The role of the individual at biological, social and societal scales

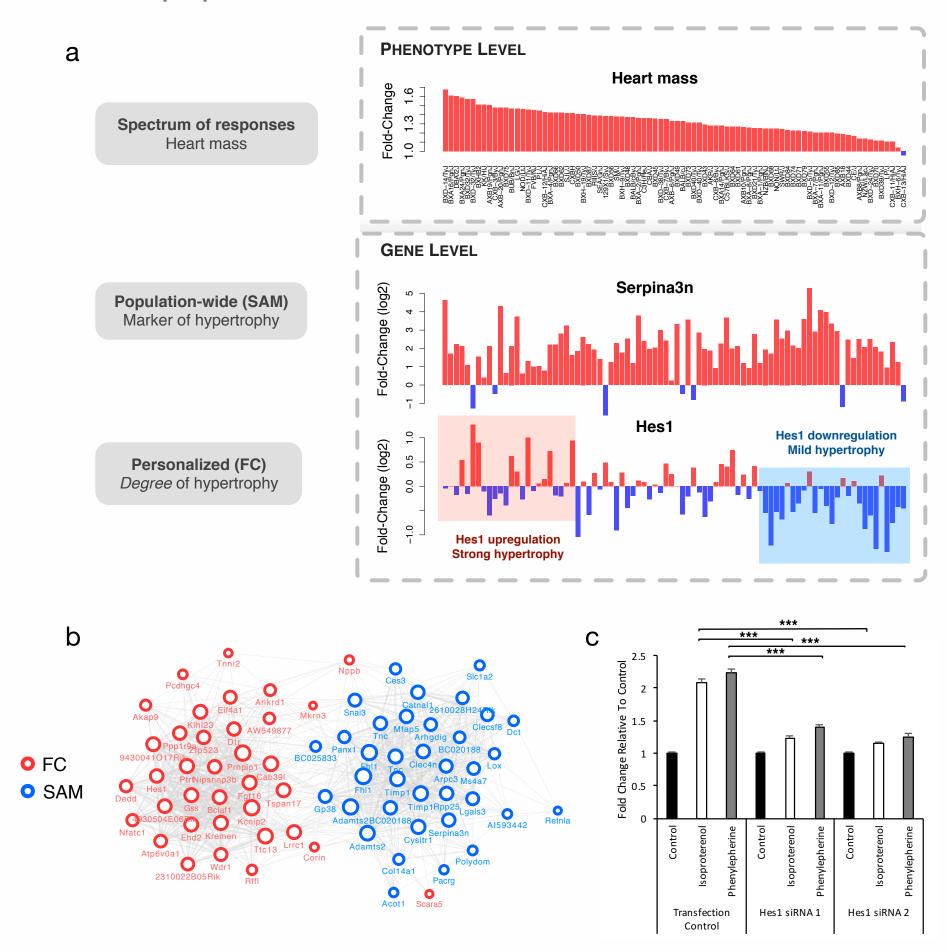
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We showcase various contributions illustrating the impact of algorithms on personalized healthcare as well as on our ability to include all relevant actors, from researchers to clinicians to innovators, in tomorrow's grand health programs.

