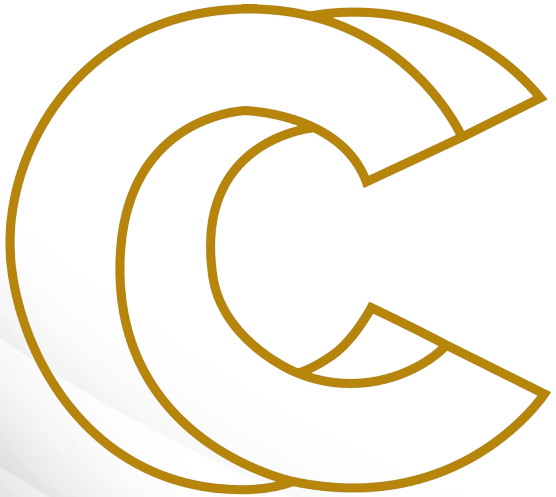
AI Meets Computational Social Science



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Institute of Physics Belgrade, NCC Serbia

About me: current roles

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INSTITUTE OF PHYSICS BELGRADE

Research Professor

Scientific Computing Laboratory

Head

Innovation Center Institute of Physics Belgrade

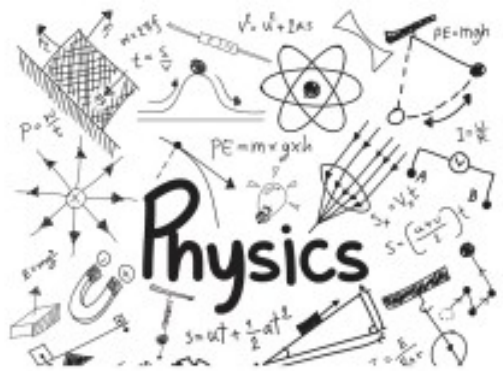
Lecturer at MSc:
Computing in Social Sciences,
Advanced Data Analytics

AI Lead

HPC SERBIA

Industry Champion

About me: my true passion



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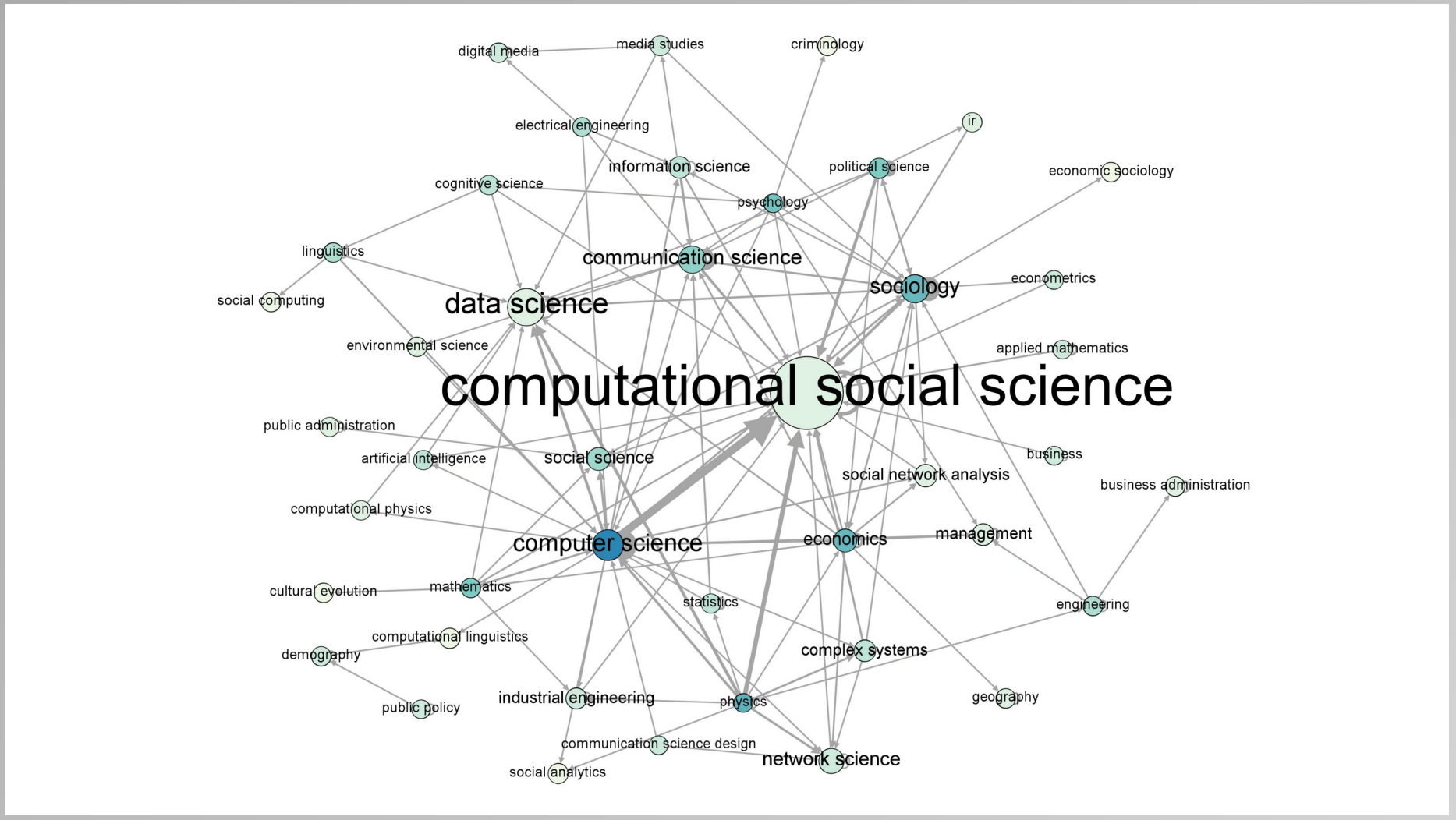
Computational Social Science - CSS



