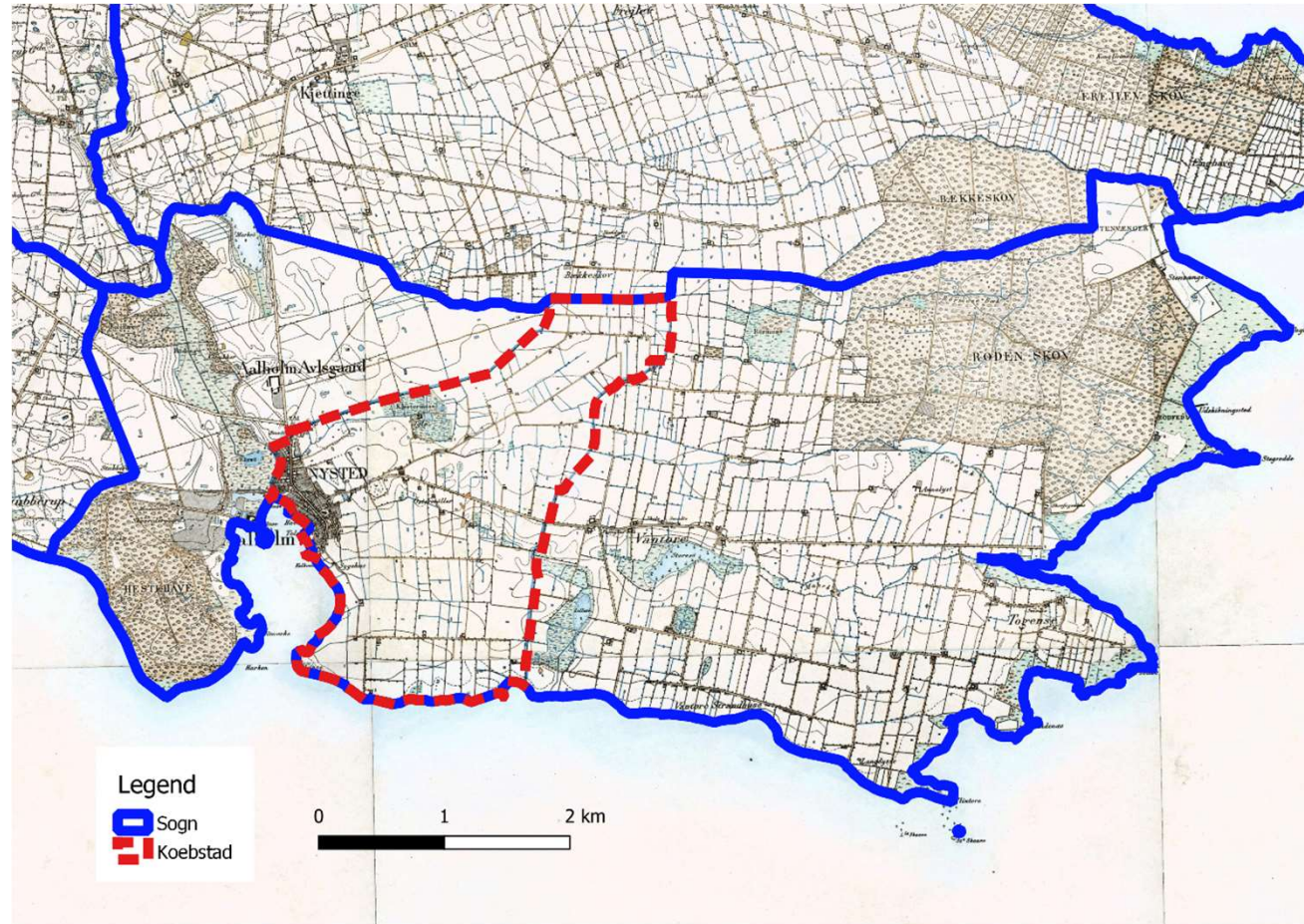
# Linking geographies – step 1

*Example:  
Nysted*



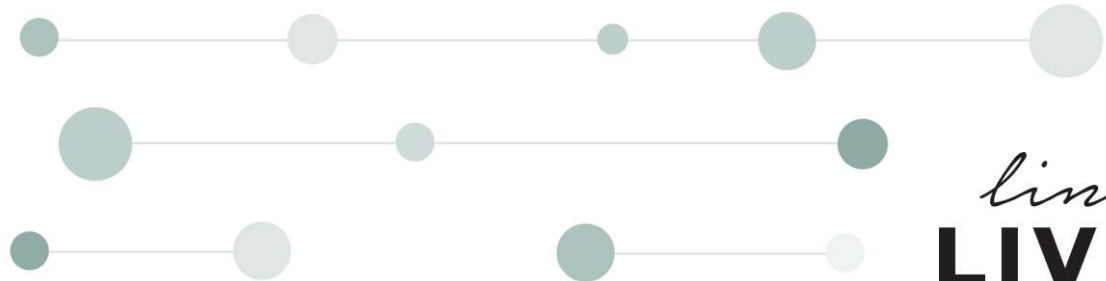
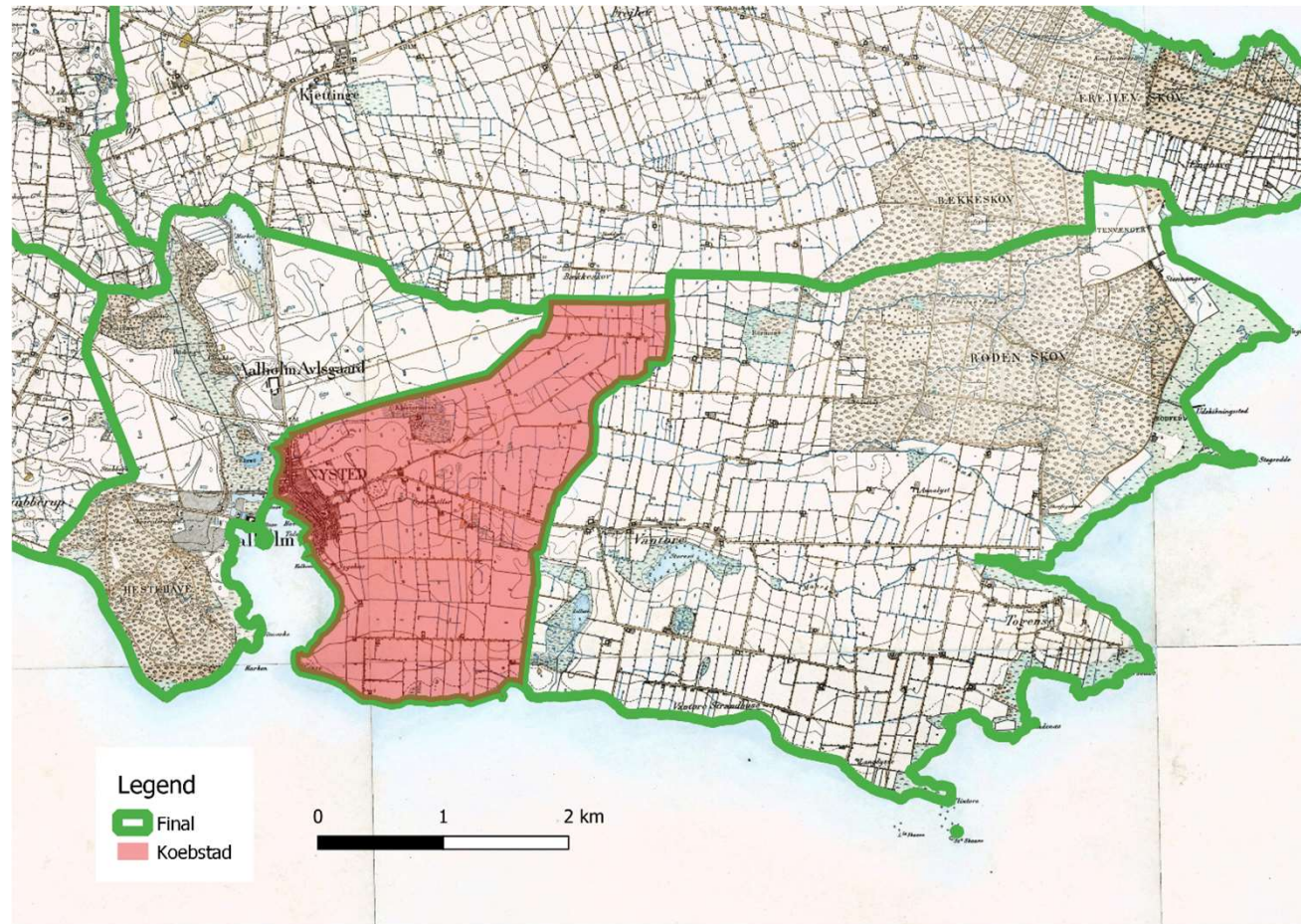
# Linking geographies – step 1

