A new look into Likert scales interpretation by intuitionistic fuzzy sets and interval-valued intuitionistic fuzzy sets

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CONTENTS

LIKERT SCALES: Characteristics, Advantages, Limitations

- Developed by Rensis Likert in 1932
- A structured method to quantify subjective data – attitudes, perceptions, opinions, behavioral tendencies.
- Core feature: Standardized ordered response format of all questions, typically ranging from strong disagreement to strong agreement, which allows researchers to capture both direction and intensity of respondents' attitudes.
- Popular psychometric tool in social sciences, education, psychology, health research and other areas.
- Simplicity, Ease of use, scalability, capacity for statistical analysis

LIKERT SCALES: Characteristics, Advantages, Limitations

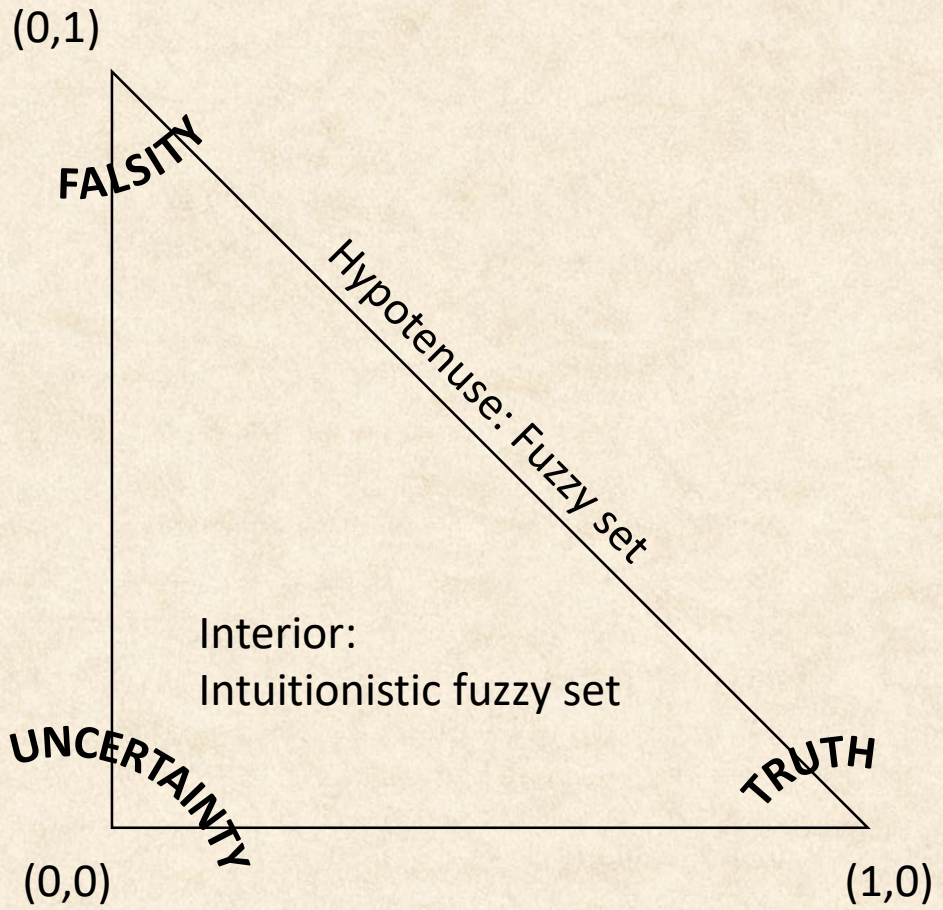
- Likert scales vary primarily in the number (granularity) and parity of response options:
  - Odd-numbered scales offer a neutral midpoint,
  - Even-numbered (forced-choice) scales discourage noncommittal, blank responses.
- Drawbacks:
  - Response bias, including central tendency bias (respondents gravitating toward the midpoint), and acquiescence bias (tendency to agree regardless of content),
  - Response options are implicitly treated as equidistant.

LIKERT SCALES AND FUZZY SETS

- Integrating fuzzy logic into traditional Likert scales has been proposed and developed in a number of researches over the past two decades.
- The usually adopted approach to bridging Likert scales and fuzzy scales passes through the development of fuzzy inference systems to model responses more flexibly:
  - acknowledging the inherent drawback of Likert scales in treating subjective opinions as discrete, equally spaced numerical values;
  - failing to capture nuances such as hesitation, ambivalence, or partial agreement;
  - instead of a single crisp category, a respondent's opinion is represented as a distribution of membership degrees across multiple categories.

Likert Scales and Intuitionistic Fuzzy Sets: MOTIVATION

- Our aim to employ IFSs in this discussion of Likert scales interpretation was motivated by the intuitionistic fuzzy interpretational triangle as a distinctive way of presenting data, compared to the fuzzy membership function plots.



