Inter-coder agreement in ATLAS.ti[i]

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What is reliability?

Reliability is the ability to rely on something, here on data generated by coders using the Atlas.ti software for generating analyzable data from textual phenomena, employing interpretations, readings, annotations, identifying notable quotations in the context of their use and coding them according to agreed upon coding instructions.

Concerns with the reliability of data are **motivated** by the experience that unreliable data reduce the chance of their analysis to lead to valid conclusions; introduce uncertainty for researchers to know what they are analyzing, and make it difficult for other scholars, critics, and stakeholders of said phenomena to interpret or build on its published findings.

Unreliable data can lead to drawing wrong conclusions from them. Before reaching any conclusions, the reliability of data can be checked by asking their analyst to articulate what each data point meant. For reliable data, there should be no ambiguity. The reliability of data can be observed only when problems are encountered. Inasmuch as data precede their analyses and eventual uses, we infer the reliability of data from the agreement observed among coders who work independently of each other and under various circumstances that should not impact the generated data. In short: reliability cannot be observed before running into trouble. It **needs to be inferred** from observable conditions that are known to reduce failures.

Three **reliability measures** can be distinguished by the sources of unreliability they capture:

- **Stability** captures individual coders' inconsistencies over time, their inability to repeat the process of generating data by coding the same documents again.
- **Replicability** is the ability of coding processes to be reproducible across different but independently working coders, applying the same coding instructions to the same documents. Measures of replicability capture both intra-coder instabilities and inter-coder disagreements. Inter-coder disagreements arise when coders differ in interpreting the documents and/or the given coding instructions, resulting in data with conflicting accounts of what was to be recorded, described, or judged. Replicability indicates the extent to which the use of coding instructions is immune to irrelevant influences, whether due to unequal coder qualifications, uncommon prejudices, or ambiguous or inappropriate coding instructions.
- **Accuracy** refers to the correspondence of coded documents with a trusted standard. It declines with intra-coder instabilities, inter-coder disagreements, and deviant proclivities for particular categories, research results, or systematic biases.

Evidence of replicability is stronger than evidence of intra-coder stabilities but weaker than evidence of accuracy. However, standards for the coding of data are rarely available and when they are, coding efforts would be mute, except for testing small subsamples of reliability data. Therefore, replicability is the reliability measure of choice.

What data are needed to infer replicability?

Reliability data that give rise to measuring inter-coder agreements from which the replicability of a population of data can be inferred consist of

- **Replications** of the very coding process to be assessed, using a sample of the phenomena of analytical interest to be converted into reliable data, employing different coders who apply the same coding instructions to the same set of phenomena
- The **sample** (volume of textual matter including videos) of phenomena to be coded has to be large enough to represent the diversity of the phenomena of analytical interest
- **Coders** have to work **independently** of each other, not communicating about their coding tasks, being **informed by identical written coding instructions**, and only these
- **Coder qualifications** have to be **sufficiently common** for coders to be freely replaceable and representative of the literary abilities of all stakeholders whose actions depend on the data generated.
- The **number of coders** employed needs to embrace the diversity of stakeholders who will have to understand the phenomena studied through the coding instructions applied. Two coders may not suffice
- Any **preparatory training** that coders received, any understandings they share during the development phase of a project, and the qualifications for which they were selected need to be **communicable for eventual replication elsewhere.**

Deviations from these conditions tend to pollute the data, inflate the observable inter-coder agreement, and lead to mistaken assurances of their replicability. For example, selecting coders among close acquaintances, among people with a vested interest in the outcome of the study, administering thorough but undocumented training, allowing them to discuss how to interpret given coding instructions, or settling emerging uncertainties by consensus, yield deceptively higher inter-coder agreements which is no longer indicative of the replicability of the generated data.

Perfect replicability means that the written coding instructions are communicable without distortions, data are perfect representations of the coded phenomena, data have the potential of leading to valid answers of given research questions, analysts can use the coding instructions in reverse, to decode what their data represent, and the stakeholders in a research project can critically evaluate the analysis, talk about, respond to, and build on published findings about these phenomena in unambiguous terms.

Reliability data in Atlas.ti:

After a principal investigator has developed suitable **coding instructions** in writing, without references to the textual matter to which they are to be applied, independently working coders are employed to apply these coding instructions to the same set of phenomena, and return comparable data to the principal investigator. Although Atlas.ti cannot prevent coders from introducing new codes, they will have to be ignored except as suggestions to improve the coding instructions for subsequent coding efforts.

