

CrEx-Wisdom Framework for fusion of crowd and experts in crowd voting environment – machine learning approach

Ana Kovacevic^{1,2}, Milan Vukicevic¹, Sandro Radovanovic¹, Boris Delibasic¹

¹ University of Belgrade, Faculty of Organizational Sciences, Belgrade, Serbia

² Saga LTD, Belgrade, Serbia



Motivation

- Crowd-voting and Crowd-sourcing are used in:
 - Important societal problems
 - Participatory budgeting
 - Many industry problems
 - Sentiment analysis
 - Data labeling
 - Ranking and selection

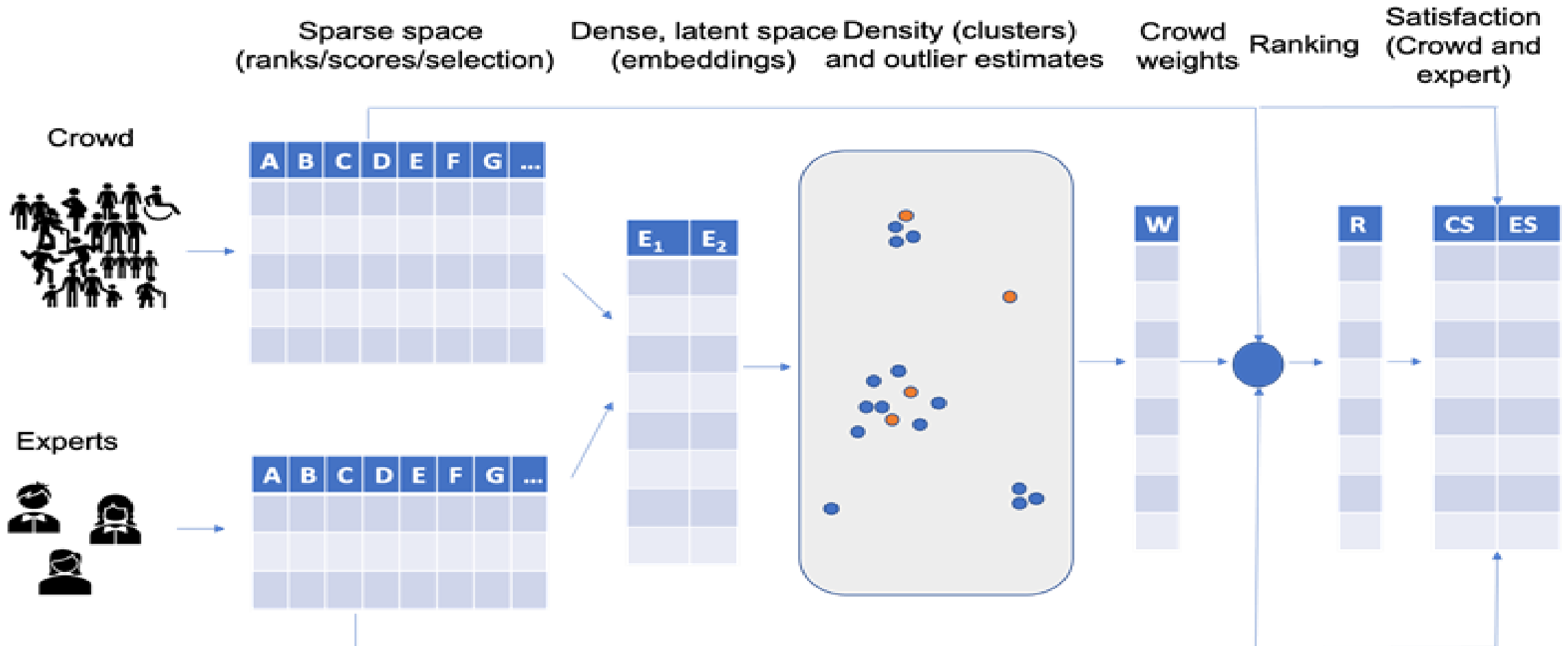


Main idea

- Exploit **expert knowledge**
- Use "**wisdom of crowd**"
- **Goal:** satisfy crowd while selecting "good quality" alternatives
- **Possible solution:** Framework for fusion expert/crowd voting



Framework for expert-crowd voting: CrEx-Wisdom



CrEx framework- Factorization

- Latent features identification phase matrix factorization algorithm Alternating Least Squares (ALS) is used

$$\hat{r}_{ui} = x_y^T \cdot y_i = \sum_k x_{uk} y_{ki}$$

- Loss function that we used is minimizing the square of the difference between all points in our data (D).