*Example:  
Nysted*



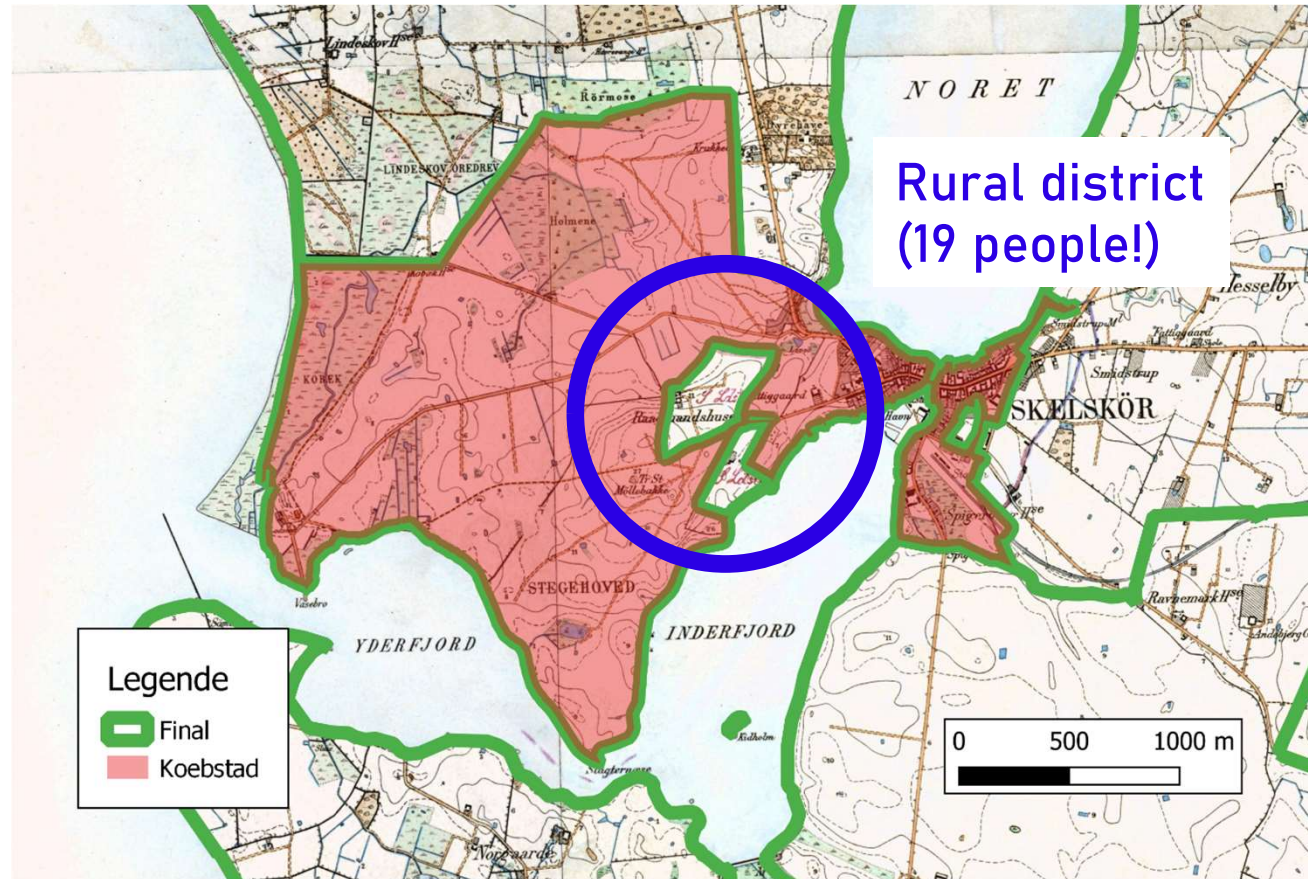
# Linking geographies – step 1

*Example:  
Nysted*



# Linking geographies – step 1

Example:  
Skælskør



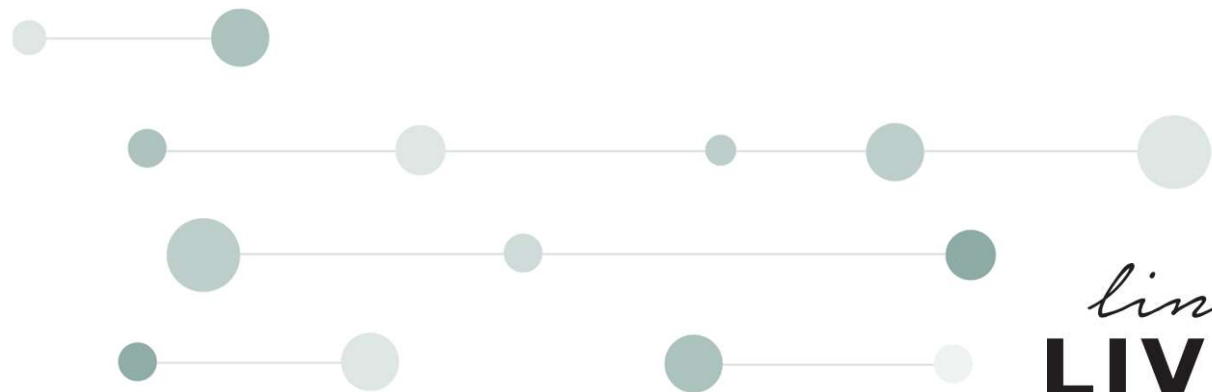
# Linking geographies – step 2

In a very hand-held manner each parish in the censuses were linked to its corresponding unit in the vector layer.

Sogn	Amt	Herred	KIPNr	dd_fif_navn	dd_fif_enhedid	dd_navn	dd_enhedid
allinge-sandvig købstæder	bornholm	nørre	a0602	Allinge-Sandvig Sogn	113960	Allinge-Sandvig Sogn	113960
hasle købstad	bornholm	nørre	a0607	Hasle Sogn	113478	Hasle Sogn	113478
klemensker	bornholm	nørre	a0605	Klemensker Sogn	113758	Klemensker Sogn	113758
olsker	bornholm	nørre	a0600	Olsker Sogn	114380	Olsker Sogn	114380
