Final Report
2012-13 Program on
Data-Driven Decisions in Healthcare (DDDHC)
July 25, 2014

1. Background

Healthcare is a central political, economic and social issue of our times. In the healthcare process, decisions are made at every level from the treatment of individual patients to formulation and evaluation of national policies. At the same time, data generation is increasing dramatically. Electronic medical records are becoming ubiquitous. Tests produce gigabytes of data, including images and biometric samples. The volumes of data are daunting in themselves; concomitant problems such as confidentiality and data quality exacerbate the challenges in producing usable tools that support principled healthcare decisions.

2. Personnel

The Program Leaders were Sheldon Jacobsen (University of Illinois at Urbana-Champaign), Myron Katzoff (National Center for Health Statistics/CDC), Mark Lewis (Cornell University), Avi Mandelbaum (Technion), Marianthi Markatou (IBM), Alan Menius (GlaxoSmithKline) Robert Obenchain (Risk Benefit Analysis), William Shannon (Washington University in St. Louis).

Local Scientific Coordinators were Nilay Argon (University of North Carolina at Chapel Hill), Julie Ivy (North Carolina State University), Vidyadhar Kulkarni (University of North Carolina at Chapel Hill), and Stanley Young (National Institute of Statistical Sciences)

The SAMSI Directorate Liaison was Alan Karr, and the National Advisory Committee Liaison was Susan Murphy (University of Michigan).

The principal visitors to the program were

- Myron Katzoff (formerly National Center for Health Statistics/CDC),
- Avi Mandelbaum (Technion)
- Robert Obenchain (Indiana University and Risk Benefit Statistics)
- Joseph Stanford (MD, University of Utah)

Faculty releases were:

- Nilay Argon (UNC STOR)
- M. Gregory Forest (UNC Applied Mathematics_)
- Vidyadhar Kulkarni (UNC STOR)
- Eric Laber (NCSU Statistics)

Graduate students (and advisers) were:

- A. Hoover (UNC Applied Mathematics; Forest)
- K. Linn (NCSU Statistics; Laber)
- Z. Sun (UNC STOR; Argon)
- H. Ye (UNC STOR; Argon)

The sole postdoctoral fellow was Kenneth Lopiano (Ph.D., Statistics, University of Florida, 2012).

3. Workshops

The **Opening Workshop** was held on August 26-29, 2012. Attendance was approximately 100. The program comprised tutorials by Marianthi Markatou (IBM) on comparative effectiveness research and Avi Mandelbaum (Technion) on data-based service systems, a keynote address "*Connections Between OR and CER*" by Sheldon Jacobson (University of Illinois), ten other invited presentations, poster sales talks, an open mike session and a concluding panel discussion that laid the ground for formation of the working groups.

The **Transition Workshop** was held on May 9-10, 2013, with a total attendance of forty. It focused on presentation and discussion of research carried out during the year by the Working Groups on Patient Flow, Dynamic Treatment Regimes, OMOP Data, and Observational CER.

Because of the scale and nature of the program, no workshops were held during the year.

The programs for the Opening and Transition Workshops are appended to this report.

4. Program Course

One course was held under the auspices of the program, with approximately 15 attendees:

Course Title: Operations Research Methods in Healthcare

Principal Instructor: V. Kulkarni, UNC

Schedule: Wednesday, 4:30-7:00 PM, September 5 - December 6, 2012

Course Description: A seminar-style course treating application of operations research methods such as stochastic modeling, queuing theory (including fluid models), optimization and simulation to problems in healthcare. Potential problems studied were data-based design of healthcare operations, patient flow, scheduling of facilities and personnel, management of transplant lists, mass casualty events and comparative effectiveness research. Students read and made presentations of material from the relevant literature.

5. Working Groups

The following Working Groups were active throughout the program year.

Dynamic Treatment Regimes, led by Eric Laber (North Carolina State University). The goal of the working group was to bring new quantitative researchers into the field of dynamic treatment regimes. Thus, a seminars and tutorials by experts in this area formed a major part of the working groups activities. Another goal of the group was the formation of smaller, more focused, subgroups working on specific research projects. These subgroups presented their research to the working group for comments and feedback. Finally, the group acted as a sounding board for its participants; in particular, they conducted case studies wherein a member brings their data and planned analysis for critique.

Distributed Health Services, led by Monica Jackson (American University) and Otis Jennings (Columbia University). The Working Group covered topics relating to public health and health concerns not currently addressed by a single existing facility. Members investigated topics such as emergency transport, community-based interventions, mobile health units, the intersection of disease propagation and health facility preparedness, certificate of need, and facility placement.

