Machine Learning in Digital Medicine

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Machine Learning in Digital Medicine has been the title for a successful IEEE Distinguished Lecturer Tour in Minnesota and Wisconsin on August 2019. The IEEE local sections of Rochester, MN, Madison, WI, and Minneapolis, MN, have been exceptional in welcoming me and advertising my talk, despite the summer season. A sincere thank you to Stephen, Tao, Christopher and Nathan for the great work done for this IEEE DL Tour!

The talk has generated interest and a fruitful discussion in each section, involving an interdisciplinary crowd of AI technical experts, clinical people, and wearable sensor engineers. The local hosts have done a terrific job also in showing me the campuses in which I have been, and they helped me a lot with the transportation from one city to another. It was a great opportunity for me to see a bit of the mid-west of the US in that few days!

In the following, a brief summary of the talk:

Digitalize human beings using biosensors to track our complex physiologic system, process the large amount of data generated with artificial intelligence (AI) and change clinical practice towards individualized medicine: these are the goals of digital medicine. At Scripps Research, we are a team of computer scientists, engineers, and clinical researchers, in partnership with health industries, and we propose new solutions to analyze large longitudinal data using statistical learning and deep convolutional neural networks to address different cardiovascular health issues.

One of the greatest contributors to premature mortality worldwide is hypertension. Lowering blood pressure (BP) by just a few mmHg can bring substantial clinical benefits, but it is hard to assess the "true" BP for an individual, since it fluctuates significantly. With a dataset of 16 million BP measurements, we unveil the BP patterns and provide insights on the clinical relevance of these changes [1].

Another prevalent health issue is atrial fibrillation (AF), the most common sustained cardiac arrhythmia, associated with stroke, heart failure and coronary artery disease. AF detection from single-lead electrocardiography (ECG) recordings is still an open problem, as AF events may be episodic and the signal noisy. Indeed, the 10 second in-clinic ECG is unlikely to capture subclinical but still meaningful problems or changes over time. Thus, a longitudinal view of cardiac activity is needed, and the analysis of such longitudinal and noisy signals opens new opportunities for developing new sensors, signal processing and AI techniques [2].

Towards the goals of AF detection, we conduct a thoughtful analysis of recent convolutional neural network architectures developed in the computer vision field, redesigned to be suitable for a one-dimensional signal, and we evaluate their performance in the detection of AF using 200 thousand seconds of ECG, highlighting the potential and pitfall of this technology compared to the use of expert features.

Looking to the future, we investigate new applications for wearable devices and advanced processing in the All of Us Research Program, an unprecedented research effort to accelerate the advent of precision medicine.

If you are interested in learning more about opportunities in Digital Medicine, or you think this IEEE Distinguished Lecture would be relevant for your institute, contact me at gquer@scripps.edu.

References:

[1] G. Quer, N. Nikzad, A. Chieh, A. Normand, M. Vegreville, E.J. Topol, S.R. Steinhubl, “Home Monitoring of Blood Pressure: Short–Term Changes during Serial Measurements for 56398 Subjects”, in IEEE Journal of Biomedical and Health Informatics, Vol. 22, No. 5, pp. 1691–1698, Sep. 2018.

[2] G. Quer, E.D. Muse, E.J. Topol, S.R. Steinhubl, “Long data from the electrocardiogram”, in Lancet, Vol. 393, pp. 2189, June 1, 2019. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)31186-9