rutsker	bornholm	nørre	a0601	Rutsker Sogn	114467	Rutsker Sogn	114467
rø	bornholm	nørre	a0599	Rø Sogn	114476	Rø Sogn	114476
bodilsker	bornholm	sønder	a0595	Bodilsker Sogn	114061	Bodilsker Sogn	114061
christiansø	bornholm	sønder	a0608	Christiansø Sogn	113118	Christiansø Sogn	113118
neksø købstad	bornholm	sønder	a0713	Nexø Sogn	114298	Nexø Sogn	114298
pedersker	bornholm	sønder	a0596	Pedersker Sogn	114404	Pedersker Sogn	114404
povlsker	bornholm	sønder	a0597	Povlsker Sogn	114408	Povlsker Sogn	114408
aaker	bornholm	sønder	a0592	Aaker Sogn	115247	Aaker Sogn	115247
aakirkeby købstad	bornholm	sønder	a0606	Aaker Sogn	115247	Åkirkeby Købstad	137179

Census units

GIS units

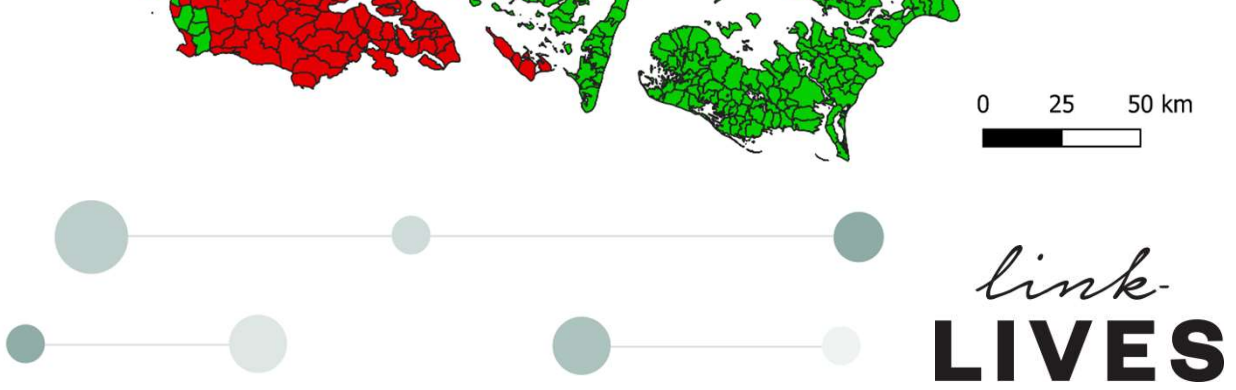
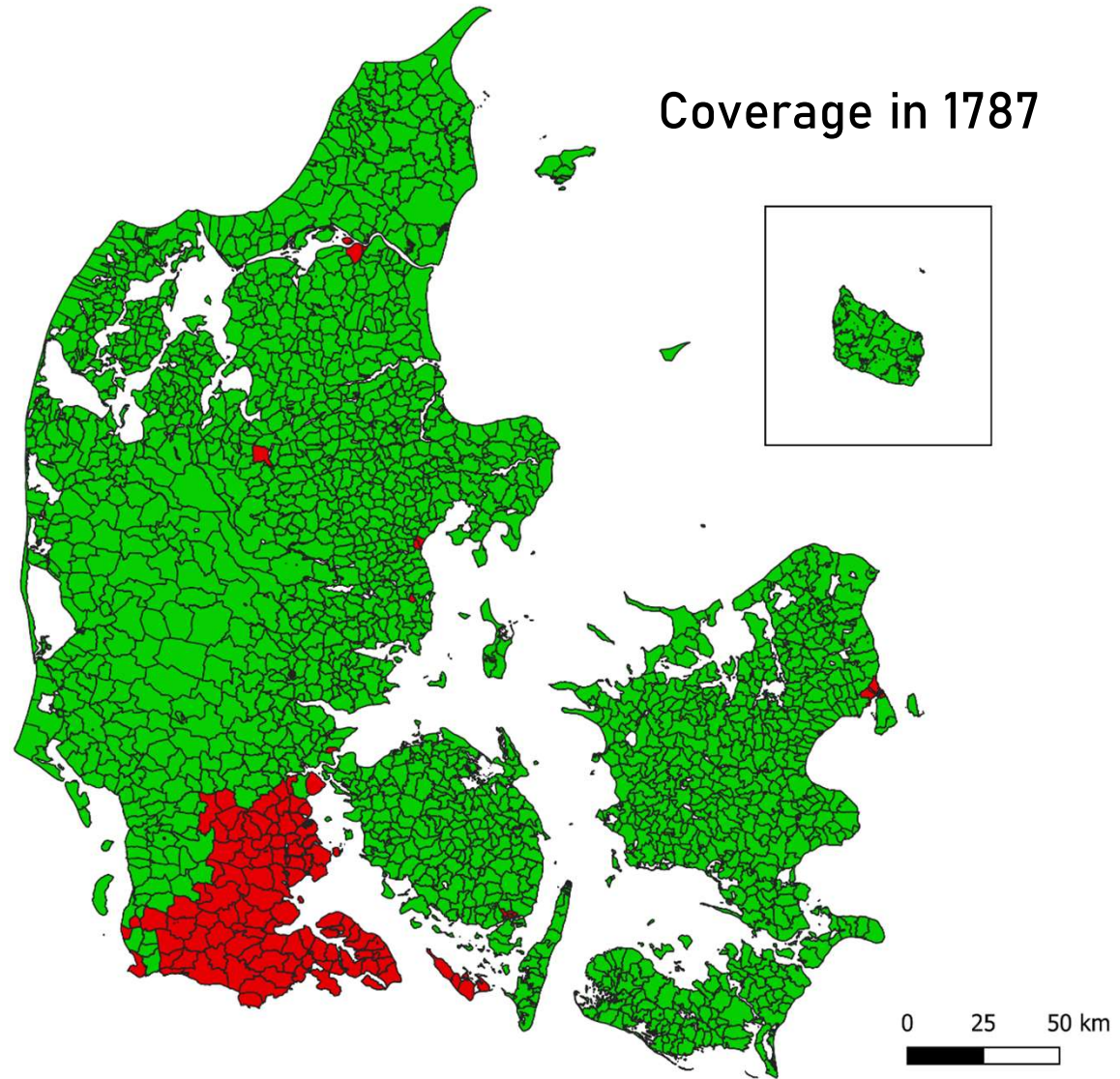


