BNU 2018: Population and Housing Censuses using administrative sources. Part I-III

The past, present and future of population censuses: Methodology and quality aspects when data sources are being reused and combined to transform a census system.

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Contents Part I - Part III

- Census history and background
- Motives for using administrative data
- The Nordic model
- Registers, data infrastructures and methods
- Other census models
- What is quality in a Census ? Assessment methods.

History

- American colonies, Quebec
- 1749 Sweden (Finland)
  - Italian and German cities 1770
  - Denmark 1787
  - US 1790, England 1801
  - France (tried) 1800, 1806
- China 1953

Role of the census

Benchmark in a National statistical system

1. For baseline estimates and small groups/domains
2. Assisting data collection; Organisation, Frames, Techniques, Routines.

Planning on local and national level

Use Internationally and for the National Accounts

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Direct Topics in a Population Census

Geographic: place enumerated and/or place of usual residence;

Family circumstances: relation to head of household or family;

Demographic: sex, age, marital status, children ever born, birthplace;

Economic: type of activity, occupation, industry, employer-employee status;

Social and political: citizenship, language, ethnic or religious affiliation

Educational: literacy or level of education, school attendance.

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Examples of Statistics from Population Census

Total population (Counts)

- population of towns and local areas
- urban-rural distribution
- household or family composition

Plus Additional topics

internal migration, income, labour-force participation, duration of marriage, etc...

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Statistics from the Housing part of the Census

Total population! (Counts of Dwellings)

Housing arrangements (used as residence, vacant or secondary use)

Occupancy status

Type of Ownership

Useful floor area

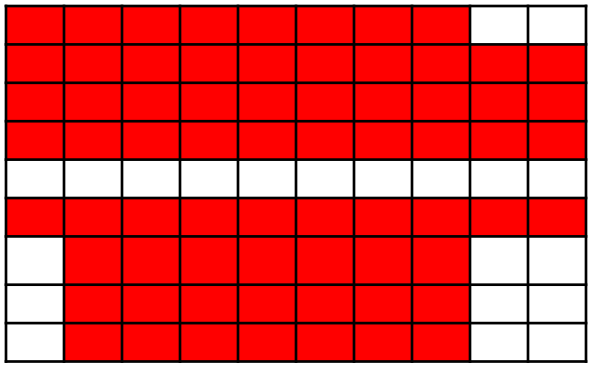
Standards of dwelling (Water, toilets, heating)

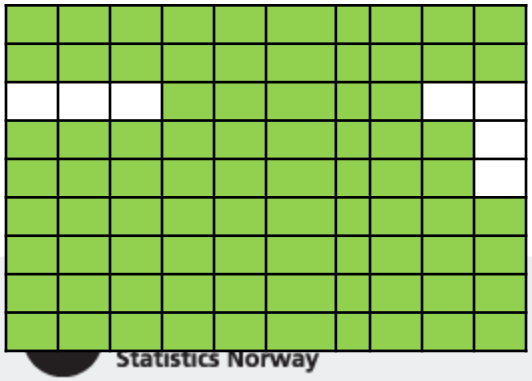
Dwellings by Type of Building, Size

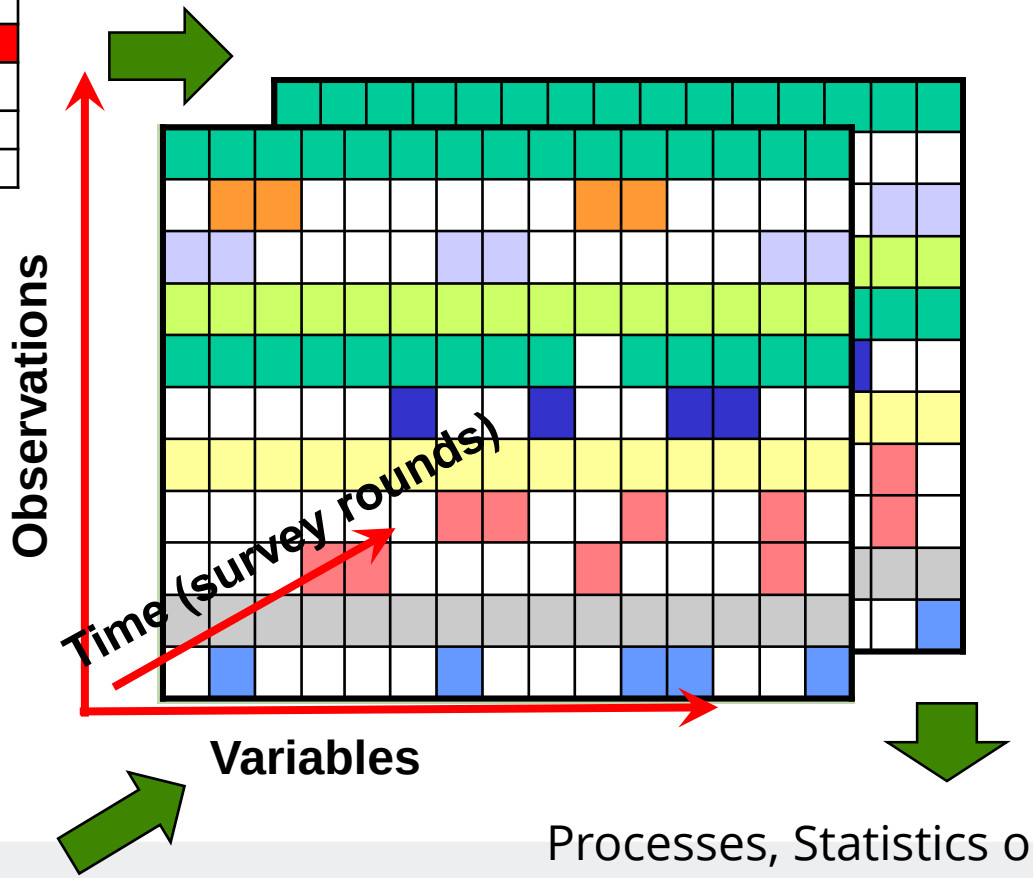
Motives for a register-based census

- Cost-efficiency
- Reduced response burden on the population
- Provides the means for recurrent register-based production of (some) social statistics
  - Improves accuracy and timeliness
- Provides the means for new, better statistics (e.g. on living conditions)
  - Improves relevance

NSO-Target!? To create (new) knowledge from recycling existing data





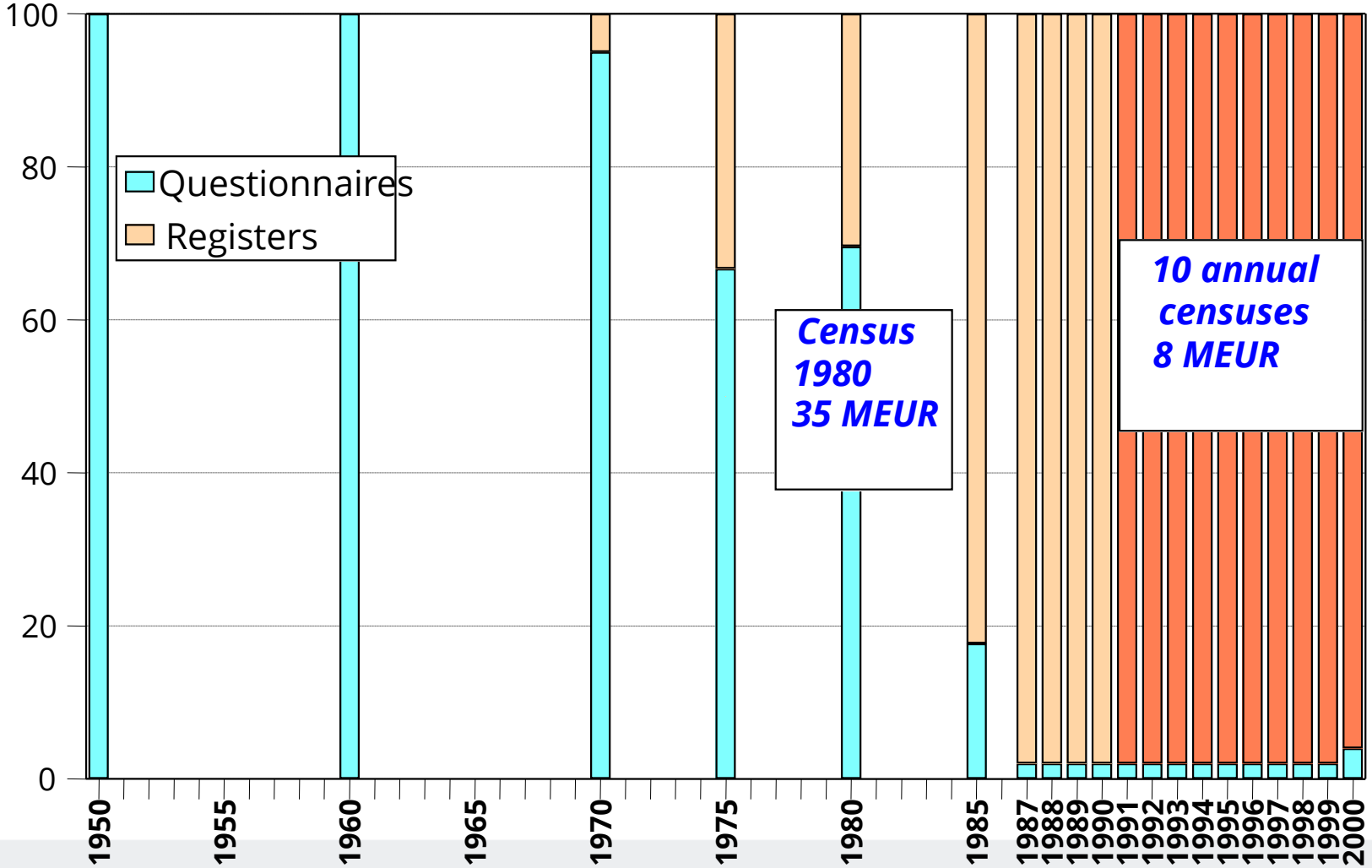


Processes, Statistics och Analyses

Decision, long term use in EU, UN mm

Cost of Censuses in Finland

Census data 1950-2000 according to the data source



Source:Statistics Finland, Kaija Routsalainen, Libourne July 2007

More countries move from a traditional census All countries try to modernize collection

UNECE keeps a good overview

https://statswiki.unece.org/display/censuses/2010+Population+Census+Round

Slovenia, Austria, The Netherlands (Reg)

Belgium, Iceland (reg plus a few surveys)

Estonia,, Germany, Latvia, Lithuania, Switzerland (Mix Reg + surveys)

France (Rolling census system)

US, Canada, UK, New Zealand, Australia, Ireland, Italy (Trad.)

