

# A cooperative game-theoretic approach to quantify the value of personal data in networks\*

Extended Abstract

[Short talk]

Michela Chessa  
Université Côte d'Azur, GREDEG, CNRS  
michela.chessa@unice.fr

Patrick Loiseau  
EURECOM, MPI-SWS  
patrick.loiseau@eurecom.fr

## CCS CONCEPTS

• **Networks** → **Network economics**;

## KEYWORDS

Personal Data, Social Network, Cooperative Game Theory

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The Internet has become an essential part of the citizens' life and of the economy. In this online ecosystem, service providers collect large amounts of personal data about individuals and use it to offer services from which they derive high profits. Personal data therefore has clear intrinsic economic value, which is extensively exploited by online services. At the same time, users also benefit from this ecosystem by being granted free access to services but it is unclear whether this appropriately compensates them for the release of their personal data. As the amount of data collected by online services is exploding, users and organizations increasingly ask for more fair, transparent, and personalized compensations. This naturally raises the question *how much is personal data worth?*

Quantifying the value of personal data is a very difficult task. Firstly, most research studies have focused on quantifying the private cost of releasing personal data. An appropriate quantification, however, should also take into account the profit that can be extracted from the data by online service providers. Secondly, profit is not extracted directly from the personal data itself but from the information the provider can derive from it, which has a very different economic nature. Indeed, while personal data is a private good that users can voluntarily decide to disclose at a given private

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cost, the information derived from it has a strong public component: information derived from personal data of a user may benefit others. Lastly, as many online services collect data not only about individual users but also about the social interactions among them, the strongest externalities are local externalities: information can be derived about a user from the personal data released by her neighbors in the social graph.

In this paper, we propose a game-theoretic approach to quantify the value of personal data that addresses the key difficulties mentioned above. Following classical economic literature [1] and recent work on privacy [3, 4], we model the public component of the provider's information as a *public good*. More specifically, to take into account the local externalities, we propose to model users interactions as a local public good game: users contribute by releasing personal data (at a private cost) and benefit from the local public good (the information derived about them that allows the provider to give them good service). The information about the users depends on the data released by themselves and by their neighbors in the social graph. Then, we propose to use solutions of a cooperative extension of this game, which measure the contribution of a user to the value extracted from the information derived from personal data (minus private cost), to quantify the value of the personal data released by a user. A cooperative solution can provide fair quantification of the value of personal data taking into account both the private cost of users and the profit extracted by the provider. It can be used for monetization or to determine the users with most valuable information for instance.

Motivated by the application to quantifying the value of personal data, our main technical contribution is the proposition and analysis of a cooperative extension of a classic local public good game [2]. We show that the game is monotonic and superadditive and that the core is non-empty; and we analyze how the allocations depend on the graph, showing that it is beneficial for the players to create new links and that the only stable network is the complete graph. Besides quantification of the value of personal data, our results could find applications in other areas modeled by local public goods.

## REFERENCES

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