Source: https://communities.springernature.com/posts/computational-social-science-heralds-the-age-of-interdisciplinary-science

Artifical Intelligence - AI

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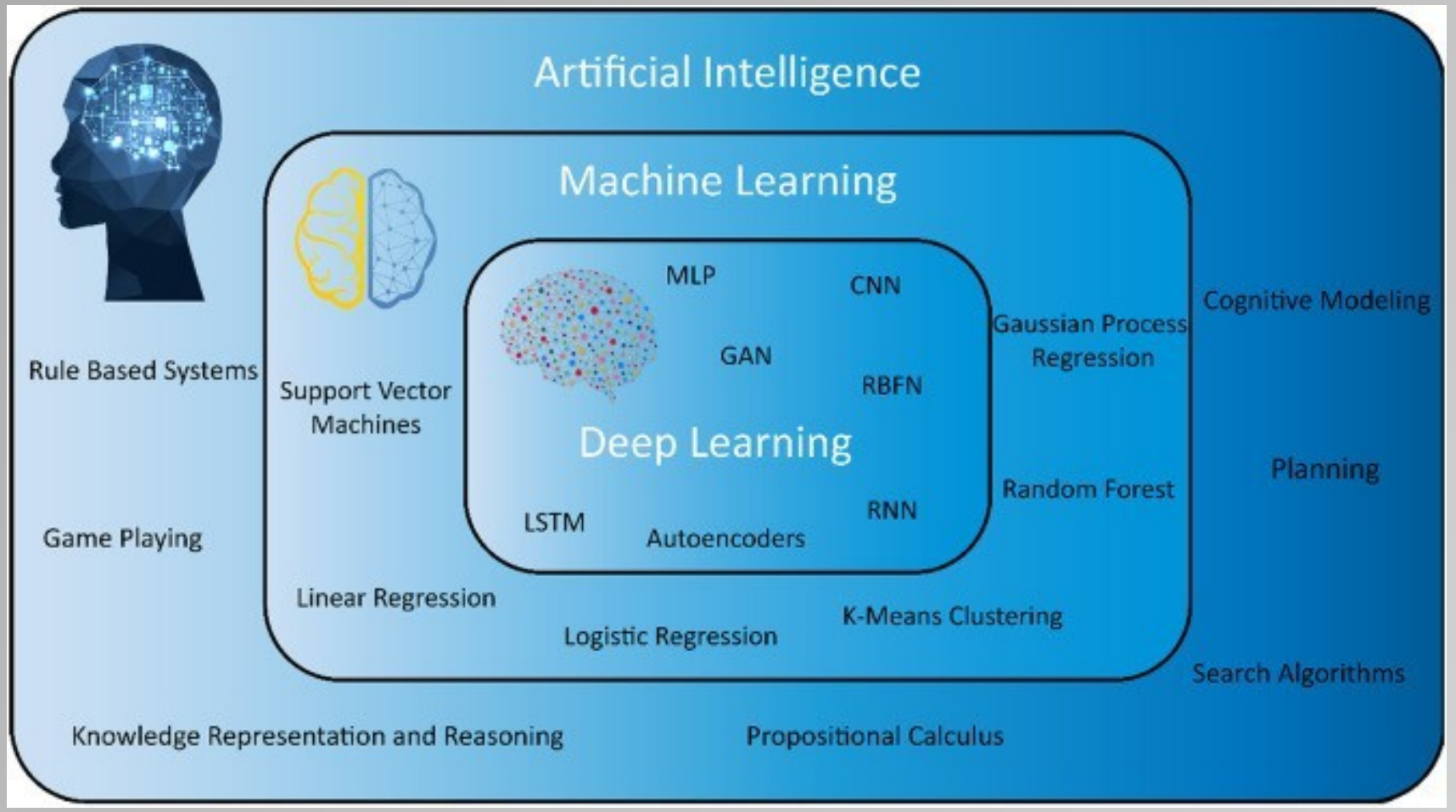

Source: https://www.linkedin.com/pulse/artificial-intelligence-automation-shaping-future-global-economy-6d1xe/

CSS beginnings

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- Physics and social sciences – more than 2 centuries long relationship
- Modeling social systems using physics and computer science models: Santa Fe Institute
-
- Early 21st century:
  - Web 2.0 – great data source
  - Computational resources
  - Physicists and computer scientists – more interested in social sciences
  - Social scientists became more interested in computational sciences

Our approach

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- **Empirical analysis -** Quantify collective behavior using methods of complex network theory and statistical physics to analyze empirical data
- **Agent-baed modeling -** data driven agent-based model of human interactions
- **Experiments -** in lab, controlled experiments with selected group of participants

Cyberemotions project

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- **Cyberemotions – Collective emtions in cyberspace –** project about the role of collective emotions in creating, forming and breaking-up e-communities
- **EU FP7 Funded project** from 2009-2013
- **Consortium:** 8 research organizations from Poland, Germany, Austria, United Kingdom, Slovenia
- **Datasets**: BBC Blog, Twitter, Digg, MySpace, IRC channels (with emotional content of messages)
- **Models:** Agent based models of emotional agents, **SentiStrength (** **https://mi-linux.wlv.ac.uk/~cm1993/sentistrength/**)
- SentiStrength classified London Olympics tweets with the results put up in lights on the EDF Energy London Eye

General structure of data

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Data:

- High-temporal resolution
- **User (U) :** unique ID; details about activity;
- **Posts/Comments (P/C):** posting time; ID's of connected users; texts;
- **Emotions (E):** Emotional content of text - 1 -positive, 0 - neutral, −1 negative, (-1,-5) - negative and (1,5) - positive

