Collective intelligence: Analysis and modeling

E. Suárez[1] V. Bucheli[1] R. Zarama[2] A. García[1]

[1]Escuela de Ingeniería de Sistemas y Computación
Universidad del Valle

[2]Departamento de Ingeniería Industrial
Universidad de los Andes

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Outline

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What is collective intelligence?

- Collective intelligence can be understood as the capacity of a group of people to collaborate in order to achieve goals in a complex context (Heylighen, 2013).
- Collective intelligence is distributed within a network where each interaction continually aggregates value. It is coordinated in real time, developed through the effective mobilization and reciprocity of competencies (Lévy, 1994).
- Collective intelligence can be seen as the capacity of a human community to evolve towards higher order complexity thought, problem solving and integration through collaboration and innovation (Pór, 1995).

What is collective intelligence?

The capacity of a collective system to evolve towards higher order complexity through networks of individual capacities.

Organization around knowledge

Understand new forms of knowledge production:

- Wikipedia: Collective encyclopedia.
- Crowdsourcing: Problem-solving and production network.
- Open Government.
- Crowdfunding: Funding network.

An attempt to measure the collective intelligence.

Outline

Analysis of structural properties of networks

Measurements:

- Clustering coefficient.
- Average path length.

Networks:

- Data from the activity Wiki-ITRB at the course PeSO at the Universidad de Los Andes, Bogotá, Colombia.
- An agent-based model of collective intelligence based on wiki systems.

Wiki-ITRB

- The purpose of the Wiki-ITRB is to collectively write ITRB (Informe Técnico de Revisión Bibliográfica—Technical Reports of Literature Reviews) documents.
- ITRB documents propose one question for a given topic, and students then include arguments, author positions and opinions about the proposed question.
- Students participated in the writing and modification of several documents and each one decided to be the author of a subset of documents, which she or he edited and evaluated.

Wiki-ITRB

- The participation of students in the Wiki-ITRB is stored up over time.
- A network from the aggregation of connected authors via co-authored documents over time is constructed.

Agents

People:

- Agent edition capacity.

Documents:

- Selection's probability.
- Total edits.

At the beginning of the simulation, every document has the same probability, 1 per total number of documents. And every agent have the same agent edition capacity.

Description

Each time unit goes as follows:

- One person is selected randomly.
- The person edits as many documents as agent edition capacity indicates.
- The documents edited by the person are chosen according to documents' probability.
- Every document edited increases by 1 its total edits.
- Probabilities of every document are updated including the edits made by the person.

At the end it is constructed a network of co-author editions, where an edge connects two people who have made editions to the same document.

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Experimental design

The probability of connection between two agents, given a determined number of agents, depends on the simulation time and the agent edition capacity.

- Total agents (A): $[10^1 - 10^3]$
- Time simulation (T): $[2 * A - 10 * A]$
- Agent edition capacity (K): $[1 - 10]$

Each simulation was run 80 times.