Coding instructions must specify

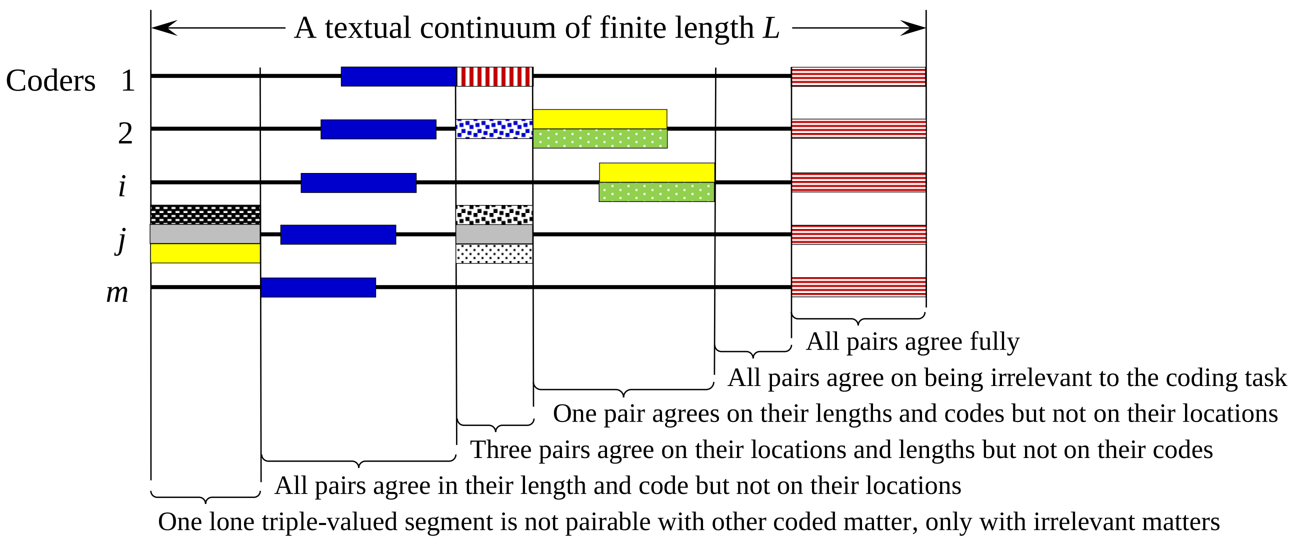
- **The set of** relevant and logically or conceptually independent **semantic domains** with definitions and examples made readily available to coders.

A **semantic domain** names a space of distinct concepts with shared meanings, e.g., “colors,” “mental illnesses,” “emotions,” “gender issues,” or “personalities.” Semantic domains may be named abstractly but are always context dependent. The concept of color is different when applied to the sky, traffic lights, a dress, an ethnic group, a political party, or the state of being drunk. The gender of German nouns is unlike the gender of living organisms. The contexts of semantic domains need to be defined and considered when coding texts. A single quote typically invokes several connected semantic domains. For example:

- “[ ] says [ ] to [ ] intending to [ ] but causing [ ]“
  defines the semantic domains of speakers, utterances, addressees, and intended and unintended consequences.
- “[ ] diagnoses [ ] to have [ ].“
  If the first semantic domain concerns medical professionals, the second concerns patients and the third illnesses. If the first is a car mechanic the other two relate to cars.

  Most semantic domains concern attributes of objects, actions, people, or abstract concepts.

- Each semantic domain circumscribes several **mutually exclusive codes.** E.g., masculine and feminine are categories of gender. Blue, green, and red are three out of many categories of color. A test may result in passing or failing it.
- Coders highlight or identify **textual segments** of a given textual continuum (quotes, propositions, paragraphs, documents or images), whose **relevance** is defined by the applicability of one or more semantic domains. Coders are to select the appropriate code or category for each semantic domain. For a graphical example, in which colors are the codes from separate semantic domains:



Terms used:

Coders: m coders are consecutively numbered: 1, 2, …, i, …, j, … m.