Likert Scales and Intuitionistic Fuzzy Sets: MOTIVATION

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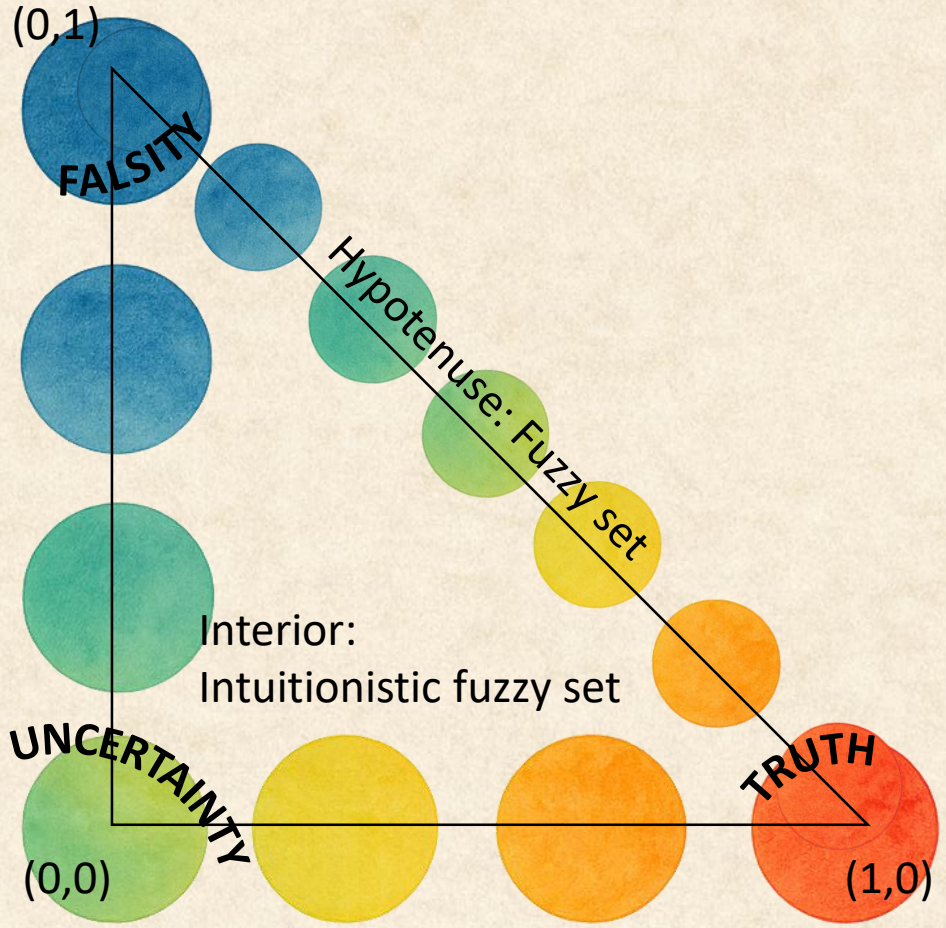
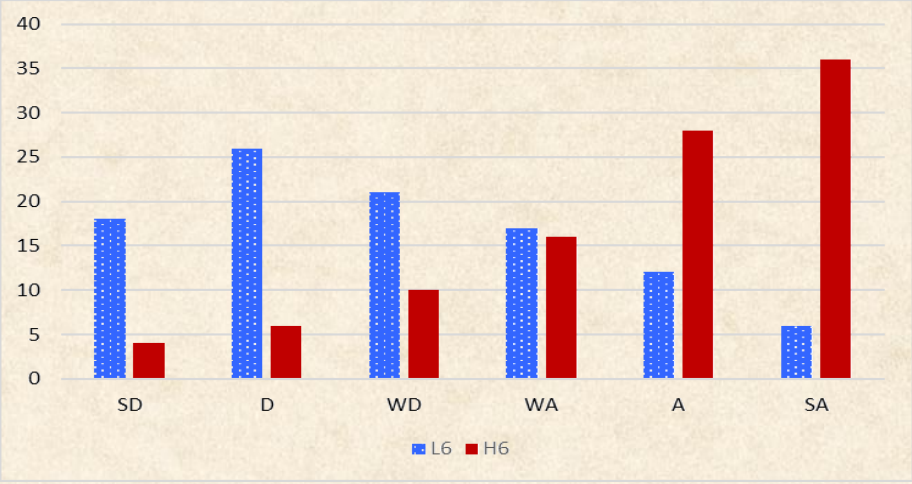
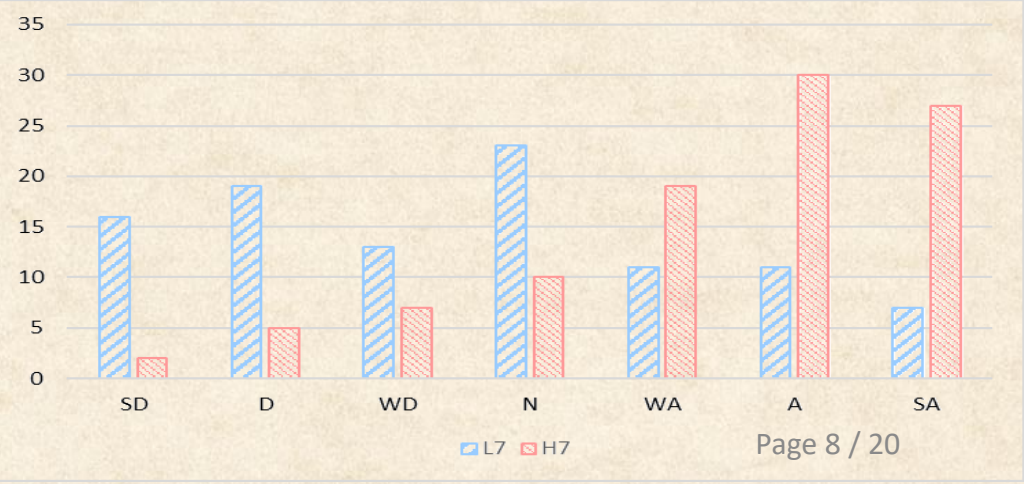


ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses distributions: four combinations formed by:
  - cultural setting (Low vs. High blood donation culture)
  - and Likert scale parity (6-point vs. 7-point)