Emotion classifier

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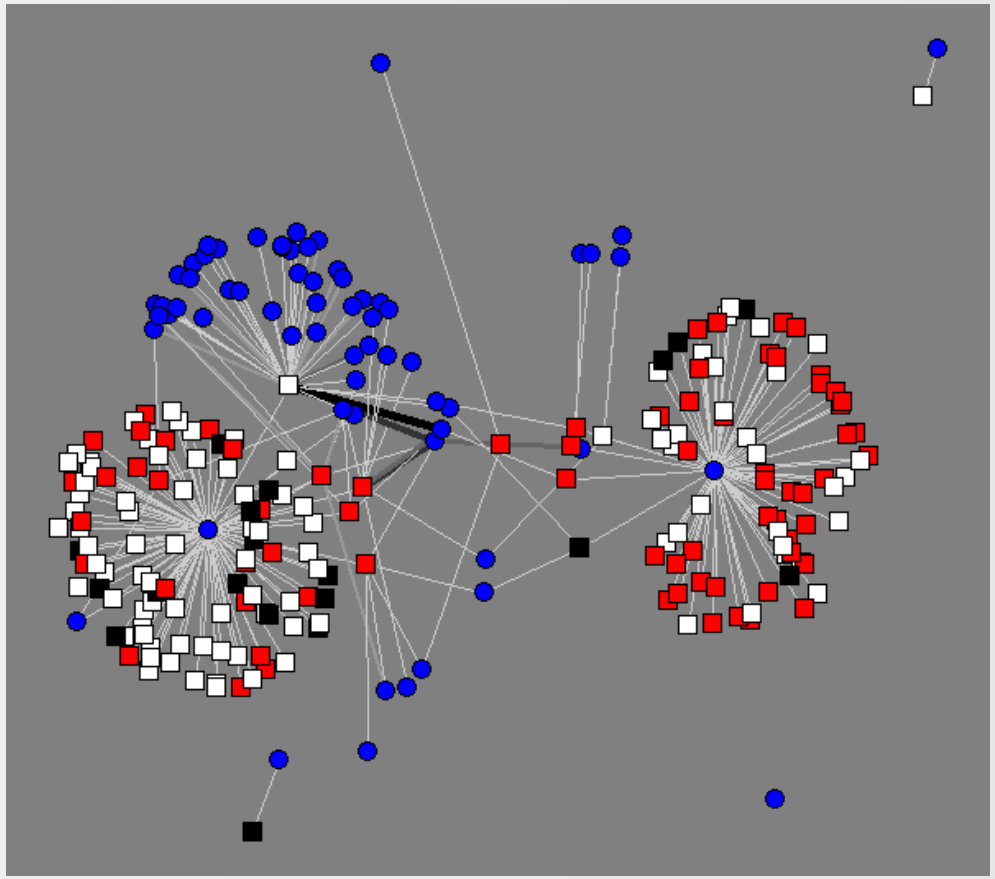
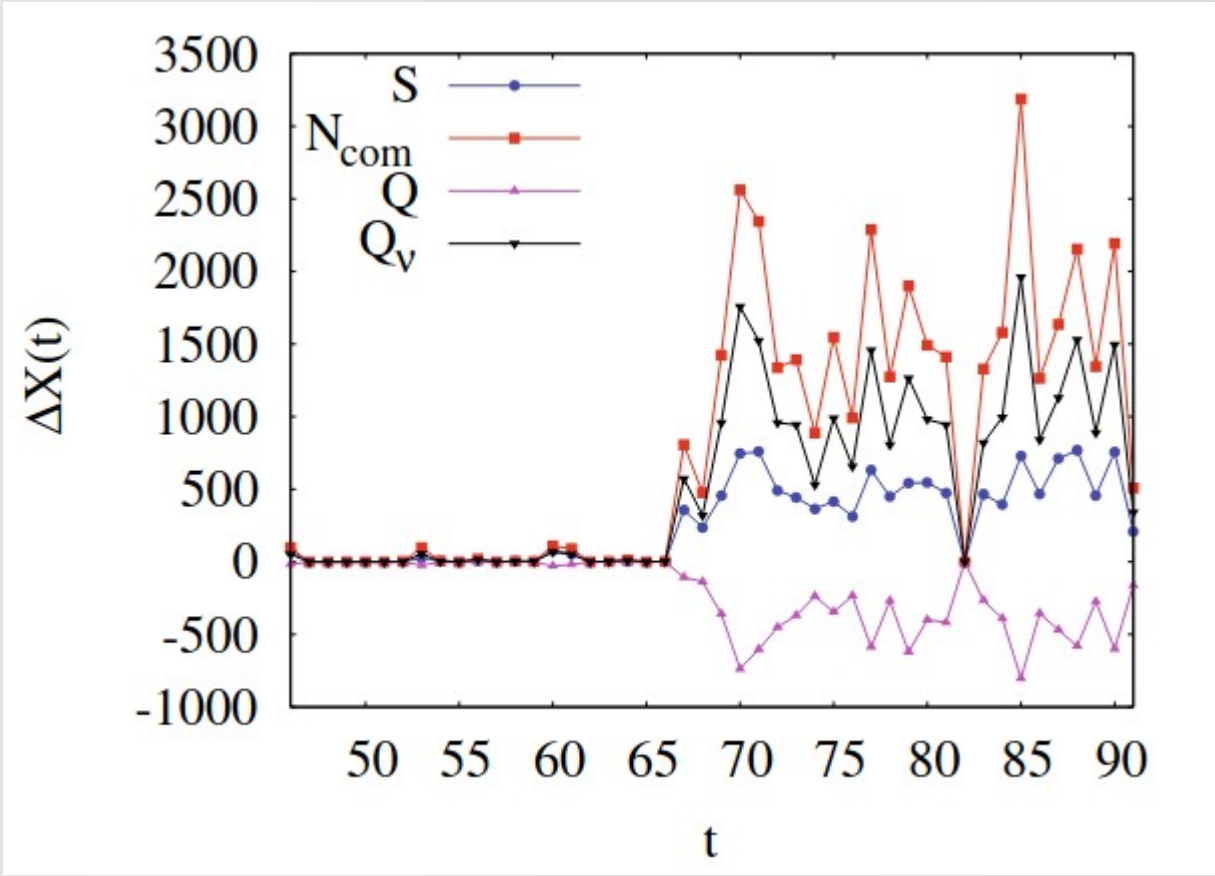
- **Extraction of emotions** – a classification problem