Data-Based Research on Patient Flow, led by Mandelbaum and Nilay Tanik Argon (University of North Carolina at Chapel Hill). The main objective of this very large working group was to use data to make better decisions about patient flow and resource allocation decisions in hospitals, clinics, and any other health care settings. Particular goals that were pursued included: (a) Comparison of practices/protocols at different types of hospitals at different countries; (b) Development of tools that would help optimize, estimate, predict, and make decisions at

individual levels that would contribute to the area of individualized medicine; (c) Estimation of triage errors and development of methods to take them into account in decision making at various levels (daily triage at ED, mass-casualty triage, and disaster/military triage); (d) Analysis of challenging modeling constructs that arise from healthcare such as time-varying (transient) models (vs. steady-state) and fork-join delays; (e) Development of flexible simulation tools to simulate operational and possibly clinical protocols, interconnected units, etc. that allow customization; and (f) Study of behavioral aspects of patients in hospitals. How do patients make decisions (e.g., leave without being seen or against medical advice)? What are the psychological factors driving patient decisions in hospitals, or elsewhere?

Observational Comparative Effectiveness Research (OCER), led by Robert Obenchain and S. Stanley Young. The goals were to (1) Advocate practices that make OCER a highly relevant and genuinely creditable alternative to Randomized Clinical Trials (RCTs) for improving current health care practice; (2) Propose and advocate methods for identification of Heterogeneous Treatment Effects (HTEs, which provide an objective basis for Individualized Medicine / Patient-Centered Outcomes Research (PCOR); (3) Champion initiatives to encourage and/or enforce OCER data sharing. Data sharing assures that key findings are "consensus views" that are not only objective but also reproducible; and (4) Develop and advocate use of interactive graphical displays of OCER information to enhance Doctor-Patient dialogs on treatment choices and to provide more realistic and easily interpretable information about uncertainty in outcomes.

Observational Medical Outcomes Partnership (OMOP) Data, led by Alan Karr (NISS) and Patrick Ryan (OMOP). The goals of the Working Group were (1) Analysis of the OMOP results database (http://omop.fnih.org/Research), leading to multiple publications, the first of which was submitted in November, 2012; and (2) Assessment of the representativeness of OMOP databases, which is crucial to assessing the broader applicability of observational medical studies.

Management of Chronic Diseases, led by Julia Ivey (North Carolina State University). The goal of the Working Group was to OR and statistical modeling tools (examples: Markov decision processes (MDP), partially observable MDP and multi-agent models to modeling of chronic diseases. Requirements for utilizing these modeling tools are metrics for measuring a "good" decision, methods for capturing disease progression, and methods for defining and characterizing the "state" of the system. Challenges included the need to capture patient preference, data analysis to capture the disease dynamics which requires time series and other longitudinal modeling of data that is often sparse or intermittent, quantitative and qualitative, with missing observations, and managing data from multiple sources.

6. Products of the Program

This section is incomplete because not all Working Group Leaders and other participants responded to requests to furnish relevant information. No works in progress are included.

6.1 Research Papers

Armony, M., Israelit, S., Mandelbaum, A., Marmor, Y,. Tseytlin, Y., Yom-Tov, G. (2014). "On Patient Flow In Hospitals: A Data-Based Queueing-Science Perspective." Submitted to *Operations Research*. Available on-line at http://ie.technion.ac.il/serveng/References/ED_Revision_Submitted.pdf

Azriel, D., Mandelbaum, A. (2014). "Erlang-S: A Data-Based Model of Servers in Queueing Networks." Submitted for publication. Available on-line at http://ie.technion.ac.il/serveng/References/paper_Erlang_S.pdf

Chakraborty, B., Laber, E., Zhao, Y. Q. (2014). "Inference About The Expected Performance of a Data-Driven Dynamic Treatment Regime." To appear in *Clinical Trials*.

Chakraborty, B. Laber, E., Zhao, Y. Q. (2013). "Inference for Optimal Dynamic Treatment Regimes using an Adaptive m-out-of-n Bootstrap Scheme." *Biometrics*, 69: 714-723

Davidian, M., Tsiatis, A.A., Laber, E.B. (2014) "Value Search Estimators for Optimal Dynamic Treatment Regimes," To appear as a chapter in *Dynamic Treatment Regimes*, SIAM Press.