	SD	D	WD	N	WA	A	SA
L6	18	26	21	–	17	12	6
H6	4	6	10	–	16	28	36
L7	16	19	13	23	11	11	7
H7	2	5	7	10	19	30	27

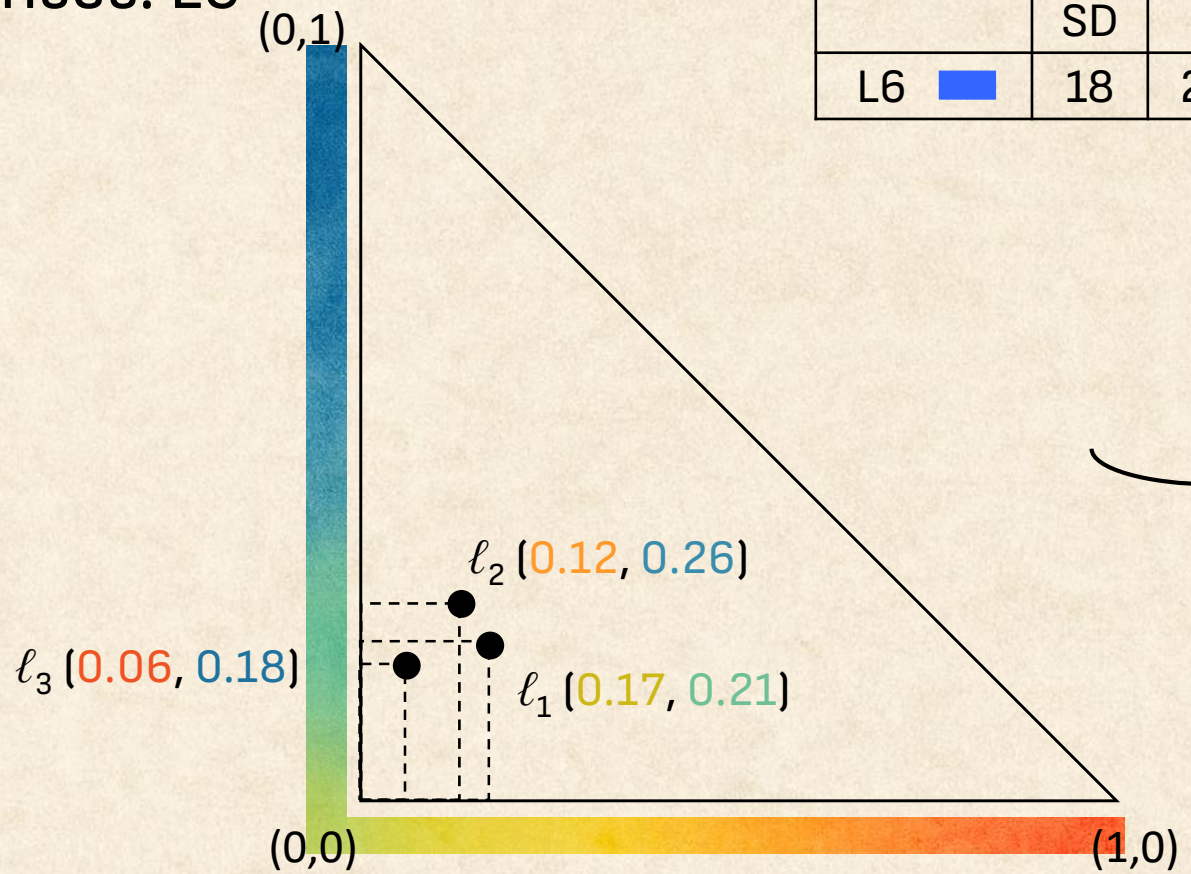


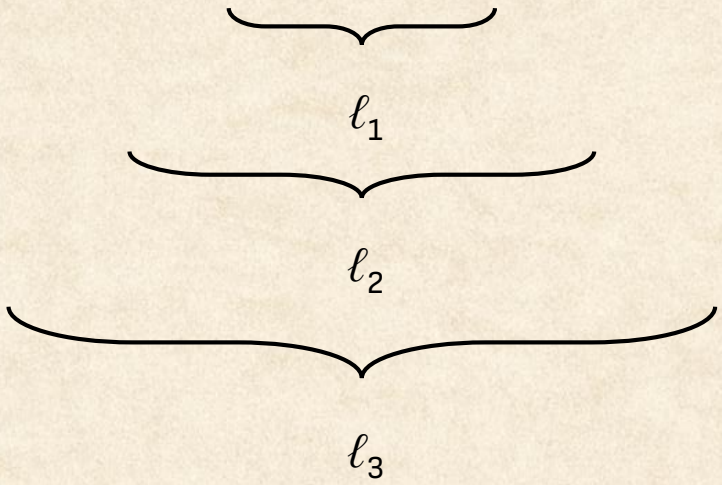


ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: L6

	SD	D	WD	N	WA	A	SA
L6	18	26	21	–	17	12	6



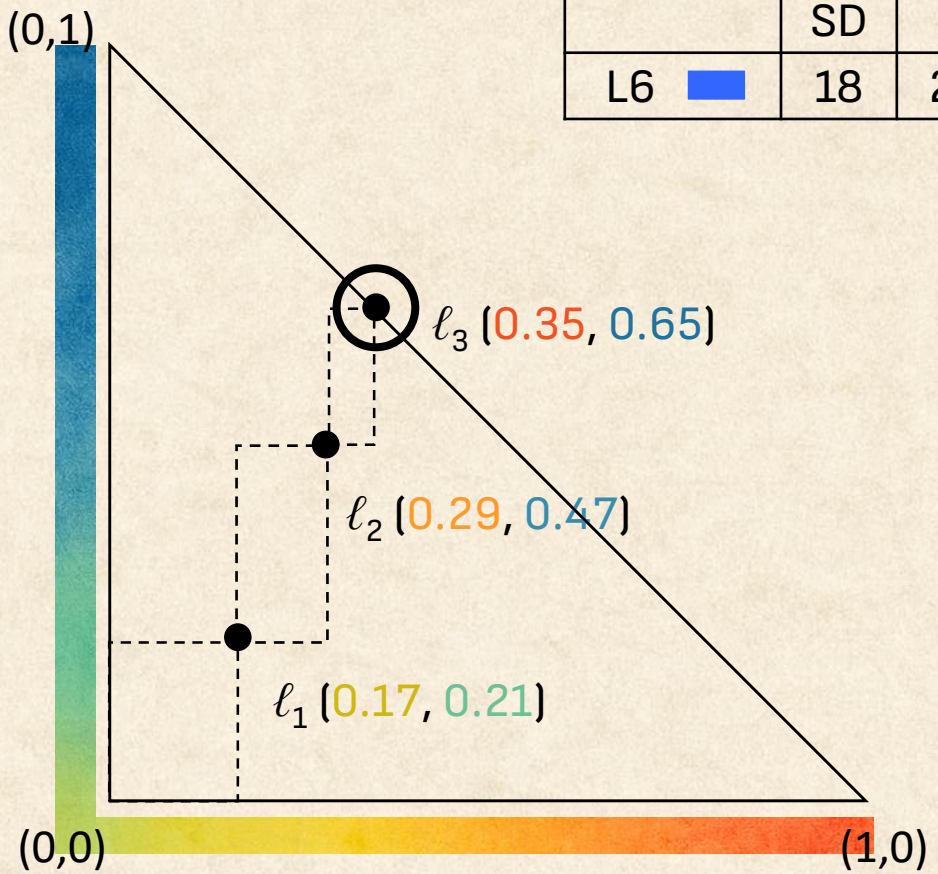


ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: L6

But this time let us do it differently!