Ukraine (no census)

Table. The year of establishing registers/introducing registers in census statistics by type of register and country

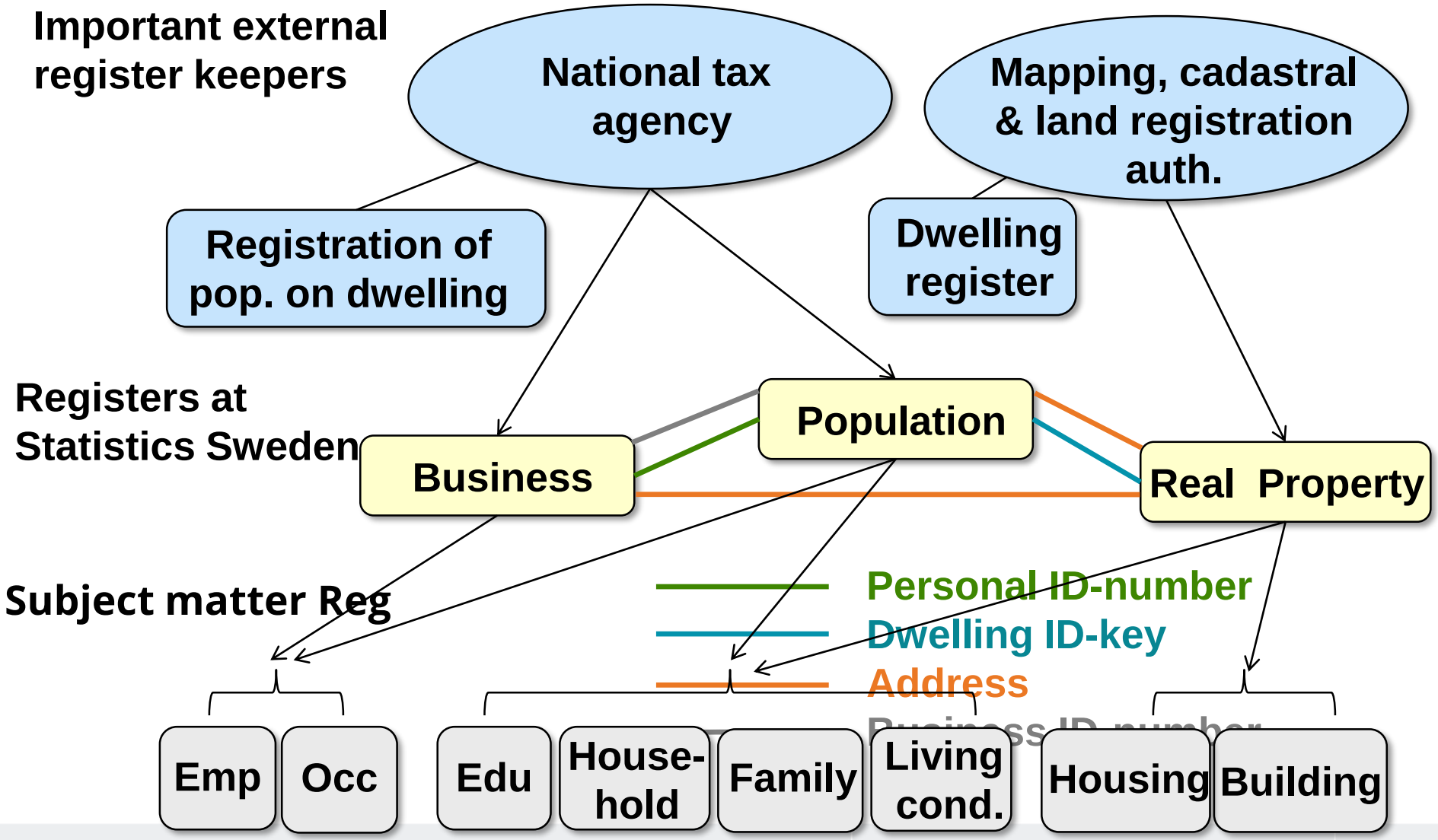
	Denmark		Finland		Norway		Sweden	
Type of register	*Estab-lished*	*First used in census*	*Estab-lished*	*First used in census*	*Estab-lished*	*First used in census*	*Estab-lished*	*First used in Census*
Central Population Register	1968	1981	1969	1970	1964	1970	1967	1975
Business Register	1975	1981	1975	1980	1965	1980	1963	1975
Dwellings	1977	1981	1980	1985	2001	*2011*	*2008?*	*2011?*
Housing conditions	1977	1981	1980	1985	2001	*2011*	*2008?*	*2011?*
Education	1971	1981	1970	1975	1970	1980	1985	1990
Employment	1979	1981	1987	1990	1978	2001	1985	1985
Family	1968	1981	1978	1980	1964	1980	1960	1975
Household[a]	1968	1981	1970	1975	2001	*2011*	*2011?*	*2011?*
Income	1970	1981	1969	1970	1967	1980	1968	1975
Totally register-based census		1981		1990		*2011*		*2011?*

[a] Household-dwelling unit, i.e. all the persons living in one dwelling

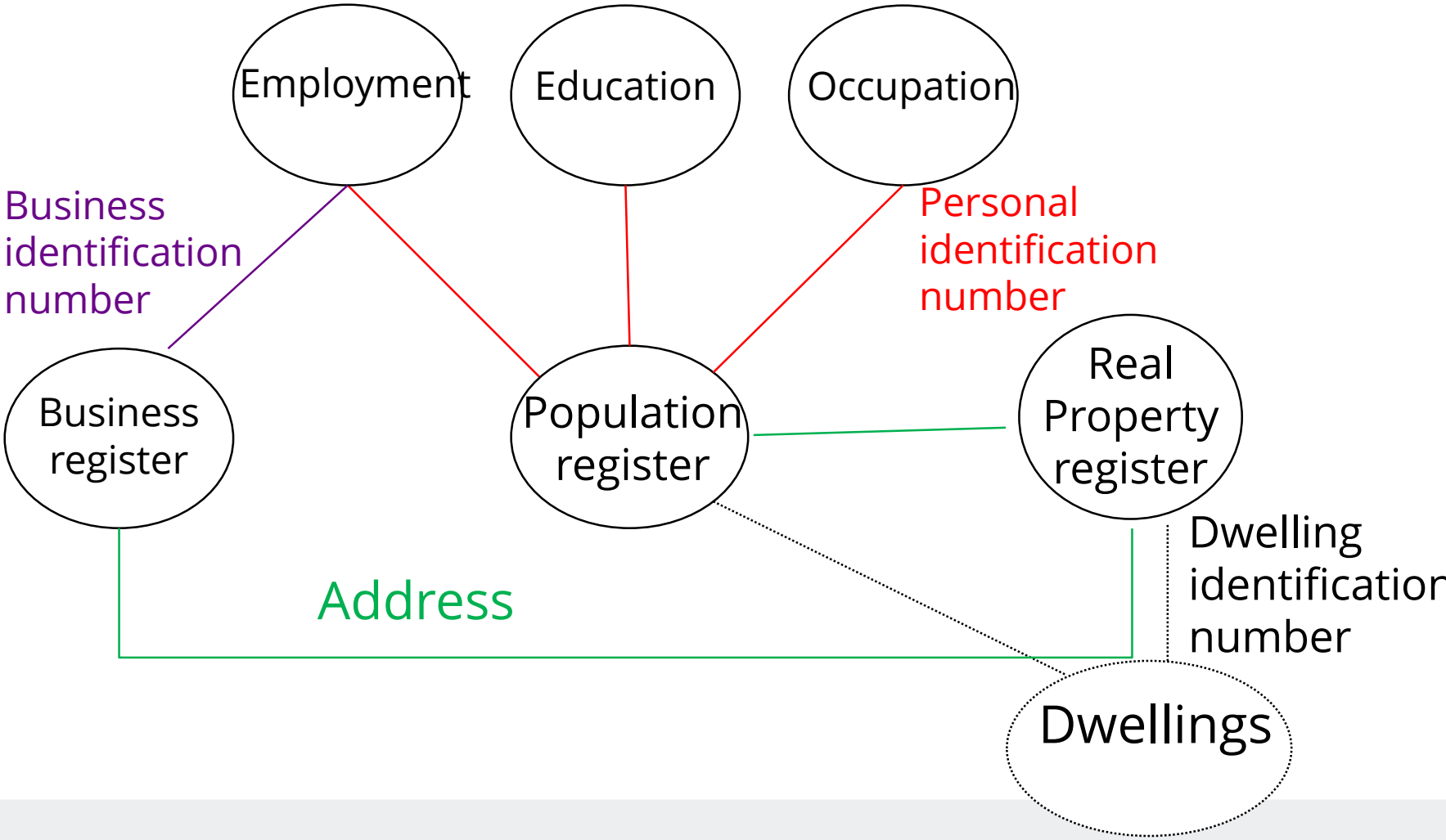
Swedish Censuses in the 20:th century

- Modern Population and housing censuses every 5th year between 1960 – 1990. Traditional censuses with increasing use of register data
- 1985 and 1990
  - High degree of computerization (main frame)
  - 1985 Public inquiry on increasing the use of registers.
  - Huge protest campaigns in media
- Cancelled 1995, 2000 (some data to Eurostat)