I. Personalized medicine

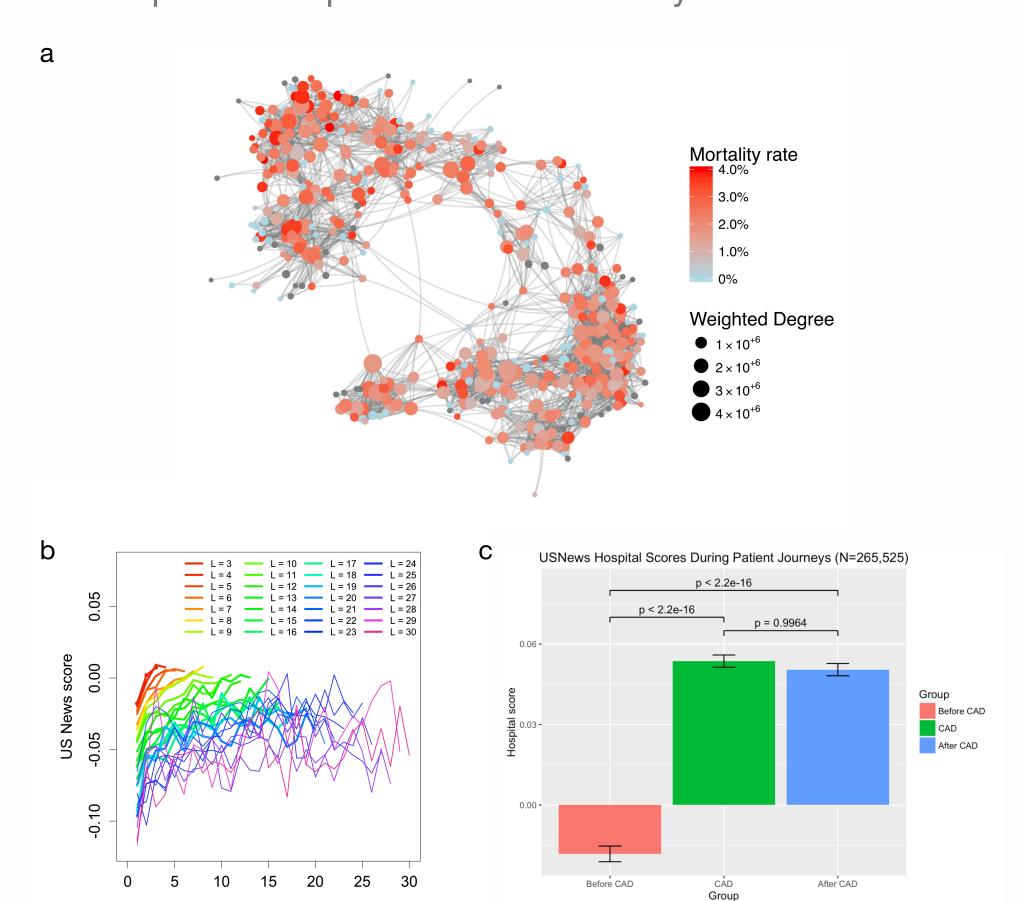
From population to individuals



We investigate individual changes of gene expression when inducing hypertrophy and heart failure in 100+ strains of genetically distinct mice from the Hybrid Mouse Diversity Panel (HMDP). (a) Genes whose expression fold-change (FC) correlates significantly with the severity of the disease are either up- or down-regulated across strains, and therefore missed by a traditional population-wide analysis of differential gene expression (SAM). (b) The "FC" and SAM genes form two distinct and dense modules in the co-expression network. (c) We validate our approach by showing that the knockdown of FC gene Hes1 induces a dramatic reduction of hypertrophy by 80-90% in neonatal rat ventricular myocytes. These results demonstrate that individualized approaches are crucial to identify genes underlying complex diseases as well as to develop personalized therapies, for example to predict the response to drug treatment.

II. Navigating the hospital network

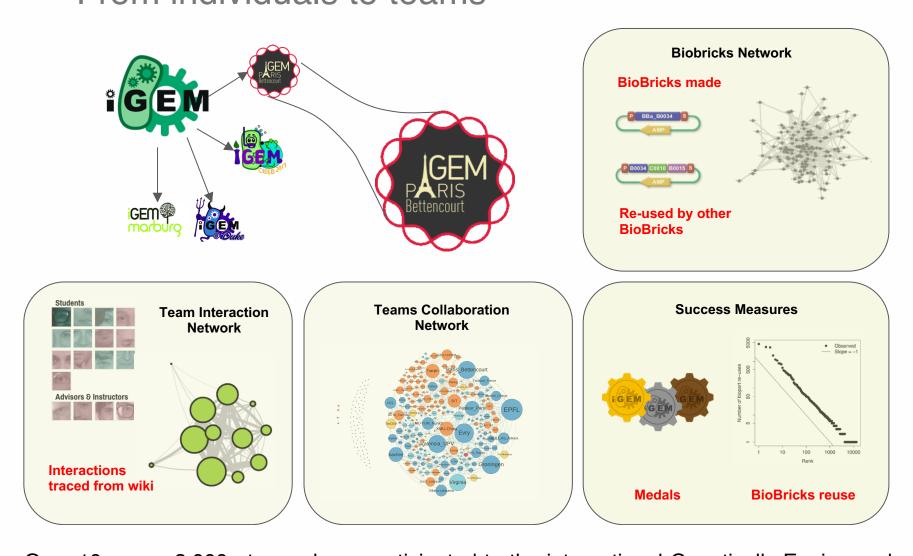
How patients explore the healthcare system



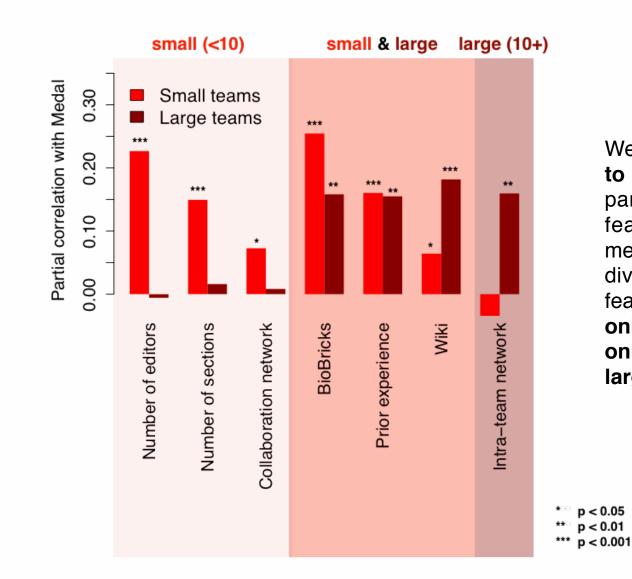
Using data from the Healthcare Cost and Utilization Project (HCUP) in California, we explore how patients navigate the hospital network. (a) Patient-sharing network reconstructed from patients trajectories (nodes are hospitals and edges are weighted by the number of patients that have been to both hospitals). Central hospitals show higher mortality rates (image courtesy of A. Dhand). (b) We collected US News scores to quantify hospital "desirability". We observe that patients optimize the hospital rank during their healthcare trajectory. (c) Looking at the subset of patients going through Coronary Artery Disease, we observe a "wake-up call" where patients go to higher-ranked hospitals for treatment. These preliminary results exhibit the potential of learning from personalized healthcare data to improve patient hospital navigation.