Segments:

Coder i’s segments: $S_{i1}, S_{i2}, \ldots S_{ig}, S_{ig+1}, \ldots, S_{i\text{last for } i}$

Coder j’s segments: $S_{j1}, S_{j2}, \ldots S_{ih}, S_{ih+1}, \ldots, S_{j\text{last for } j}$

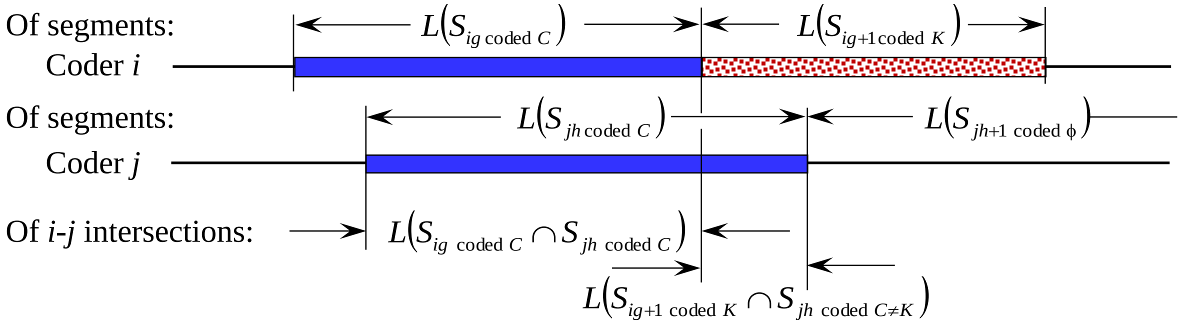
Semantic domains and their codes applied to segments:

Each segment is represented by a set C or K of applicable semantic domains c, k, or none, ϕ.

Uncoded or irrelevant matter, gaps between identified segments, are referred to by $\phi \in C$ or $\phi \in K$

A semantic domain s is coded by sets C_s or K_s of codes c_s, k_s, or none ϕ_s. Ideally, codes are single-valued, c_s or k_s, mutually exclusive, c_s implies not k_s, and exhaustive, ϕ_s does not occur.

Lengths (the number of smallest distinguishable units: e.g., characters for texts or seconds of videos):



The total lengths of the continuum: $L = \sum_{g=1=i'\text{s first}}^{i'\text{s last}} L(S_{ig}) = \sum_{h=1=j'\text{s first}}^{j'\text{s last}} L(S_{jh})$

Differences:

With the number of elements in sets referred to as its cardinality $|C|$:

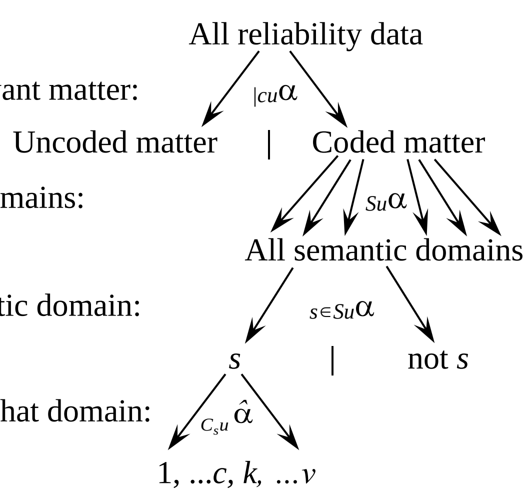
Multi-valued differences between two sets C and K: $\Delta_{CK} = |C||K| - |C \cap K|^2$

Differences between sets C and K whose multi-valuedness is ignored. Ideally, codes c and k are to be mutually exclusive:

$$\nabla_{CK} = |C||K| - |C \cap K| \text{ where } \nabla_{C\phi} = |C|;\ \nabla_{\phi\phi} = 0$$

Between single codes c and k: $\Delta_{ck} = \nabla_{ck} = {}_{\text{nominal}}\delta^2_{ck} = \begin{cases} 0 & \text{iff } c = k \\ 1 & \text{iff } c \neq k \end{cases}$

Coefficients of inter-coder agreement provided by Atlas.ti



(1) Of relevant/irrelevant matter: A binary measure

(2) Of all semantic domains: A multi-valued measure

(3) Of any one semantic domain: A binary measure

(4) Of coding within that domain: An approximations of the single-valued agreement of coding a semantic domain (not implemented in the current version of ATLAS.ti)

(1) The binary **agreement on the relevance of textual matter for a research project as judged by the applicability of given coding instructions.** It is based on the distinctions between relevant + (coded at least once) and irrelevant ϕ (leftover) matter.