*link-*  
**LIVES**

# Coverage

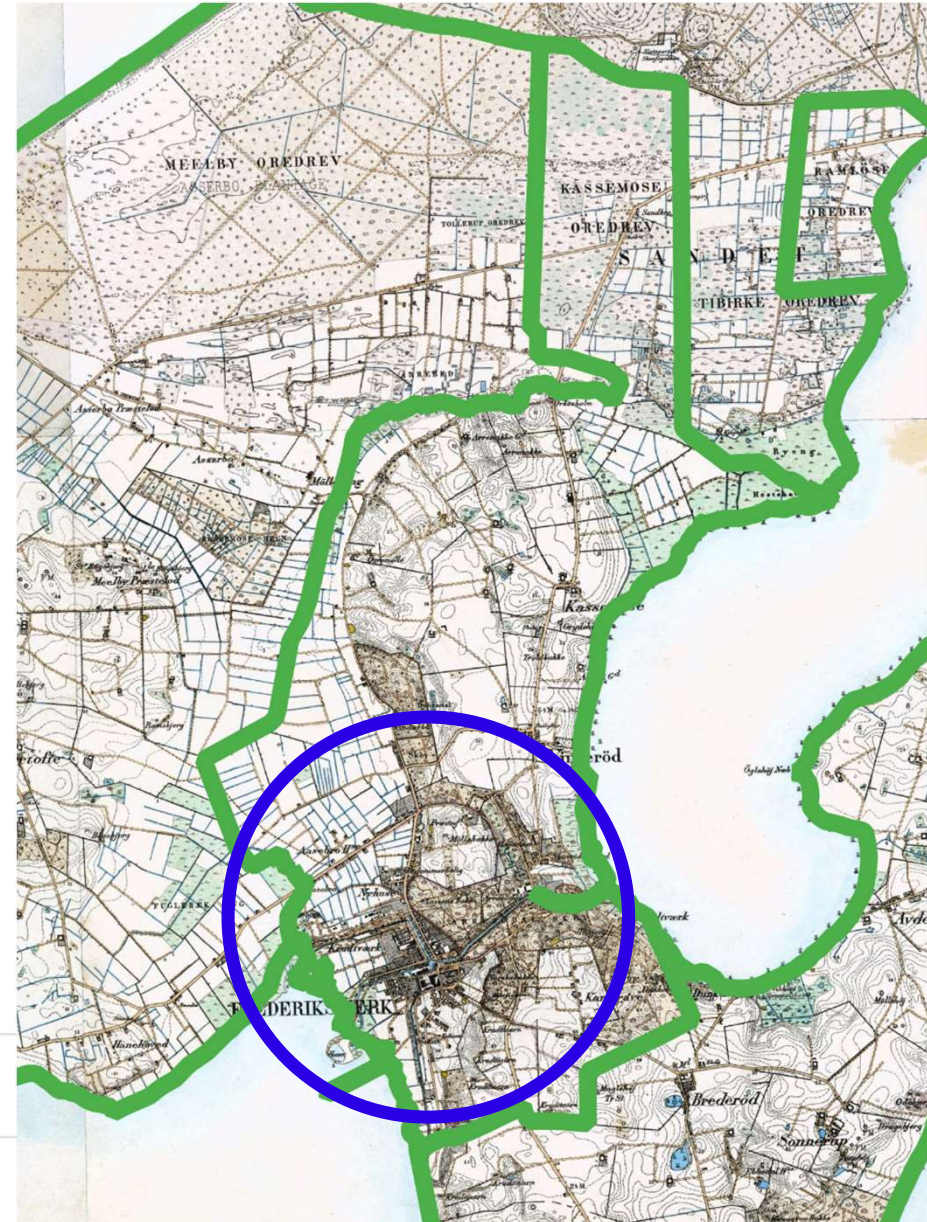
The vast majority of the spatial units in the census data were placed

	1787	1801	1811
% of DigDag parishes with a link	94	95	96
% of DDD-population linked to map	99	99	99