III. Collaborative research

From individuals to teams



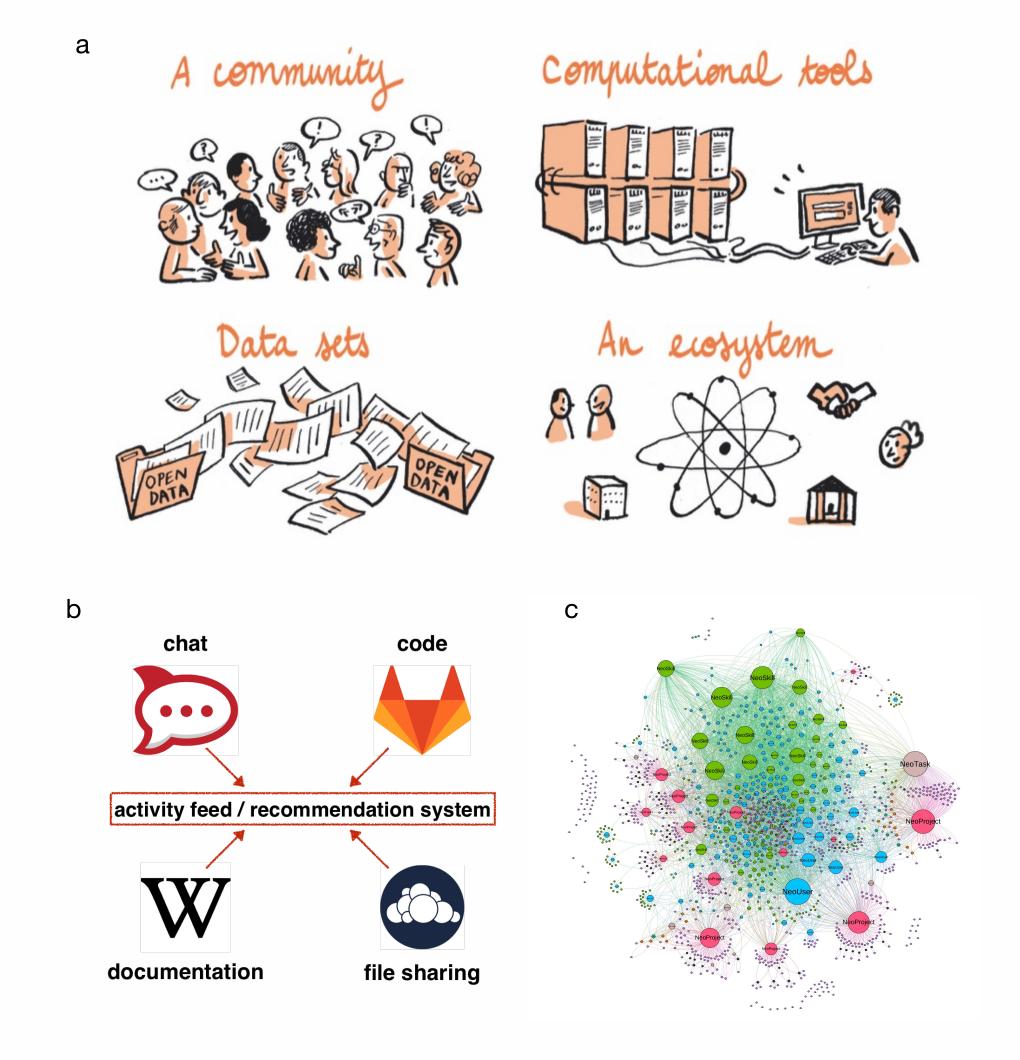
Over 10 years, 2,000+ teams have participated to the international Genetically Engineered Machines (iGEM) competition, documenting their progress and results on open wiki websites. Team internal networks are reconstructed from wiki notebooks co-edition. Teams collaborate with one another, forming a collaboration network. They produce BioBricks by combining previously made BioBricks or engineering new ones. Finally, team success is determined by the prizes and medals they receive, as well as their BioBricks re-use by other teams.



We uncover features associated to team success. We compute the partial correlation between team features and medal quality (no medal, bronze, silver or gold). We divide features in three groups: features predictive for small teams only (<10 editors), for large teams only (≥10) and for both small and large teams.

IV. Open science at scale

The role of AI in large-scale research programs



(a) The Epidemium program (www.epidemium.cc) is a community-based, open science data challenge. With Just One Giant Lab, we designed a platform for participants to post projects and work together. (b) The platform aggregates various open-source collaborative tools (Rocket Chat, Gitlab, Wiki, and Owncloud). (c) The gathered data is then used to feed a recommendation system based on the underlying network, allowing to "design serendipity" by connecting the right person to the right task/project/collaborator. We are now re-designing the platform for an upcoming beta-release (jogl.io).







