Causal Inference for Systems Medicine

Benos’ Lab
ISP 5min talk, August 2019

Takis Benos, PhD
Professor, Computational and Systems Biology
University of Pittsburgh SOM

E-mail: benos@pitt.edu
Lab URL: http://www.benoslab.pitt.edu
Integrating multi-modal data using ML

PHENOTYPE
Hypothesis generation pipeline using graphical models

MULTI-SCALE DATA
- Omics
- Microbiome
- Lab tests
- Demographics
- Imaging
- Clinical tests

PRIOR KNOWLEDGE
- OMIM
- KEGG
- DrugNet

LATENT CONFOUNDERS

APPLICATIONS
- Biomarker selection
- Patient stratification
- Disease mechanisms
- Molecular pathways
- Outcome predictions

Integrated dataset

Model

X

Model

Hypothesis generation

Causal - MGM

DrugNet

KEGG

OMIM

PRIOR KNOWLEDGE

© Benos lab / Univ of Pittsburgh 2014-2019
Ongoing projects in the lab

- **Further development of CausalMGM**
- **Application to TOPMed data (emphasis on COPD progression)**
- **Investigate the effect of microbiome and diet in PH**
- **Lung function impairment in HIV patients** (blood biomolecules, microbiome, clinical)
- **Drivers of tissue heterogeneity in IPF** (histopathology, omics and clinical)
- **IPF progression in the lung**
- **Cancer vaccines**
- **Early detection of lung cancer**

<table>
<thead>
<tr>
<th>Project</th>
<th>Funding Agency</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Further development of CausalMGM</td>
<td>R01 NLM (Benos et al)</td>
<td></td>
</tr>
<tr>
<td>Application to TOPMed data (emphasis on COPD progression)</td>
<td>U01 NHLBI (Benos et al)</td>
<td></td>
</tr>
<tr>
<td>Investigate the effect of microbiome and diet in PH</td>
<td>P01 NHLBI (co-I)</td>
<td></td>
</tr>
<tr>
<td>Lung function impairment in HIV patients</td>
<td>R01 NHLBI (Benos/MPI)</td>
<td></td>
</tr>
<tr>
<td>Drivers of tissue heterogeneity in IPF</td>
<td>R01 NHLBI (Benos/MPI)</td>
<td></td>
</tr>
<tr>
<td>IPF progression in the lung</td>
<td>U01 NHLBI (Benos/MPI)</td>
<td></td>
</tr>
<tr>
<td>Cancer vaccines</td>
<td>R35 NCI (co-I)</td>
<td></td>
</tr>
<tr>
<td>Early detection of lung cancer</td>
<td>Not funded (yet!)</td>
<td></td>
</tr>
</tbody>
</table>
**Some alumni from Benos’ lab (PhD students, postdocs)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Program</th>
<th>Years with us</th>
<th>Currently at…</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vineet Raghu</td>
<td>CS @ Pitt</td>
<td>2015-2019</td>
<td>Harvard Univ/MGH</td>
<td>Postdoctoral fellow</td>
</tr>
<tr>
<td>Kristina Buschur</td>
<td>CPCB</td>
<td>2012-2019</td>
<td>Columbia Univ</td>
<td>Postdoctoral fellow</td>
</tr>
<tr>
<td>A J Sedgewick</td>
<td>CPCB</td>
<td>2012-2016</td>
<td>NantOmics LLC</td>
<td></td>
</tr>
<tr>
<td>Grace Huang</td>
<td>CPCB</td>
<td>2007-2013</td>
<td>Pinterest</td>
<td>Data Science Manager</td>
</tr>
<tr>
<td>Sabah Kadri</td>
<td>CPCB</td>
<td>2007-2012</td>
<td>Northwestern Univ</td>
<td>Assit Prof</td>
</tr>
<tr>
<td>Rachel Brower-Sinning</td>
<td>CPCB</td>
<td>2008-2011</td>
<td>UPMC</td>
<td></td>
</tr>
<tr>
<td>David Corcoran</td>
<td>Human Genetics</td>
<td>2003-2007</td>
<td>Duke University</td>
<td>Founding Director, Data Analysis Core</td>
</tr>
<tr>
<td>Shaun Mahony</td>
<td>Post-doc</td>
<td>2005-2007</td>
<td>Penn State</td>
<td>Assistant Professor</td>
</tr>
<tr>
<td>Alain Tchagang</td>
<td>Post-doc</td>
<td>2007-2008</td>
<td>Natl Res Council Canada</td>
<td></td>
</tr>
</tbody>
</table>
Questions ???

Electronic contacts:
benos@pitt.edu
http://www.benoslab.pitt.edu