Input to the Swedish register based census



Links


Employment
Education
Occupation
Business identification number
Personal identification number
Business register
Population register
Real Property register
Dwelling identification number
Address
Dwellings

The weakest link - the Dwelling ID-key

- Two important steps:
  1. Construction of Dwelling register
     - Unique address for real property (building)
     - Unique dwelling number within building
     - Unique dwelling ID-key
  2. Registration of (registered) population on dwelling
- Complex processes and tight schedule

Constructing the Dwelling register

- Complex interaction required between
  - Municipalities
  - Mapping, cadastral & land registration authority
  - Real property owners
- Residents living in multi-dwelling buildings were informed about their dwelling numbers by the property owner

Populations, units and definitions

With a well functioning population register, individual person is a basic unit.

Households and Families are trickier.

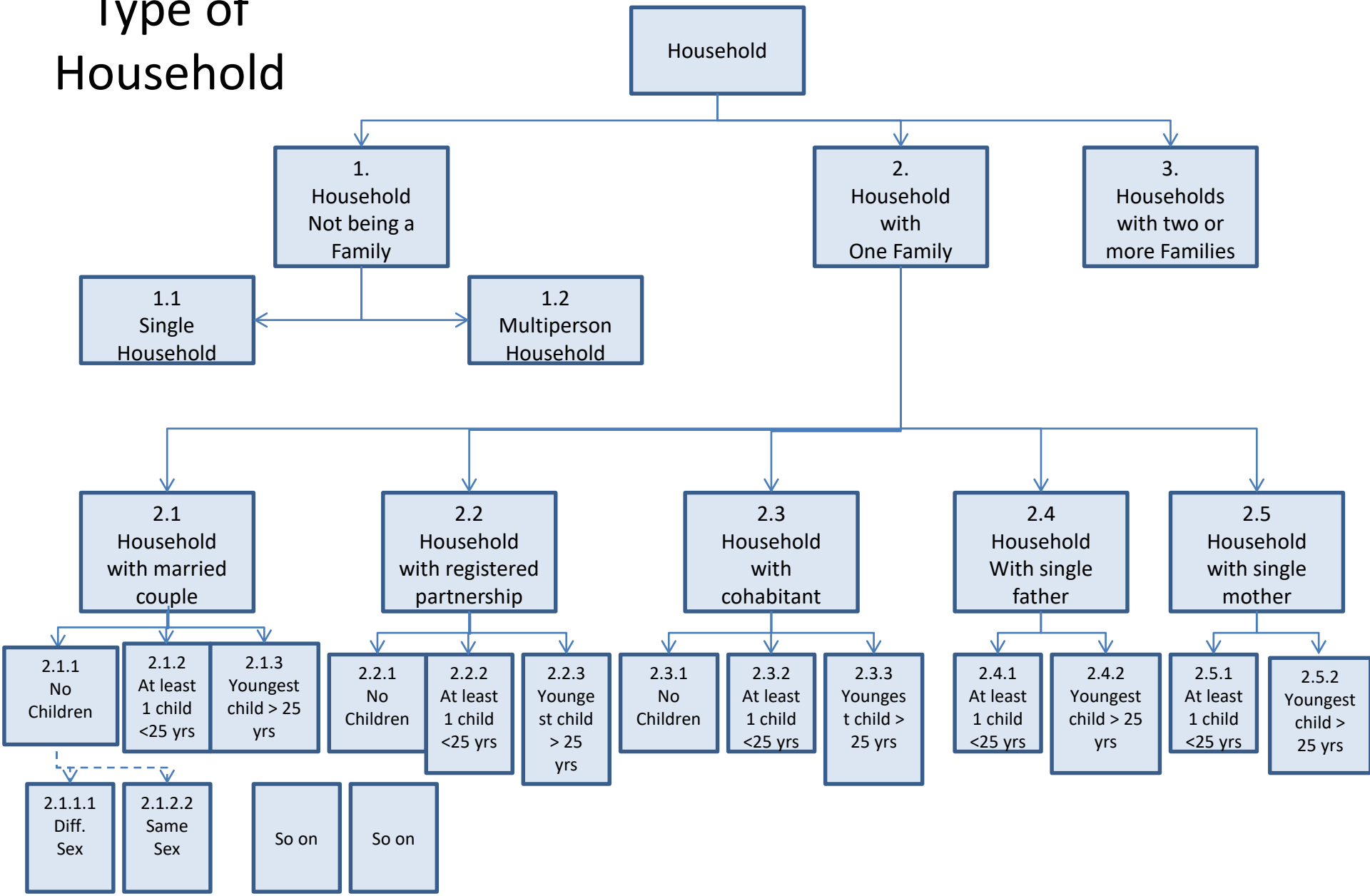
On the housing side Properties is the basic (legally regulated) unit. Buildings and Dwellings are units assigned to them where people live businesses are active etc. Addresses, Geocodes are attributes.

Populations, units and definitions

De jure or de facto population?

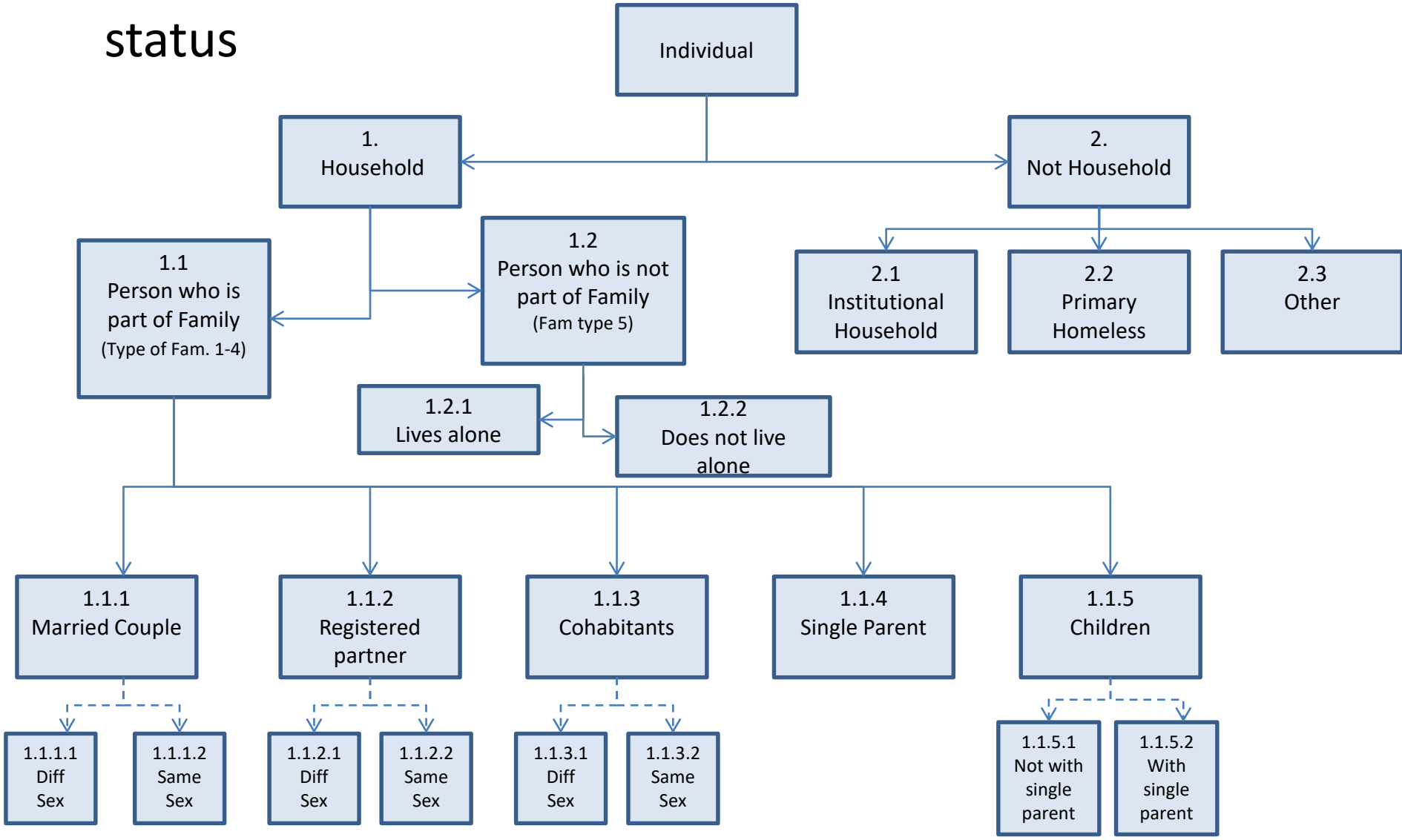
Institutions, dormitories, Age limits?