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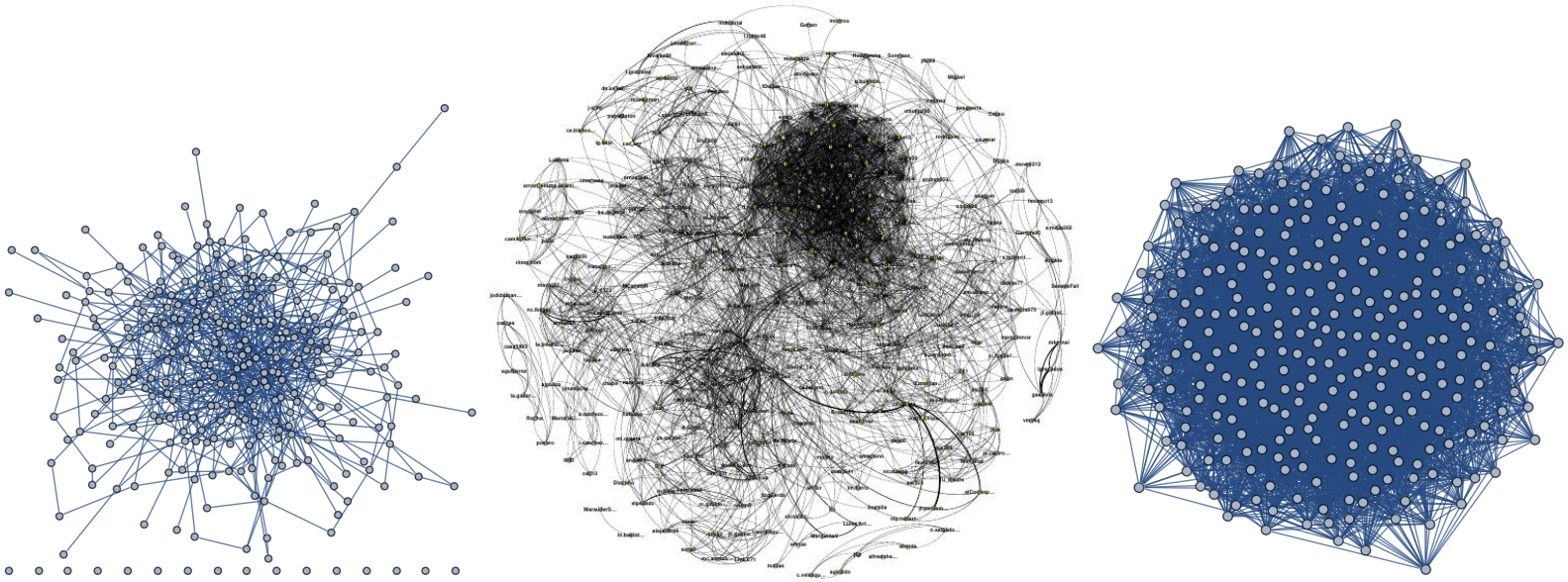
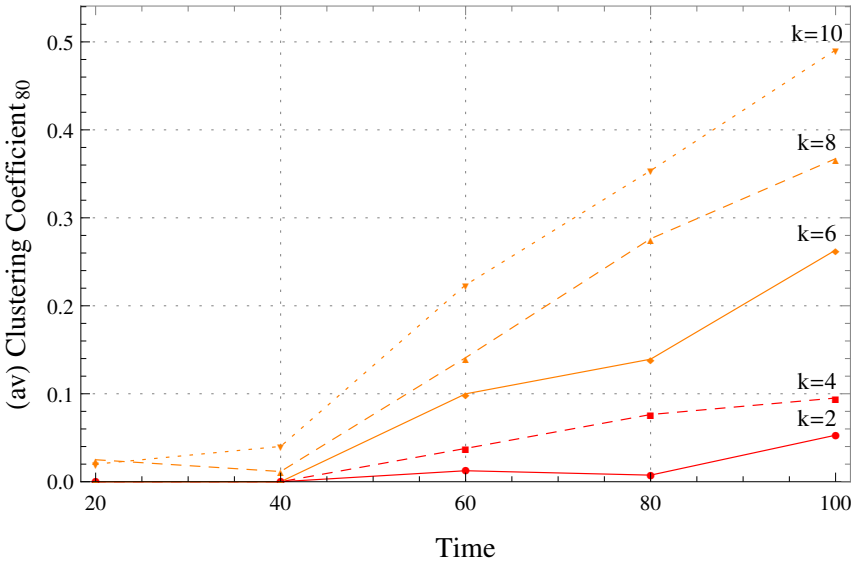
Networks

