Report on paper "Feedback Capacity of Stationary Gaussian Channels", by Young-Han Kim, IEEE Transactions on IT, Vol. 56, No. 1, pp.57-85, Jan. 2010.

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Theme: This paper examines the feedback capacity of additive stationary Gaussian noise channels.

Results: The author uses a variational approach to establish the feedback capacity of additive stationary Gaussian noise channels. When the noise is modeled as a first-order autoregressive (ARMA) moving-average process, the solution is presented in closed form. It shows that the famous iterative coding technique of Schalkwijk and Kailath achieves capacity for the first order ARMA noise case, giving a positive solution to an over-40-year old problem. Additionally, the author extends his results to a k-dimensional version of the Schalkwijk-Kailath scheme to achieve the feedback capacity of any ARMA noise of order k, showing that the optimal transmitter iteratively removes the receiver`s equivocation about the transmitted message.

These results extend the author`s earlier establishment of a closed-form expression for the feedback capacity of the first-order ARMA noise model, found by a brute-force maximization approach.

The novelty of these results also lies in the used methods. Earlier attempts to solve this problem were based in looking for a closed-form expression for the n-th extension of the channel and then examining its limiting behavior. The approach in the paper is different in that it examines the limit directly as the solution of an infinite-dimensional variational problem. This alternate route replaces an infinite sequence of finite dimensional optimization problems by a single infinite-dimensional optimization problem that produces the same solution, justified by the interchange of limit and maximum operations.

Also of interest is the interdisciplinarity of the results, which have already had repercussions in estimation, control and communication theories.

Paper: The author writes with elegance and clarity on the history of this problem, providing a detailed account of four lines of earlier attacks, all based on the limit of finite dimensional optimization problems. The mathematics is carefully motivated and explained. The links to auxiliary mathematics of estimation and control theories are also carefully provided. The author develops a sequence of characterizations of the feedback capacity, starting from the formulation of Cover and Pombra, that are progressively more concrete and that illuminate the interplay between estimation, control and communication theories. Using these relations, the Gaussian feedback capacity problem is cast as a stochastic control problem of the receiver`s estimation error, which, in turn, can be viewed as an entropy maximization problem of the output spectrum.

Impact: The paper has been cited by a number of publications (20 citations of the original Arxiv preprint, and 11 citations of the Transactions on IT article, according to Google Scholar). These references point to the establishment of the feedback capacity in itself, and also to the opening of new avenues of interplay between estimation, control and communication theories. This shows the great potential of this paper as a source of inspiration for interdisciplinary results.

Conclusion: This paper has important links to the past and future of Information Theory. From one perspective, it establishes the solution to a long standing classical problem, with origins in Shannon`s work. From the other point of view, it opens news scenarios for interconnecting disciplines that have always had a close but not intimate relationship. Based on these considerations and on the wide implications of the results, I believe this paper is a very strong candidate for the 2011 Information Theory Paper Award.