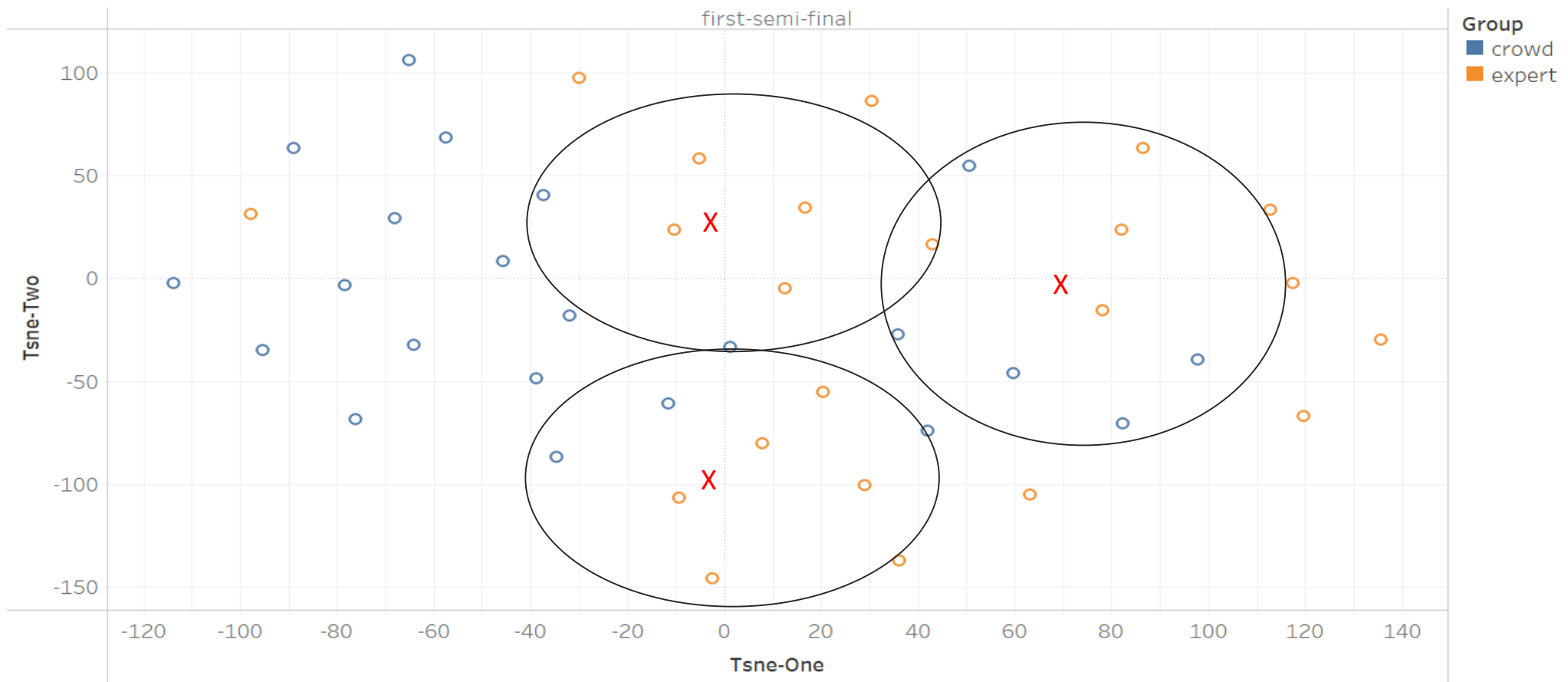
$$L = \sum_{u,i \in D} (r_{ui} - x_u^T \cdot y_i)^2 + \lambda_x \sum_u \|x_u\|^2 + \lambda_y \sum_u \|y_i\|^2$$

