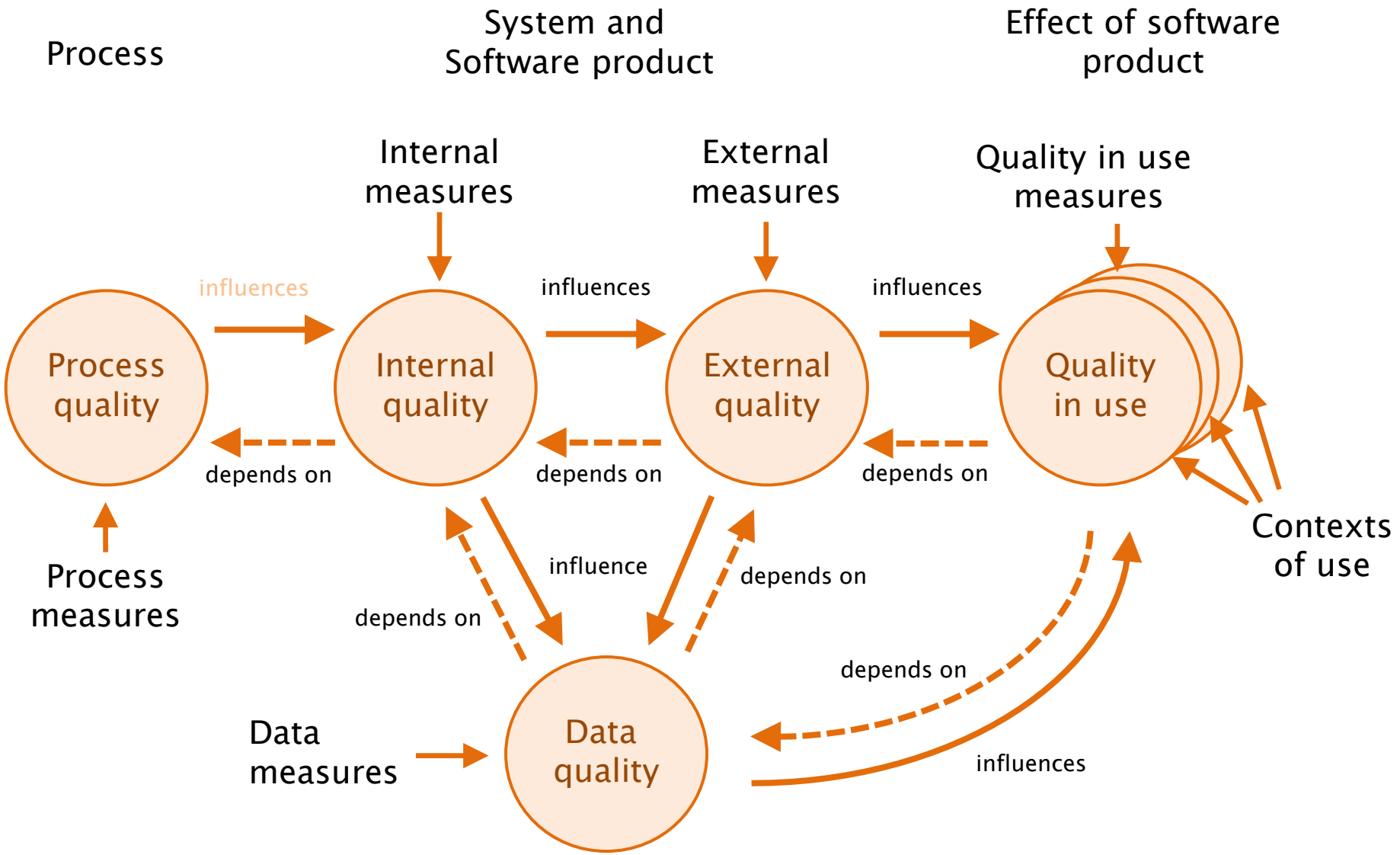
Data Quality

Data Management and Visualization

SOftEng
http://softeng.polito.it

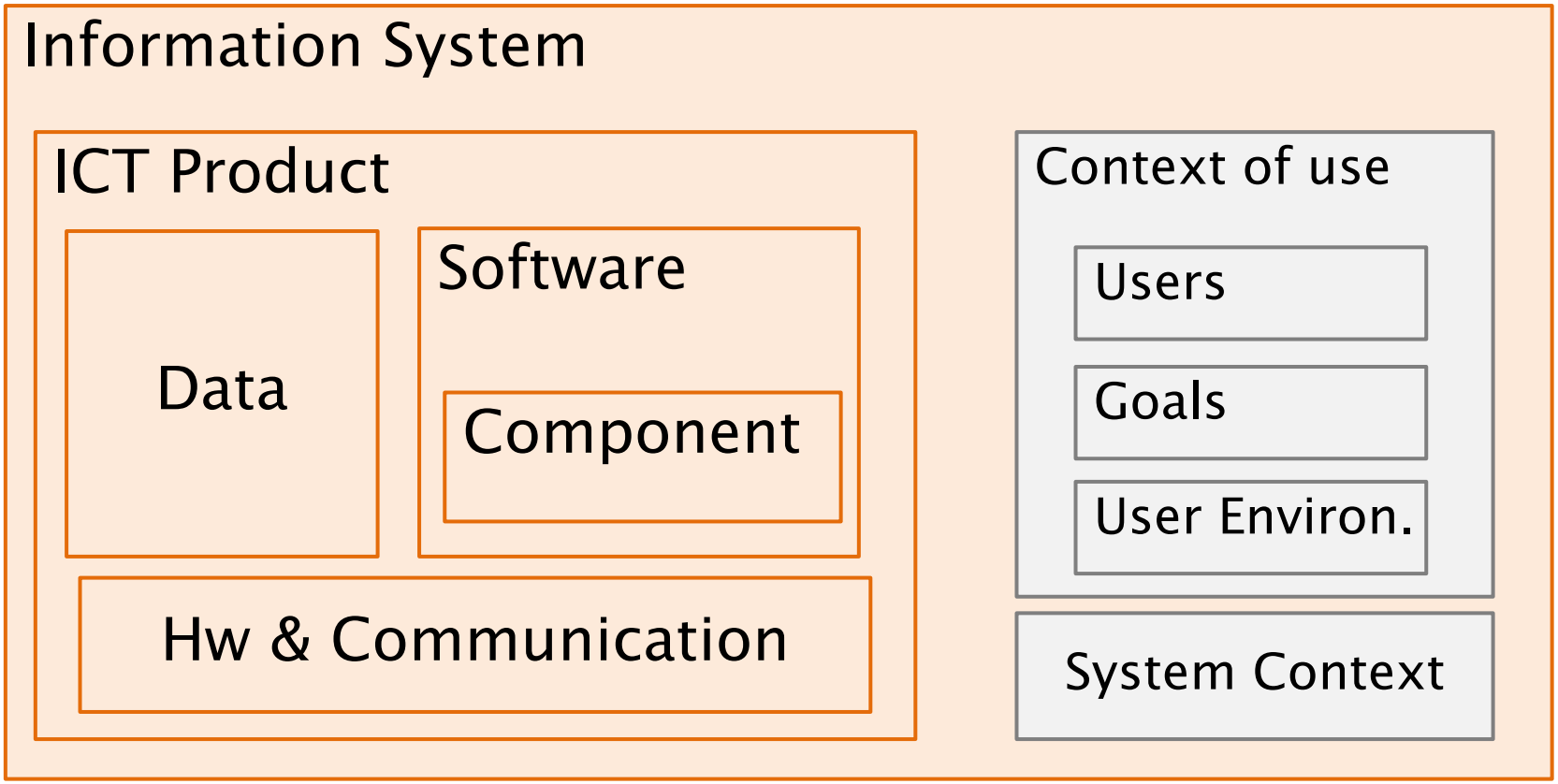
Licensing Note

Software Qualities

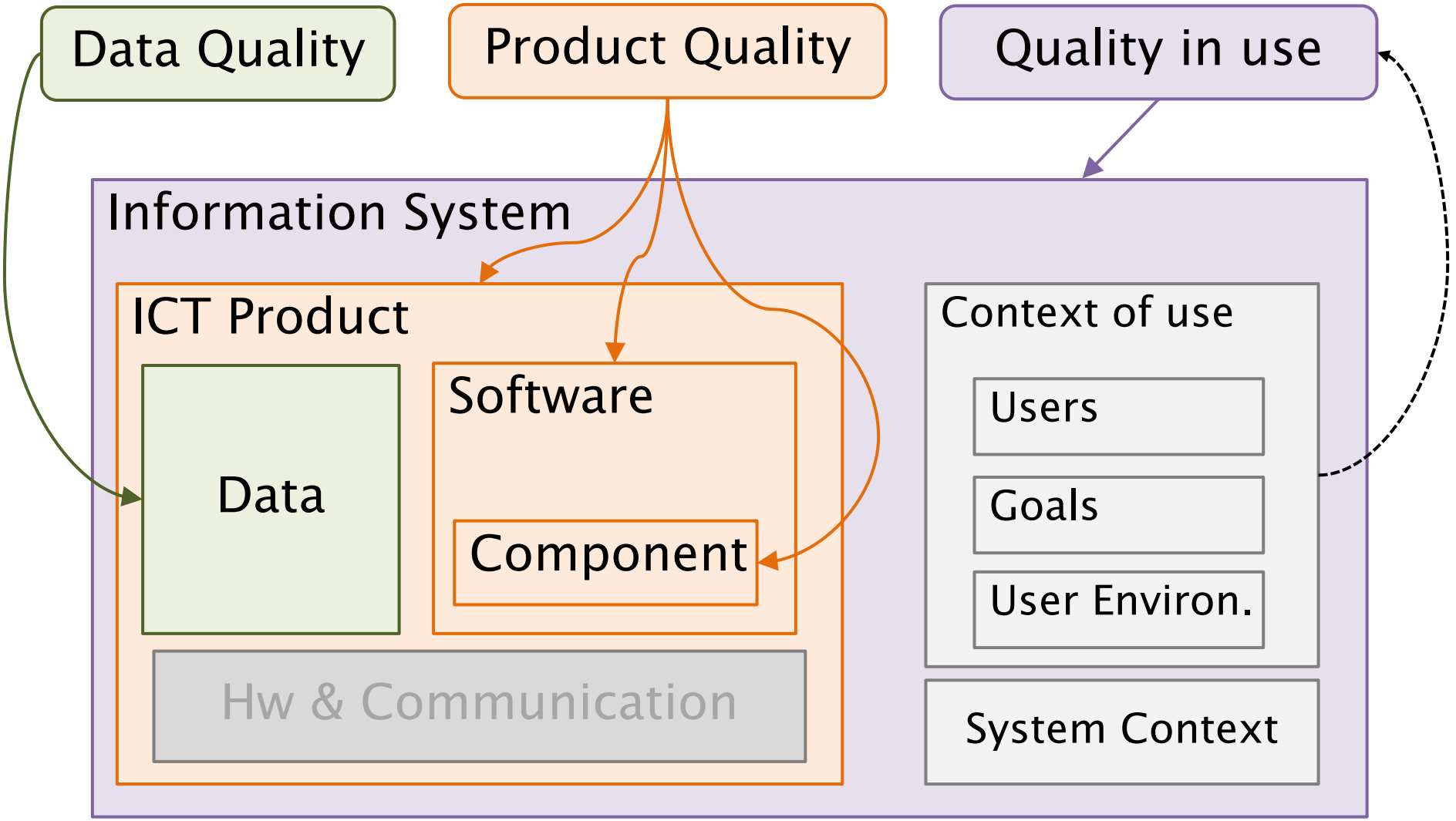


Adapted from ISO/IEC 25020

Target entities