# Unresolved (but minor) issues

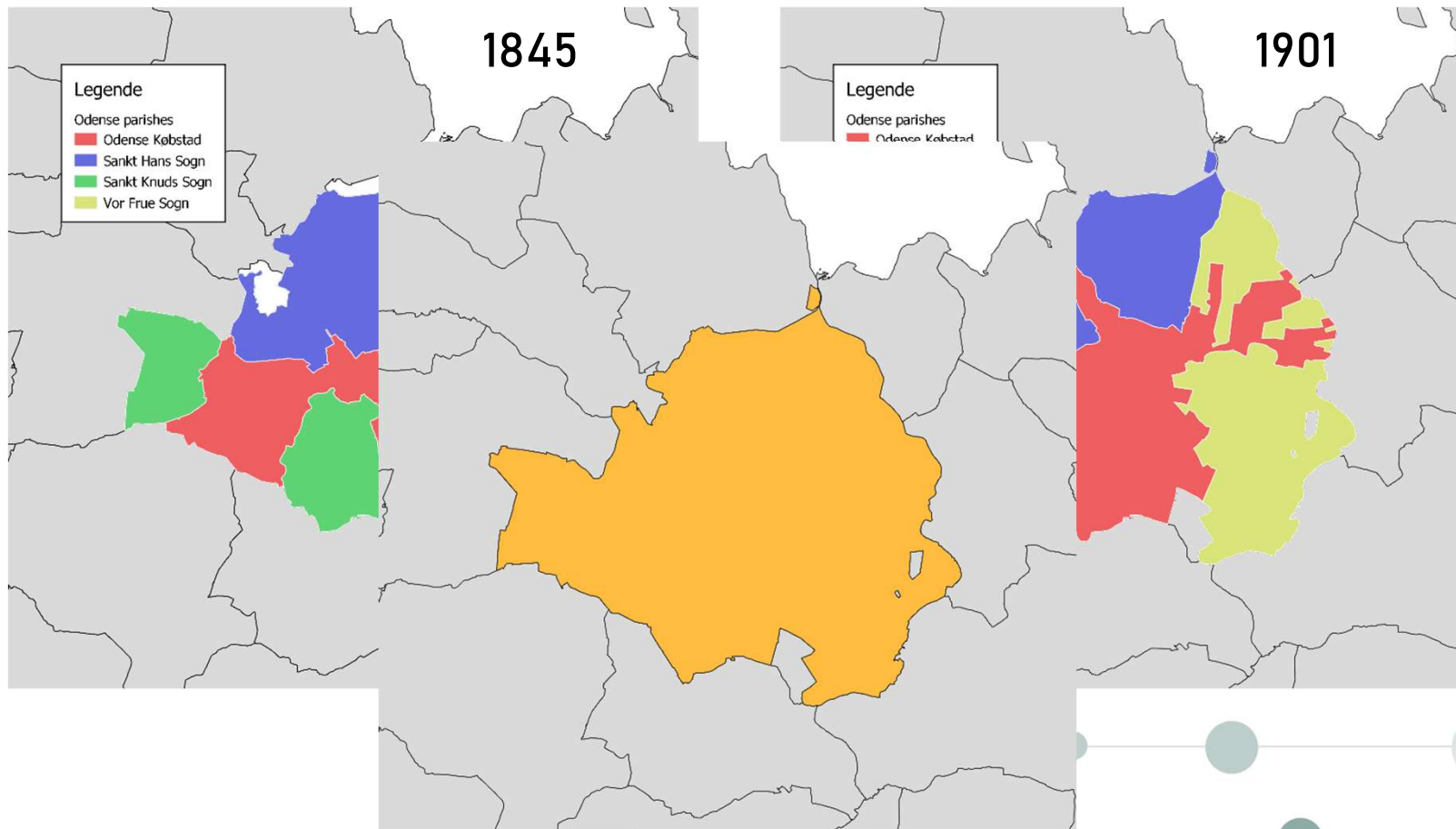
1. Census counters did not strictly follow the boundaries of “interwoven” parishes
2. Within the framework of DigDag, we cannot distinguish towns that are not technically towns (“handelspladser”)





# Mapping across time 1787-1901

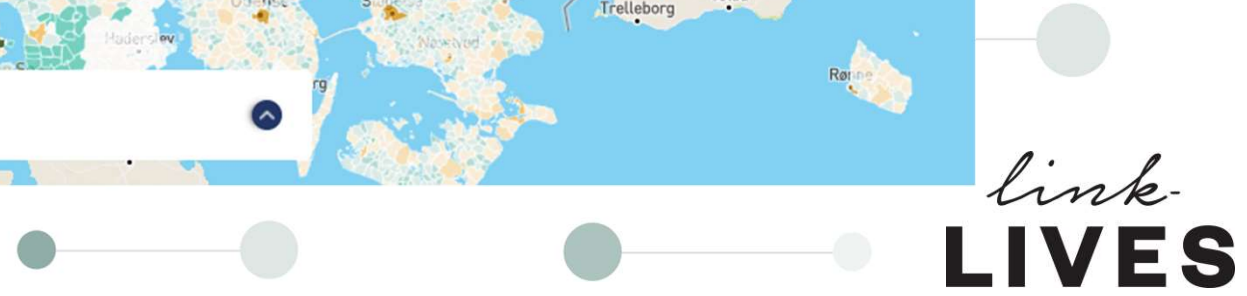
Aside from census-specific vector layers, we wanted a single file that all census years could be mapped to. This required some aggregation.



# Folk i Fortiden

<https://folkifortiden.dk/map/>

The screenshot displays the 'Folk i Fortiden' web application interface. At the top, there is a dark blue header with the RIGSARKIVET logo on the left and navigation links: 'Kom i gang', 'Hjælp', 'Kort', 'Download grunddata', and 'Om Folk i Fortiden'. On the right side of the header is the 'FOLK I FORTIDEN' logo. Below the header, the interface is divided into a left sidebar and a main map area. The sidebar contains a search field labeled 'Søgefelt' with the placeholder 'Søg på stednavn'. Below the search field is a timeline for the year 'År' with markers for 1787, 1801, 1834, 1840, 1845, 1850 (highlighted), 1860, 1880, and 1901. There is a 'Nulstil kort' link and a 'Sammenlign to år' option. The 'Geografi' section has checkboxes for 'Sogn/Købstad' (checked) and 'Amt'. The 'Måde' section has checkboxes for 'Procent' and 'Antal' (checked). At the bottom of the sidebar, there are sections for 'Udvælg og vis data på kort', 'Køn', and 'Alder'. The main map area shows a map of Denmark with various regions highlighted in orange and yellow. There are navigation controls like zoom in (+) and zoom out (-) buttons, and a 'Download de viste data' button. A 'Vis atypiske grupper' and 'Vis kort side-ved-side' option are also present. A 'Overzicht' button is located at the bottom of the map area.