Its matrix of observed coincidences:

	ϕ	$+ \neq \phi$	
ϕ	$\ell_{\phi\phi}$	$\ell_{\phi+}$	$\ell_{\phi\cdot}$
$+$	$\ell_{+\phi}$	ℓ_{++}	$\ell_{+\cdot}$
	$\ell_{\cdot\phi}$	$\ell_{\cdot+}$	$\ell_{\cdot\cdot} = 1$

is constructed from coincidences:

$$\ell_{\phi+} = \frac{\sum_{i=1}^{m}\sum_{j\neq i}^{m}\sum_{g,h} L\left(S_{ig\ \text{coded}\ \phi} \cap S_{jh\ \text{coded}+}\right)}{m(m-1)L} = \ell_{+\phi}$$

$$\ell_{\phi\cdot} = \frac{\sum_{i=1}^{m}\sum_{g} L\left(S_{ig\ \text{coded}\ \phi}\right)}{mL} = \ell_{\cdot\phi}$$

and

$$\ell_{++} = \ell_{\cdot\cdot} - \ell_{\phi\cdot} - \ell_{+\phi}\,. \qquad (1)$$

Its observed disagreement is:

$${}_{|cu}D_o = \ell_{\phi+} + \ell_{+\phi} \qquad (2)$$

The "|" in its subscript indicates that binary distinction among unitized continua.

Its expected coincidences are:

$$e_{\phi+} = \frac{\ell_{\phi\cdot}\ell_{\cdot+}}{1 - \frac{\ell_{\phi\cdot}}{(mL)^2} - \frac{1}{(mL)^2}\sum_{i=1}^{m}\sum_{g}\left(L\left(S_{ig\ \text{coded}+}\right)\right)^2} = e_{+\phi}$$

$$e_{\phi\phi} = \frac{\ell_{\phi\cdot}\ell_{\cdot\phi} - \frac{\ell_{\phi\cdot}}{mL}}{1 - \frac{\ell_{\phi\cdot}}{(mL)^2} - \frac{1}{(mL)^2}\sum_{i=1}^{m}\sum_{g}\left(L\left(S_{ig\ \text{coded}+}\right)\right)^2}$$

$$e_{++} = \frac{\ell_{+\cdot}\ell_{\cdot+} - \frac{1}{(mL)^2}\sum_{i=1}^{m}\sum_{g}\left(L\left(S_{ig\ \text{coded}+}\right)\right)^2}{1 - \frac{\ell_{\phi\cdot}}{(mL)^2} - \frac{1}{(mL)^2}\sum_{i=1}^{m}\sum_{g}\left(L\left(S_{ig\ \text{coded}+}\right)\right)^2} \qquad (3)$$

Its expected disagreement is:

$${}_{|cu}D_e = e_{\phi+} + e_{+\phi} \qquad (4)$$

And the binary ${}_{|cu}\alpha$**-agreement** becomes:

$${}_{|cu}\alpha = 1 - \frac{{}_{|cu}D_o}{{}_{|cu}D_e} = 1 - \frac{\ell_{\phi+}}{e_{\phi+}} \qquad (5)$$

(2) The **agreement on recognizing diverse semantic domains within relevant matter:**

Any segment may be described in terms of several semantic domains. Being logically or conceptually independent of each other, joint accounts constitute multi-valued coding.

$_{Su}\alpha$ assesses the agreement on recognizing semantic domains, (not their distinct codes and excluding all references to uncoded matter ϕ). Accordingly, C and K are the sets of semantic domains, containing at least one.

Its coincidences are:

$$\ell_{CK} = \frac{\sum_{i=1}^{m}\sum_{j\neq i}^{m}\sum_{g,h} L\left(S_{ig\,\text{coded}\,C\neq\phi} \cap S_{jh\,\text{coded}\,K\neq\phi}\right)}{(m-1)mL\ell_{++}} \qquad (6)$$

Its coincidence matrix is:

$$\begin{array}{c|cccccc|l}
 & 1 & 2 & \dots & K & & . & \\
\hline
1 & \ell_{11} & \ell_{12} & \dots & \ell_{1K} & & . & \ell_{1\cdot} \\
2 & \ell_{21} & \ell_{22} & \dots & \ell_{2K} & & . & \ell_{2\cdot} \\
C & \ell_{C1} & \ell_{C2} & \dots & \ell_{CK} & & . & \ell_{C\cdot} = \sum_{K\neq\phi}\ell_{CK} \\
: & : & : & ::: & : & & : & : \\
. & . & . & \dots & . & & . & . \\
\hline
 & \ell_{\cdot 1} & \ell_{\cdot 2} & \dots & \ell_{\cdot K} & & . & \ell_{\cdot\cdot} = 1
\end{array}$$