Target entities vs. Q. Models



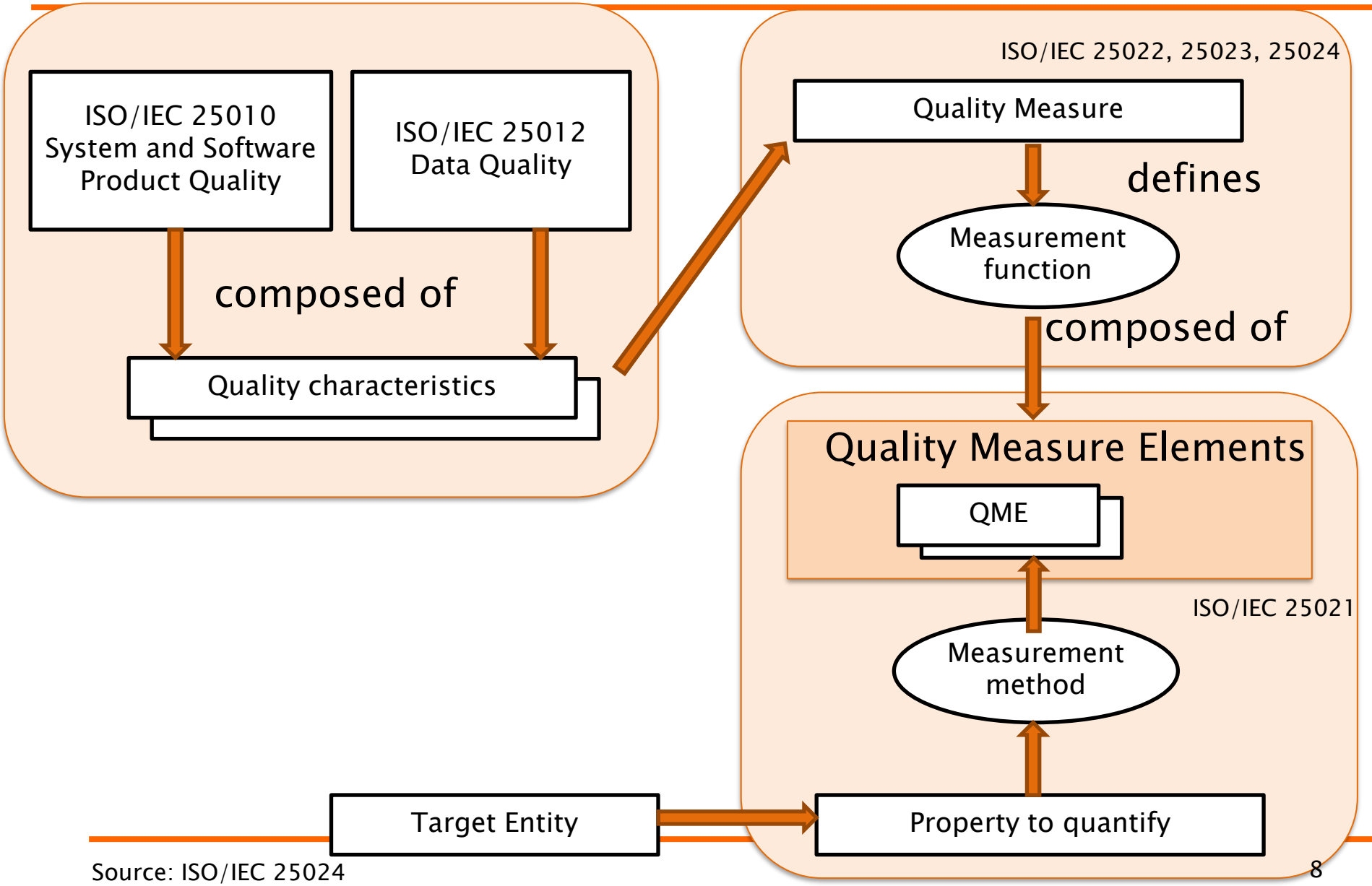
Software Product Quality

- ISO/IEC 9126: Issued 1991, revised 2001
  - Being retired

- ISO/IEC 250xx - **SQuaRE**
  - Software product Quality Requirements and Evaluation
  - Family of standards
    - in development