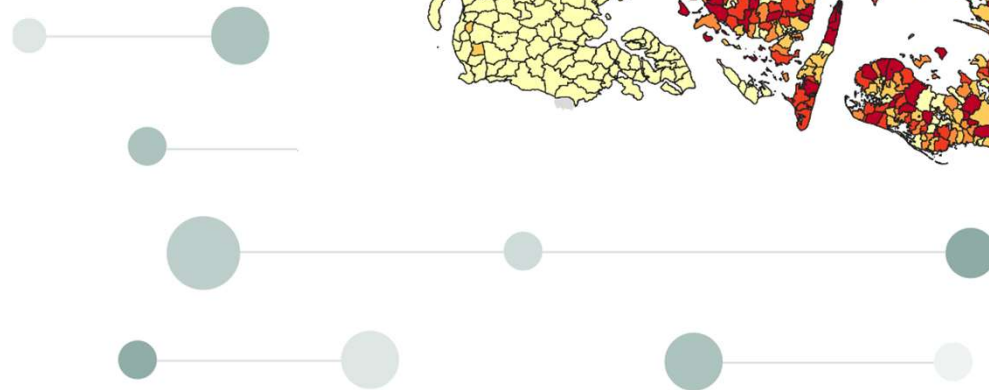
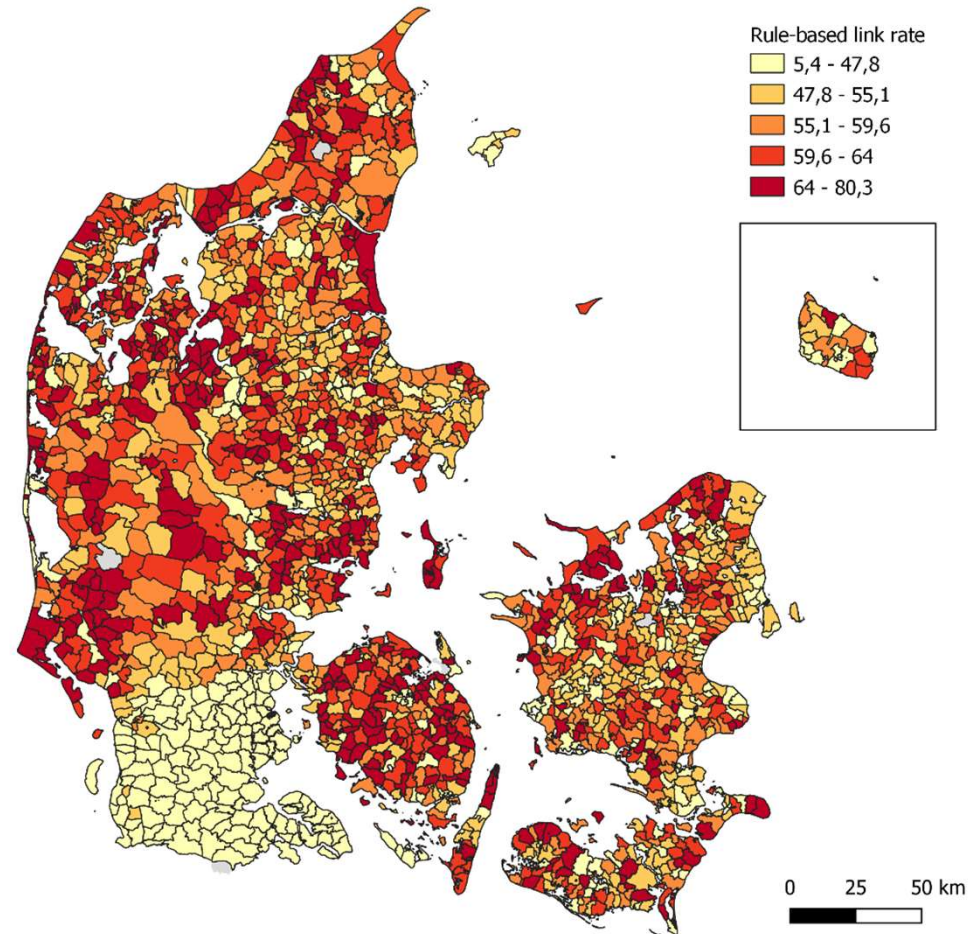


# How do we use the data? – for linking

We use the geography to organize the data and create an identifier for each parish across the census years.

This is particularly important when understanding our link rates, which can vary due to a lot of local variables.

Rule-based link rate: 1860 linked to 1850





# How do we use the data? – for research

Current research projects:

- Changing patterns of cause of death in Copenhagen 1860-1910
- Regional differences in 19<sup>th</sup> century infant and child mortality
- Interaction between social and geographical mobility
- Relationship between gender and migration in longitudinal perspective



# Perspectives

First version of our links is published in a few weeks.

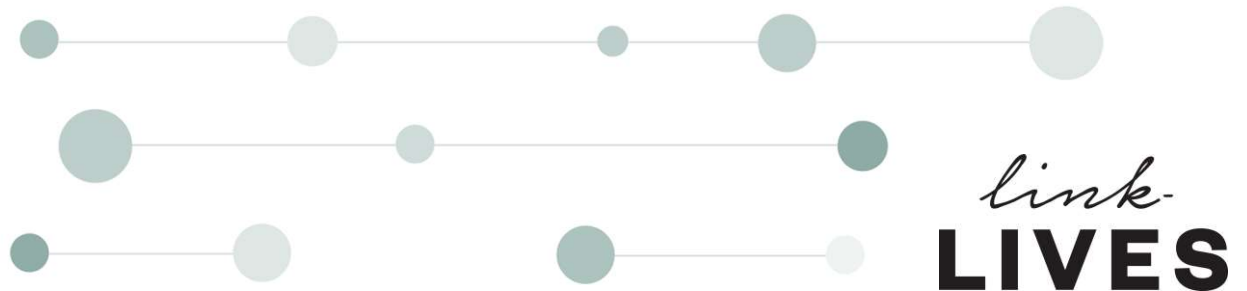
The screenshot displays the linkLIVES search interface. At the top, there are navigation links: "Om projektet", "Nyheder", "Deltag", "Livsforløb", and the "linkLIVES" logo. A language selector is set to "English".

The search bar includes a "Tilbage til forsiden" link, a search history link "Min søgehistorik", and search filters for "Fritekst" (kirsten sofe), "Efternavn" (jensen), and "Fødselsår" (1857). There are also options to "Tilføj felt" and "Nulstil". The "Resultattype" section has checkboxes for "Personregistrering" and "Livsforløb", and a checkbox for "Inkluder stavevariationer". A "SØG" button is present.