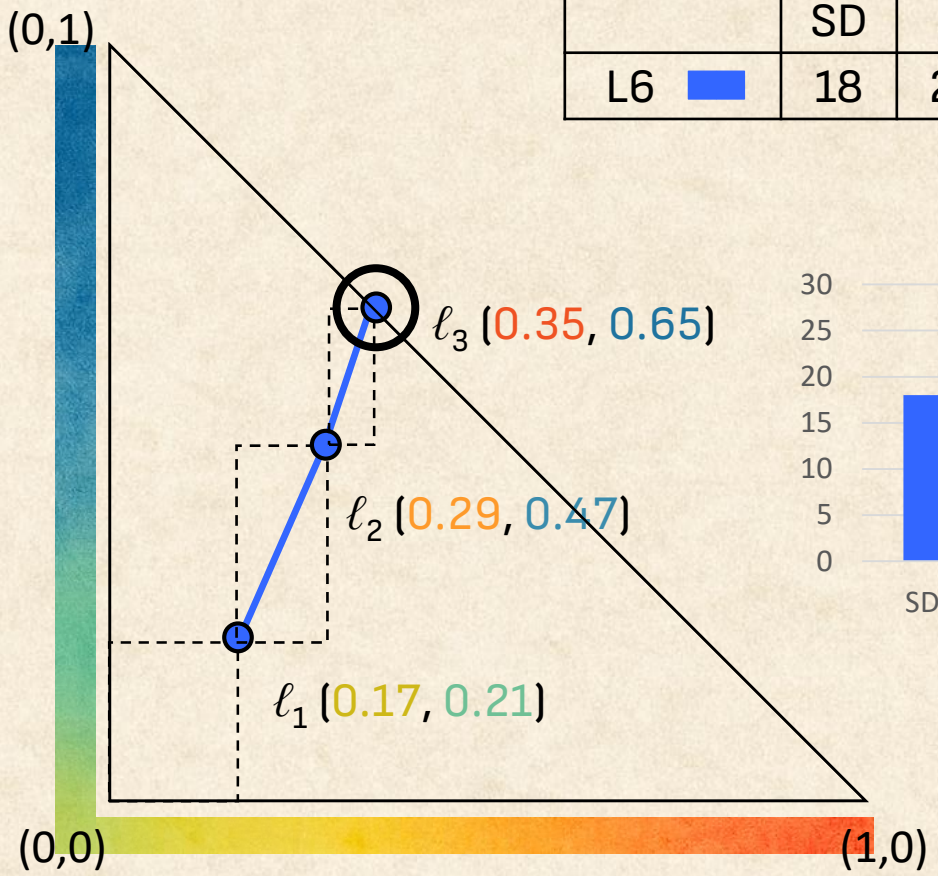
	SD	D	WD	N	WA	A	SA
L6	18	26	21	–	17	12	6

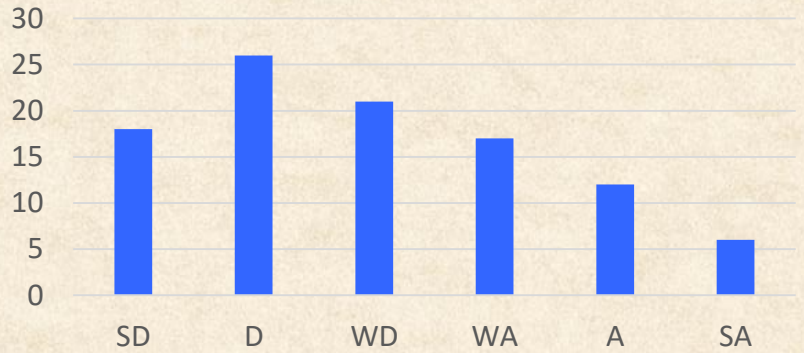


ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: L6

	SD	D	WD	N	WA	A	SA
L6	18	26	21	–	17	12	6

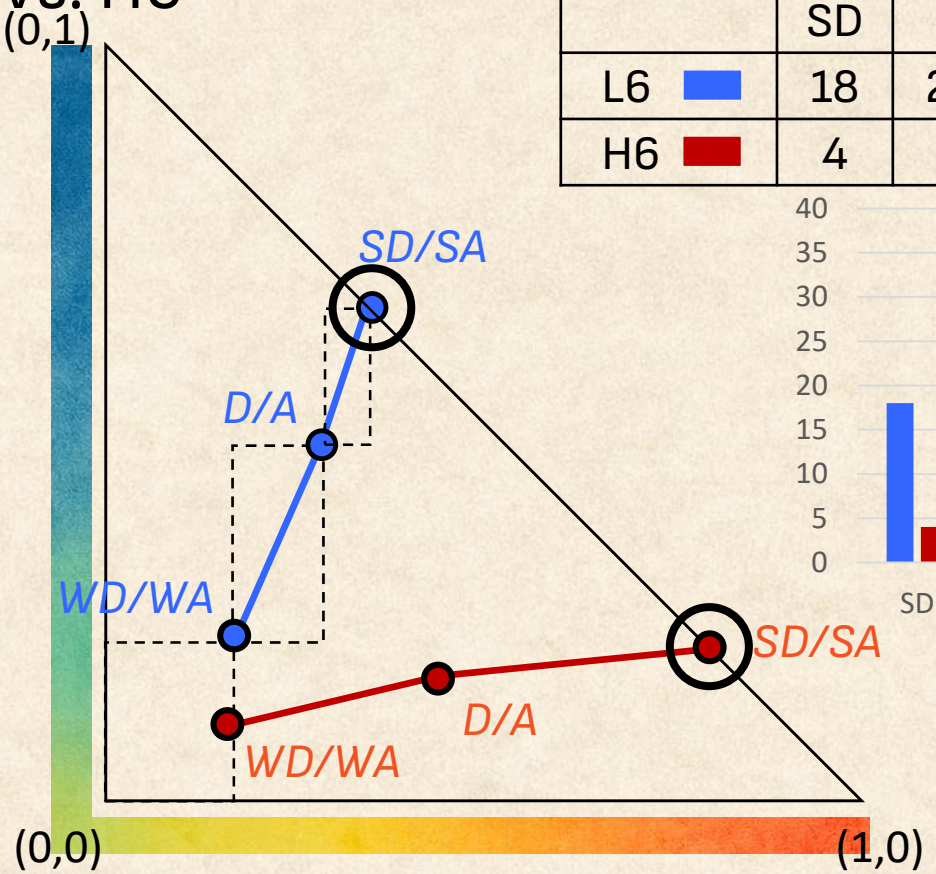




ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: L6 vs. H6

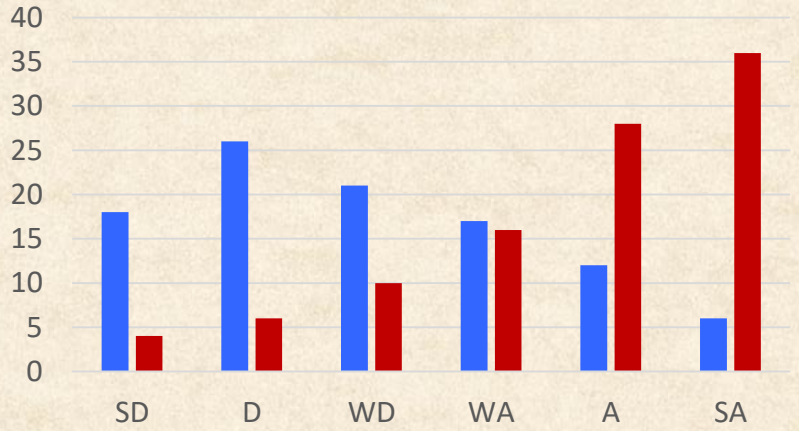
	SD	D	WD	N	WA	A	SA
L6	18	26	21	–	17	12	6
H6	4	6	10	–	16	28	36



