Cancer is not merely an acute event but a chronic condition.

Patients want results that enable a better life across the continuum.

Patient Life Span Navigation
Patient Life Span Navigation

A. Individual patient’s health along the continuum of life.

B. Forecast disease progression with similar patients.

C. Precise (reproducible) and accurate (meaningful) diagnosis and monitoring of the disease.

D. Navigation with equal precision and accuracy across socioeconomic spectrum and ethnic diversity.
Life Span Navigation: Step by Step

A: Patient Health: NCI/DoD
- Analytical tools for the objective measurement of human performance
- Therapy, drug selection
- Rare cell morpho-proteo-genomics

B: Patient Forecasting: NCI/VA
- Big-data scientist training enhancement program
- Mathematical models to accurately represent specific patient cohorts
- HD single cell analysis

C: Disease Status: fNIH/Pharma Industry
- Therapy, drug selection
- HD single cell analysis

X: Navigator:
Provide patients and physicians more relevant, accurate, and actionable information to improve treatment options.
Spatiotemporal Modeling of Cancer Progression: From longitudinal data to Markov diagrams

Paul K. Newton
Viterbi School of Engineering, Department of Mathematics, and Norris Comprehensive Cancer Center
University of Southern California
Spatiotemporal dissemination patterns are first depicted using tree-ring diagrams for genetic types.
And for different treatments

5 year progression of lung cancer

30 paths
Treated with bevacizumab

Not treated with bevacizumab
190 paths
Then we model metastatic progression using Markov networks to produce detailed and accurate statistical forecasts.

Full network structure of metastatic breast cancer

Paths from breast

Paths into bone

Last met before deceased
Reduced diagrams lead to biological insights and medical hypothesis testing.
This leads to:

- Deep and organized view of cancer progression which we are currently developing for: Breast, Lung, Prostate, Colorectal and other cancers
- We can use this to produce highly accurate statistical forecasting tools for actionable clinical predictions
- We can then generate and test medical hypotheses
- Use as a framework for developing and testing adaptive therapeutics which require a detailed understanding of the spatial and temporal complexity of both the primary tumor, and the associated metastatic tumors
Collaborators

Mathematics and Physics of Cancer Metastasis

Mathematics, Physics, Molecular Biology
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- Paul Newton
- Jim Hicks

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- Lyudmila Bazhenova

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Quantified and Applicable: Designing solutions that mimic human decision making

- **Patient**: I am a 53 year old female diagnosed with stage 1 triple-negative breast cancer in 2011 who has now metastasis in the bones: what does that mean?
  - **Navigator**: This happens to about 30% of patients like you. Go here for more data.

- **Physician**: Previous standard of care applied to all triple negative patients but what do we know about the next metastasis?
  - **Navigator**: TNBC to bone is likely followed by lung or liver. Trials exist in PARPi.

- **Scientist**: TNBC patients seem to fall into two groups of short term survivors and long term survivors. I wonder how they differ?
  - **Navigator**: Here are progression pathways, the survival curves and the newest proteogenomics data.