Below the search bar, there are filters for "Filter resultater" (Alle filtre), "Antal per side" (10), and "Sorter efter" (Relevans). A note indicates "Viser 1 livsforløb og 1 personregistrering".

The results are displayed in a table-like format:

Icon	Category	Name	Details	Action
📅	personregistreringer	<b>Kirsten Sophie Jensen</b> ★ 1857 + 1877 Niløse Sogn Holbæk Amt, Niløse Sogn, Merløse, Holbæk	Personregistreringer 2 personregistreringer i perioden 1860 - 1877. Folketælling 1860, Kirkebog 1875-1891	<a href="#">SE FORLØB →</a>
📄	Folketælling	Ukendt <b>Kirsten Sofie Jensen</b> ★ 1857 Niløse Sogn Holbæk Amt, Niløse Sogn, Merløse, Holbæk	Registrering Folketælling 1860 Niløse, Merløse Herred, Danmark Amt	<a href="#">SE DATA →</a>

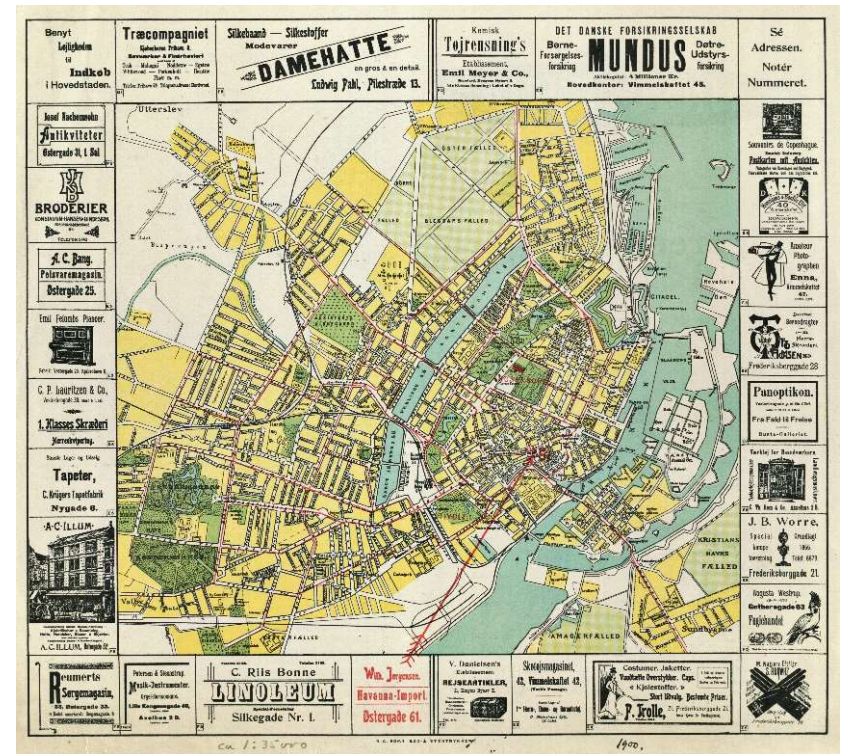


# Mapping Copenhagen in growth

1850, population: ca. 130,000



1900, population: ca. 400,000



# Prior to expansion

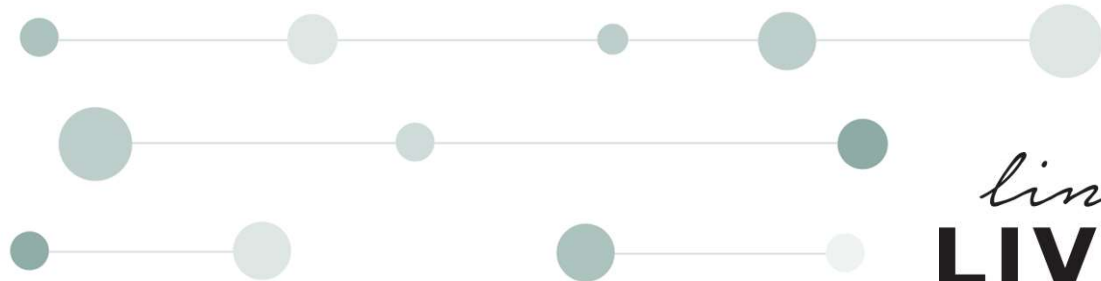
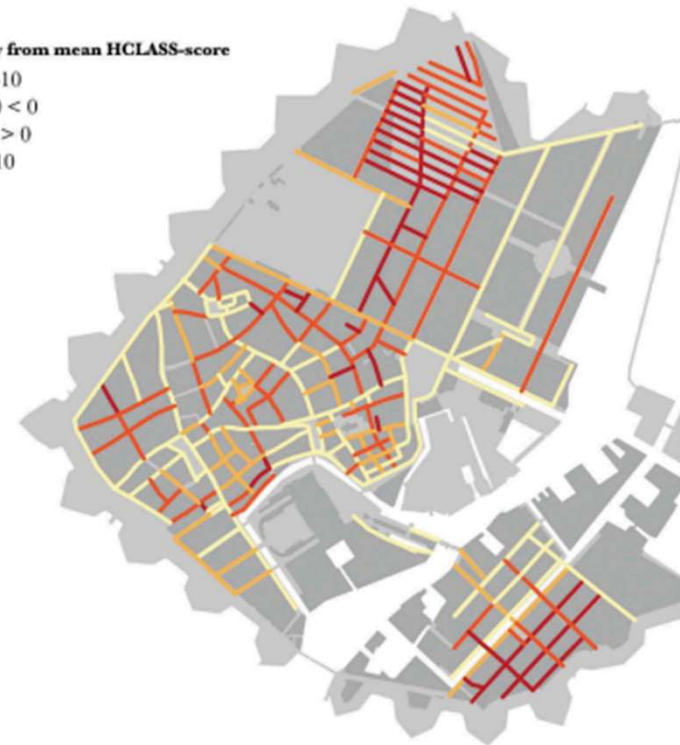
Digital cadastral map (1860) from DigDag



Social class by street (1845)

% dev from mean HCLASS-score

- < -10
- 10 < 0
- 10 > 0
- > 10





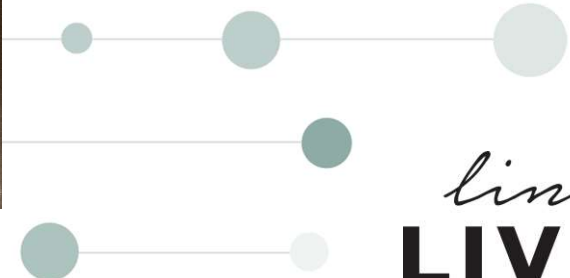
# Issues when mapping the expanding city

Expansion is a continuous development, but we are trying to map data at a specific point in time (census day).