Type of Household



anders.holmberg@ssb.no Source: Statistics Sweden Census project

Household status



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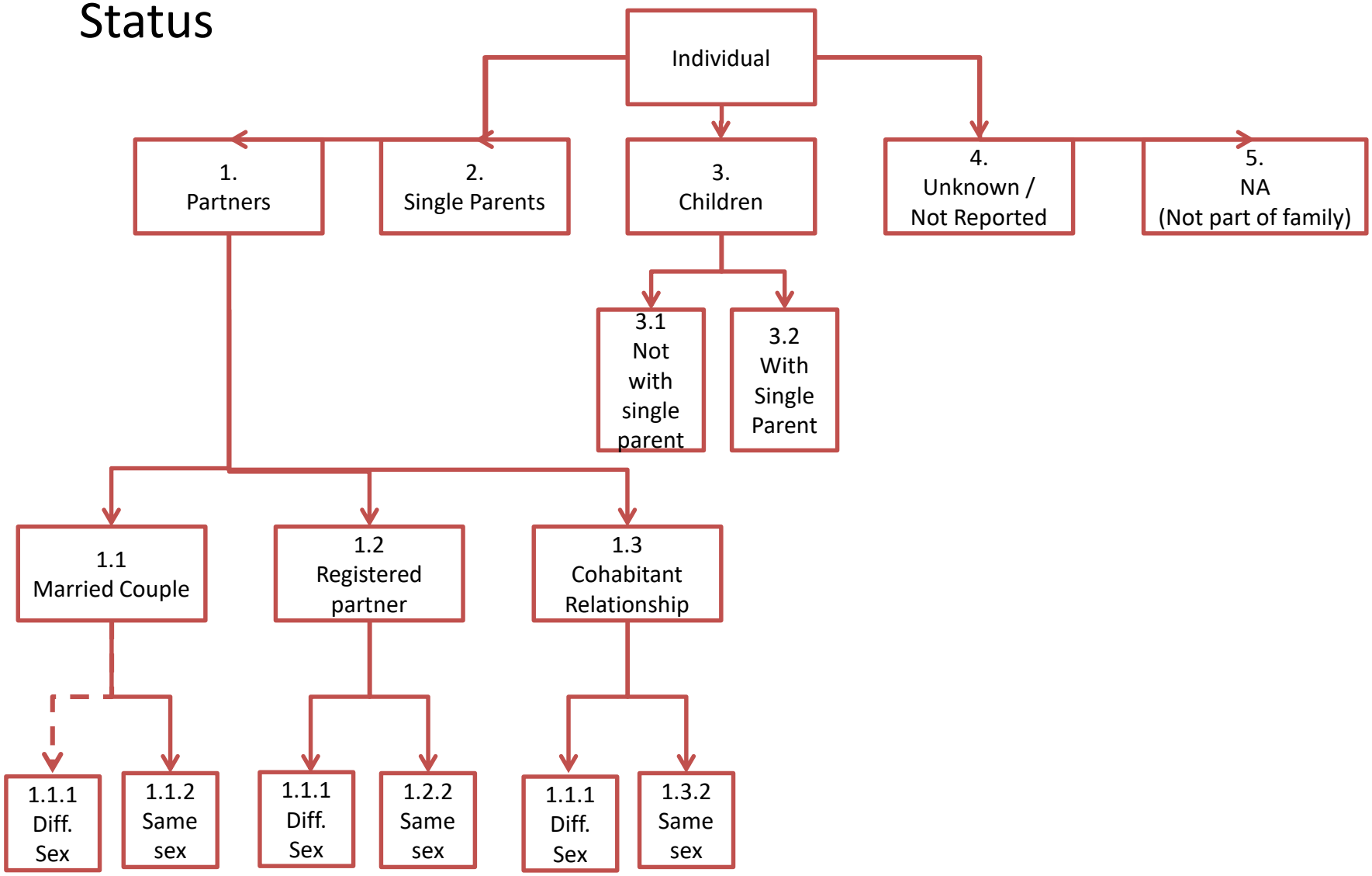
Family Status



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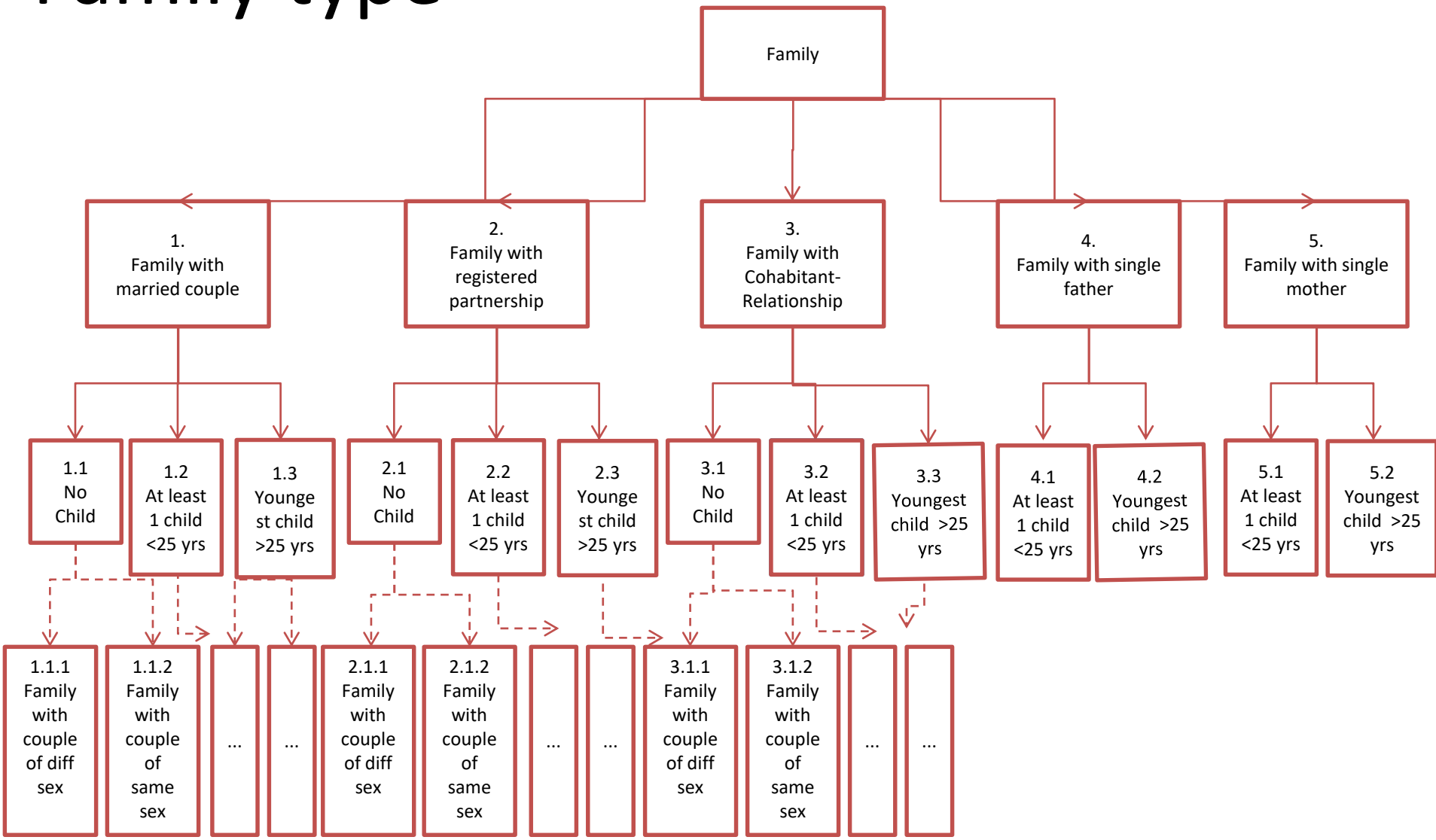
Family type



anders.holmberg@ssb.no Source: Statistics Sweden Census project

Notifications to the population register

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Definition of the census population

- Registered population (12 month criteria)
- Place of birth – A newborn children born in Sweden, is registered in the parish in which the mother was registered at the time of birth. If the mother was not registered at the time of birth, the child is registered only if the father was registered and guardian. A newborn baby, born abroad, are registered only if the mother was registered at the time of birth.

anders.holmberg@ssb.no Source: Statistics Sweden Census project

Families

- *The family nucleus is defined in the narrow sense, that is as two or more persons who belong to the same household and who are related as husband and wife, as partners in a registered partnership, as partners in a consensual union, or as parent and child.*
  - Cohabitation
  - One person is not a family;
    - how many families does a household of a married couple and a lodger consist of. 1+0?
    - The lodgers household status is ”none” but is he included in a type of private household – ”Married couple households”?

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Definitions of cohabitation

- *Two persons are considered to be partners in a 'consensual union' when they*
  - *belong to the same household*
  - *have a marriage-like relationship with each other*
  - *are not married to or in a registered partnership with each other.*
- Sex and age critieria ?