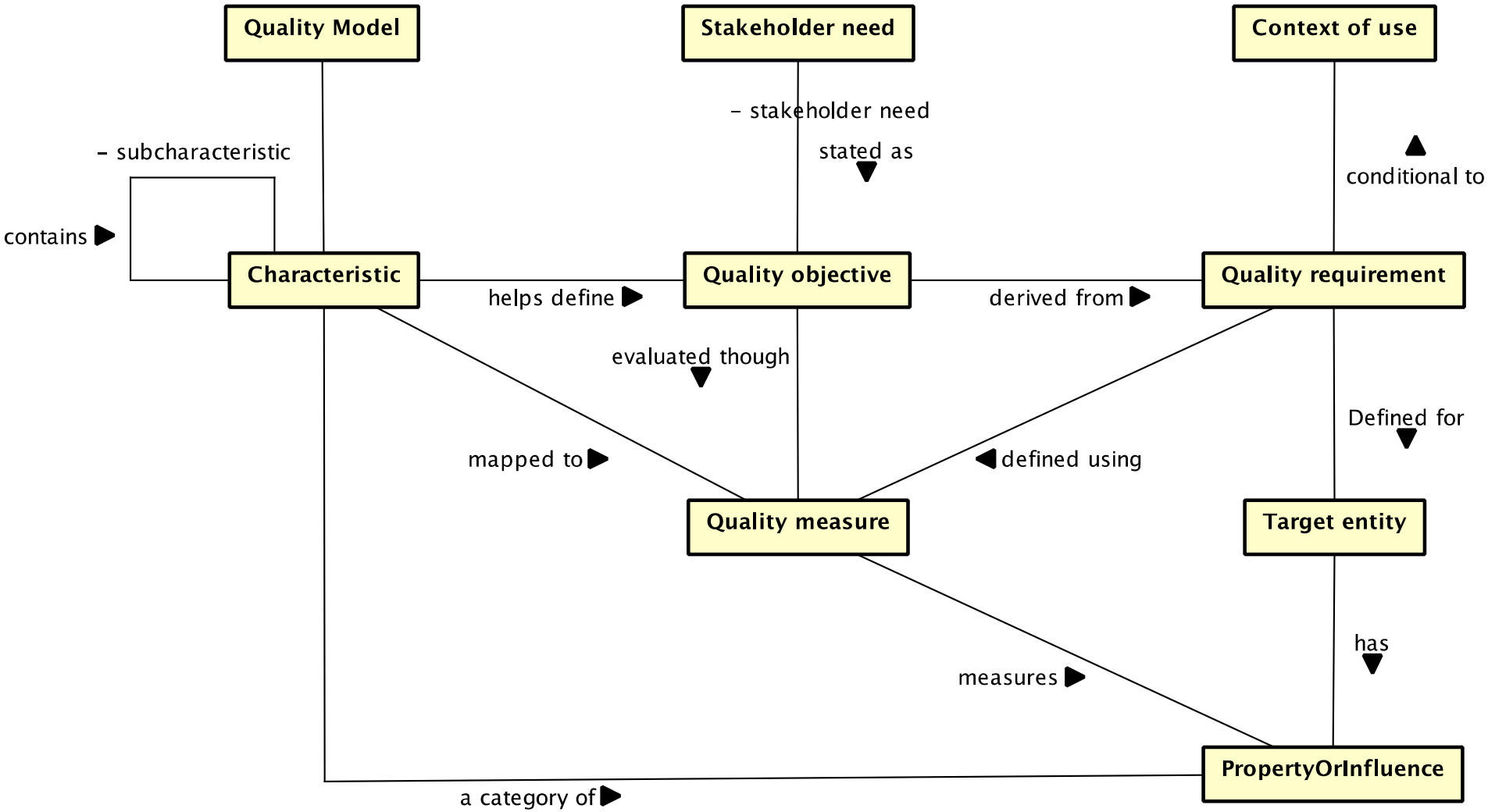
ISO SQuaRE – Standard Family

Relationships among standards



Source: ISO/IEC 25024

Quality conceptual model

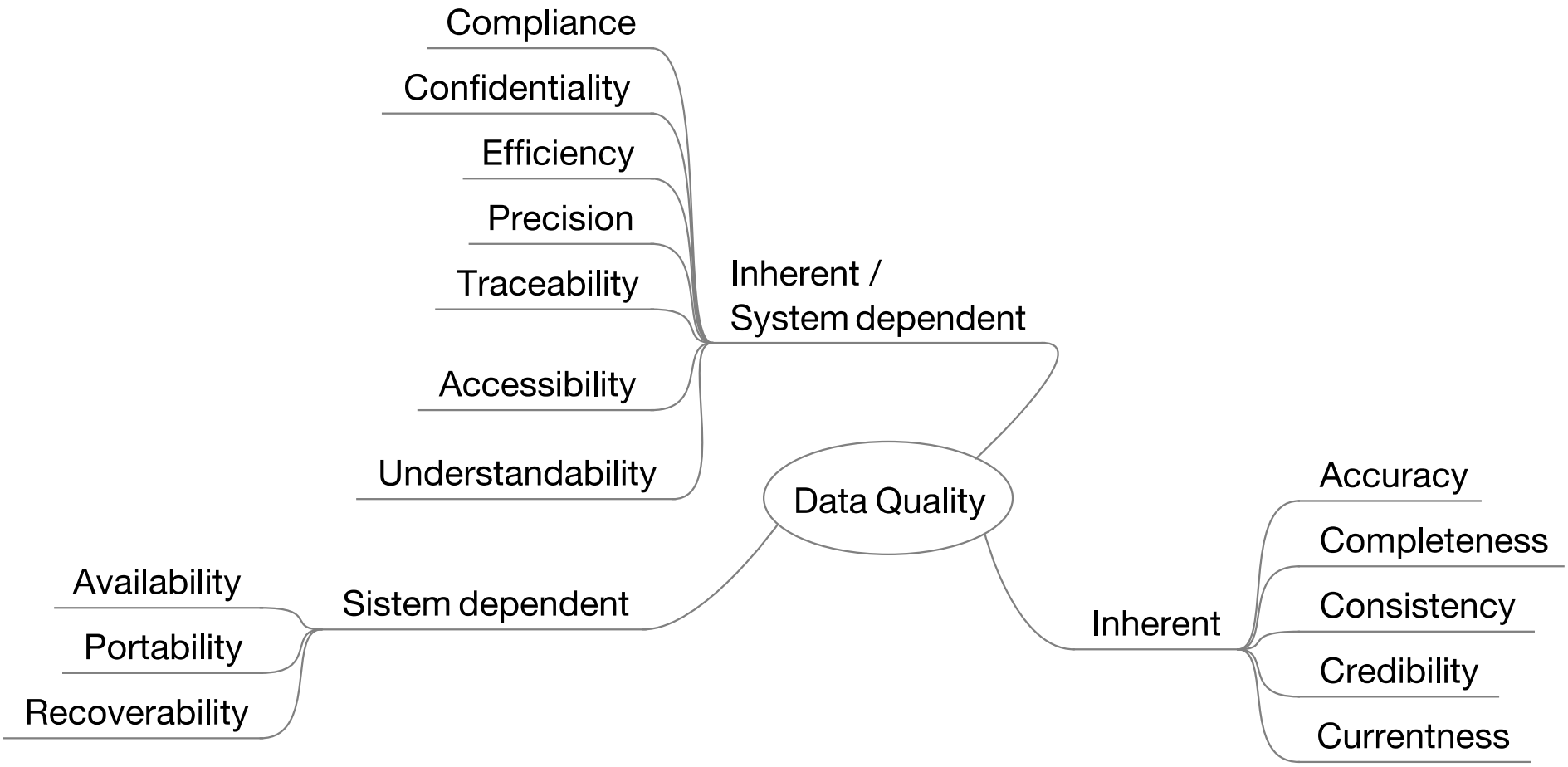


Model structure

- Characteristic
  - Main aspects, e.g., usability
- Sub-Characteristic
  - Specific aspects, e.g. accessibility
- Measure
  - Measurement function to evaluate a specific (sub)-characteristic
- Measure element
  - Fundamental

Data Quality

Data Quality Model



Quality characteristics

Inherent: facts

- Accuracy
- Completeness
- Consistency
- Currency
- Credibility

- Accessibility
- Compliance
- Confidentiality
- Efficiency
- Understandability
- Precision
- Traceability

- Availability
- Portability
- Recoverability

System dependent: artefacts

Quality characteristics

- **Accuracy**
- **Completeness**
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- **Credibility**

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- Compliance
- Confidentiality
- Efficiency
- **Understandability**
- **Precision**
- Traceability

- Availability
- Portability
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Accuracy

- Correspondence between data and reality
  - Syntactic
    - It belongs to a set of validated information
  - Semantic
    - The meaning (the content) corresponds to the reality

Open or Closed World?

