**Should Machines Understand Nature to Pass the Turing Test?**

**Co-evolving AI and Systems/Synthetic Biology**

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Deciphering and understanding nature is one of the greatest challenges of human intelligence. Living organisms evolve their parts and systems to produce functions and behaviors needed to survive and flourish in natural and synthetic environments. Evolution has been often associated with life-long learning. Humans have been documenting and attempting to understand nature since the beginning of our existence. Thus, both knowledge and understanding of nature is part of our cumulative intelligence. **One of the many important distinctions between us and other living species in addition to language is our ability to advance science.** It has been argued that intelligence itself is a product of natural evolution summarized nicely in the following quote "We see things as we are not as they are". **One could even dare to conjecture that the necessity to decode and respond to nature and its complexity is what drove human intelligence.** Thus, we hypothesize that "applying" AI to learning to reason about life may lead to a better understanding of nature, learning and intelligence. In this talk we briefly review several foundational contributions that AI already made to biology. These major contributions creatively adapted techniques in speech, language, computer vision, graphical models, neural networks, constraint satisfaction and more. These basic techniques and their variants are now in routine use in Computational and Systems Biology. The AI roots of computational biology inspire many new insights and future developments and suggest that co-evolution of AI (defined broadly not just deep learning) and systems-synthetic biology is a perfect blender for accelerating advances in AI and Biology.

As a proof of concept, we describe a first of a kind community project called **"Computational Bridges to Experiments" (COMBREX).** COMBREX aims to **drive** biological experiments by an AI system that performs many tasks including **asking** the most informative questions that catalyze the fastest advances in predictive knowledge or other priorities. The prioritization of questions is inspired by Active Learning frameworks. The project features a combination of novel scientific, technical and logistic ideas including a new funding scheme, citizen's science, tracking provenance and knowledge gaps, and more. We believe that COMBREX serves as possible human centered model for an **open society of human and robot scientists.** COMBREX was co-founded by Dr. Richard Roberts and benefitted from ideas and contributions from numerous biological and computational scientists. In particular, we were influenced by foundations of Active Learning by Dana Angluin at Yale.

**Bio:** Prof. Simon Kasif was trained in AI and CS. His mentors in AI were Profs. Azriel Rosenfeld and Jack Minker (pioneers in Computer Vision and Deductive Databases respectively). He directed the AI Lab at Johns Hopkins University engaged in both theory and development of parallel AI systems, Reasoning and Machine Learning. In 1999, he joined the Human Genome Project (MIT Genome Center and CRL/HP Labs). He then co-founded the BU Center for Advanced Genome Technology (with Charles DeLisi who started the Human Genome Project at DOE). Prof. Kasif was also appointed at Children's Hospital (Harvard-MIT program in Health Sciences and Technology) and Joslin Diabetes Center. He held many advisory and consulting positions in academia and industry. In Computational and Systems Biology, his contributions include popularizing graphical models for molecular biology (1992- with Art Delcher), co-development of a widely used system for microbial gene finding system (GLIMMER, with Salzberg and Delcher), introduction of network based protein function prediction, invention of biological context networks (with Noga Alon and John Rachlin), COMBREX (with Rich Roberts and Martin Steffen), co-pioneering AI/network models for the study of aging, wellness and disease staging (With Zak Kohane and Ron Kahn) and more. This work would not be possible without numerous exceptional students, fellows and colleagues that did the heavy lifting moving ideas from the crib to full maturity, wide acceptance and deployment.