Datasets: BBC Blogs (June 2007-February 2009) posts – 3792, comments 80873, users – 21462; **Digg** (February 2009 – April 2009) posts – 3984, comments – 917708, users - 82201

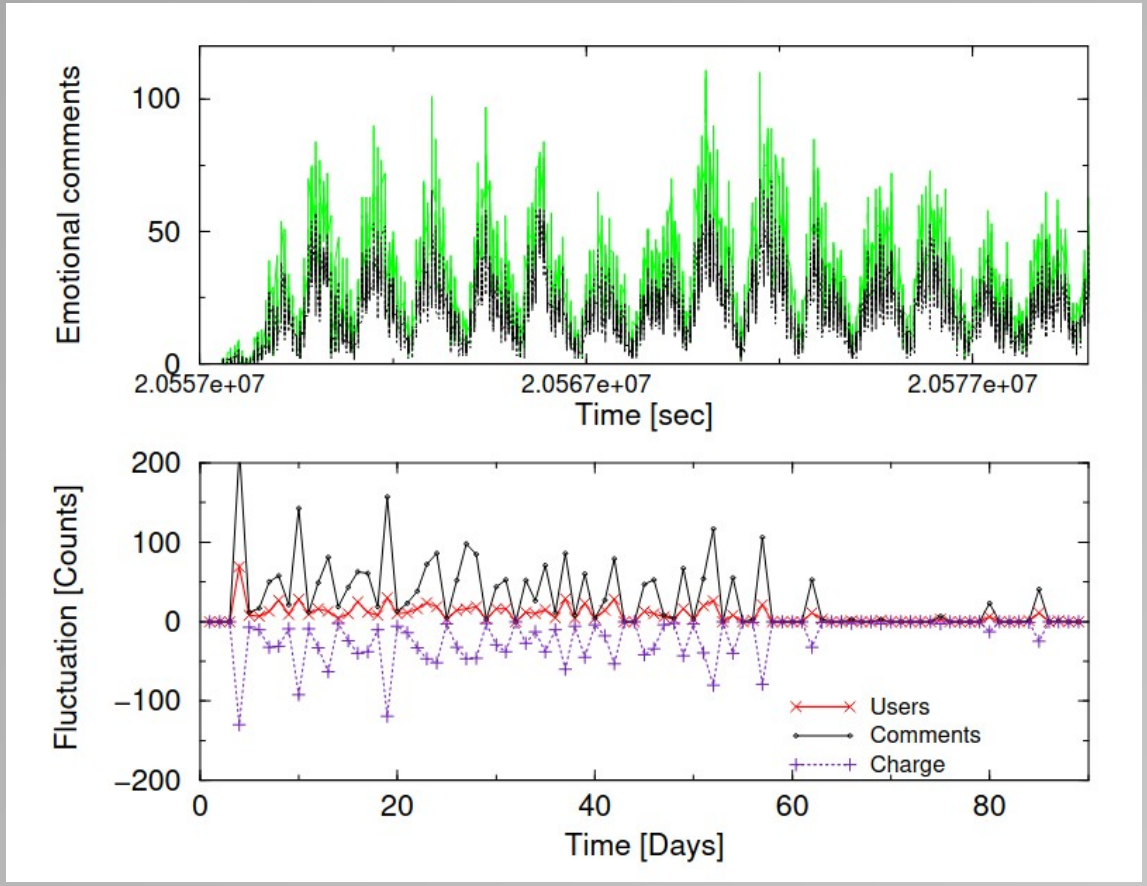
- **Supervised:**
  - document D – objective or subjective, positive or negative
  - language model classifier
  - D represented by tokens, n-gram approximation
  - BLOGS06 dataset – 16 481 – objective, 7930 – negative documents, 9 968 – positive
  - 70% accuracy