- Closed World (CWA):
  - The knowledge represented in the data (and its schema) is complete
  - E.g., if a code appears in the list of valid codes it is correct, otherwise it is wrong
- Open World (OWA):
  - The knowledge represented in the data is (knowingly) incomplete
  - E.g., if a code appears in the list of valid codes it is correct, otherwise it is not possible to tell for sure

CWA – Accuracy: Genomics

- Human genes are known and coded, each has a predefined symbol
- Any code not included in those predefined represents a syntactic accuracy error
- E.g. code '**SEPT2**'(Septin-2) when imported into  is automatically turned into 'September 2'

OWA – Accuracy

How to decide what is accurate?

- Rules that define what is syntactically correct
  - E.g. regular expressions
- Constraints to define what values are semantically acceptable
  - E.g. validity interval

Where do rules come from?

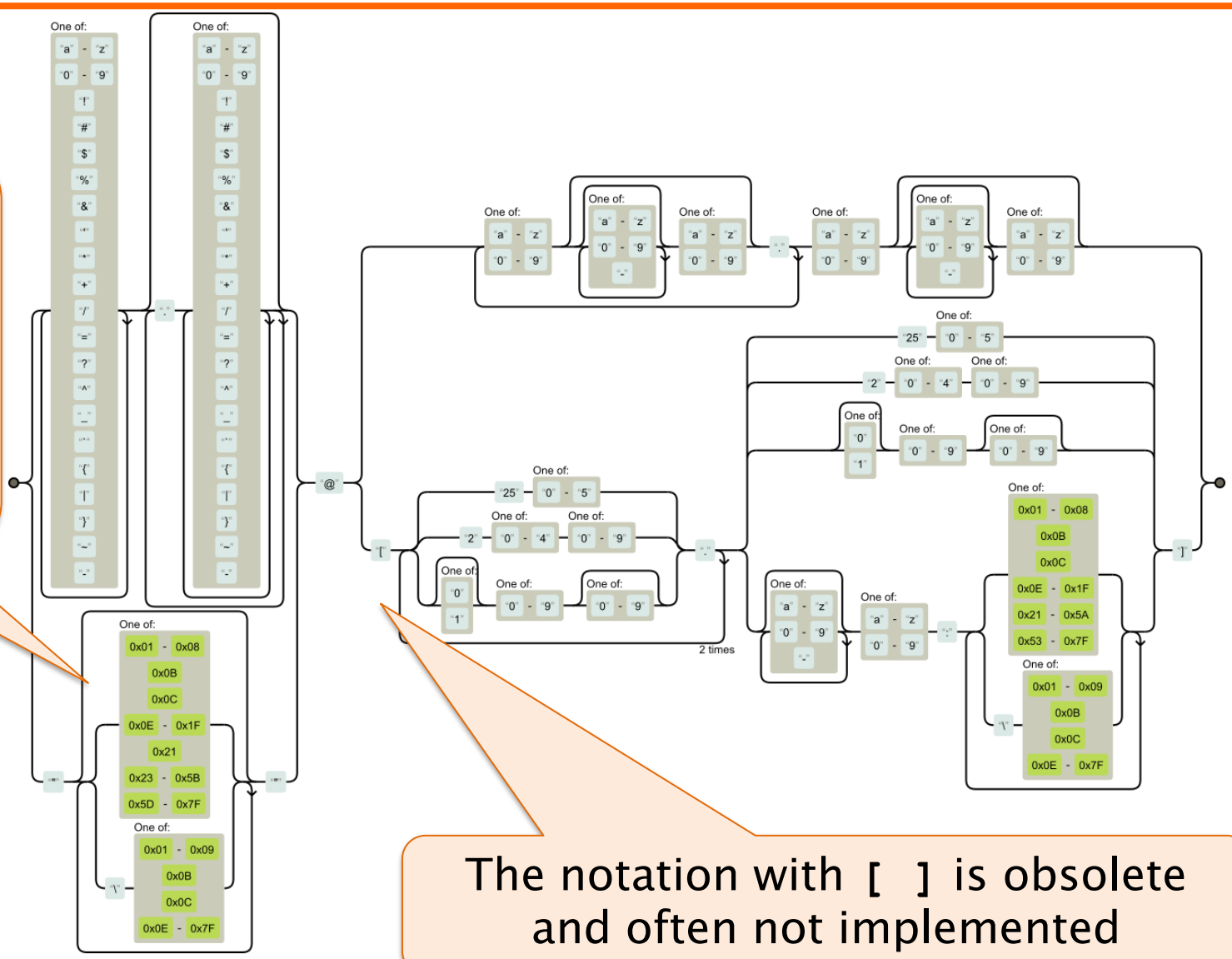
- Standard
- Domain knowledge
- Similar data
- Past data

OWA: Email per RFC-5322

```
\A(?:[a-z0-9!#$%&'*+/=?^_`{|}~-]+(?:\.[a-z0-
9!#$%&'*+/=?^_`{|}~-]+)*
  |  "(?:[\x01-\x08\x0b\x0c\x0e-\x1f\x21\x23-\x5b\x5d-
\x7f]
       |  \\[\x01-\x09\x0b\x0c\x0e-\x7f])*")
@ (?:(?:[a-z0-9](?:[a-z0-9-]*[a-z0-9])?\.)+[a-z0-
9](?:[a-z0-9-]*[a-z0-9])?
  |  \[(?:(?:25[0-5]|2[0-4][0-9]|[01]?[0-9][0-
9]?)\.){3}
 (?:25[0-5]|2[0-4][0-9]|[01]?[0-9][0-9]?|[a-z0-9-]*[a-
z0-9]:
           (?:[\x01-\x08\x0b\x0c\x0e-\x1f\x21-\x5a\x53-
\x7f]
           |  \\[\x01-\x09\x0b\x0c\x0e-\x7f])+)
     \])\z
```

OWA: Email per RFC-5322

Non printable characters are usually a problem for email clients



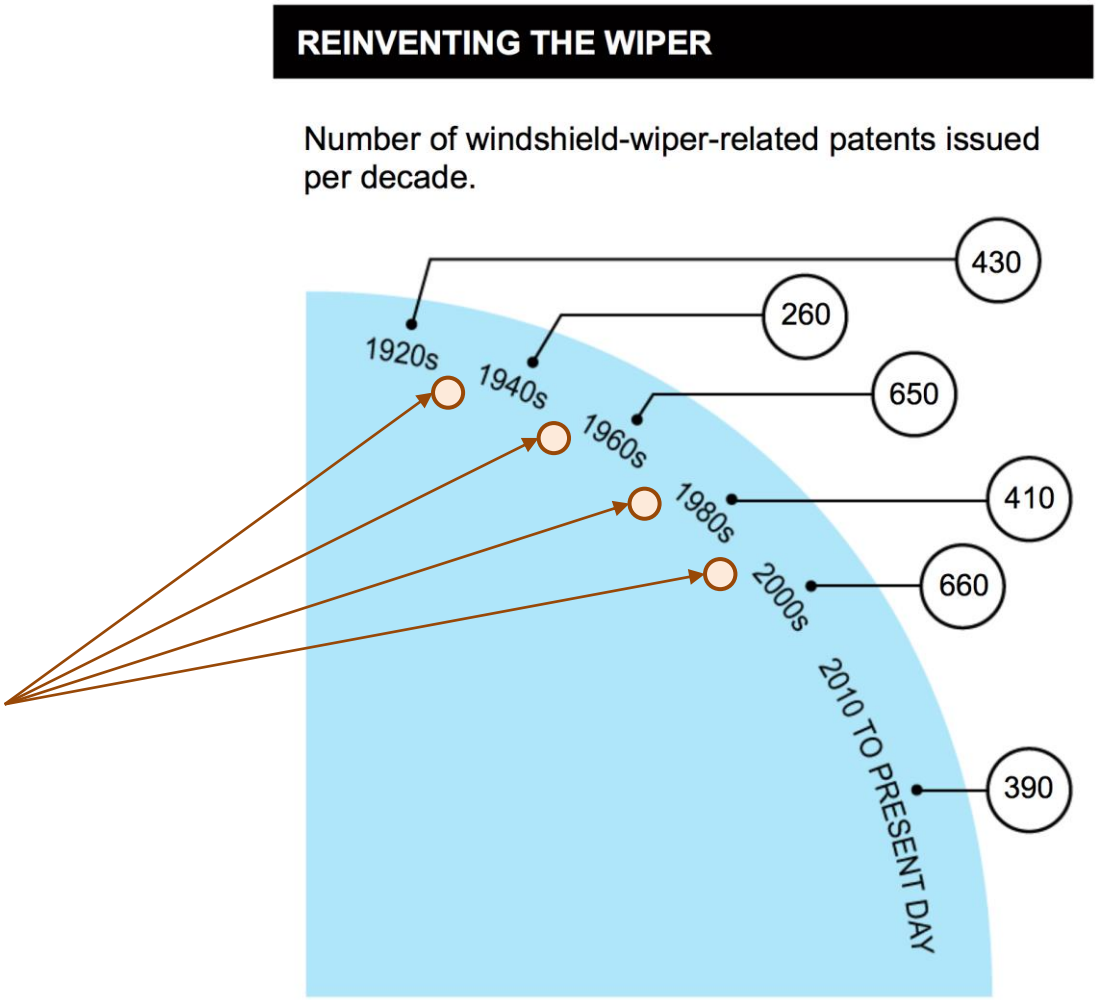
The notation with [ ] is obsolete and often not implemented

Completeness

- Computer: presence of all necessary values
  - Both to entity occurrences and to attributes of a single occurrence
  - Note: not all missing values constitute a completeness issue
- User: how much the available data is capable of satisfying the needs

Completeness

What about 1930s, 1950s, 1970s, 1990s ?



