

BENOS LAB NEWSLETTER

Welcome to the Benos Lab Newsletter



By Takis Benos

IT FEELS STRANGE to write a newsletter. But there are so many things going on, and I wanted to keep a record of them. A little more than two years ago, we were bidding farewell to two great PhD students, Kristina Buschur and Vineet Raghu, who were moving to Columbia and Harvard, respectively, to continue pursuing careers in science as postdoctoral fellows. A few months later we started hearing about “a new virus” that was spreading in Asia and in March 2020 everything came to a standstill. Most people watched from home while history was unfolding. Lockdowns, BLM protests in response to George Floyd’s murder, elections amidst the pandemic with unprecedented turnout, insurrection, and attack at the Capitol, change of government, vaccine rollout. The Lab actively participated in committees aiming to improve diversity and communication in the department and the university. At the same time, we were able to continue working. This is an advantage that we, computational researchers, have: the ability to work remotely. During that time the Lab flourished, which made me proud amidst the grim surroundings. Since the Fall of 2019, five new people joined our group, we published 21 papers and we submitted or participated in 26 grants; four of them got funded, while 5 more are still pending. Very productive time indeed. But we missed human interactions. Lab members who were hired in 2020 had only met via Zoom with the rest of the group! So, at the end of April, when everyone of us had already been vaccinated, I organized an outdoors’ cookout. The people were so happy to meet in person (or meet again) that we were continuously chatting. The party went on until late-night and we still did not want to end it. I hope that Science will finally prevail over superstitions and fake news, and we will get out of this terrible situation soon and start living normal again.



Kristina and Vineet



Our new building (800 Murdoch)

AT A GLANCE

INTRODUCING THE BENOS LAB

BENOS LAB PUBLICATIONS

The Benos Lab in papers during the pandemic

Highlighted paper of 2020

WHAT WE ARE UP TO RECENT ACCOMPLISHMENTS OF OUR LAB MEMBERS

EVENTS

WE BID FAREWELL TO HAOPU



Zoom Lab picture

Introducing the Benos Lab

We are a diverse, interdisciplinary team who likes to tackle important questions in *systems medicine* by developing and using novel *machine learning* algorithms. Our group, at the Department of Computational and Systems Biology, University of Pittsburgh, currently consists of **7 graduate students** and **3 postdocs**. The Lab also collaborates with Maria Kapetanaki, research faculty in our department. We have active collaborations with both clinical and basic science researchers in the University of Pittsburgh, Carnegie Mellon University, Harvard, Ohio State and University of Louisville. We are currently funded by interdisciplinary and highly collaborative NIH grants in diverse topics, such as single cell molecular mechanisms of aging, and development of causal modeling algorithms with applications to biomarker identification for alcoholic hepatitis severity, lung diffusion impairment in HIV, and COPD subtyping.

Our publications during the pandemic

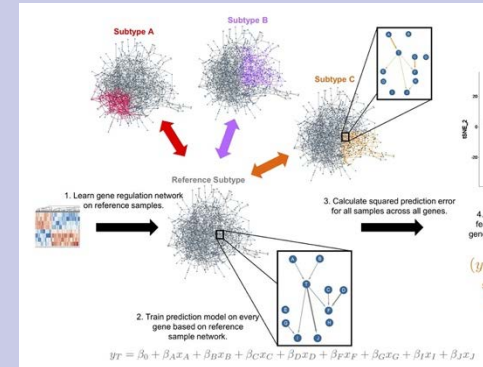


Despite the pandemic and the unavoidable lack of in-person communication, the Lab managed to stay quite active and productive. We published in basic science / computational journals like *Nature Commun*, *Nucl Acids Res*, *Bioinformatics*, and clinical journals like *Am J Resp Crit Care Med*, *Thorax*, and *Eur Resp J*. We also published peer-reviewed conference papers in the 2020 NeurIPS Workshop on Causality, the 2020 IEEE BIBE conference, and an IEEE/ACM conference. Thematically, our papers focus on the effect of microbiome in severe lung disease; the molecular mechanisms of lung fibrosis and aging; and the factors affecting lung function in COPD patients. Computationally, we develop causal inference and other machine learning algorithms to use for integrative analysis of biomedical data and for developing predictive models of clinical outcomes.

Benos Lab publication list:

https://www.csb.pitt.edu/Faculty/benos/?page_id=1219

Highlighted paper of 2020



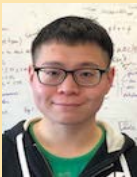
In the beginning of 2020, Kristina's first author paper is published [Buschur, Chikina, Benos, 2020, *Bioinformatics*]. This paper presents a novel method for identifying gene network perturbations on single samples. The new algorithm is named **ssNPA** (single sample Network Perturbation Assessment) and works in the following way. A reference gene network is created from control samples using causal learning methods (Bayesian networks). A predictor of each gene's expression in the reference samples is built from the surrounding genes (i.e., Markov blanket) of this gene in the network. Then, for every new sample, ssNPA assesses the local network perturbation by measuring how well the learned predictors work on this sample. Subsequently, these "perturbation vectors" can be used to group the query samples into clusters that might correspond to different cell types or disease subtypes, depending on the application. This is a flexible and robust framework and we expect it to be broadly used in the future.