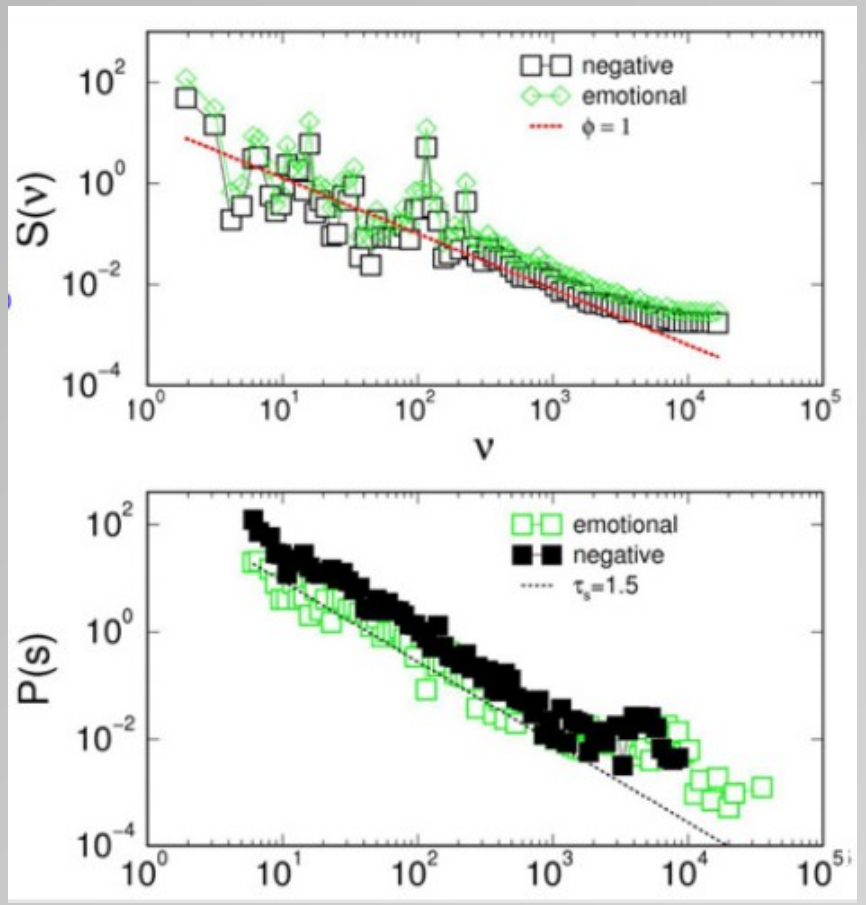
Popular BBC Blogs





Discussion driven Diggs - SOC





CTRUST project

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CTRUST - Topology-derived methods for the analysis of collective trust dynamics – project about understanding rise and fall of collective trust in online communities

Science Fund Republic of Serbia – PRIZMA program

Consortium: Institute of Physics Belgrade, Faculty of Philosophy Novi Sad, Institute of Nuclear Science VINČA

Datasets: MADOC: Multi-Platform Aggregated Dataset of Online Communities
https://zenodo.org/records/14637314

Empirical analysis: scripts and resutls available on Github

Agent-based modeling: models and scripts available on Github

Science Fund of the Republic of Serbia

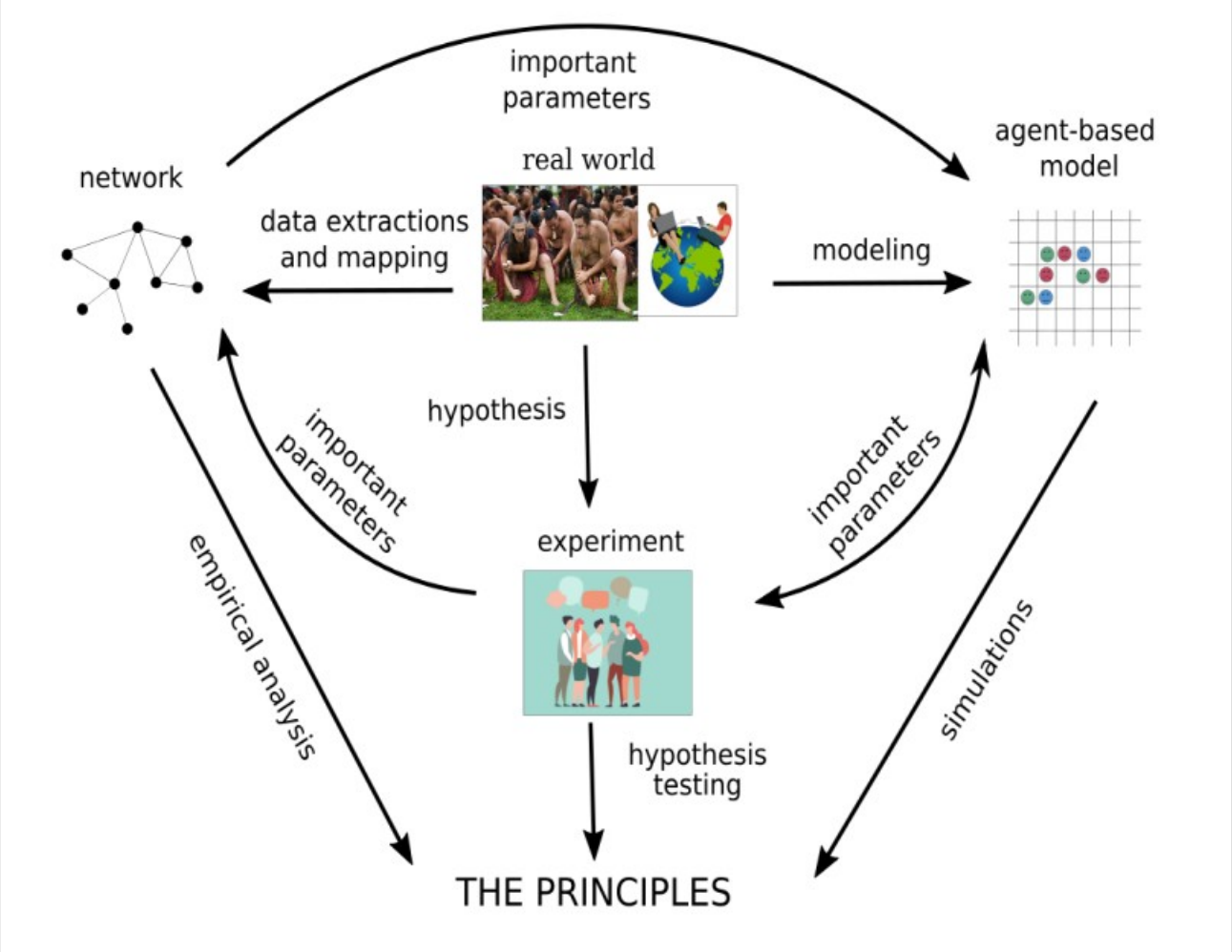
CTRUST

INSTITUTE OF PHYSICS BELGRADE

ФИЛОЗОФСКИ ФАКУЛТЕТ · НОВИ САД

www.ctrust.ac.rs

CTRUST approach



MADOC dataset

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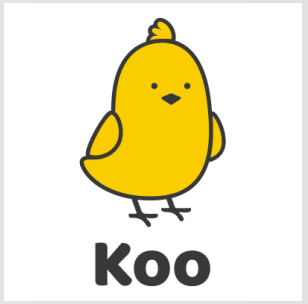

MADOC dataset: 18.9M posts, 236M comments, 23.1M users

AI usage: topic alignment, sentiment analysis

Application: collective trust, community dynamics, migration of users between platforms, toxic behavior