A possible hypothesis, another one considered later

Source: http://www.nytimes.com/2014/09/14/magazine/who-made-that-windshield-wiper.html?_r=0

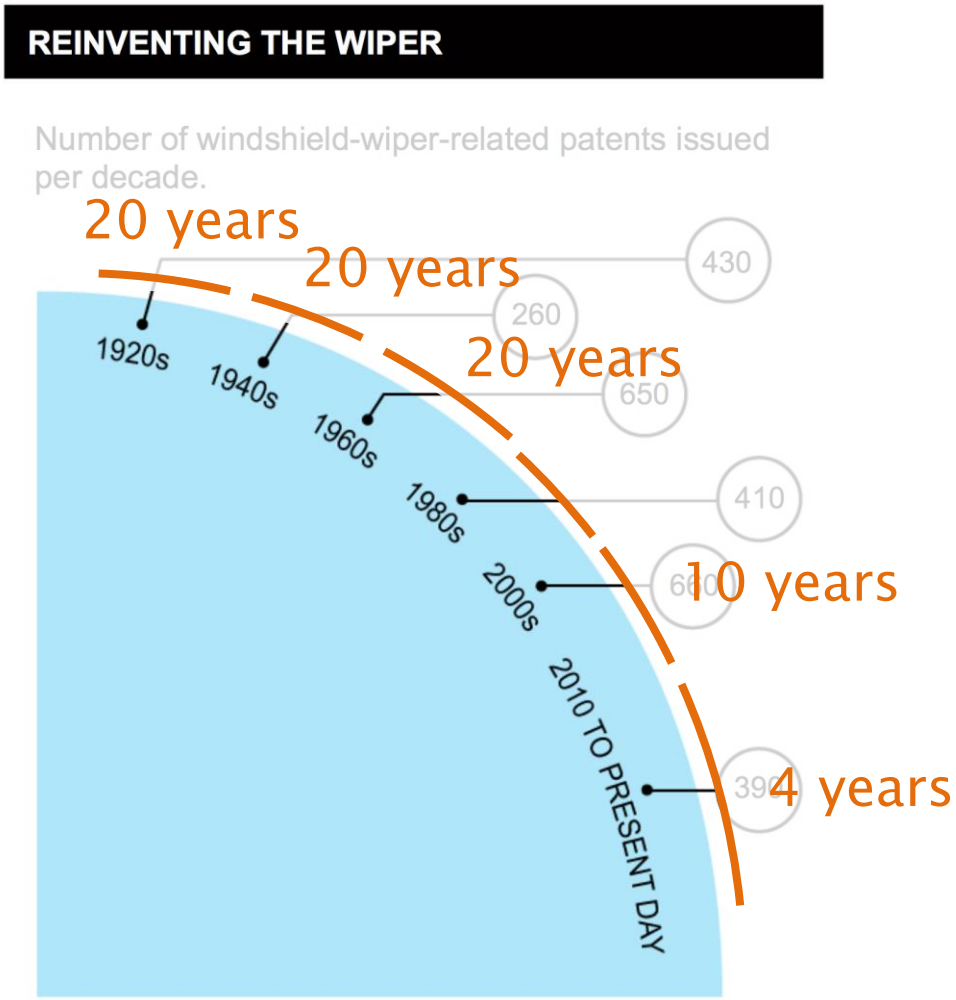
Consistency

- Absence of contradictions in the data
  - Referential integrity
    - Often guaranteed in RDBMS
  - Duplication
    - Increase the risk of inconsistency on update
  - Semantic
    - E.g. birth date must be before death date

Consistency in graph data

- Values in a series of data encoded with visual attributes must be comparable
  - Consistent aggregation level
  - Consistent measurement method
  - Consistent target entities

Aggregation level



Count on of events on periods of different length are not comparable

A possible hypothesis, another one considered earlier

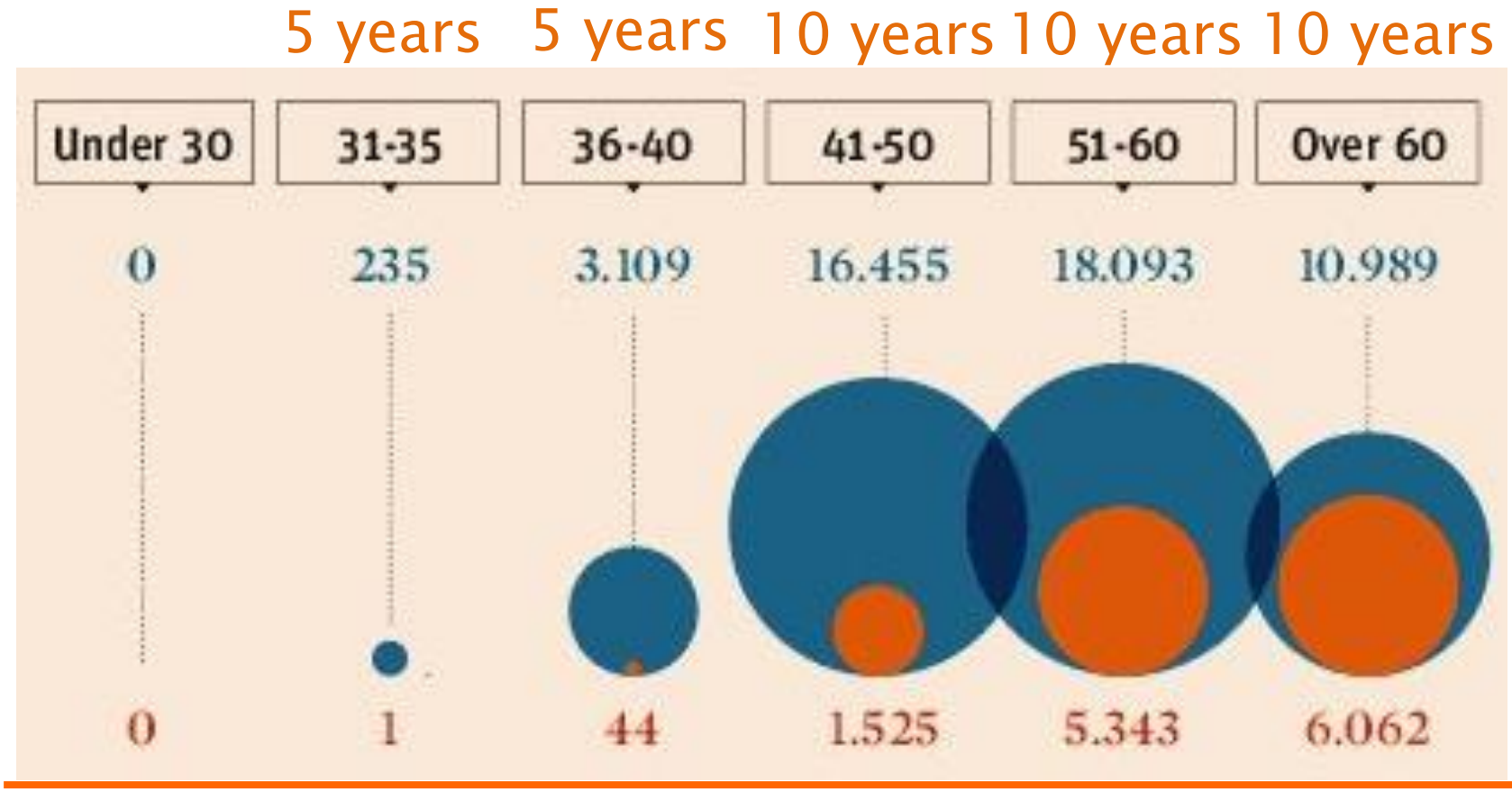
Source: http://www.nytimes.com/2014/09/14/magazine/who-made-that-windshield-wiper.html?_r=0

Aggregation level

Period	Duration [years]	Patents	Pat. per year
1920s	20	430	21.5
1940s	20	260	13.0
1960s	20	650	32.5
1980s	20	410	20.5
2000s	10	660	66.0
2010 to present	4	390	97.5

When comparing values corresponding to entities or categories with different *size*, normalized values (i.e. densities) are comparable, absolute values are not!