The multi-valued differences between any two sets C and K are: $\Delta_{CK} = |C||K| - |C \cap K|^2$ (7)

Its observed disagreement is:

$$_{Su}D_o = \frac{\sum_{C\neq\phi}\sum_{K\neq\phi}\ell_{CK}\Delta_{CK}}{\sum_{C\neq\phi}\sum_{K\neq\phi}\ell_{CK}|C||K|} \qquad (8)$$

The capital S in its subscript refers to potentially multi-valued sets of semantic domains, coded at least once.

Its expected coincidences are:

$$e_{C\neq K} = \frac{\ell_{C\cdot}\ell_{\cdot K}}{1 - \frac{1}{(mL\ell_{++})^2}\sum_{i}^{m}\sum_{g}\left(L(S_{ig\,\text{coded}\,\neq\phi} \cap \bigcup_{j\neq i,h} S_{jh\,\text{coded}\neq\phi})\right)^2}$$

$$e_{C=K} = \frac{\ell_{C\cdot}\ell_{\cdot K} - \frac{1}{(mL\ell_{++})^2}\sum_{i}^{m}\sum_{g}\left(L(S_{ig\,\text{coded}\,C=K\neq\phi} \cap \bigcup_{j\neq i,h} S_{jh\,\text{coded}\neq\phi})\right)^2}{1 - \frac{1}{(mL\ell_{++})^2}\sum_{i}^{m}\sum_{g}\left(L(S_{ig\,\text{coded}\neq\phi} \cap \bigcup_{j\neq i,h} S_{jh\,\text{coded}\neq\phi})\right)^2} \qquad (9)$$

Its expected disagreement is:

$$_{Su}D_e = \frac{\sum_{C=1}^{v}\sum_{K=1}^{v} e_{CK}\Delta_{CK}}{\sum_{C=1}^{v}\sum_{K=1}^{v} e_{CK}|C||K|} \qquad (10)$$

The **$_{Su}\alpha$-agreement** is:

$$_{Su}\alpha = 1 - \frac{_{Su}D_o}{_{Su}D_e} \qquad (11)$$

(3) The **agreement of identifying any one semantic domain *s* among all,** (coded at least once):

Semantic domains of interest have to be extracted from the coincidences ℓ_{CK} of sets of semantic domains defined by (6). A chosen semantic domain *s* may be a member of an observed set of semantic domains: $s \in C$ or it may not $\bar{s}$:

The four observed coincidences for any one semantic domain $s \in S$ are:

	s	$\bar{s}$	
s	ℓ_{ss}	$\ell_{s\bar{s}}$	$\ell_{s\cdot}$
$\bar{s}$	$\ell_{\bar{s}s}$	$\ell_{\bar{s}\bar{s}}$	$\ell_{\bar{s}\cdot}$
	$\ell_{\cdot s}$	$\ell_{\cdot\bar{s}}$	$\ell_{\cdot\cdot} = 1$

And extracted from ℓ_{CK} of (6) by:

$$\ell_{s\bar{s}} = \frac{\sum_{K \neq \phi} \ell_{CK} \begin{cases} |K| & \text{iff } s \notin K \text{ and } s \in C \\ |K \cap \bar{C}| & \text{iff } s \in K \text{ and } s \in C \end{cases}}{\sum_{C \neq \phi} \sum_{K \neq \phi} \ell_{CK} |C||K|} = \ell_{\bar{s}s}$$

$$\ell_{ss} = \frac{\sum_{K \neq \phi} \ell_{CK} |K \cap C| \quad \text{iff } s \in K \text{ and } s \in C}{\sum_{C \neq \phi} \sum_{K \neq \phi} \ell_{CK} |C||K|}$$

$$\ell_{s\cdot} = \frac{\sum_{K \neq \phi} \ell_{CK} |K| \quad \text{iff } s \in C}{\sum_{C \neq \phi} \sum_{K \neq \phi} \ell_{CK} |C||K|} = \ell_{s\bar{s}} + \ell_{ss} = 1 - \ell_{\bar{s}\cdot}. \qquad (12)$$