(Assumptions set to minimize misclassification errors)

anders.holmberg@ssb.no Source: Statistics Sweden Census project

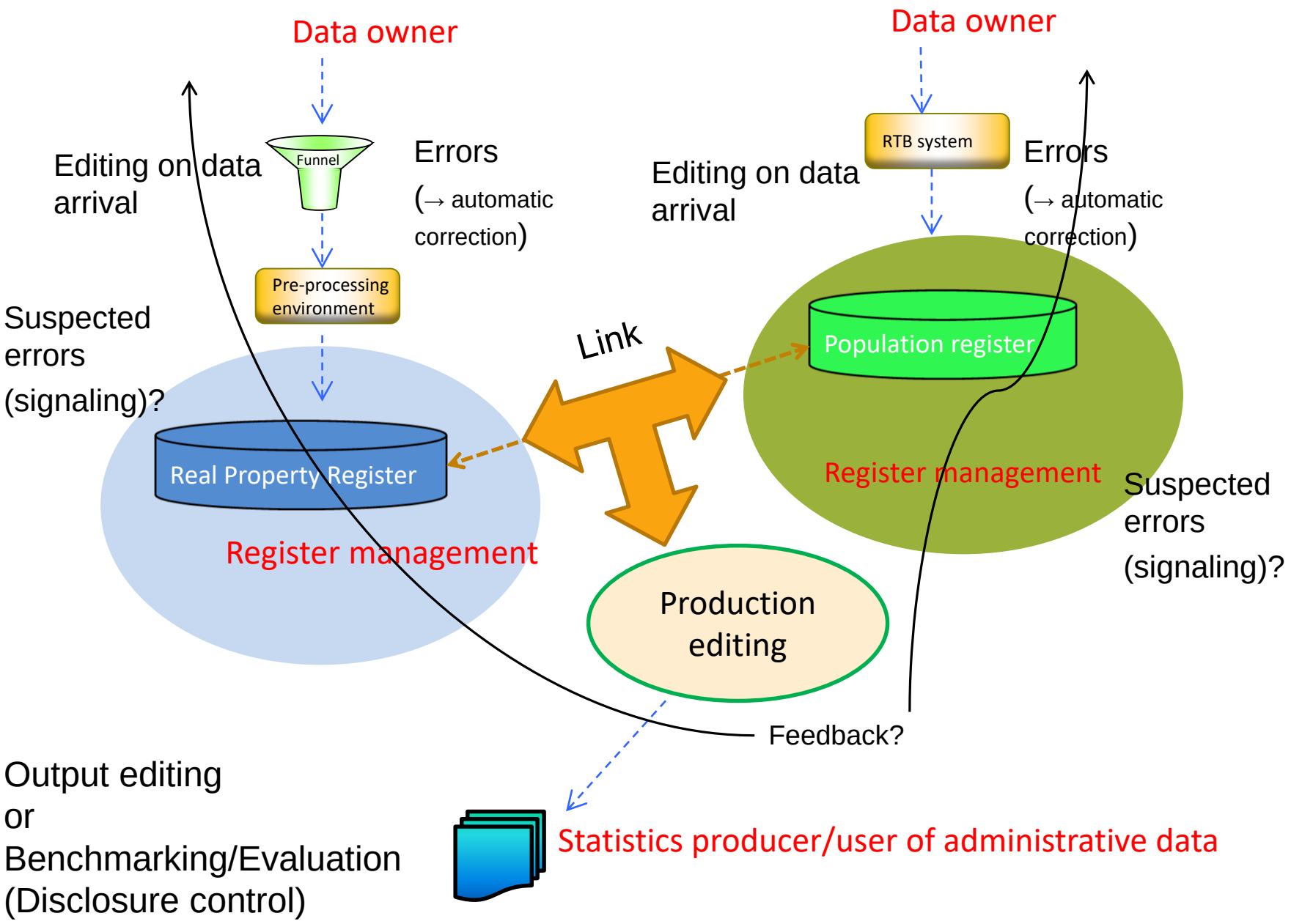
A selection of concerns

- ALL of the traditional error sources in surveys are present!?
- Many different authorities are involved
- In Sweden: 290 different municipalities and about 2 million real estate owners has to be informed and willing to provide information.
- Different actualities in the registers.

A selection of concerns

- SWE: Different input (processes) for one- and two-dwelling buildings and multi-dwelling buildings.
- Both real property owners, residents and municipalities are respondents, what are their incentives?
- Relevance of some of the variables
- Large amounts of data
- The quality of the other registers ? What happens when they are joined?

Processes and Editing of the Census



What if the administrative registers do not exist?

- Can the NSO create statistical versions for census or other purposes?
- Hybrid censuses (Combining registers and ‘direct’ survey type data collections
- Investments in statistical systems

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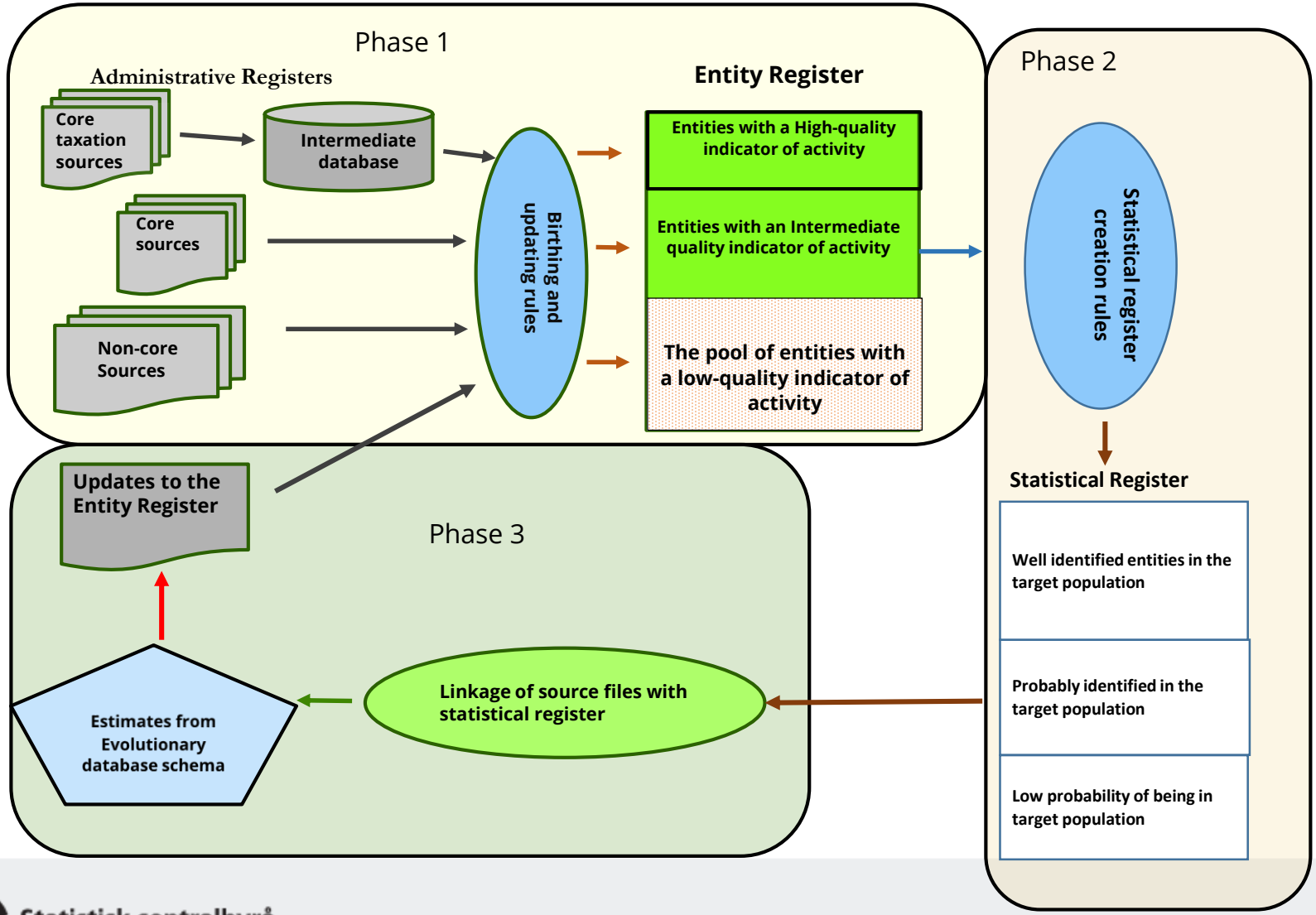
A evolutionary model for adminstrative data in statistics