What we are up to - Recent accomplishments of Benos Lab members



Max Dudek

Max was an undergraduate student from CS @ Pitt, who worked his capstone project in the Benos Lab (2020-2021) on porting our toolbox, *CausalMGM*, from Java to C++. Max received an **NSF fellowship** in 2021 and he is now a PhD student at U Penn.



Minxue Jia

Minxue is a 4th year student at the CMU-Pitt Comput Biol program (CPCB). He has an MSE in Chemical Engineering from Johns Hopkins. He is working on further developing ssNPA for high-dimensional data and on investigating the molecular mechanisms of pulmonary fibrosis and aging. In Spring 2021 he successfully defended his thesis proposal. He has **2 recent publications**:

- Cruz*, Jia*, et al, *Am J Resp Crit Care Med* (2021) 204:608-610.
- Tabib, et al, *Nature Commun* (2021) 12:4384.



Tyler Lovelace

Tyler is also a 4th year CPCB student. He has a BSc in Biomedical Engineering from Texas A&M. He is working on causal algorithms for censored and other variables. In Spring 2021 he successfully defended his thesis proposal. He has co-authored **1 recent publication**.

- Cardenes, et al, *Scientific Reports* (2021) 11:490



Haiyi Mao

Haiyi is a 3rd year student in the Intelligent Systems Program (ISP). He has an MSc in Computer Science from Northeastern University. He is working on causal algorithms for high-dimensional, unstructured data. He has **1 recent conference publication**.

- Mao, et al, (2020) *IEEE BIBE*, pp. 85-88.



Khaled Sayed, PhD

Khaled is a postdoctoral fellow. He earned his PhD in Electrical and Computer Engineering from the University of Pittsburgh. He is working on mechanisms of liver development and aging. He has co-authored **1 recent publication**.

- Molina, et al, *Cell Reports* (2021) 36:109310.



Robert Gregg, PhD

Robert is a postdoctoral fellow. He earned his PhD in Chemical and Petroleum Engineering from the University of Pittsburgh. He is working on COPD progression. Robert has also received a competitive **T15 Fellowship** (Biomedical Informatics) in 2021.



Daniel Yuan

Daniel is also a 4th year CPCB student. He has a BSc in Biomedical Engineering from Johns Hopkins University. He is working on causal algorithms for time course data and studying the molecular mechanisms of immunoprevention. In Spring 2021 he successfully defended his thesis proposal. He has co-authored **1 recent publication**.

- Fuccello, et al, (2020) *NeurIPS 2020 Workshop on Causal Discovery and Causality-Inspired Machine Learning*

Daniel received a competitive **T32 Fellowship** (Immunology) in 2020.

Farewell to Haopu

In 2021, we bid farewell to Haopu, a Tsinghua scholar who was a member of our Lab since 2019. Tsinghua scholars are selected MD students from Tsinghua University, P.R. China,



who are visiting University of Pittsburgh for two years and engage in research with one (or more) groups here. Haopu arrived in Pittsburgh right before the pandemic started and thus, it was more difficult for him. He investigated the relation between microbiome and outcomes in patients at the intensive care unit (ICU). This is a collaboration with Drs Kitsios and Morris at the Department of Medicine. Despite the obstacles due to COVID, Haopu worked diligently and produced four papers through our Lab

and another three with our collaborators. In two of these papers, Haopu was first author (*Thorax* and *Annals in Translational Medicine*). Congratulations Haopu and good luck to your career! We will certainly miss you.



Benos Lab cookout in April 2021.

2021 GRANTS & DISTINCTIONS

The Benos Lab receives **two R01 grants** from NHLBI-NIH in the Summer of 2021. One is for developing interpretable probabilistic graphical models for multi-modal datasets. The methods will be used to identify factors causally linked to the progression of chronic obstructive pulmonary disease (COPD). The second is for developing machine learning methods to identify and study COPD subtypes from blood gene expression measurements and clinical data.


Robert Gregg was awarded an NIH-NLM T15 Postdoctoral Scholarship from the Department of Biomedical Informatics, University of Pittsburgh School of Medicine starting in August 2021.


Takis becomes a standing member of the Biomedical Informatics, Library and Data Sciences Review Committee in November 2021. This is the NIH study section that reviews grant proposals for the National Library of Medicine (NLM).

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