Feldman, J., Liu, N., Topaloglu, H. Ziya, S. (2014). "Appointment Scheduling under Patient Preference and No-Show Behavior." To appear in *Operations Research*.

Gurvich, I., A. Ward, A. (2014). On the dynamic control of matching queues. To appear in *Stochastic Systems*. Available on-line at http://www-bcf.usc.edu/~amyward/Gurvich_Ward_2014.pdf.

Huang, J. Mandelbaum, A. (2014). "Control of Patient Flow in Emergency Departments, or Multiclass Queues with Deadlines and Feedback." Submitted to *Operations Research*. Available on-line at http://ie.technion.ac.il/serveng/References/ED_Revision_Submitted.pdf

Huang, Y. and Laber, E.B. (2014) "Personalized Evaluation of Biomarker Value: A Cost-Benefit Perspective." To appear in *Statistics and Biosciences*.

Huang, Y., Laber, E.B., Janes, H. (2014) "Characterizing Expected Benefits of Biomarkers in Treatment Selection." To appear in *Biostatistics*.

Hurwitz, J. E., Lee, J. A., Lopiano, K. K., McKinley, S. A., Keesling, J., Tyndall, J. A. (2014). "A Flexible Simulation Platform to Quantify and Manage Emergency Department Crowding.,"*BMC Medical Informatics and Decision Making*, *14*(1), 50.

Laber, E.B., Linn, K.A., Stefanski, L.A. (2014) "Interactive Q-learning." To appear in *Biometrika*.

Laber, E.B., Lizotte, D.J., Ferguson, B. (2014) "Set-valued Dynamic Treatment Regimes for Competing Outcomes." To appear in *Biometrics*.

Laber, E.B., Zhao, Y. (2014) “Tree-based Methods for Optimal Treatment Allocation.” Submitted to *Biometrika*.

Laber, E.B., Davidian, M., Tsiatis, A., Holloway, S.T. (2014) “Discussion of Biomarkers to Optimize Patient Treatment Recommendations.” To appear in *Biometrics*.

Laber, E.B., Murphy, S.A. (2014), “Adaptive Inference after Model Selection.” Submitted to *Journal of the Royal Statistical Society Series B.*

Laber, E.B., Qian, M. (2014) “Evaluating Personalized Treatment Regimes,” To appear in *Methods in Comparative Effectiveness Research*, CRC Press.

.Linn, K. (2104). “iqLearn: Interactive Q-learning in R.” To appear in *Journal of Statistical Software.*

Linn, K. (2104). “Interactive Q-learning” To appear in *Biometrika*.

Linn, K.A., Laber, E.B., Stefanski, L.A. (2014) “Interactive Q-learning for Probabilities and Quantiles.” Submitted for publication.

Linn, K.A., Laber, E.B., Stefanski, L.A. (2014) “Constrained Estimation for Competing Outcomes.” To appear as a chapter in *Dynamic Treatment Regimes*, SIAM Press.

Liu, N. (2013). “Case Study: Operations of the NewYork-Presbyterian Hospital’s Ambulatory Care Network.”

Liu, N. (2014). “Optimal Choice for Appointment Scheduling Window under Patient No-show Behavior.” Submitted for publication. (Winner of the third place in the 2013 INFORMS Junior Faculty Interest Group (JFIG) Paper Competition.)

Liu, N., Finkelstein, S., Kruk, M., Jani, B., Rosenthal, D.. (2014). “An Analysis of Patient Preferences and Choice Behavior in Outpatient Appointment Scheduling.” Submitted for publication.

Liu, N. Ziya, S. (2014). “Panel Size and Overbooking Decisions for Appointment-based Services under Patient No-shows.” To appear in *Production and Operations Management*.

Lopiano, K., Obenchain, R., Young, S. S. (2014). “Fair Treatment Comparisons in Observational Research." To appear in *Statistical Analysis and Data Mining.*

Mandelbaum, A., Momčilovič, P. (2014). Performance-Based Routing. Submitted for publication. Available on-line at http://ie.technion.ac.il/serveng/References/Performance_Based_Routing_Full.pdf

Mandelbaum, A., Momčilovič, P. (2014). “Personalized Queues: The Customer View, Via Least-Patient First Routing.” Submitted for publication. Available on-line at http://ie.technion.ac.il/serveng/References/LPF.pdf

McCormick, T. H., Ferrell, R. Karr, A. F., Ryan P. B. (2014). ”Big Data, Big Results: Knowledge Discovery in Output from Large-Scale Analytics.” To appear in *Statistical Analysis and Data Mining*.