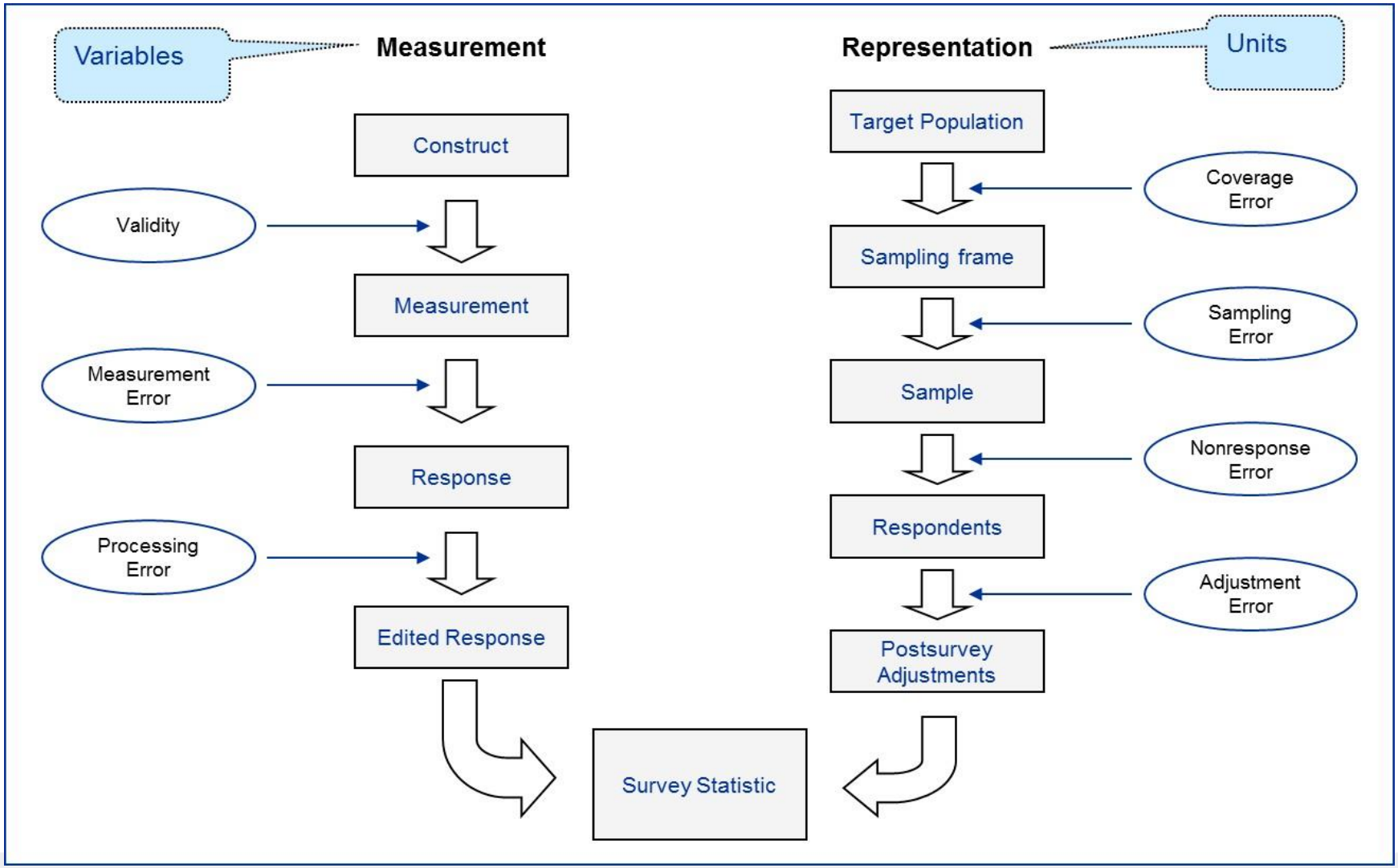


Quality aspects of a census based on administrative data

- Relevance, Accuracy, Timeliness, Punctuality, Accessibility, Clarity, Comparability and Coherence
- How to assure quality?
- How to measure quality ?
- How to enable continuous improvement?

Total survey error framework

(Groves et al. 2004, Fig. 2.5)



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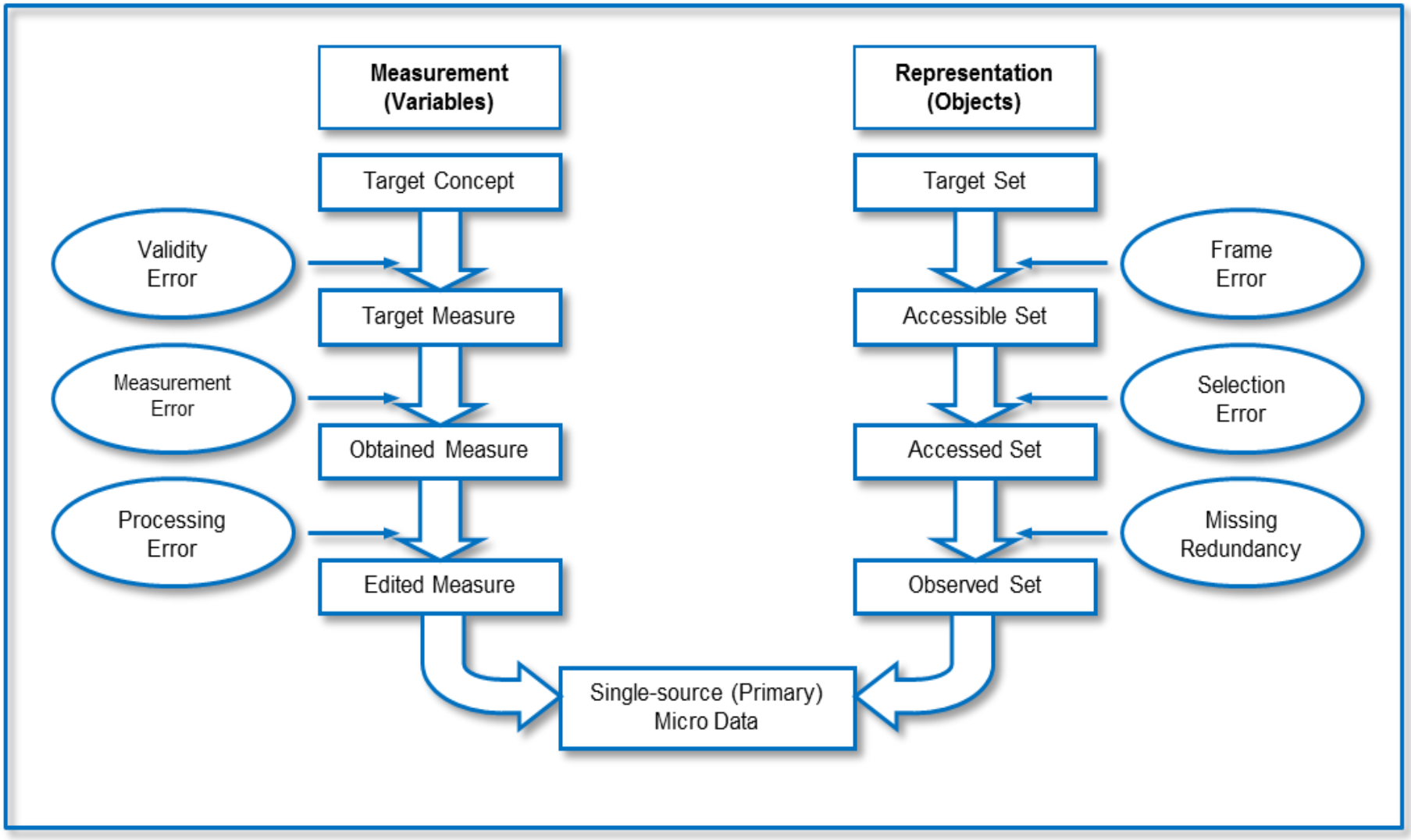
Two-phase life-cycle (I): primary source data (Zhang, 2012)



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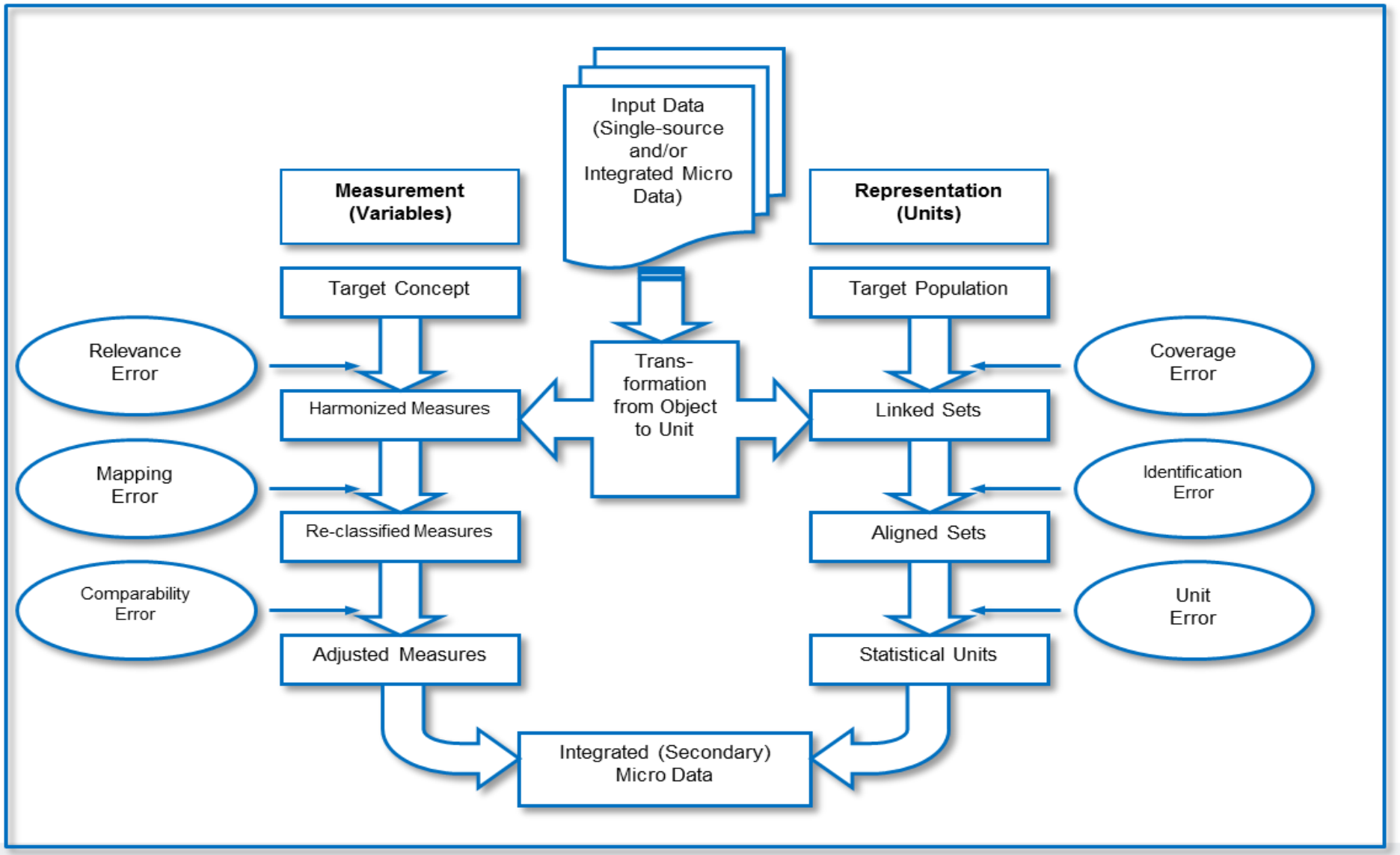
Two-phase life-cycle (II): secondary integrated data



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Quality reporting in Eurocensus: Accuracy

- Accuracy: Composition of data sources

The data sources used for census purposes often have more than one origin. Data from two registers might be merged or data obtained by means of a field enumeration might be linked to data available in a register.

