DISTRIBUTED BANACH-PICARD ITERATIONS FOR DISTRIBUTED INFERENCE: THEORY AND APPLICATIONS

FRANCISCO L. ANDRADE, JOÃO XAVIER, AND MÁRIO A. T. FIGUEIREDO

Abstract. Many inference problems can be mathematically formulated as finding a fixed point of a contractive operator/map. In modern distributed scenarios (e.g., distributed machine learning or sensor networks), this map can be naturally written as the average of individual maps held locally and privately (*i.e.*, the agents don't want to share their local data with the others) by a set of agents linked by a (maybe sparse) communication network. Starting with the classical Banach-Picard iteration (BPI), which is is a widely used natural choice to find fixed points of locally contractive maps, this talk shows how to extend the BPI to these distributed settings. We do not assume that the locally contractive map comes from an underlying optimization problem, which precludes exploiting strong global properties such as convexity, coercivity, or Lipschitzianity. Yet, we present a distributed algorithm (called *distributed Banach-Picard iteration* – DBPI) that keeps the linear convergence rate of the standard BPI for the average locally contractive map. As an application, we derive and prove linear convergence of two distributed algorithms for two classical data analysis problems: the expectation-maximization algorithm for parameter estimation from noisy and faulty distributed sensors; principal component analysis with distributed data (equivalently finding the top m eigenvectors of a positive semidefinite matrix, which is the average of local matrices held by the network agents).

More details about this work can be found in [1, 2].

References

[1] F. Andrade, M. Figueiredo, and J. Xavier. Distributed Banach-Picard Iteration for locally contractive maps. *IEEE Transactions on Automatic Control*, 68 (2023, to appear) `https://doi.org/10.1109/TAC.2022.3152722`

[2] F. Andrade, M. Figueiredo, and J. Xavier. Distributed Banach-Picard Iteration: Application to Distributed EM and Distributed PCA. *(submitted)* `https://arxiv.org/abs/2106.10665`

Francisco L. Andrade; Instituto de Telecomunicações, Instituto Superior Técnico, Unversity of Lisbon, Portugal.
E-mail address: `francisco.lima.a@gmail.com`

João Xavier; Instituto de Sistemas e Robótica, Instituto Superior Técnico, Unversity of Lisbon, Portugal
E-mail address: `francisco.lima.a@gmail.com`

Mário A. T. Figueiredo; Instituto de Telecomunicações, Instituto Superior Técnico, Unversity of Lisbon, Portugal
E-mail address: `mario.figueiredo@tecnico.ulisboa.pt`

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