Paper: **https://arxiv.org/abs/2501.12886**, accepted at ICWSM‘25
https://www.icwsm.org/2025/index.html

Source: **https://zenodo.org/records/14637314**

MADOC: topic alignment

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- **Groups from Reddit and VOAT**: funny, gaming, gifs, pics, videos, technology, fatpeoplehate, GrateAwakening, MillionDollarExtreme, CringeAnarchy, KokatuInAction, MensRights

- **Topic alignement for Koo and Bluesky:**
  - - combined communities from Reddit and VOAT for each group
  - - removed: stop words, common words (occuring in more than 99%), removed documents with less than 20 and more than 2000 words
  - - Latent Dirichlet Allocation – determined topics within each group and corresponding 20 keywords
  - **-** unique set of words per group - filtered to retain only the least frequen English words
  - - **basic filter:** documents containing at least one community keyword
  - - **strict filter**: documents containing at least two different community keywords

MADOC: sentiment

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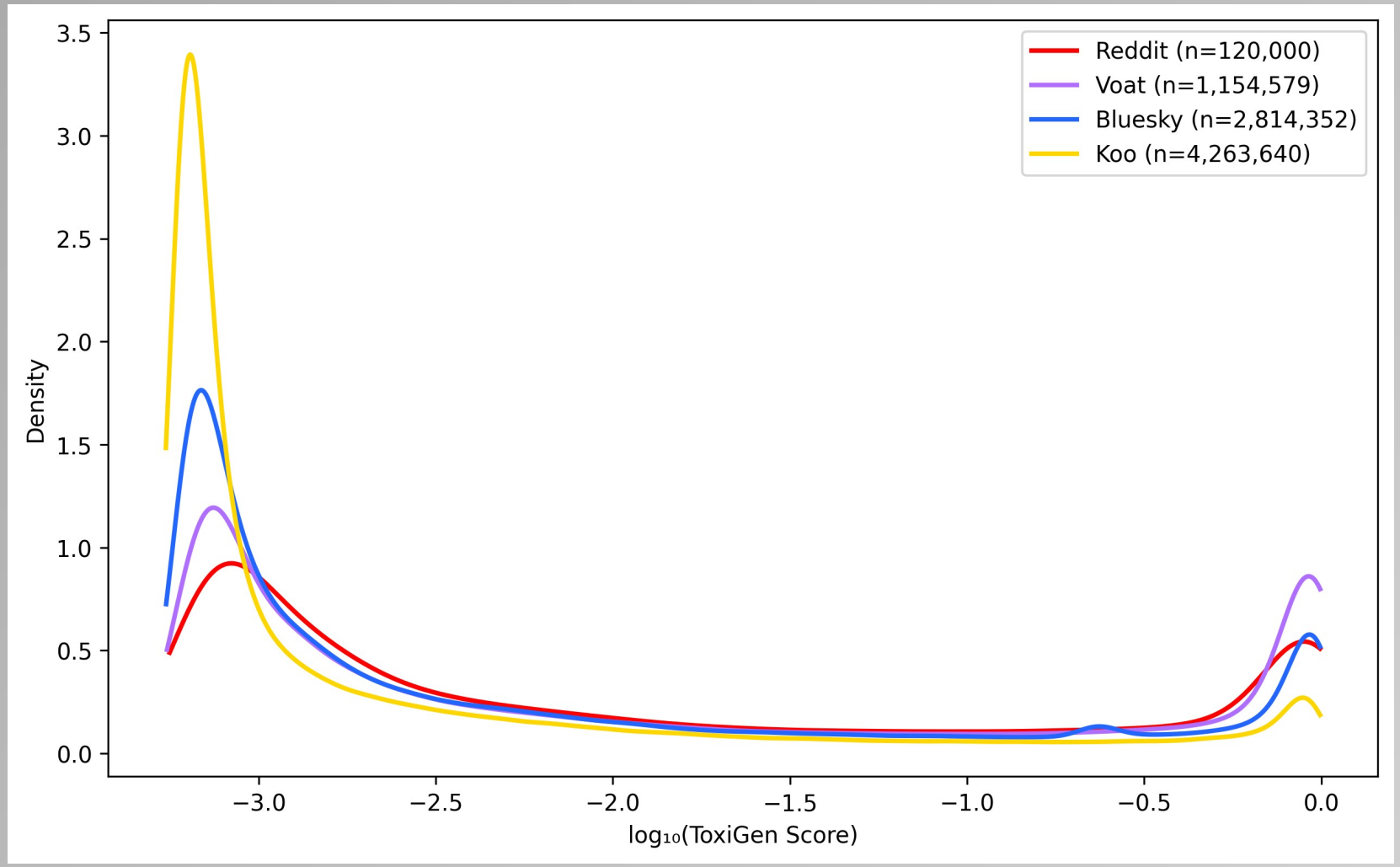
- **VADER:** sentiment of posts and comments
  - VADER (Valence Aware Dictionary and sEntiment Reasoner) is a lexicon and rule-based sentiment analysis tool that is specifically attuned to sentiments expressed in social media
  - https://github.com/cjhutto/vaderSentiment
  - for each post/comment we provided compound value between -1.0 and 1.0

- **TextBlob:**
  - TextBlob: Simplified Text Processing – python library for text processing
  - https://textblob.readthedocs.io/en/dev/
  - for each post/comment we provide polarity between -1.0 and 1.0, and objectivity between 0.0 (objective) and 1.0 (subjective)

- **ToxiGen RoBERTa:**
  - used to detect implicit hate speech
  - https://huggingface.co/tomh/toxigen_roberta
  - toxicity between 0.0 (non-toxic) to 1.0