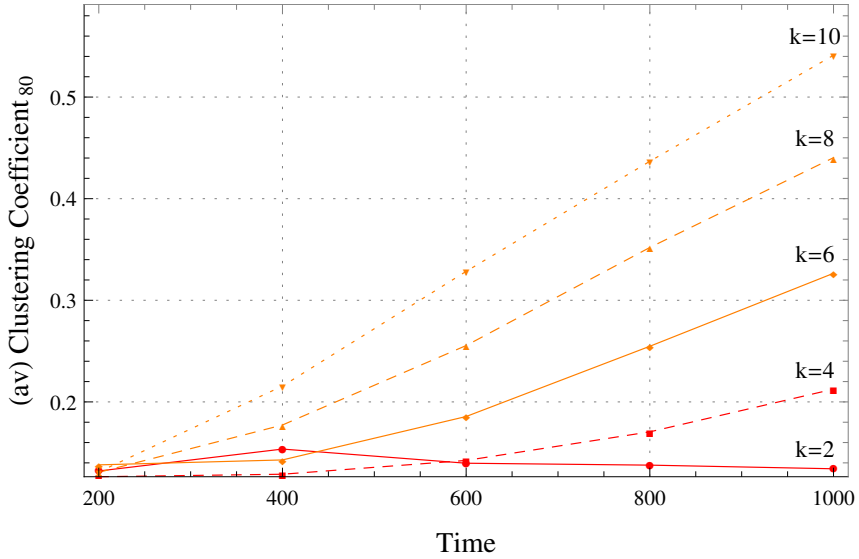


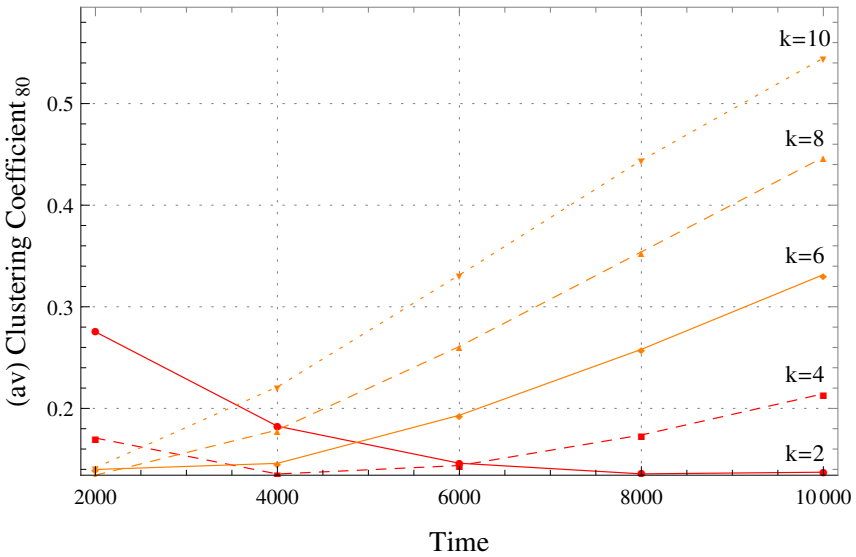
(a) T=1500 and K=3 (b) Wiki-ITRB (c) Probability = 0.1

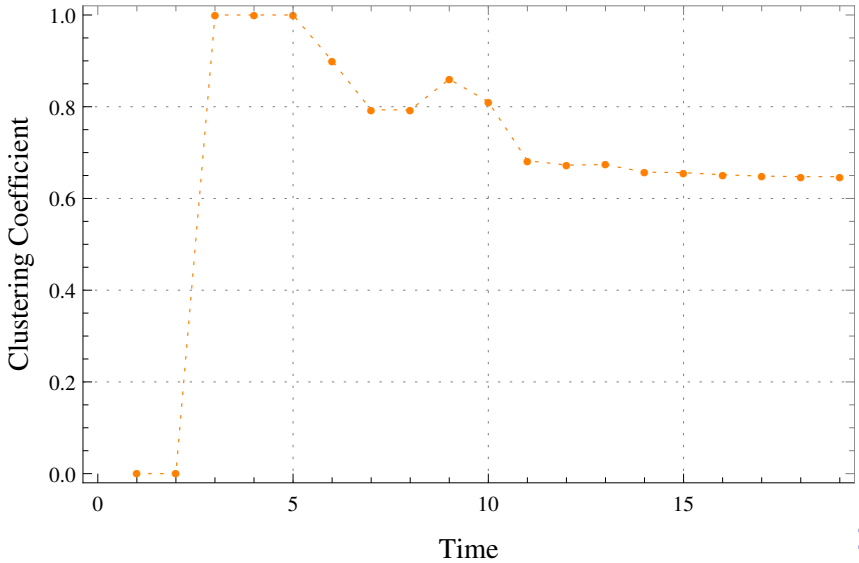
Figure: Networks with 300 nodes. Results from the model (a), the Wiki-ITRB (b) and a random graph with Bernoulli distribution (c).