ℓ_3 (0.35, 0.65)

ℓ_2 (0.29, 0.47)

ℓ_1 (0.17, 0.21)



h_3 (0.80, 0.20)

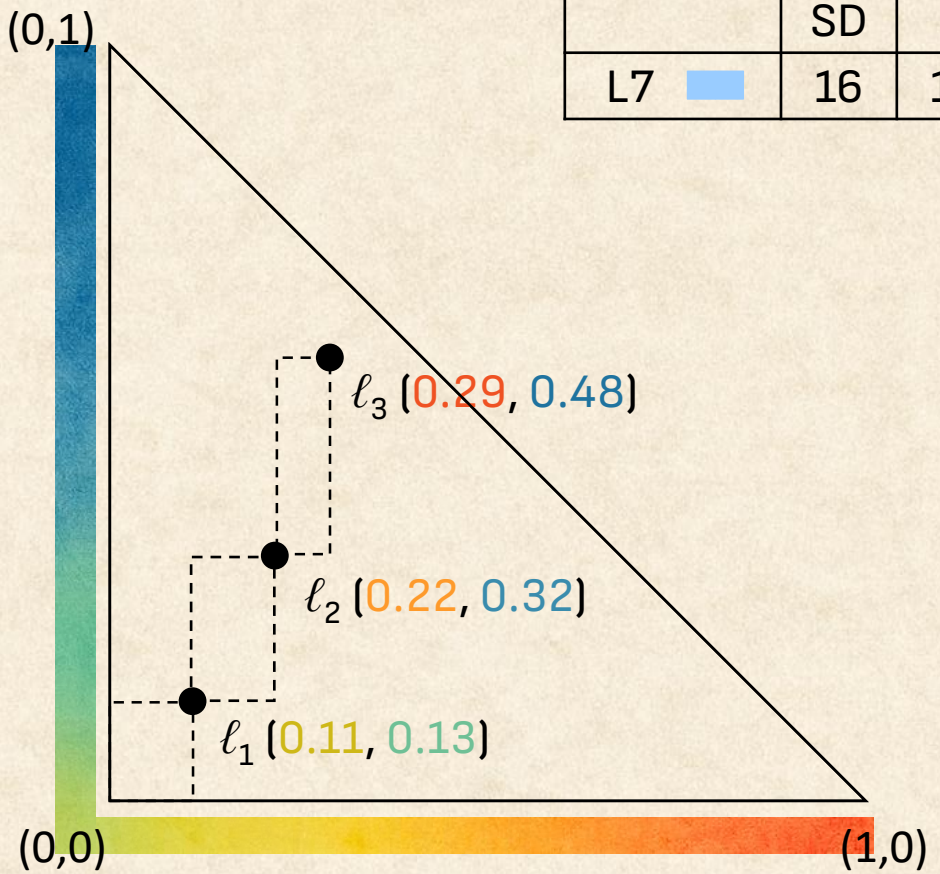
h_2 (0.44, 0.16)

h_1 (0.16, 0.10)

ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: L7

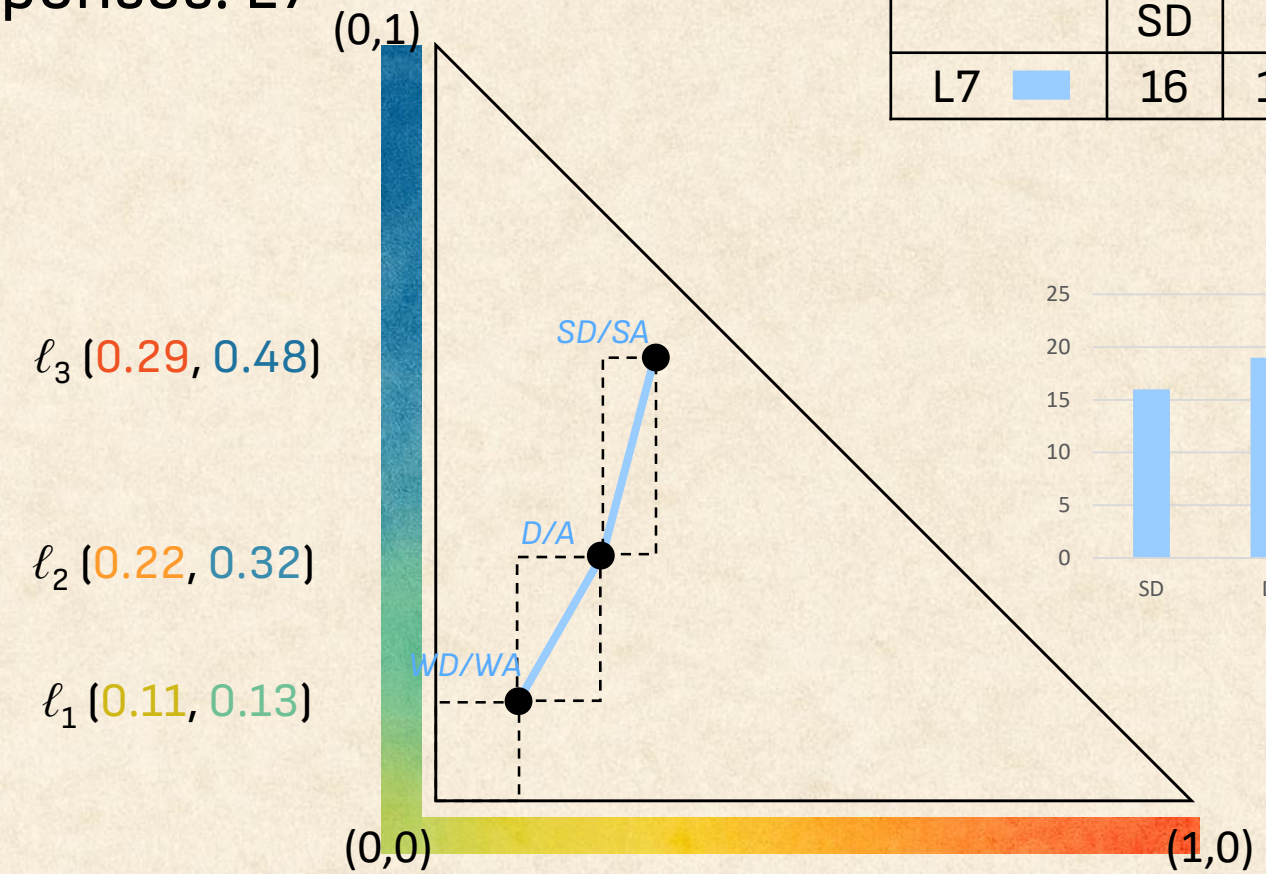
	SD	D	WD	N	WA	A	SA
L7	16	19	13	23	11	11	7