MADOC: statictics



CSS and LLMs

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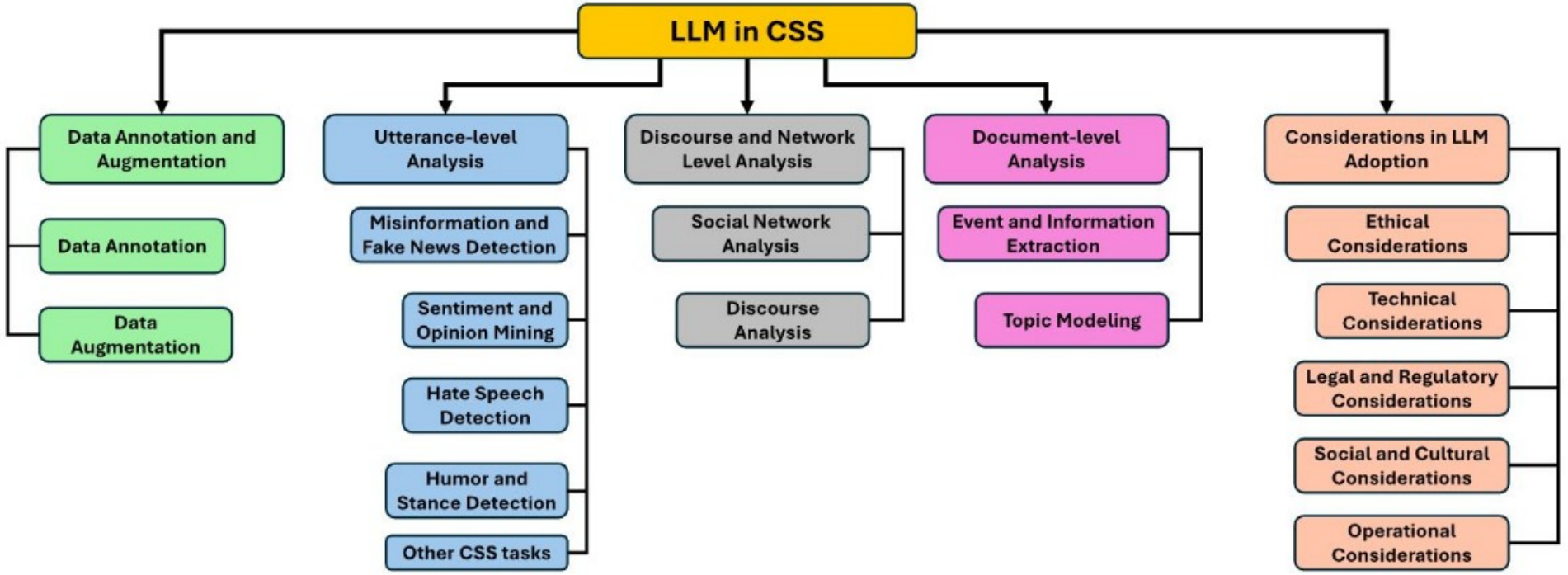

Thapa, S., Shiwakoti, S., Shah, S. B., Adhikari, S., Veeramani, H., Nasim, M., & Naseem, U. (2025). Large language models (LLM) in computational social science: prospects, current state, and challenges. *Social Network Analysis and Mining*, *15*(1), 1–30. https://doi.org/10.1007/s13278-025-01428-9

Agent-based modeling before LLMs

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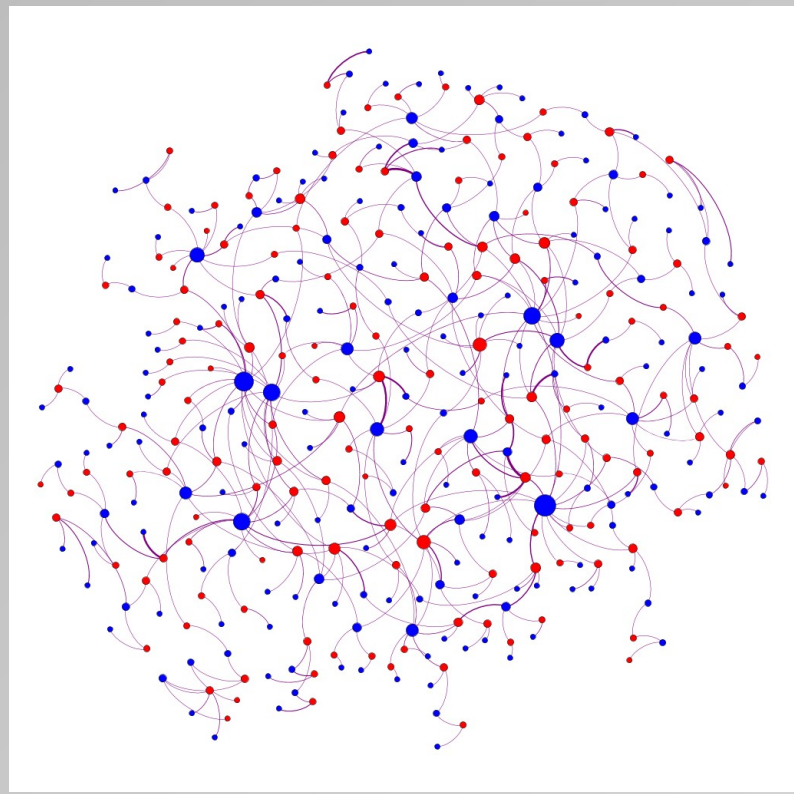
Agent‘s state defined by equation and interact through evolving networks network of posts and users

$$a_i(t+1) = \begin{cases} (1-\gamma_a)a_i(t) + [h_i^a(t) + qh_{mf}^a(t)](d_1 + d_2(a_i(t) - a_i(t)^2))(1-a_i(t)) & \text{if } \Delta t_i < 1 \\ (1-\gamma_a)a_i(t) & \text{otherwise} \end{cases}$$

$$v_i(t+1) = \begin{cases} (1-\gamma_v)v_i(t) + [h_i^v(t) + qh_{mf}^v(t)](t)(c_1 + c_2(v_i(t) - v_i(t)^3))(1-|v_i|) & \text{if } \Delta t_i < 1 \\ (1-\gamma_v)v_i(t) & \text{otherwise} \end{cases}$$