Aggregation level



Source: Corriere della Sera, 09 Settembre 2017

Aggregation level

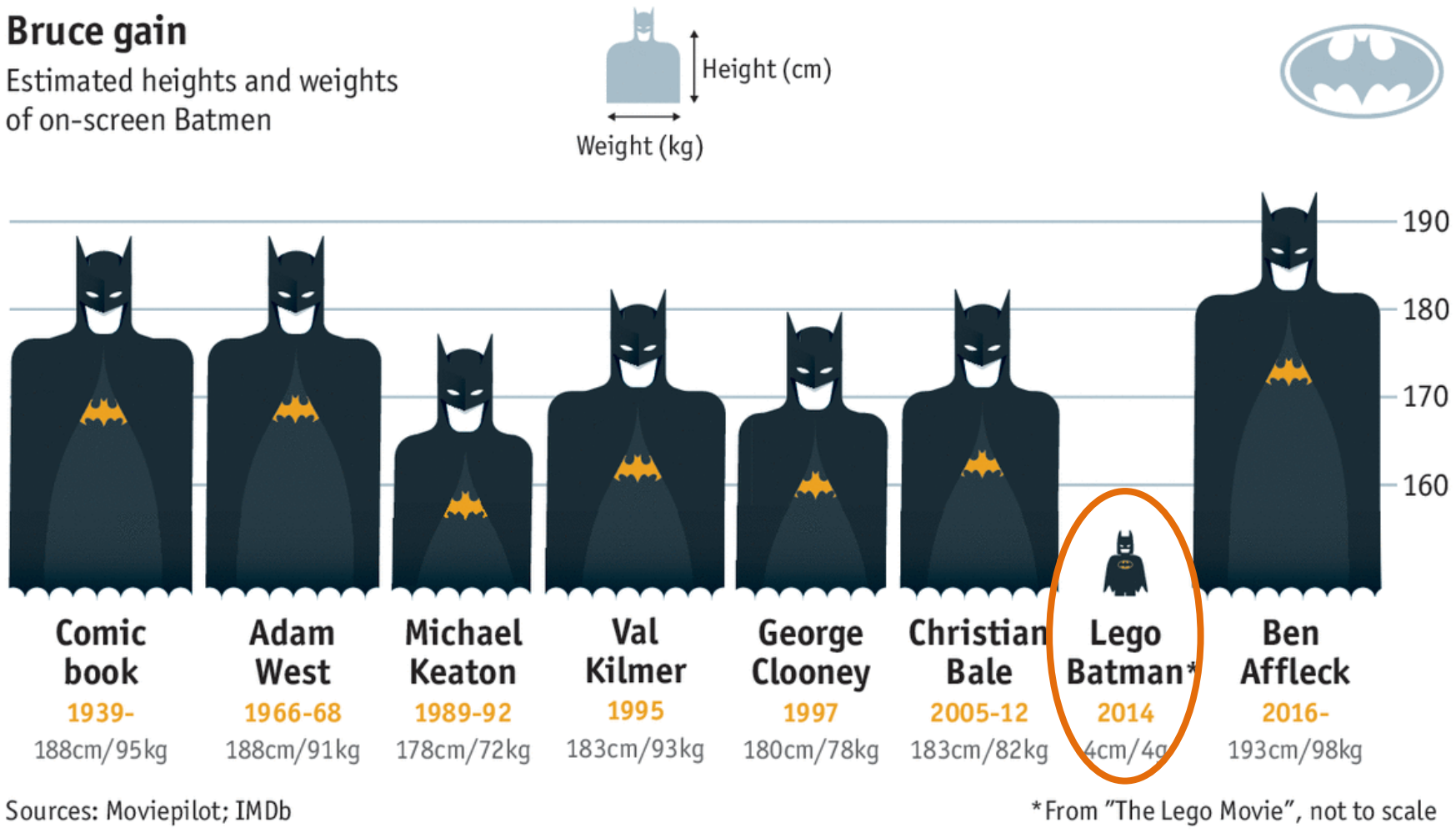
Range	Size	Count	Density
31–35	5	235	47.0
36–4	5	3109	621.8
41–50	10	16455	1645.5
51–60	10	18093	1809.3
Over 60	10	10989	1098.9
	Ratios:	5.3	2.6

Lie factor = 2

Consistent method

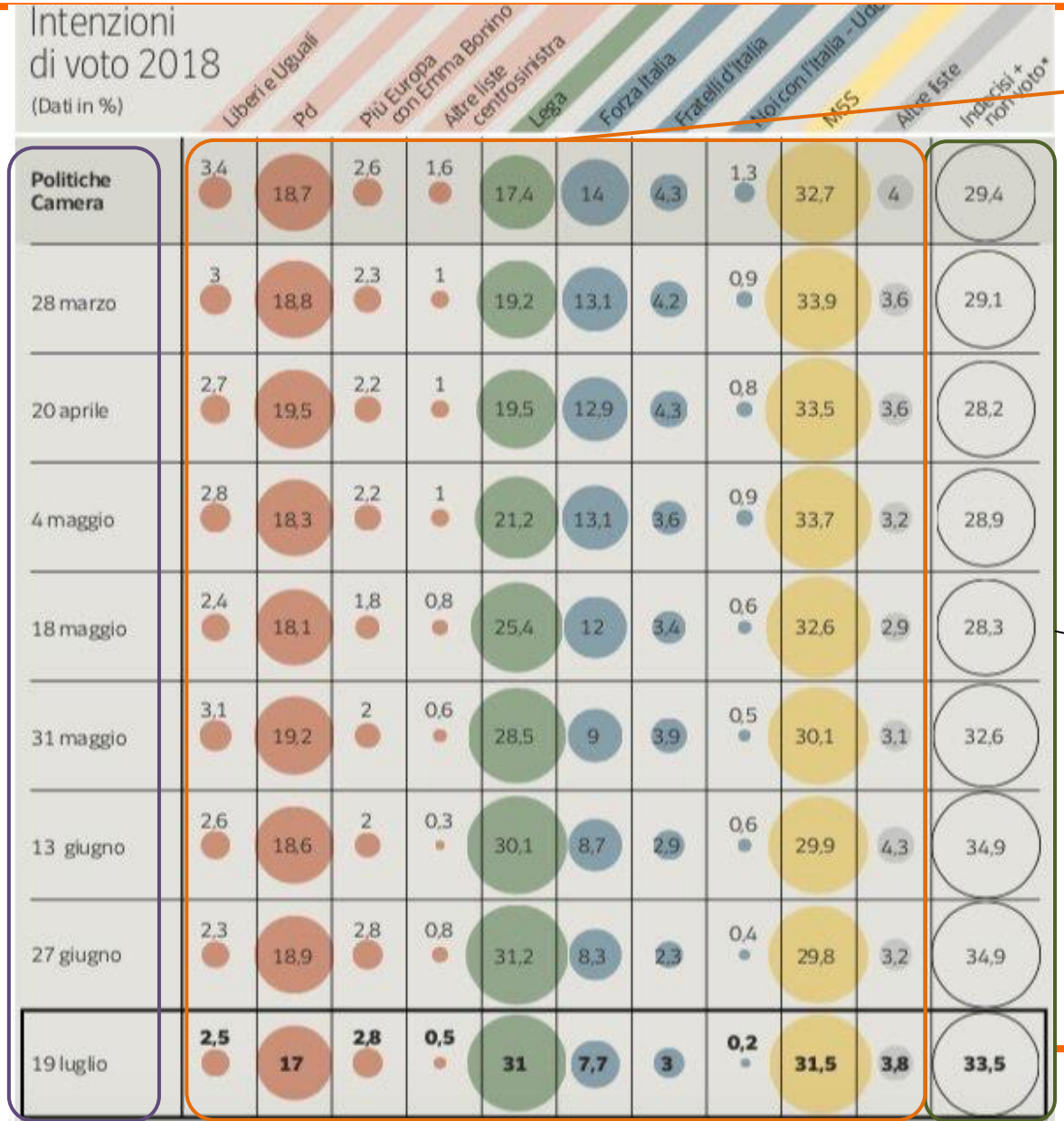
- A series of values that are not measured using the same method might not be directly comparable
  - estimate vs. actual, projection vs. final
  - periodic samples collected at different possibly non-equivalent times
    - e.g. different period of year, week, day