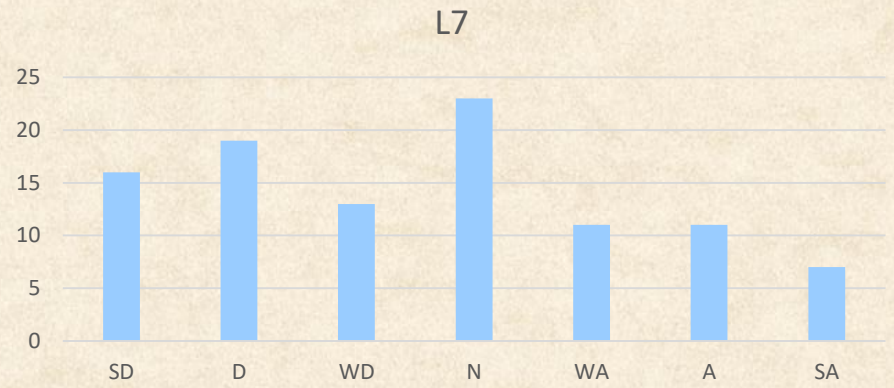


ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: L7

	SD	D	WD	N	WA	A	SA
L7	16	19	13	23	11	11	7





ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: L7 vs. H7

	SD	D	WD	N	WA	A	SA
L7	16	19	13	23	11	11	7
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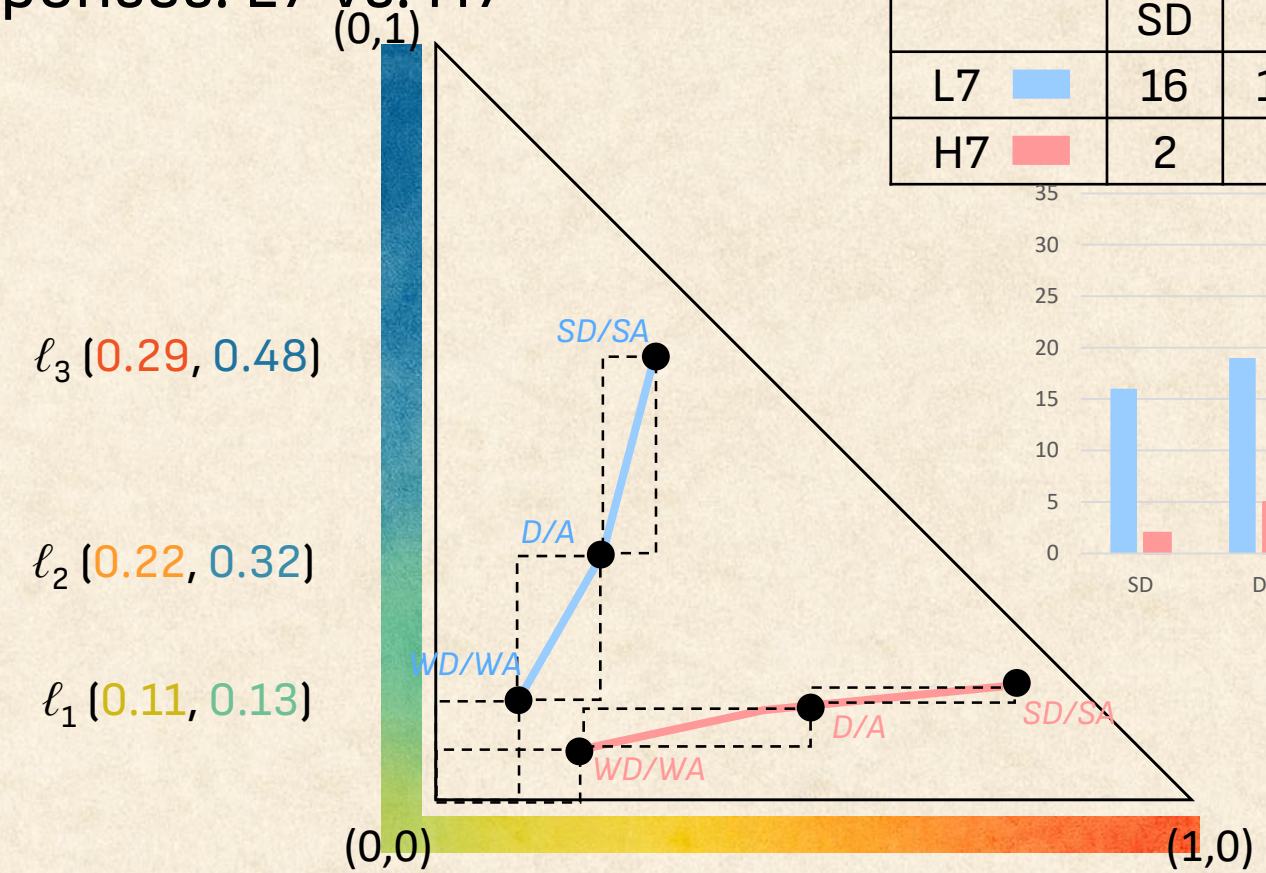
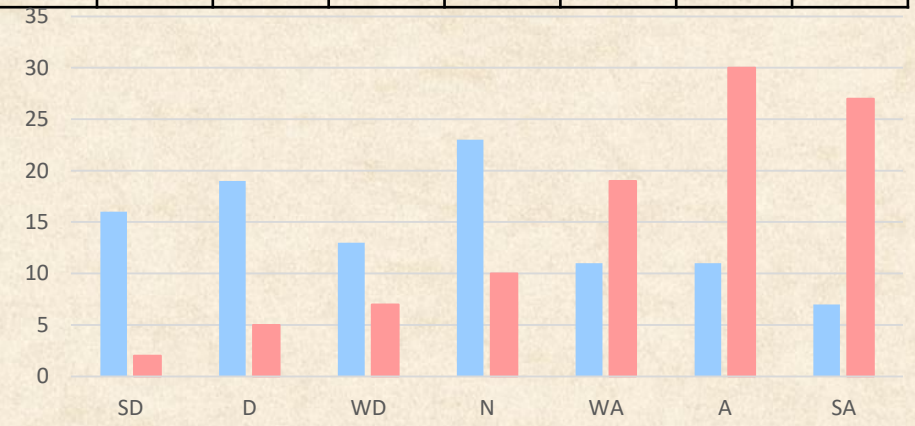