McKeague, I. W., Qian M. (2014). “Evaluation of Treatment Policies based on Functional Predictors.” To appear in *Statistica Sinica*.

Schulte, P., Tsiatis, A., Laber, E.B., Davidian, M. (2014). “A Comparison and Q- and A-Learning.” To appear in *Statistical Science*.

Song, R., Wang, W., Zeng, D., Kosorok, M. (2014). Penalized Q-learning for Dynamic Treatment Regimens. To appear in *Statistica Sinica*.

Wu. F., Laber, E.B., Lipkovitch, I., and Severus, E (2014). “Estimating an Optimal Treatment Regime for Bipolar Depression Using STEP-BD.” Submitted for publication.

Wu. F., Laber, E.B., Severus, E. (2014) “Introduction to SMARTs,” To appear as a chapter in *Bipolar Disorders*, Oxford University Press.

Zhao, Y. Q., Zeng, D., Laber, E., Kosorok, M. R. (2014) “New Statistical Learning Methods for Estimating Optimal Dynamic Treatment Regimes.” To appear in *Journal of the American Statistical Association*.

Zhao, Y. Q., Kosorok, M. R. (2014) “Discussion of Combining Biomarkers to Optimize Patient Treatment Recommendations.” To appear in *Biometrics*.

Zhao, Y. Q., Laber, E. B. (2014) “Estimation of Optimal Dynamic Treatment Regimes.” To appear in *Clinical Trials*.

6.2 Selected Presentations

Karr, A. F.: “Analysis of the OMOP Results Database: Does the Analysis Method Matter More than the Truth?” Department of Biostatistics and Bioinformatics, Georgetown University, April 2013.

Karr, A. F: “Effects of Method Parameters and Ground Truth in the OMOP Results Database,’ RTI International, September 2013.

Karr, A. F.: “Effects of Method Parameters and Ground Truth in the OMOP Results Database,” OMOP Symposium, Bethesda, MD, November 2013.

Laber, E.: Presentations at Atlantic Causal Inference Conference, Brown University, Providence, RI, May 2014; Midwest Biopharmaceutical Statistics Workshop, Ball State University, Muncie, IN, May 2014; Trends and Innovations in Clinical Trial Statistics Conference, Morisville, NC, April 2014; Department of Biostatistics, University of Pittsburgh, Pittsburgh, PA, April 2014; NIPS, Workshop on Causality and Experimental Design, Lake Tahoe, NV, December 2013; INFORMS, Minneapolis, MN, October 2013; Society for Medical Decision Making,

Baltimore, MD; y-BIS, Istanbul, Turkey, September 2013; Joint Statistical Meetings, Montreal QC, August 2013; ENAR, Orlando, FL, March, 2013.

Linn, K., “Smooth Estimators of Optimal Dynamic Treatment Regimes,” INFORMS Healthcare in Chicago, June 2013.

Linn, K.: “Smooth Estimators of Optimal Dynamic Treatment Regimes,” Joint Statistical Meetings Montreal, August 2013.

Liu N.: “An Analysis of Patient Preferences and Choice Behavior in Outpatient Appointment Scheduling.” M&SOM Healthcare SIG Conference, Seattle, WA, June 2014.

Obenchain, R.: “Patient Micro-Aggregation: Bottom-Up Statistical Methodology for Rapid Medical Learning," Department of Biostatistics, University of North Carolina at Chapel Hill, April 2014.

Qian, M.: “Constructing Treatment Policies Using Q-learning with L-1 regularization,” ENAR Spring Meeting, Baltimore, MD, March 2014.

Qian, M.: “Experimental design for comparing adaptive interventions,” Center for Behavioral Cardiovascular Health, Department of Medicine, Columbia University Medical Center

Zhao, Y.: “New Statistical Learning Methods for Estimating Optimal Dynamic Treatment Regimes,” Fred Hutchinson Cancer Research Center, Seattle, WA, February 2014.

Zhao, Y.: “Efficient Augmentation And Relaxation Using Large-Margin Treatment Regimes for Personalized Medicine,” 2014 Atlantic Causal Inference Conference, Providence, RI, May 2014.

6.3 Proposals

PCORI Proposal: "Patient Micro-Aggregation: Bottom-Up Statistical Methodology for Rapid Medical Learning" PI = R. Obenchain (NISS), August 2013.