Addresses are constantly changing, streets growing in length. The boundaries are unclear



Different ends of  
Nørrebrogade,  
1890s



# Our solution: tax districts

Nyhavn's Rode.
1
St. Annæ Øster Kvarter.

## Fortegnelse

Sogn	adresse
Amagergade	Amagergade 1, -Matr 326 Baghus 1.sal Christianshavn
Amagergade	Amagergade 1, -Matr 326 Baghus 2.sal Christianshavn
Amagergade	Amagergade 1, -Matr 326 Baghus Stuen Christianshavn
Amagergade	Amagergade 1, -Matr 326 Forhus 1.sal Christianshavn
Amagergade	Amagergade 1, -Matr 326 Forhus 2.sal Christianshavn
Amagergade	Amagergade 1, -Matr 326 Forhus 3.sal Christianshavn
Amagergade	Amagergade 1, -Matr 326 Forhus Stuen Christianshavn
Amagertorv	2. Sal No. 1. Matrikel 50.
Amagertorv	3. Sal No. 1. Matrikel 50.
Amagertorv	Stuen og 1. Sal No. 7. Matrikel 47. Baghus
Amaliegade	Stuen og 1. Sal Hus no. 7, Matrikel 156
Antonistræde	Stue og 1. Sal No. 13. Matrikel 239
Antonistræde	Stue og 1. Sal No. 4, Matrikel 232
Antonistræde	Stuen og 1. Sal No. 12, Matrikel 228, Forhus
Antonistræde	Stuen- 1. Sal- 2. Sal No. 10, Matrikel 229
Asylgade	1. Sal No. 1, Matrikel 135
Asylgade	2. Sal No. 1, Matrikel 135
Asylgade	3. Sal No. 1, Matrikel 135
Asylgade	Stuen No. 1, Matrikel 135
Badevejen	1. Sal No. 1 Matrikel 498
Badevejen	2. Sal No. 1 Matrikel 498
Badevejen	3. Sal No. 1 Matrikel 498
Badevejen	4. Sal No. 1 Matrikel 498
Badevejen	Stuen No. 1 Matrikel 498
Baggesensgade	Baggesensgade 1,matr.36E4 1.Sal Kjøbenhavn Udenbys Klædebo Kvarter
Baggesensgade	Baggesensgade 1,matr.36E4 2.Sal Kjøbenhavn Udenbys Klædebo Kvarter
Baggesensgade	Baggesensgade 1,matr.36E4 3.Sal Kjøbenhavn Udenbys Klædebo Kvarter
Baggesensgade	Baggesensgade 1,matr.36E4 4.Sal Kjøbenhavn Udenbys Klædebo Kvarter
Baggesensgade	Baggesensgade 1,matr.36E4 Stuen Kjøbenhavn Udenbys Klædebo Kvarter
Baggesensgade	Baggesensgade 1,matr.36E4 Kjælder Kjøbenhavn Udenbys Klædebo Kvarter
Batterivej	1. Sal No. 1, Matrikel 430
Batterivej	2. Sal No. 1, Matrikel 430
Batterivej	3. Sal No. 1, Matrikel 430
Batterivej	Stuen No. 1, Matrikel 430

Partikulier . . . . .	12	5	4	50
Glarmesterenke . . . . .	8	2	1	50
Kjøbmand . . . . .	36	36	27	
Væxelerer . . . . .	140	140	105	
Glarmester . . . . .	12	6	4	
Torrakettafabrikant . . . . .	20	18	13	50
Politibetjent . . . . .	10		4	
Skibstemrer . . . . .	8	2	1	50
Detailhandler . . . . .	24	24	18	
Antikvitetskænder . . . . .	16	12	9	
Grosserer . . . . .	64	64	48	
Snøktersvend . . . . .	8	2	1	50
Saleimagermester . . . . .	16	13	9	
Tømmersvend . . . . .	8	2	1	50
Billelskærersvend . . . . .	8	2	1	50
Frakon . . . . .	10	4	3	
Skibbygger . . . . .	14	9	6	75
Detailhandler . . . . .	12	6	4	50
Høfskomager . . . . .	80	80	60	
Blomsterhandler . . . . .	24	24	18	

# Conclusions

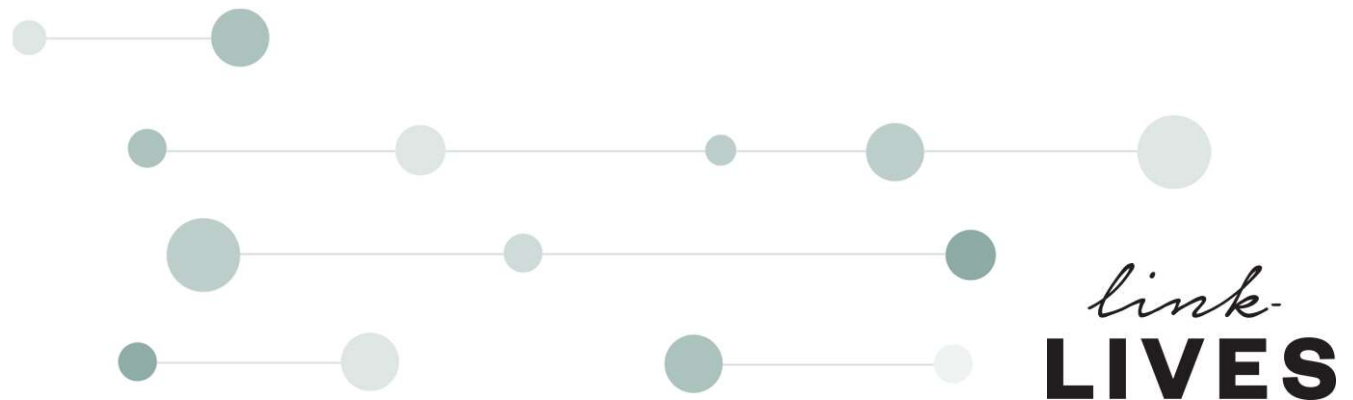
The Danish census are a very rich, but slightly messy dataset, so a very handheld way of geocoding it was necessary.

However:

- GIS data is mostly ready
- Census data is available
- Links are coming soon

Next challenges:

- How do we map life-courses rather than census appearances?
- Will the census maps perform well at mapping across sources?



**Questions?**