ℓ_3 (0.29, 0.48)

ℓ_2 (0.22, 0.32)

ℓ_1 (0.11, 0.13)



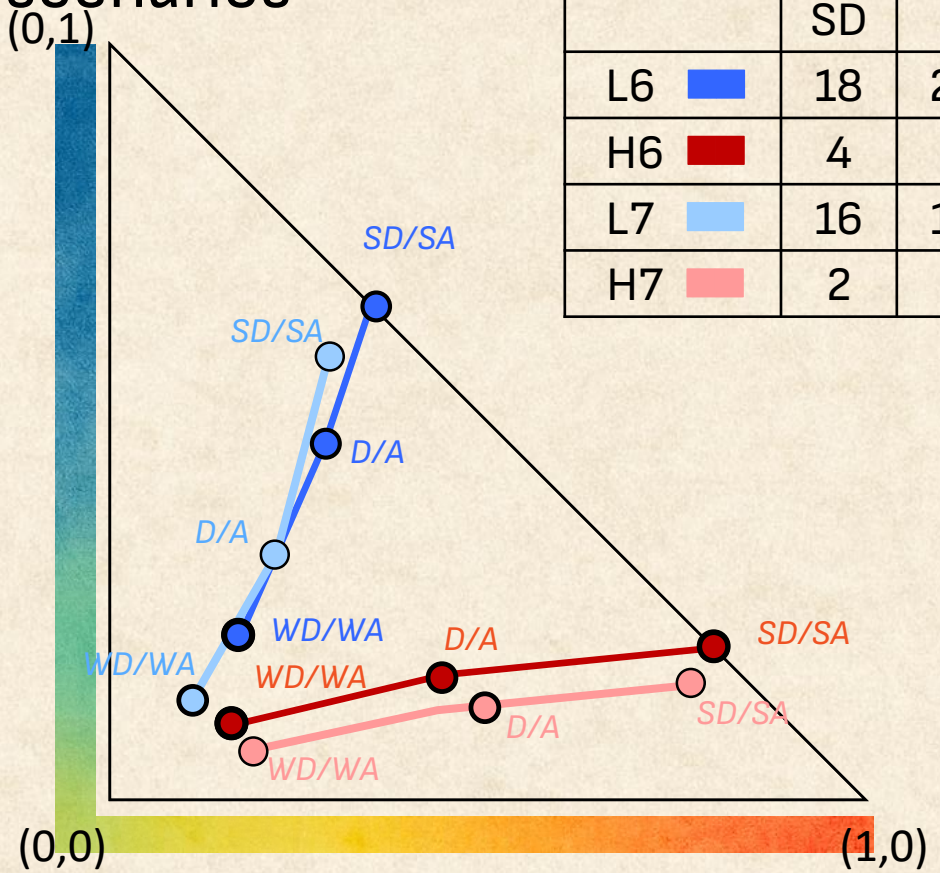
h_3 (0.76, 0.14)

h_2 (0.49, 0.12)

h_1 (0.19, 0.07)

ILLUSTRATIVE EXAMPLES: Blood donation attitudes

- Question: *Is donating blood a moral responsibility?*
- Responses: All scenarios



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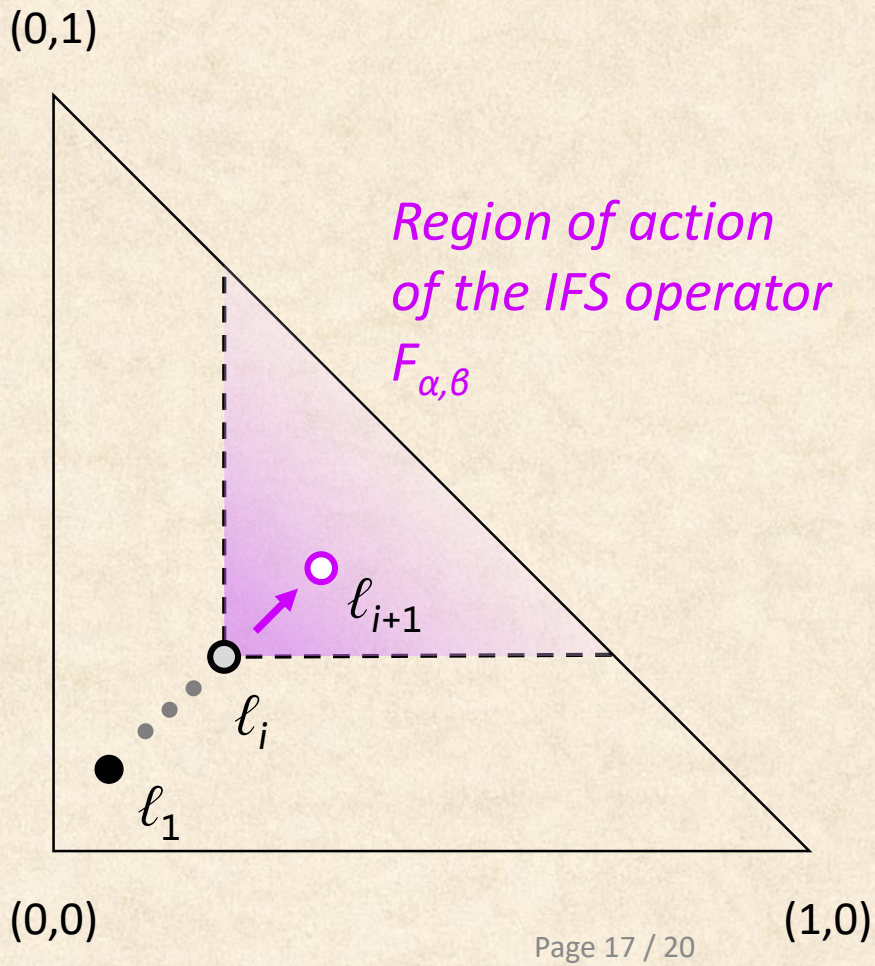
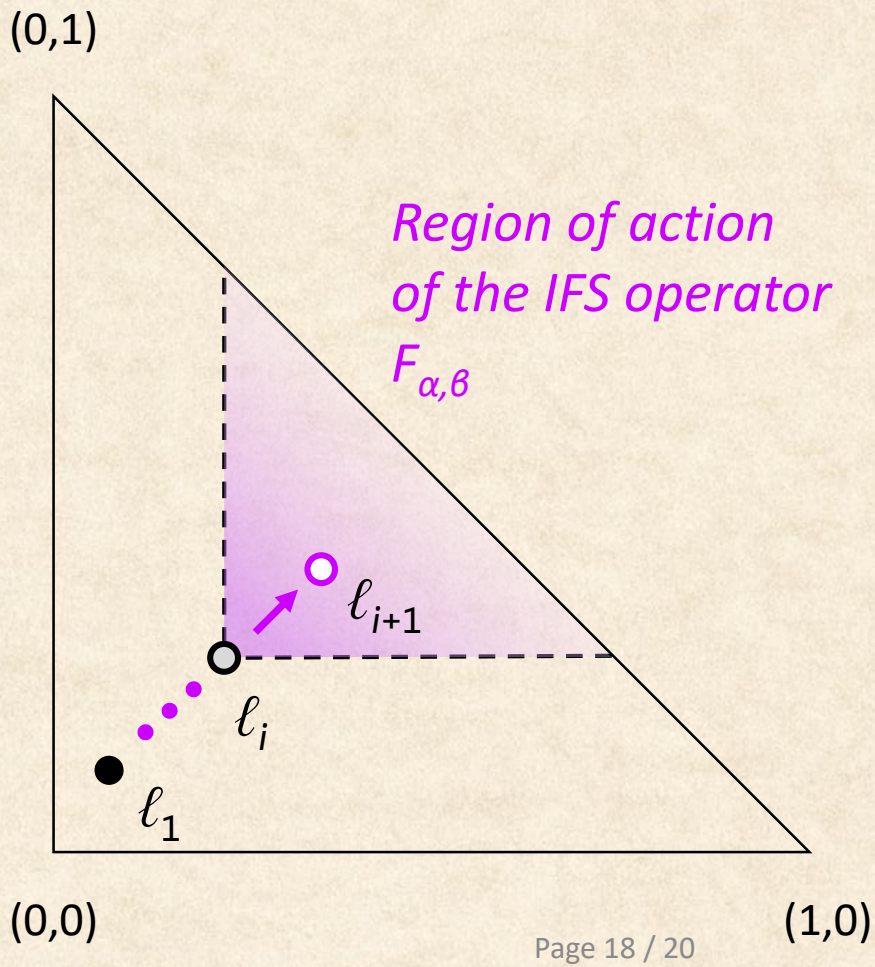
MAIN RESULTS: Likert Scales and Intuitionistic Fuzzy Sets