Consistent target entities



Economist.com

Consistent target



Politiche Camera	3,4	18,7	2,6	1,6	17,4	14	4,3	1,3	32,7	4	29,4
28 marzo	3	18,8	2,3	1	19,2	13,1	4,2	0,9	33,9	3,6	29,1
20 aprile	2,7	19,5	2,2	1	19,5	12,9	4,3	0,8	33,5	3,6	28,2
4 maggio	2,8	18,3	2,2	1	21,2	13,1	3,6	0,9	33,7	3,2	28,9
18 maggio	2,4	18,1	1,8	0,8	25,4	12	3,4	0,6	32,6	2,9	28,3
31 maggio	3,1	19,2	2	0,6	28,5	9	3,9	0,5	30,1	3,1	32,6
13 giugno	2,6	18,6	2	0,3	30,1	8,7	2,9	0,6	29,9	4,3	34,9
27 giugno	2,3	18,9	2,8	0,8	31,2	8,3	2,3	0,4	29,8	3,2	34,9
19 luglio	**2,5**	**17**	**2,8**	**0,5**	**31**	**7,7**	**3**	**0,2**	**31,5**	**3,8**	**33,5**

Poll dates

Different political parties

Undecided/NA

Consistent target

- Proportions computed on different reference wholes

$$Undecided = \frac{n_{undec} + n_{NA}}{N_{sample}}$$

$$P_i = \frac{n_p i}{N_{sample} - n_{undec} - n_{NA}}$$

Currency

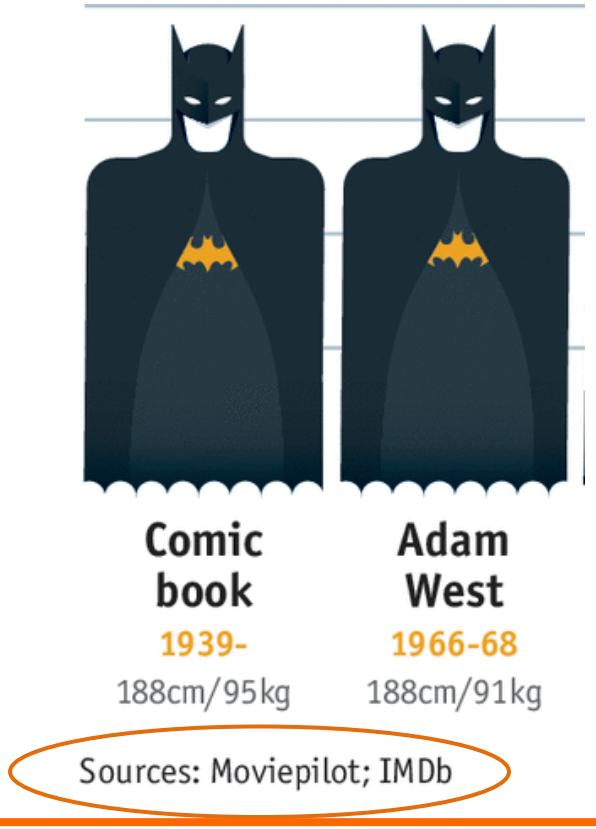
- Currency is the extent to which data is up-to-date
  - With reference to the reality and
  - With reference to the task at hand

- Lack of information to establish currency is an Understandability issue

Credibility

- The extent to which data are regarded as true and credible by users

- What is the source of the data showed in the graph?

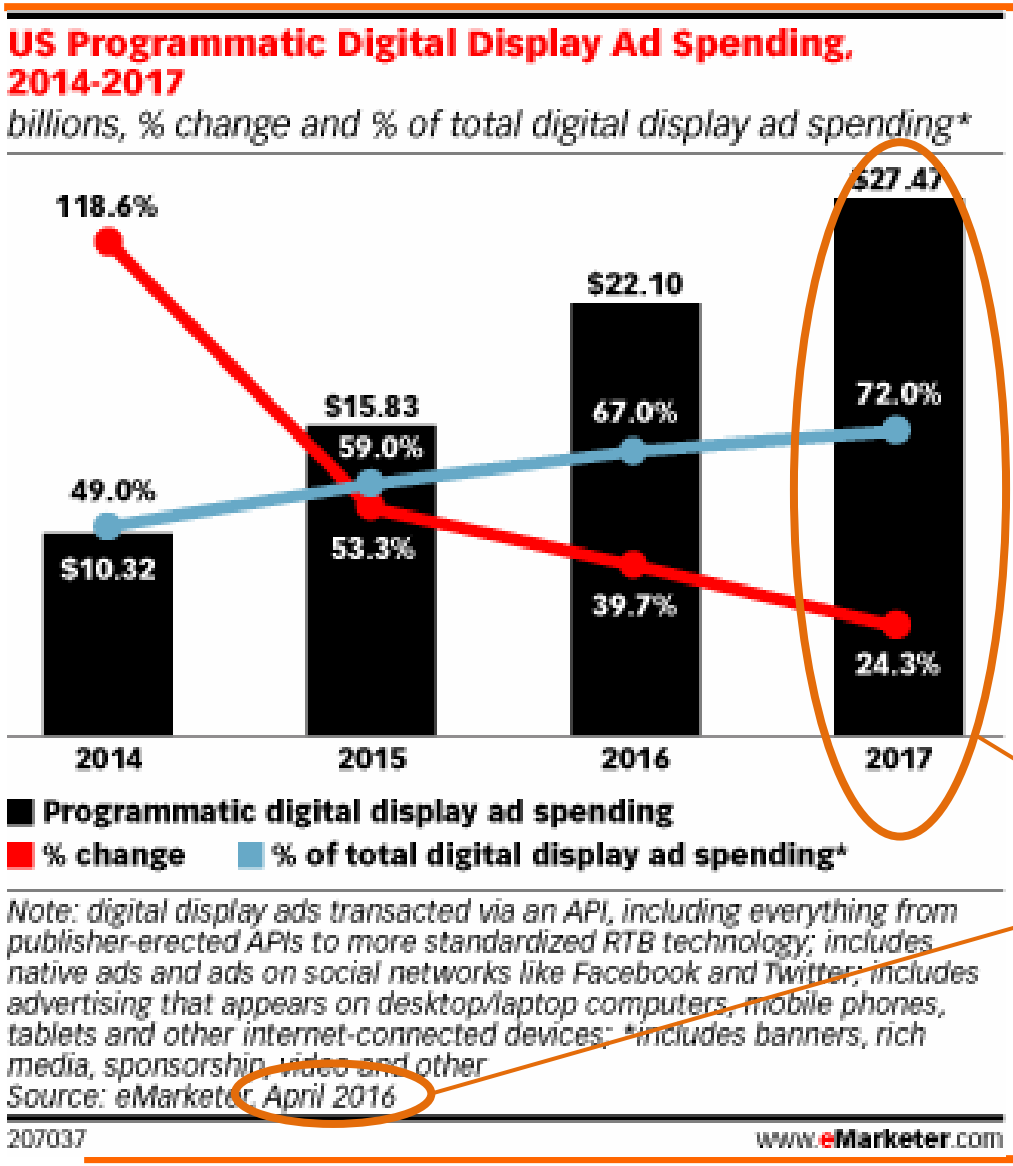


Understandability

- The extent to which data can be read and interpreted by users

- How is data measured? Is there a track of how values are collected, measured or estimated?
  - If multiple multiple methods are used that might represent an inconsistency issue.