Clustering coefficient

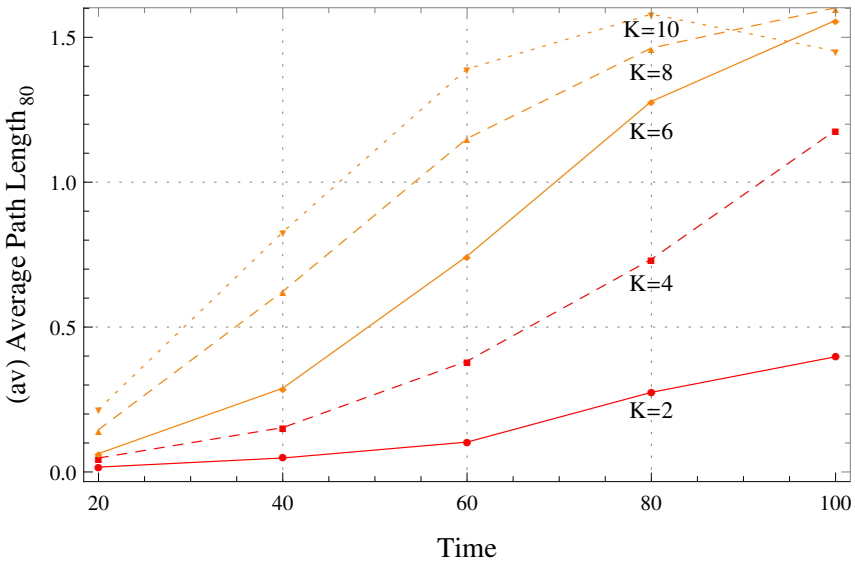


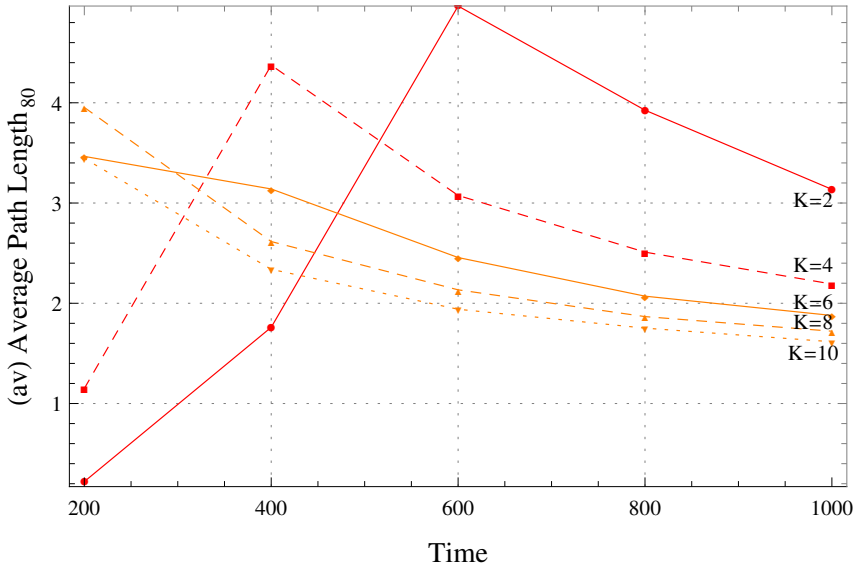


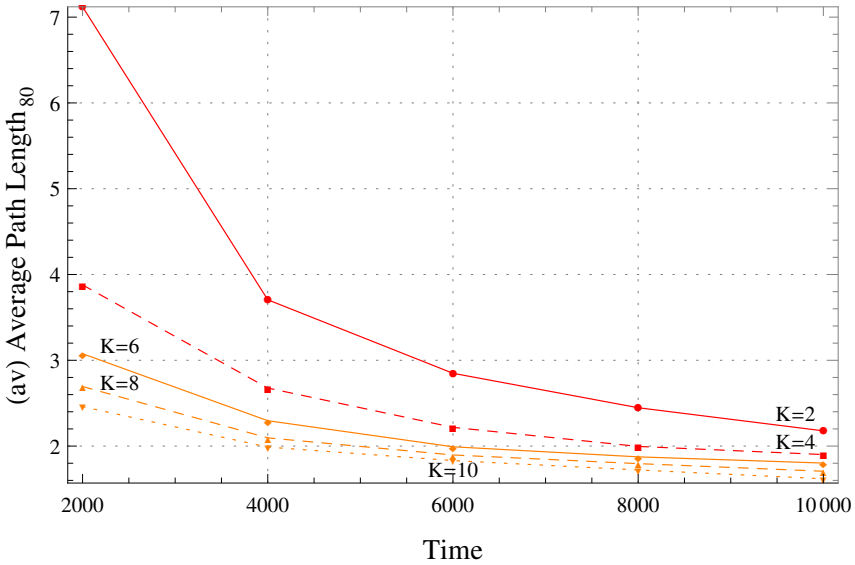


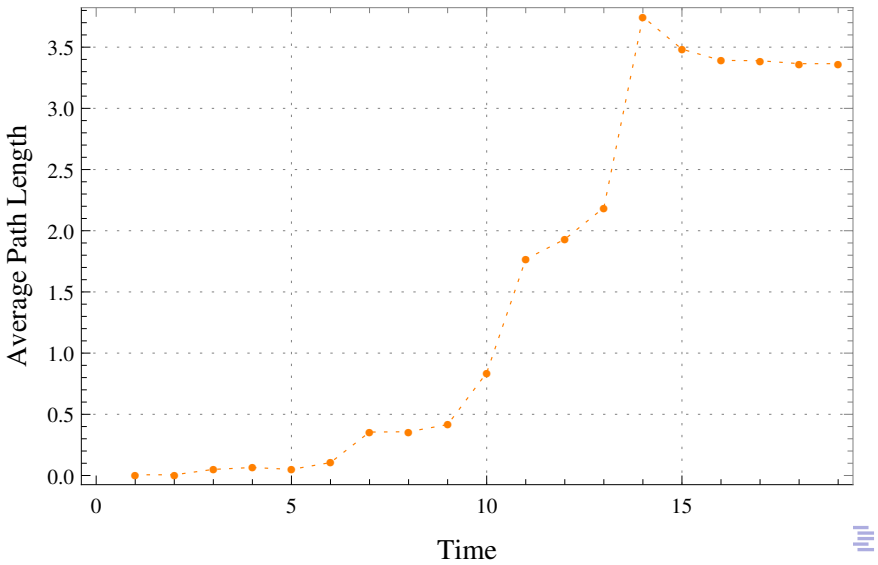


Average path length









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Discussion

- It was constructed a framework to study networks resulting from interaction rules at a micro level. It allows for the study of collective intelligence based on a network science approach.
- The proposed model reproduces the behavior observed in the PeSO course; this behavior is also described for small world networks. From this, we interpret that collective intelligence emerges from cumulative dynamics.

Discussion

- Both the clustering coefficient and the average path length have consistent values in terms of individual edition capacity (K) and time units (T), where neither could be too large or too small. Higher values of T implies that a lot of agents have connections and the small world structure disappears. Smaller values of K implies there is not growth over time and, therefore there is not a self-organized system.

Future work

- In-depth study of the proposed model: distribution of agent edition capacity (k) and the computation of other measurements such as Small-World Characteristic Q and robustness.
- The model presented here is an accumulative system, where there is no loss of information (no loss of nodes or edges). It is proposed that in future work, a less accumulative system should be examined.
- It is necessary to develop a better understanding of collective intelligence in order to investigate how teaching methodologies in higher education can be designed to develop collective thinking.