- Calculate user weights as similarities to experts



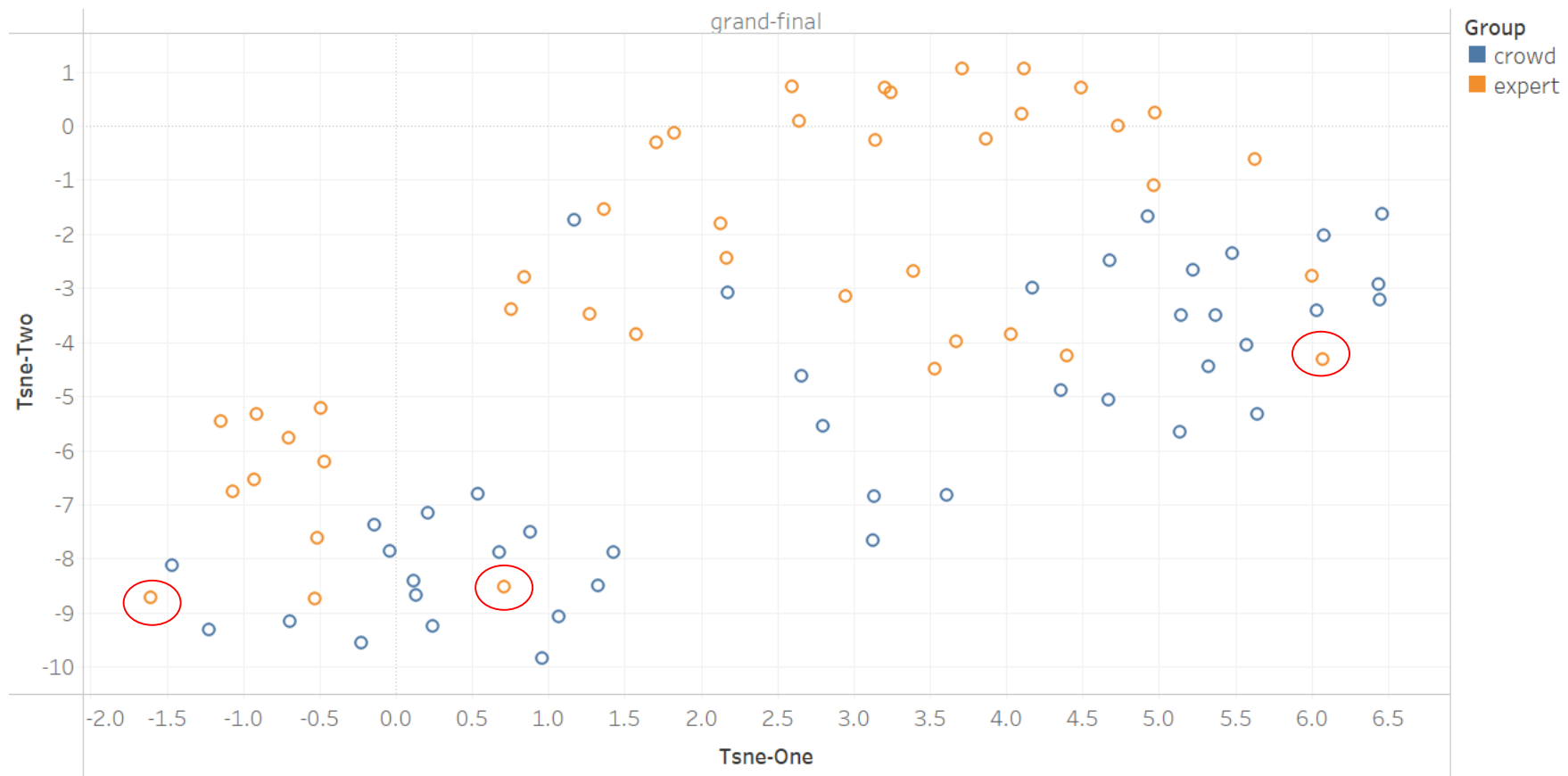
CrEx framework– Clustering

- **K-means** algorithm (clustering)
- Cluster quality measure - **Silhouette index**



CrEx framework – Outlier detection

Isolation forest (outlier detection) for estimation of voters agreement (density, variance)



Data

- Euro Song Contest
- Every county has **Expert** voting and **Crowd** voting
- Three years included (2016, 2017, 2018)
- Three different types of events (grand final, and two semifinal)

Crows voting

Voter id	Serbia	Germany	Italy	Finland
Serbia		8	12	
Germany	10		8	
Italy	8	10		12
Finland	8	10		
SUM	26	28	20	12

Expert voting

Voter id	Serbia	Germany	Italy	Finland
Serbia		10		8
Germany	8		10	12
Italy	12	10		8
Finland		12	10	
SUM	20	32	20	28



Experimental setup

- Two benchmarks:

1. **Current Eurovision weighting method**

- Crowd votes and expert votes are aggregated separately
- Points are summarized and implicitly evenly weighted (50% each)

2. **Simple “Single Weighting Crowd” method**

- Calculate similarity for each crowd participant to every expert,
- Find maximum similarity value and use it as the weight of a particular voter
- Multiplied votes with its calculated weight,
- Weighted crowd data is summarized together with expert votes in order to get final winning ranking



Evaluation

- Satisfaction can be defined as Average difference in points .