'Record linkage' means the process of merging information from different data sources by comparing the records for the individual statistical units and merging the information for each statistical unit where the unit to which the records refer is the same.

1. How well do the published data reflect the 'true' size of the population?

2. How much are the published data based on real observations?

3. How many of the records in the data source have been used for the census?

Quality reporting: an assessment of coverage and of the imputed and deleted data records.

1. The match between the estimated target population (the best estimate for the 'true' population) and the census population (mostly affected by coverage errors),

2. The effect of record imputations and deletions

3. The effect of any method or technique that adjusts the weights of data records to obtain a better fit of the census population to the target population and/or to increase the plausibility and consistency of the data,

4. The effect of frames that are samples.

Quality reporting Accuracy: an assessment of coverage

Coverage assessment means a study of the difference between a specified target population and its census population.

‘Post-enumeration survey’ means a survey conducted shortly after the enumeration for coverage and content assessment purposes.

‘Under-coverage’ means the set of all statistical units that belong to a specified target population, but are not included in the corresponding census population.

‘Over-coverage’ means the set of all statistical units that are included in a census population used to report on a specified target population without belonging to that target population.

Quality reporting Accuracy: an assessment of the imputed and deleted data records. Attributing weights $\neq 1$ to data records

Weights different from 1 can be set for the following reasons.

Records are imputed not physically, but only virtually (e.g. a record is weighted by 2 to substitute for an invalid record, which is weighted 0)

NSO can scale some data up or down by systematically increasing or decreasing the weights of parts of the census population

Methods that adjust the weights of data records to improve the plausibility and/or consistency of the data are used.

Quality reporting Accuracy : QUANTITATIVE INFORMATION ON THE TOPICS

Reasons for data records where information on a topics is missing

The data source is a composed data source. It is the result of record linkage from original data sources, some of which might not cover the complete census population.

Unit no-information might have lead to data not being available

There might have been *item no-information* for that topic

Quality assessment

- Aim is to assess quality of both input to and output from a register based sources
- Questions that need to be answered: How to
  - derive data on variables not available in registers?
  - distinguish between no data and missing data in registers?
  - resolve discrepancies between sample data and (derived) register data?

A key issue: reconciliation

- Reconciliation through renewed contact via telephone with respondents will be used, but ...
- ...other methods, e.g., models and rules, will have to be used
- Nonresponse in the evaluation survey causes additional problems

Errors in registers categorical variables

	Register		
Evaluation source	Category 1	Category 2	Sum
Category 1			$N1\bullet$
Category 2			$N2\bullet$
Sum	$N\bullet1$	$N\bullet2$	

The proportion of **gross error** in a category is given by $GE_j = (N\bullet j + Nj\bullet - 2Njj)/N\bullet j$ where Njj is the number of objects of category j in both the evaluation and register. $N\bullet j$ and $Nj\bullet$ indicate summation over rows and columns, respectively.

Evaluating base register quality: an example from 2011 deciding on a derived a variable.

- Register variable based on operational definition of Cohabitant (person living in consensual union)
- Sample data from the LFS

	According to register ,model based on <15 years difference	
According to LFS	Cohabitant	Not Cohabitant
Cohabitant	19.7 %	3.3 %
Not Cohabitant	3.5 %	73.4 %

Net error 3.5 -3.3 = **0.2 %**

Gross error 3.3 + 3.5 = **6.8 %**

Evaluating base register quality: an example from 2011 deciding on a derived a variable.

- The same backgeound data, but only for people
  - Resident in large cities (according to register)
  - 15 – 25 years old

	According to register ,model based on <15 years difference	
According to LFS	Cohabitant	Not Cohabitant
Cohabitant	11.0 %	5.0 %
Not Cohabitant	9.5 %	74.5 %

Net error 9.5 -5.0 **= 4.5 %**

Gross error 9.5 +5.0 **= 14.5 %**

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Evaluating base register quality: an example from 2011 deciding on a derived a variable.

- The same data, but only for people
  - Resident in large cities (according to register)
  - 26 – 35 years old

	According to register ,model based on <15 years difference	
According to LFS	Cohabitant	Not Cohabitant
Cohabitant	29.8 %	7.1 %
Not Cohabitant	8.0 %	55.1 %

Net error 8.0 – 7.1 **= 0.9 %**

Gross error 8.0 + 7.1 **= 15.1 %**

Base register quality: An operational definition of cohabitants

Age	Column 1	2	3	4
15-25	11 %	5 %	9,5 %	74,5 %
26-35	29,8 %	7,1 %	8 %	55,1 %
36-45	21 %	4 %	3,5 %	71,5 %
46-55	14,3 %	3,9 %	2,8 %	79 %
56-65	9,8 %	2,2 %	2,7 %	85,3 %
66-74	7,9 %	1,8 %	2,1 %	88,2 %
75+	5,6 %	0	2,2 %	92,2 %
Total	17,7 %	4,3 %	5 %	73 %

Larger cities Register definition < 15 years age difference

Column 1: Cohabitant in both sources, 2: Cohabitant in LFS Not according to Base register, 3: Not Cohabitant in LFS Cohabitant in Base register, 4: Not Cohabitant in both sources.

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Statistics' Quality and Evaluations

- Missing values: their effects and how to treat it.
  - Imputation techniques or weighting techniques
- Quality Evaluation
  - EU quality requirements on the Census data
  - Data Quality (Micro and/or macro) ?
  - Production of recurrent social statistics with the register system
  - An integrated register and sample survey QC-scheme?

Swedish Census
Household statistics - an evaluation study

- To evaluate the quality of
  - the Dwelling register
  - the registration of people on dwelling
  - their combined effect on household statistics
- If possible, provide information that can be used to improve the quality of census statistics
- Sample survey in order so measure to what extent answers were consistent with the register information at the reference date.

Some errors: causes & consequences

Property register/ Dwelling register	**Population register**	**Error type**
Address missing	No dwelling key	Missing value
All dwellings missing/All except one dwelling missing	No dwelling key Wrong type of housing code, no questionnaire sent out	Missing value Errors giving large HH-sizes
A few dwellings missing on an address	Various cases of mismatches between registers	Missing value & HH-size errors
Correct information	Classical data collection problems (measurement/ response process, data processing)	In most cases, Missing values

The setup of the evaluation study

- Select sample of individuals
- Collect vital household data for sampled individuals
- Compare sample and register data at the individual level and try to resolve true circumstances
- Estimation of parameters of interest

Questionnaire and data collection

- Limited amount of questions regarding
  - Address and no. of dwellings at the address
  - The dwelling in which respondent lives
  - Other people living in the same dwelling
- Questionnaire distributed via mail
- Data capture via web or self-administered questionnaire
- Follow-up of non-respondents via mail and telephone

Issues in design of an evaluation

- Collecting data on household status with a self administered questionnaire (Web/paper) is not straightforward!
- Nonresponse in the evaluation survey is problematic!
  - Many possible causes, which call for different actions
- Reconciling observed discrepancies requires large resources
  - The amount of possible combinations in error is large and requires manual handling

Sampling design

- Stratified SRS, n=15,000, 108 strata, defined by register-data on
  - Existence of Dwelling ID-key
  - Residence Municipality (grouped)
  - Age class
  - Type of dwelling
  - Number of families in dwelling

Sample size allocation

- Oversampling of persons from strata for which dwelling ID-key is missing (1/3), as they
  - will cause errors in register-based production
  - are more likely to be nonrespondents in the evaluation study
- Proportional allocation, with upper and lower boundaries, for remaining strata