Its observed disagreement is:

$$_{s \in Su}D_{\mathrm{o}} = \frac{\sum_{K \neq \phi} \ell_{CK} \begin{cases} |K| & \text{iff } s \notin K \text{ and } s \in C \\ |K \cap \bar{C}| & \text{iff } s \in K \text{ and } s \in C \end{cases}}{\sum_{K \neq \phi} \ell_{CK} |K| \quad \text{iff } s \in C} = \frac{\ell_{s\bar{s}}}{\ell_{s\cdot}} \qquad (13)$$

Its expected coincidences e_{CK} are derived from (9).
Its expected disagreement is obtained by applying the form of (13) to these expected coincidences:

Its expected disagreement is:

$$_{s \in Su}D_{\mathrm{e}} = \frac{\sum_{K \neq \phi} e_{CK} \begin{cases} |K| & \text{iff } s \notin K \text{ and } s \in C \\ |K \cap \bar{C}| & \text{iff } s \in K \text{ and } s \in C \end{cases}}{\sum_{K \neq \phi} e_{CK} |K| \quad \text{iff } s \in C} = \frac{e_{s\bar{s}}}{e_{s\cdot}} \qquad (14)$$

The $_{s \in Su}\alpha$**-agreement** is:

$$_{s \in Su}\alpha = 1 - \frac{_{s \in Su}D_o}{_{s \in Su}D_e} = 1 - \frac{\ell_{s\bar{s}} e_{s\cdot}}{e_{s\bar{s}} \ell_{s\cdot}} \qquad (15)$$

(4) The **agreement on coding a chosen semantic domain,** ideally assigning single codes c_s and k_s to segments identified with the chosen semantic domain s.

The sum of the lengths of all pairable segments judged in terms of the chosen semantic domain s is obtained from the matrix of observed coincidences ℓ_{CK} defined in (6):

$$\sum_{K \neq \phi} \ell_{CK} \text{ iff } s \in K \text{ and } s \in C$$

Each segment is coded by semantic domain-specific codes, including single codes c_s or k_s, sets C_s or K_s of two or more such codes, and none, ϕ_s. Their subscripts associate them with s.

Segments are to be **single-valued** and the codes of a semantic domain are to be **mutually exclusive**, i.e., only one semantically distinct code is to be assigned to each identified segment. Assigning more than one code violates this requirement. Such violations tend to occur when coders are careless, uncertain, unable to decide which code applies, or coding instructions are ambiguous. Because Atlas.ti cannot prevent coders from assigning more than one code to a segment, the agreement measure ${}_{C_s u}\hat{\alpha}$ it provides relates to the agreement measure ${}_{c_s u}\alpha$ for the single-valued coding of semantic domains as follows:

- When the coded segments do not contain such confusions and all $|C_s| \leq 1$: ${}_{C_s u}\hat{\alpha} = {}_{c_s u}\alpha$
- When data contain segments coded $|C_s| > 1$, ${}_{C_s u}\hat{\alpha}$ seeks to approximate ${}_{c_s u}\alpha$ by ignoring the multi-valuedness of such confusions and presuming they would be corrected.

To reveal whether the calculated agreement is correct (and publishable) or an approximation (a non-publishable invitation to correct apparent confusions).

Approximations may not equal the agreement measured after violations are corrected.

Note: In the following definitions, C_s and K_s denote sets of codes of the semantic domain s, including single codes c_s and k_s and missing codes ϕ_s as special cases. By contrast, ℓ_{CK} denotes the observed coincidence of two sets C and K of semantic domains as defined by (6).

The observed coincidences of coding a chosen semantic domain s are generated by scanning all coincidences for it (in the denominator of (16)) and recognizing their coding (in its numerator):

$$\ell_{C_s K_s} = \frac{\sum_K \ell_{CK} \text{ iff } C_s \text{ and } K_s}{\sum_K \ell_{CK} \text{ iff } s \in K \text{ and } s \in C} \quad (16)$$

Its matrix of observed coincidences is:

Sets of s's Codes:	ϕ_s	1_s	.	K_s	.	.	
ϕ_s	$\ell_{\phi_s \phi_s}$	$\ell_{\phi_s 1_s}$	.	$\ell_{\phi_s K_s}$	.	.	$\ell_{\phi_s \cdot}$
1_s	$\ell_{1_s \phi_s}$	$\ell_{1_s 1_s}$	.	$\ell_{1_s K_s}$	.	.	$\ell_{1_s \cdot}$
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
C_s	$\ell_{C_s \phi_s}$	$\ell_{C_s 1_s}$	.	$\ell_{C_s K_s}$	.	.	$\ell_{C_s} = \sum_{K_s} \ell_{C_s K_s}$ including $\ell_{C_s \phi_s}$
.	.	.	.	.	.	.	.
	$\ell_{\cdot \phi_s}$	$\ell_{\cdot 1_s}$	.	$\ell_{\cdot K_s}$	.	.	$\ell_{\cdot\cdot}=1$