NSF SBIR Proposal, PI = K. Lopiano, December 2013

NIH SBIR Proposal: PI = K. Lopiano, April 2014 (with Duke collaborators)

EPRI Proposal: Development of a Medicare Cohort Dataset for Use in Air Pollution Epidemiological Research. PI = S. S. Young (NISS), June 2014

NSF STTR Proposal: PI = K. Lopiano, June 2014 (with East Carolina University and University of Florida collaborators)

6.4 Ongoing Collaborations

Collaboration between NISS and American Society for Clinical Oncology (ASCO), led by NISS acting director Nell Sedransk and ASCO Chief Medical Officer Richard Schilsky (catalyzed by DDDHC postdoc K. Lopiano and former NISS director A. Karr)

Lopiano, K.: Continuing collaboration with UNC-Chapel Hill to conduct research regarding patient flow in emergency departments: Jeffrey Strickler, Debbie Travers, Nilay Argon, Serhan Ziya

Lopiano, K.: Continuing collaboration with Duke University to conduct research regarding clinical decision support for anticoagulation management: Deepak Voora

Lopiano, K.: Continuing Collaboration with East Carolina University to conduct research regarding patient flow in emergency departments: Timothy Reeder

Lopiano, K.: Continuing Collaboration with University of Florida to conduct research regarding patient flow in emergency departments: Adrian Tyndall

Liu, N. Pang. G., Wang, R.: Managing Customer Choice in Queues.

Obenchain, R., Young, S. S., Lopiano, K.: Local Estimation Strategies Applied to Observational Health Care Data and U.S. Air Pollution Data.

6.5 Spinoff Corporation

Roundtable Analytics, LLC, Winterville, NC. Founder and Principal Collaborator is DDDHC postdoc Kenneth Lopiano.

SAMSI 2012-13 Program on
Data-Driven Decisions in Healthcare

Opening Workshop

Schedule

Sunday, August 26, 2012
Radisson RTP

9:15-9:45 a.m.	Registration and Continental Breakfast
9:45-10:00	Welcome and Introduction **Alan Karr**, NISS
10:00-11:15	Tutorial: Comparative Effectiveness Research: An Overview and Some Methodological Challenges **Marianthi Markatou**, IBM
11:15-11:30	Break
11:30-12:30	Tutorial Cont'd: Comparative Effectiveness Research: An Overview and Some Methodological Challenges **Marianthi Markatou**, IBM
12:30-1:30	Lunch
1:30-2:45	Tutorial: Data-Based Service Networks: A Research Framework for Asymptotic Inference, Analysis and Control of Service Systems **Avi Mandelbaum**, Technion
2:45-3:00	Break
3:00-4:00	Tutorial Cont'd: Data-Based Service Networks: A Research Framework for Asymptotic Inference, Analysis and Control of Service Systems **Avi Mandelbaum**, Technion

Monday, August 27, 2012
Radisson RTP

8:00-8:30 a.m.	Registration and Continental Breakfast
8:30-8:45	Welcome and Introduction **Alan Karr**, NISS
8:45-9:45	Keynote: *Connections Between OR and CER* **Sheldon Jacobson**, University of Illinois
9:45-10:00	Break
10:00-12:00	Technical Session: Screening and Treatment of Chronic Diseases

	Can We Do Better than "One Size Fits All"?: OR Models for Screening and Treatment **Julie Simmons Ivy**, North Carolina State University *Data-Driven Medical Decision Making of Chronic Disease Patients* **Mariel Lavieri**, University of Michigan Discussant: **Turgay Ayer**, Georgia Tech
12:00-2:00	Lunch
2:00-4:30	Technical Session: Valid Prediction from Medical Observational Data *A Predictivist Approach to Observational Analyses in Healthcare* **David Madigan**, Columbia University *Nonparametric Preprocessing for Head-to-Head OCER* Predictions* **Robert Obenchain**, Risk Benefit Analysis Discussant: **Stanley Young**, NISS
4:30-5:30	Participatory Session: Poster Advertisements
5:30-7:30	Reception and Poster Session

Tuesday, August 28, 2012
Radisson RTP

8:00-8:30 a.m.	Registration and Continental Breakfast
8:30-10:00	Technical Session: Patient Flow *Staffing to Stabilize Customer Delays in Service Systems with Time-Varying Arrivals* **Yunan Liu**, North Carolina State University *ICU Congestion: The Impact on Patient Flows* **Carri Chan**, Columbia University
10:00-10:15	Break
10:15-12:00	Technical Session Cont'd: Patient Flow *Mathematical Models for Hospital Inpatient Flow Management* **Jim Dai**, Cornell University and Georgia Tech Discussant: **Guodong Pang**, Pennsylvania State University
12:00-2:00	Lunch
2:00-4:15	Technical Session: Healthcare CER