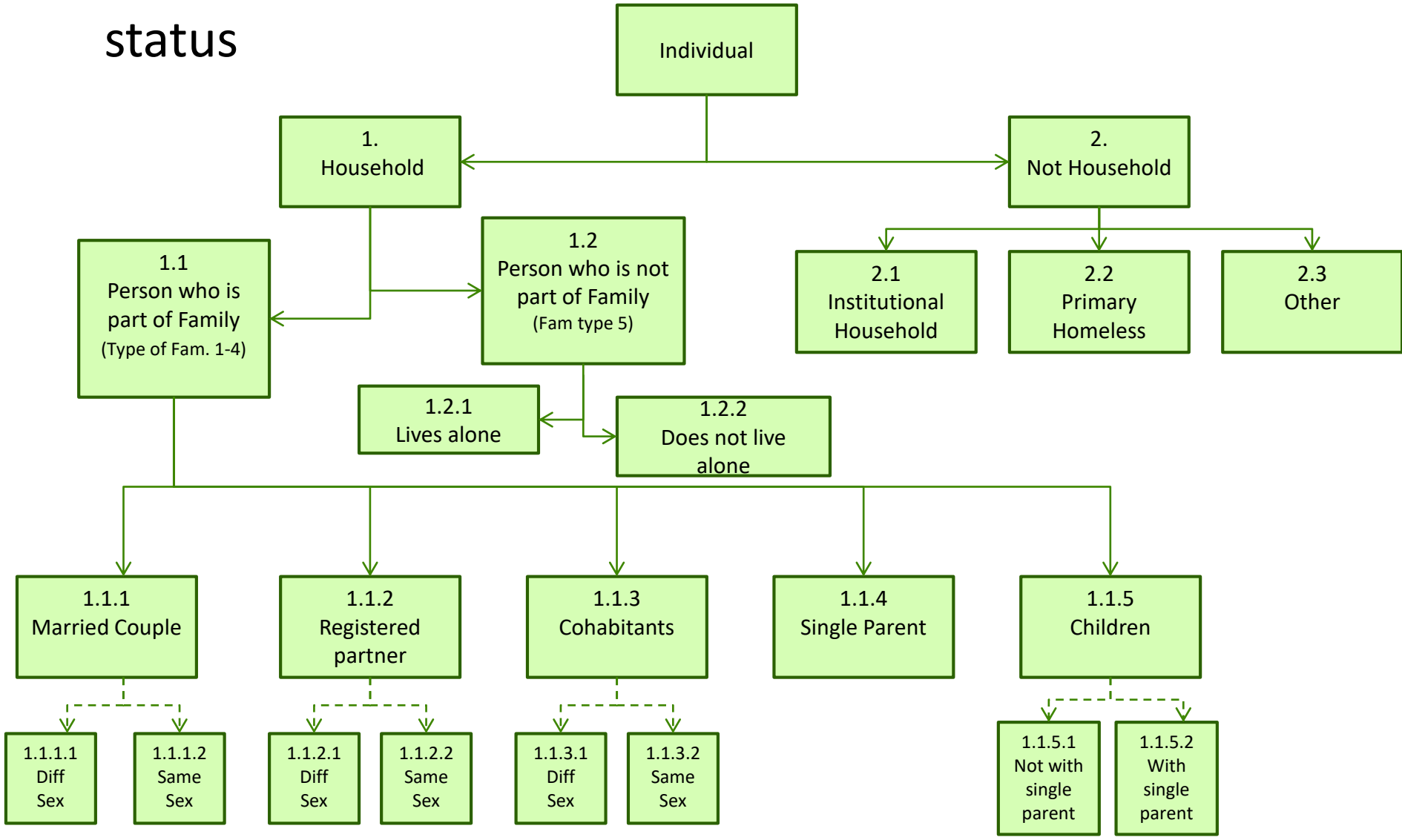
Data collection

- First invitation by mail to respond by web only. Second invitation by mail to those not yet responding, including a printed copy of the questionnaire. Finally a third possibility to respond, by a telephone interview.
- Data collected between January and May 2012.
- Response rate of 62 percent (65 percent weighted). More than 40 percent response rate in all strata.
- If household size or household type differed between survey and register: re-contact by telephone in order to establish the “true” value. Almost 3000 individuals contacted, 85 percent of the 3000 agreed to confirm.

Some important parameters

- Proportions
  - Persons linked to (partly) incorrect address
  - Persons/households living in a rented dwelling
- Gross and net errors (using sample and register data)
  - Persons after household status
  - Private households after type of household

Household status



Some results based on the evaluation study

Variables; household size, household type, type of ownership

- Gross error: data quality for different types of analysis
- Net error: data quality for aggregates

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Some results based on the evaluation study (Werner 2014)

Estimated no. of hhs in r and c :

$$\hat{Y}_{rc} = \frac{X_{.c}}{\hat{X}_{.c}} \sum_{h=1}^{H} \frac{N_h}{n_h} \sum_{k \in rc} y_k$$

$X_{.c}$ 'known' Hhs in class c from census

$\hat{X}_{.c}$ estimated no. Hhs in c from census

$y_k = 1/a_k$, a_k # persons ≥18 yrs in hh from $ev\ Surv$

$x_k = 1/b_k$, b_k # *persons ≥18 yrs in hh from* $Census$

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Some results based on the evaluation study

92,1 % (± 0,8 %) of hhs have correct size (# inhabitants).

Errors higher for class 6-10 and 11+

(5-10 46% net error 36” +/- 8”).

Net error estimates indicate show 1 and 2 person hhs are underestimated by 10.3 and 9.3 % respectively.

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Some results based on the evaluation study

The results indicate that the number of smaller households are underestimated and the number of larger households are overestimated by the register.

	1	2	3	4	5	6–10	11+	Total
Total	-	-	0	0	+	+	+	-
Stockholm	-	-	0	0	0	+	+	-
Gothenburg	-	-	0	0	+	+	+	-
Malmo	-	-	0	0	0	+	+	-
Municip. > 70”	-	-	0	0	0	+	+	-
Smaller Municip	-	-	+	0	0	+	+	-

Evaluation: Which source is most reliable?

Variable	# Miss-matches	# Where correct information was collected	Register information correct	Questionnaire information correct	Other informa-tion correct
# inhabi-tants	2 410	2 034	239	1 653	142
HH-type	2 251	1 881	469	1 205	207
Total	2 817	2 394	–	–	–

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Other evaluations done in the Swedish census

Evaluation of dwelling ownerships

Comparison of Household counts depending on definitions.

Comparison of the dwelling register and a survey of available rental apartments

Quality treatments in the census

- Imputation?
  - No useful auxiliary information to aid imputation, since no reliable household information existed from another source
- Matching persons without dwelling keys to apartments?
  - Assuming that the relationship between size of apartment and size of household is similar for individuals with and without registered dwelling keys would have yielded doubtful quality of the result: 48 percent of the persons with missing dwelling keys had addresses in buildings with no apartments according to the Real Property Register.
- Adjustment for missing data was not required by Eurostat

The number of persons with missing identification key has decreased (2,3% in 2017).

To use the LFS to assess Quality in a Census system?

The Census:

- Straightforward goal and delivery
- Once done the results are what they are
- The population of individuals fairly well known
- Only some variables not known
- Requirements fairly modest

System of social statistics

- More detailed statistics
- Flexible output, a core not decided,
- User Requirements
- Household population, definitions, uses, models
- Maintenance over time
- Microdata Quality

Sketching an Integrated Register and Sample Survey QC-scheme

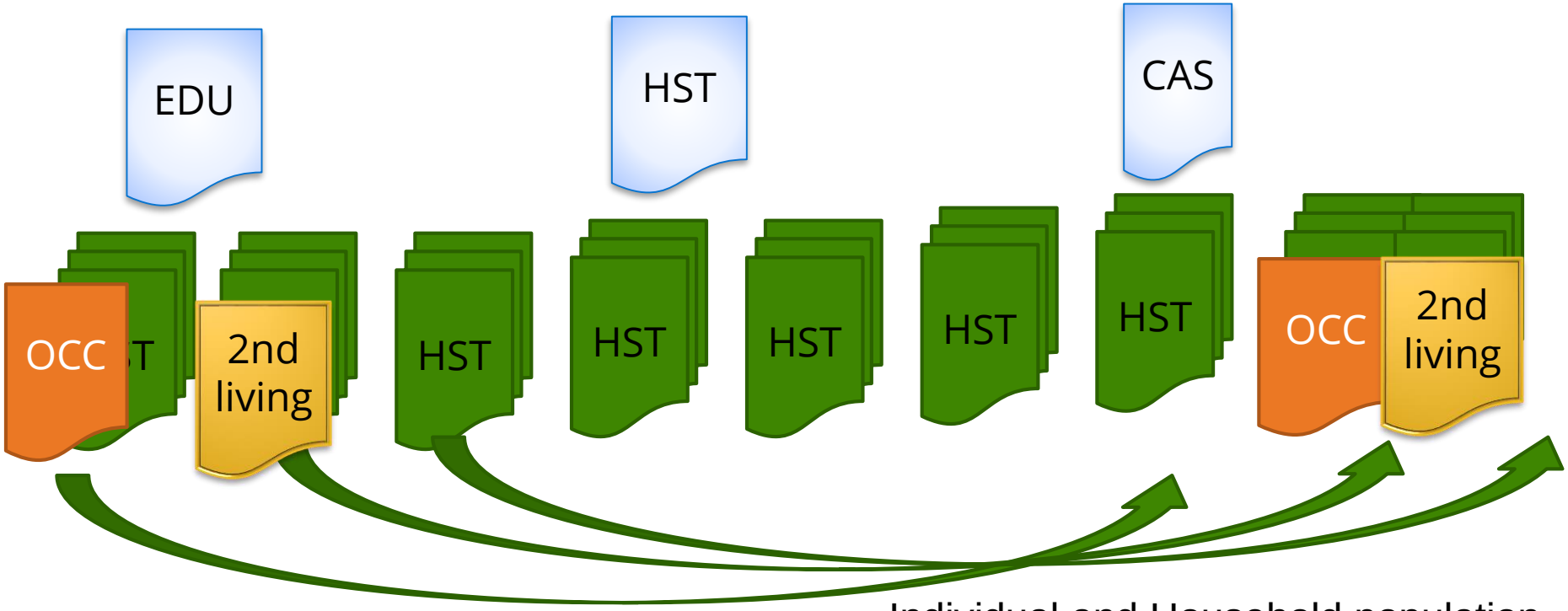
Recurrent and inbuilt system to maintain populations and quality assure standardised core variables in a national statistics production system.

How to cope with the Housing statistics and Property and Building population?

Other sources: E.g. Smart meters,

Cross checks with other registers?

Sketching an Integrated Register and Sample Survey QC-scheme



The LFS-panels, A tailored complement survey, geographic rotation? Subpopulations? Use of other surveys and sources. Test of assumptions as well , frequency is a function NSOs quality dedication.

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