$$avg PD = \frac{1}{m} \sum_{i=1}^m \sum_{j=1}^n |x_{wj} - x_{ij}|$$

Where:

m – number of voters

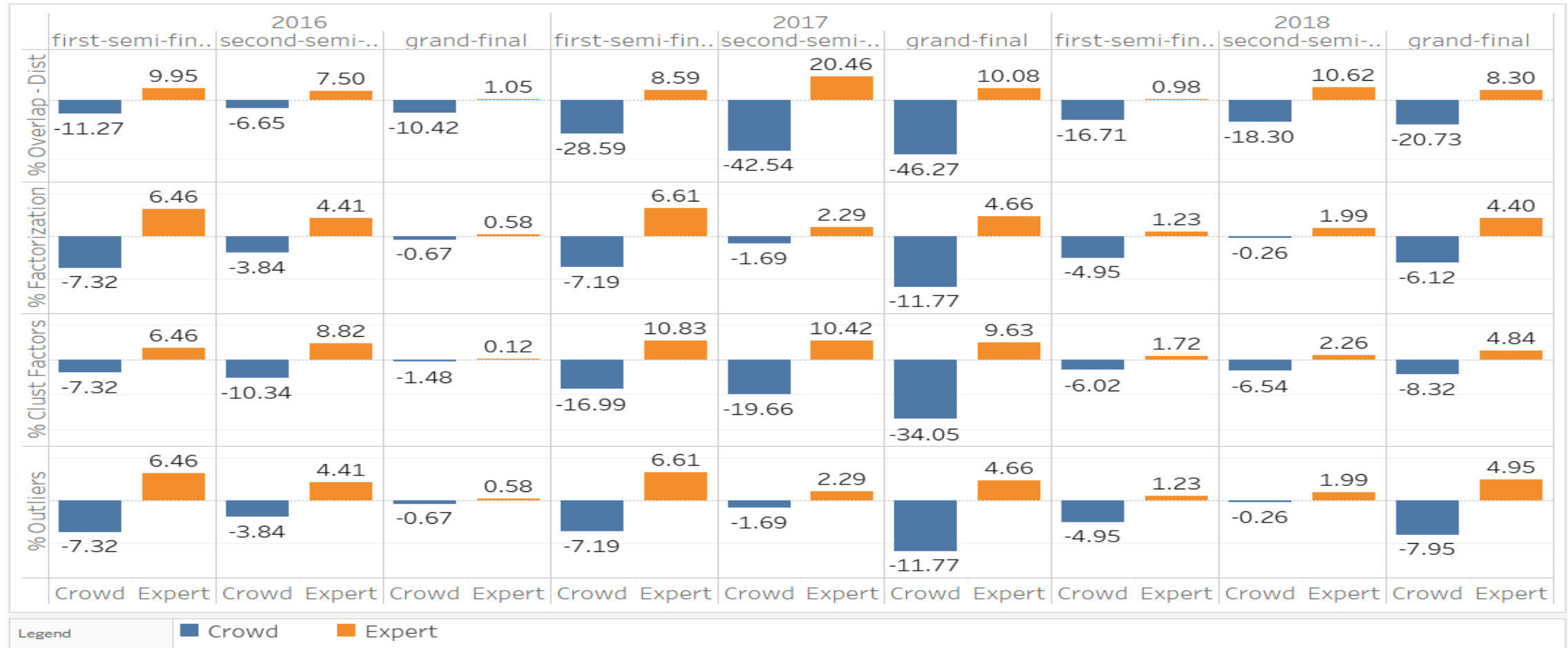
n – number of alternatives

x_{wj} - winning alternative points at rank j

x_{ij} - alternative points of i -th user at rank j



Results



Results

Year	Event type	OVERLAP	FACTORIZATION	CLUST-FACTORS	OUTLIERS
2016	first-semi-final	1.13	1.13	1.13	1.13
2016	grand-final	9.90	1.15	12.64	1.15
2016	second-semi-final	0.89	0.87	1.17	0.87
2017	first-semi-final	3.33	1.09	1.57	1.09
2017	grand-final	4.59	2.53	3.54	2.53
2017	second-semi-final	2.08	0.74	1.89	0.74
2018	first-semi-final	17.00	4.03	3.50	4.03
2018	grand-final	2.50	1.39	1.72	1.61
2018	second-semi-final	1.72	0.13	2.90	0.13



Conclusion

- Proposed CrEx framework for integration of expert and crowd votes
 - Weighting of crowd voters on the individual level,
 - Representation of votes in latent space,
 - Estimation of consensus level between voters (clustering and outlier detection)
- Compromise between crowd and experts



Future work

- Evaluate more machine learning methods for embedding of votes in latent spaces, clustering and outlier detection.
- Validate approach against different voting data (e.g. curriculum creation, best paper awards etc.) where we expect less bias and more consistent voting from experts.



Thank you!