	CER Visions and Realities: A Methodologic Perspective **Constantine Gatsonis**, Brown University *Ranking Providers for Comparative Effectiveness Research* **William Shannon**, Washington University Discussant: **Myron Katzoff**
4:15-4:30	Break
4:30-5:30	Participatory Session: Open Mike Session

Wednesday, August 29, 2012
Radisson RTP

8:00-8:30 a.m.	Registration and Continental Breakfast
8:30-10:00	Technical Session: OMOP Research and Data *Lessons from the Observational Medical Outcomes Partnership: Opportunities for Exploring Healthcare Databases to Study the Effects of Medical Products* **Patrick Ryan**, OMOP Discussant: **Alan Menius**, GlaxoSmithKline
10:00-10:30	Break
10:30-12:00	Panel Discussion: Research Priorities for the DDDHC Program **Sheldon Jacobson**, University of Illinois **Avi Mandelbaum**, Technion **Marianthi Markatou**, IBM **Sally Morton**, University of Pittsburgh
12:00-1:00	Lunch
1:00-3:00	Open Discussion: Proprosals for Working Groups and Working Group Formation and Initial Meetings

Data-Driven Decisions in Healthcare Transition Workshop

May 9-10, 2013

SCHEDULE

Thursday, May 9
SAMSI

8:30-9:00	Registration and Continental Breakfast
9:00-9:15	Welcome and Introductions
	<u>Patient Flow</u>
9:15-9:45	**Nilay Tanik Argon**, UNC and **Avi Mandelbaum**, SAMSI and Technion ***"****Data-Based Research on Patient Flow: Working Group Progress and Individual Adventures"*
9:45-10:15	**Nan Liu**, Columbia University *"Patient Preferences in Appointment Scheduling: Empirical Estimation and Operations Modeling Opportunities"*
10:15-10:30	Break
10:30-11:00	**Petar Momcilovic**, University of Florida *"Queueing Perspective of Patient Flow: Towards Personalized Models"*
11:00-11:30	**Amy Ward**, University of Southern California *"Modeling Patient Flow in Emergency Departments using Fork-Join Networks"*
11:30-12:00	Discussion
12:00-1:30	Lunch
	<u>Dynamic Treatment Regimes</u>
1:30-2:00	**Kristin Lynn**, North Carolina State University *"Smooth Estimation of Optimal Dynamic Treatment Regimes"*
2:00-2:30	**Yingqi Zhao**, University of Wisconsin Madison *"Statistical Learning Methods for Estimating Optimal Dynamic Treatment Regimes"*
2:30-3:00	Discussion
3:00-3:30	Break

OMOP Data

3:30-4:00 **Rebecca Ferrell**, University of Washington
"Challenges of Analyzing OMOP "Big Results" and Some Visual Approaches"

4:00-4:30 **Alan Karr**, NISS
"Analysis of the OMOP Results Database -- Does the Method Matter More than the Truth?"

4:30-5:00 Discussion

5:00-7:00 Poster Reception
SAMSI will provide poster presentation boards and tape. The board dimensions are 4 ft. wide by 3 ft. high. They are tri-fold with each side being 1 ft. wide and the center 2 ft. wide. Please make sure your poster fits the board. The boards can accommodate up to 16 pages of paper measuring 8.5 inches by 11 inches.

Friday, May 10
SAMSI

8:30-9:00 Continental Breakfast

Observational CER

9:00-9:30 **Kenneth Lopiano**, SAMSI
"sNMF for Sparse Data and Method for Determining Matrix Degree from Noisy Data"

9:30-10:00 **Kumer Das**, Lamar University
"*Contingency Table Analysis via Matrix Factorization*"

10:00-10:30 **Myron Katzoff**, CDC (retired)
"Recursive Partitioning Applied to Complex Sample Survey Data"

10:30-10:45 Break

10:45-11:15 **Robert Obenchain**, Risk-Benefit Analysis
"Local Control Methodology"

11:15-11:45 **Stanley Young**, NISS
"Status of Datasets"

11:45-12:30 General Discussion: Future Directions and Collaborations

12:30 Workshop Adjourns: Lunch Available for Participants