Understandability

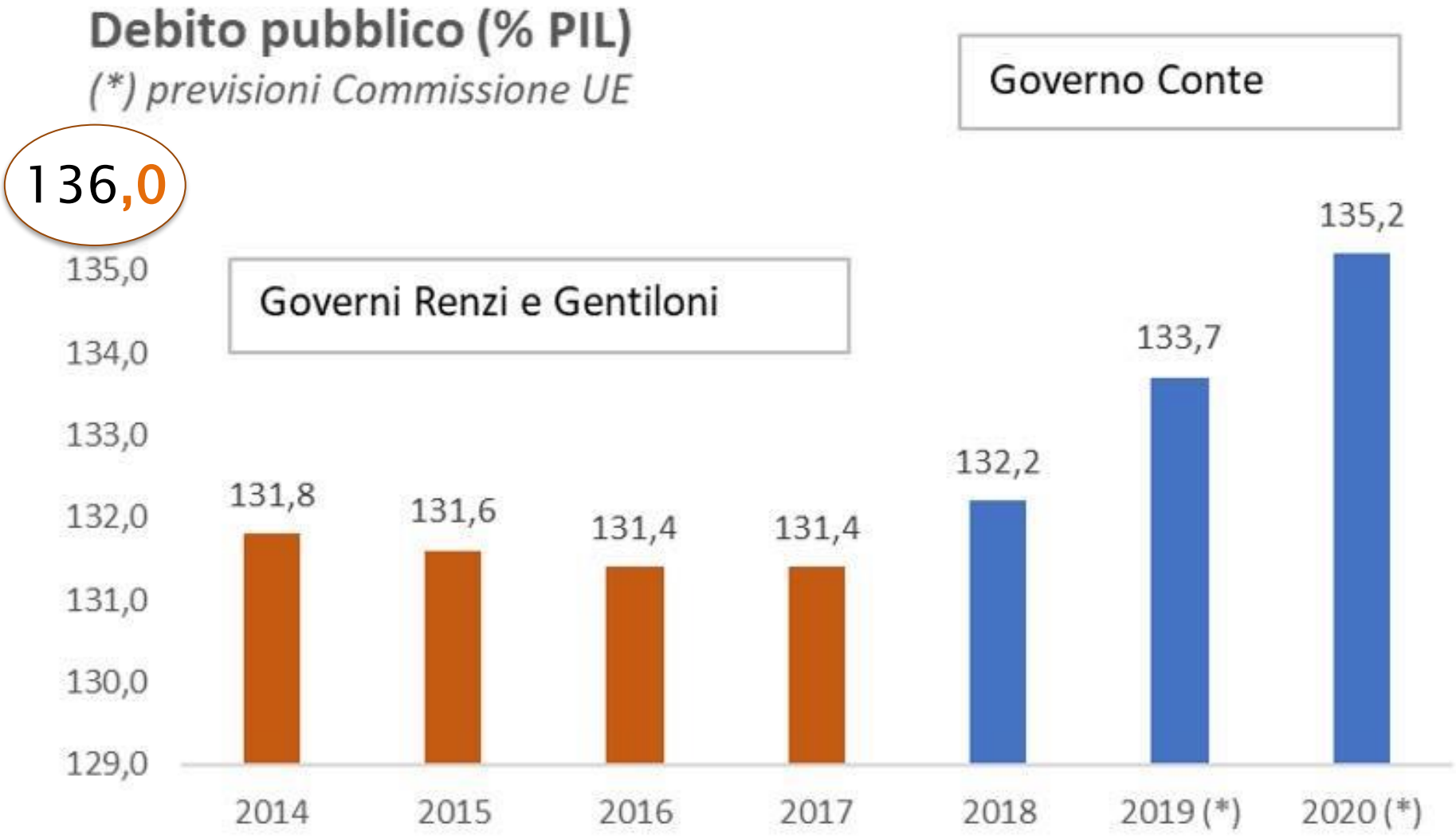


Data from 2016 including values for 2017. Undeclared mix of projections and final data.

Precision

- The capability to provide the degree of information needed in a stated context of use
  - Enough information to allow discriminate
  - Not too much to overload reader
    - Related to "Utility"

Precision


Debito pubblico (% PIL)
(*) previsioni Commissione UE
Governo Conte
136,0
Governi Renzi e Gentiloni
135,0
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131,0
130,0
129,0
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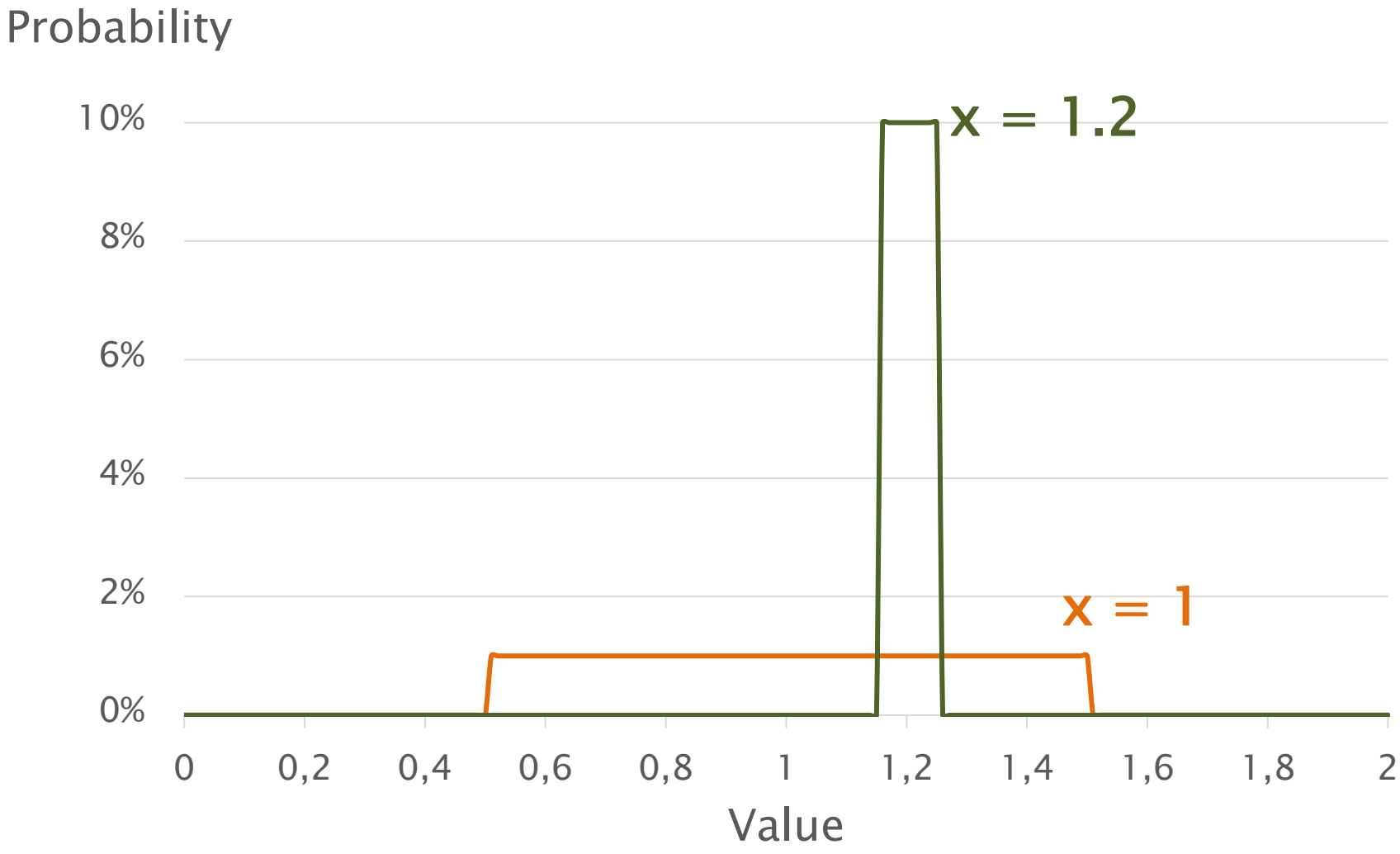
131,6
131,4
131,4
132,2
133,7
135,2
2014
2015
2016
2017
2018
2019 (*)
2020 (*)

Precision



References

- ISO/IEC 25010 – System and software quality models
- ISO/IEC 25012 – Data Quality model
- ISO/IEC 25024 – Measurement of data quality