Toy-like models

Pro: simple enough to understand rough picture

Cons: very far from realistic situations and hard to directly compare with empirical results

Agent-based modeling with LLMs

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LLMs revolution in agent-besed modeling:

- LLMs as agents – several agent types

- platforms that recreate specific setting: X, Reddit, other platforms

- other parameters to make the systems more realistic

- simulation of real systems, scenario testing, synthetic data creation

- platforms: Ysocial: https://ysocialtwin.github.io/, MachineSoM: https://github.com/zjunlp/MachineSoM, WelfareDiplomacy: https://github.com/mukobi/welfare-diplomacy

CTRUST: Agent-based model

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- Adapted version of YSocial to simulate Reddit dynamics: https://github.com/atomashevic/YClient-Reddit
- **LLM -** Dolphin3 LLM
- **Agents‘ detailed psychological profiles:** demographic characteristics, political affiliations, Big Five personality traits, education levels, and critically, configurable toxicity propensities ranging from "absolutely no" to "extremely" toxic behavior
- **Community:** technology

CTRUST: Agent-based model

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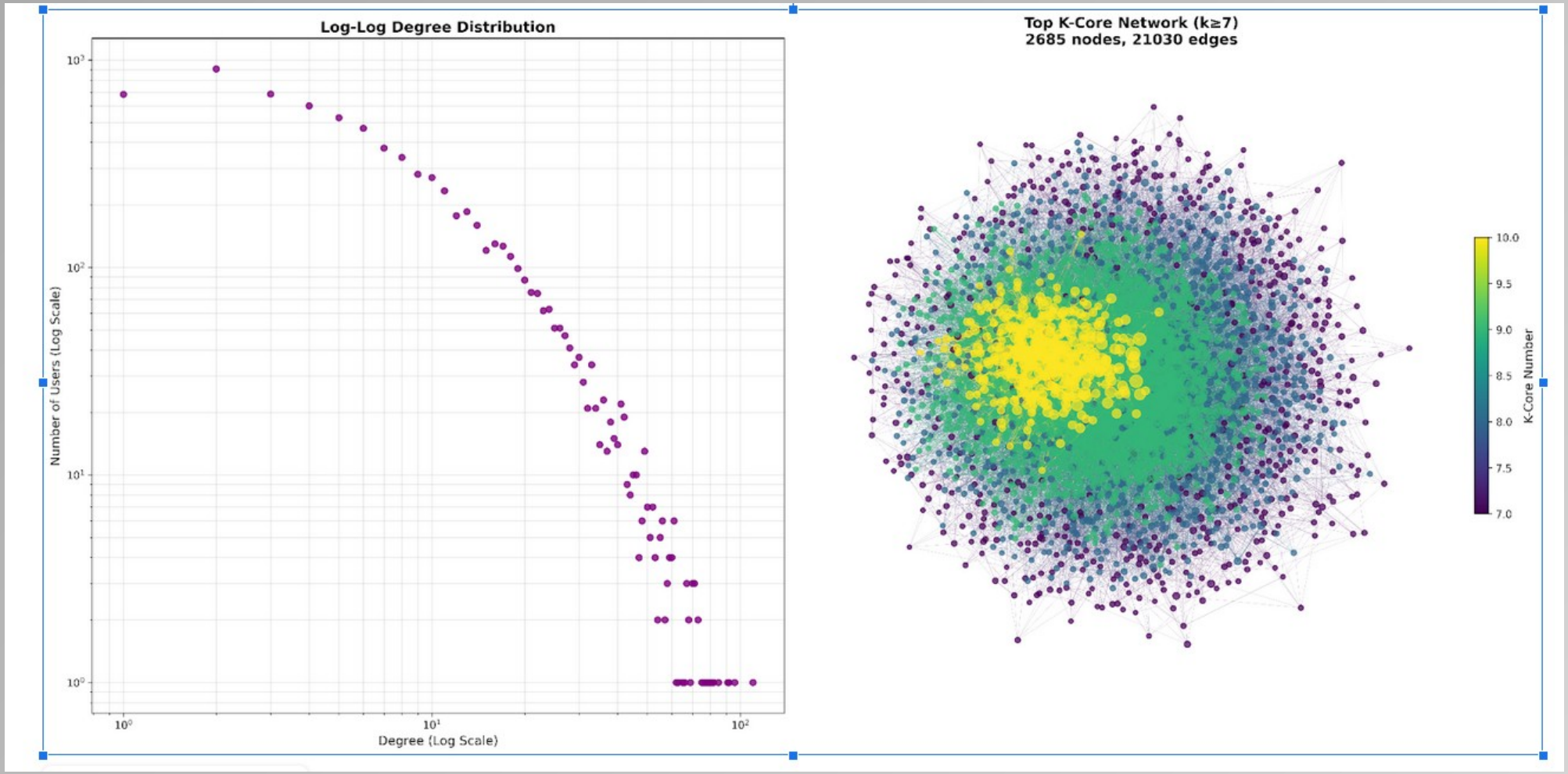

CTRUST: TEAM

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Institute of Physics
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CTRUST: TEAM

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Sara Major
Faculty of Philosophy Novi Sad

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Microsoft

Conclusions

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- AI is a part of computational social science – information extraction, data curation, prediction, simulation
- Explainability is a must have
- Computational social science needs to part of AI

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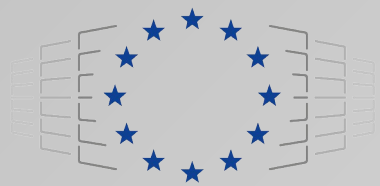
Thanks!

Co-funded by
the European Union



EuroHPC
Joint Undertaking

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Science Fund
of the Republic of Serbia

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