In the approximated agreement ${}_{C_s u}\hat{\alpha}$, the multi-valued difference function Δ_{CK} in disagreements (8) and (10) is replaced by:

$$\nabla_{CK} = |C||K| - |C \cap K| \text{ where } \nabla_{C\phi} = |C| \text{ and } \nabla_{\phi\phi} = 0 \quad (17)$$

in (18) and (20), which ignores the actual multi-valuedness of a coded semantic domain *s*:

Its observed disagreement becomes: $${}_{C_s u}\hat{D}_o = \frac{\sum_{C_s}\sum_{K_s} \ell_{C_s K_s} \nabla_{C_s K_s}}{\sum_{C_s}\sum_{K_s} \ell_{C_s K_s} |C_s||K_s|} \quad (18)$$

Its expected coincidences $e_{C_s K_s}$ are obtained from the expected coincidences e_{CK} used by ${}_{S u}D_e$:

$$e_{C_s K_s} = \frac{\sum_K e_{CK} \text{ iff } C_s \text{ and } K_s}{\sum_K e_{CK} \text{ iff } s \in C \text{ and } s \in K} \quad (19)$$

Its expected disagreement is: $${}_{C_s u}\hat{D}_e = \frac{\sum_{C_s}\sum_{K_s} e_{C_s K_s} \nabla_{C_s K_s}}{\sum_{C_s}\sum_{K_s} e_{C_s K_s} |C_s||K_s|} \quad (20)$$

And the approximated agreement for coding a semantic domain *s* is: $${}_{C_s u}\hat{\alpha} = 1 - \frac{{}_{C_s u}\hat{D}_o}{{}_{C_s u}\hat{D}_e} \quad (20)$$

Again: When all codes used as mutually exclusive, ${}_{C_s u}\hat{\alpha} = {}_{c_s u}\alpha$ is an accurate agreement measure. When coding contains any one or more $|C_s| > 1$, ${}_{C_s u}\hat{\alpha}$ is an approximation and cannot be interpreted as measuring the reliability of coding the chosen semantic domain. You should examine the sources of the apparent confusions and take corrective actions.

(5) When the coding of a semantic domain fails to be mutually exclusive, all users of ATLAS.ti are made aware of this fact and encouraged to turn its indications from **red** to **black**:

Principal investigators or analysts may need to communicate with the coders who exhibit such confusions, evaluate their impact on the research project, and revise their coding instructions.

Individual coders may need to examine the sources of their problems and be given the opportunity to correct them as needed before submitting their coded texts to the analysts.

Both are provided access to semantic domain and coder-specific accounts of the kinds and frequencies of their confusions but only for segments S_{ig} coded $|C_s| > 1$ or not coded ϕ_s at all.

Their frequency distribution is: $$n_{ck} = \sum_g \sum_{c \in C_s} \sum_{k \in C_s,\, k \neq c} 1 \text{ iff } C_s > 1 \text{ or } \phi_s \quad (21)$$

Tabulated for codes:

	ϕ_s	1_s	…	k_s	…
ϕ_s	$n_{\phi\phi}$	$n_{\phi 1}$	…	$n_{\phi k}$	…
1st code by name	$n_{1\phi}$	n_{11}	…	n_{1k}	…
cth code by name	$n_{c\phi}$	n_{c1}	…	n_{ck}	…
:	:	:	:::	:	:::
vth codes by name	$n_{v\phi}$	n_{v1}	…	n_{vk}	…

[i] Developed from Chapter 12 in Klaus Krippendorff (2019), *Content Analysis; An Introduction to Its Methodology, 4th Edition*. Thousand Oaks, CA: Sage. Partly implemented in Klaus Krippendorff; Yann Mathet; Stéphane Bouvry & Antoine Widlöcher (2016). On the Reliability of Unitizing Textual Continua: Further Developments. *Quality & Quantity 50*, 6: 2347-2364. Online since 2015.9.15 at https://link.springer.com/article/10.1007/s11135-015-0266-1