- Drawbacks and benefits:
  - x *n* response options but $\lfloor \frac{n}{2} \rfloor$ points
  - ✓ Information how the polar and other equidistant options are mutually connected
  - ✓ Constructed IF points sequencies (trajectories) require application of the IFS topological operators
    - ✓ Specifically in the Likert scale interpretation: operator $F_{\alpha,\beta}$



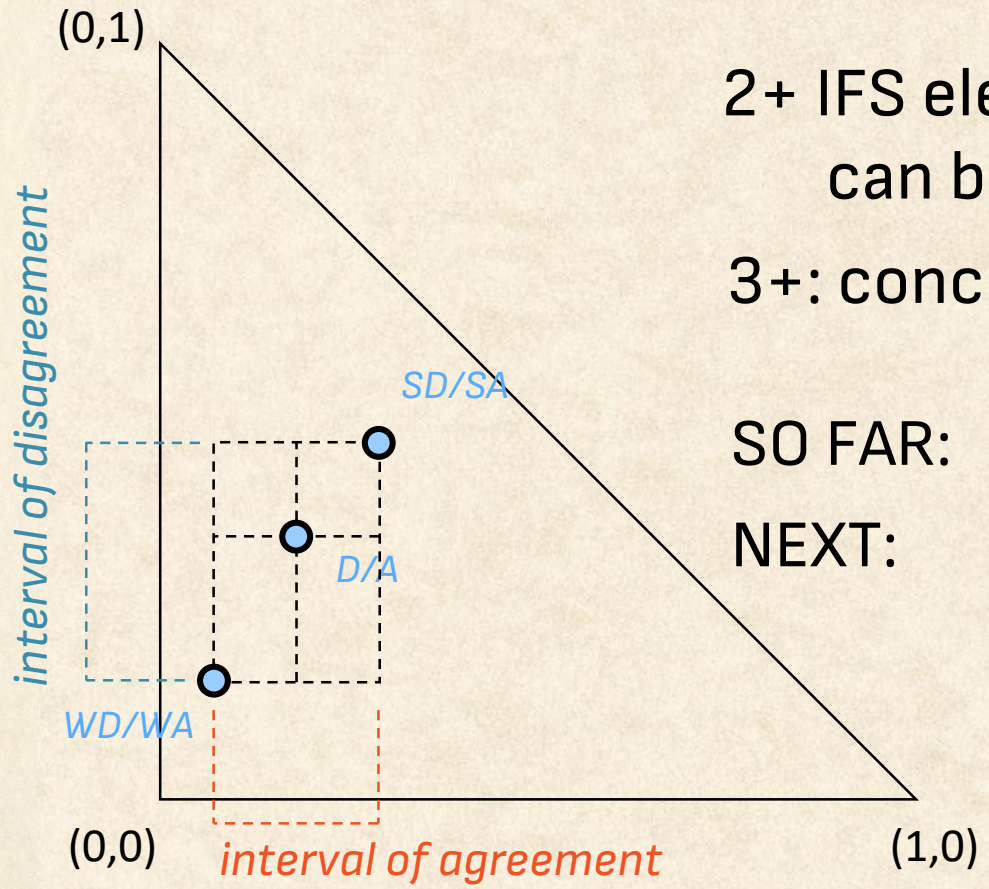
MAIN RESULTS: Likert Scales and Intuitionistic Fuzzy Sets

- Questions for research:
  - ✓ Effect of parity (with and without neutral midpoint)
  - ✓ Effect of granularity (number of Likert scale points)
  - ✓ IF points trajectories and their properties (concavity, monotonicity, etc.)
  - ✓ Extend the idea to IFS interpretation of different statistical distributions



MAIN RESULTS: Likert Scales and Intuitionistic Fuzzy Sets

- Getting the Interval-Valued Intuitionistic Fuzzy Sets into the picture:



2+ IFS elements (points) form intervals and can be interpreted as an IVIFS element

3+: concept of "nested IVIFS"

SO FAR: Same question / different cohort

NEXT: Same cohort / different questions

CONCLUSION

- The analytic and graphical interpretation of Likert scales by IFS can be helpful in analysis of attitudes, patterns and trends, specifically when considering indeterminacy.
- The proposed idea of constructing IF pairs from the Likert scale points / values may be worth applying to other survey tools different from LSs.
- Also, IFS interpretation of different statistical distributions can be tested using the same idea.

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Thank you for your attention!

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