



NURSING INFORMATICS  
Empowered Care Through Leadership and Technology



# Using Information Technology to Transform Practice-Based Research

## The Omaha System Partnership for Knowledge Discovery and Health Care Quality

Karen A. Monsen, PhD, RN, FAAN  
University of Minnesota School of Nursing



# Envisioning Research in a Whole New World

- **April, 2010:** Invitation by Dean Delaney to start a warehouse of Omaha System data within the School of Nursing Center for Nursing Informatics
- **April – June:** Developed concept, including a 3-component structure
- **June, 2010:** Began to formally invite Omaha System colleagues to participate
- **November, 2011:** Affiliate members from 15 countries, 18 member scientific team, 35 projects, funding



# Envisioning Research in a Whole New World

- Transformed by technology:
  - Networked
  - Standardized
  - Data-rich



Barabasi Lab Image <http://barabasilab.com/gallery/g1.php>

# Science and technology: Networks

Skitter data depicting a macroscopic snapshot of Internet connectivity, with selected backbone ISPs (Internet Service Provider) colored separately by K. C. Claffy

- ANS
- ATT
- BBN/GTE
- CERFnet
- Digox
- Ebone
- MCI
- Netcom
- PSI
- Qwest
- Sprint
- UUnet
- Verio
- Unknown

# Leonhard Euler (1707-1783)

- Graph theory: nodes and edges
- Seven Bridges of Königsberg

MAE West

Source

MAE East

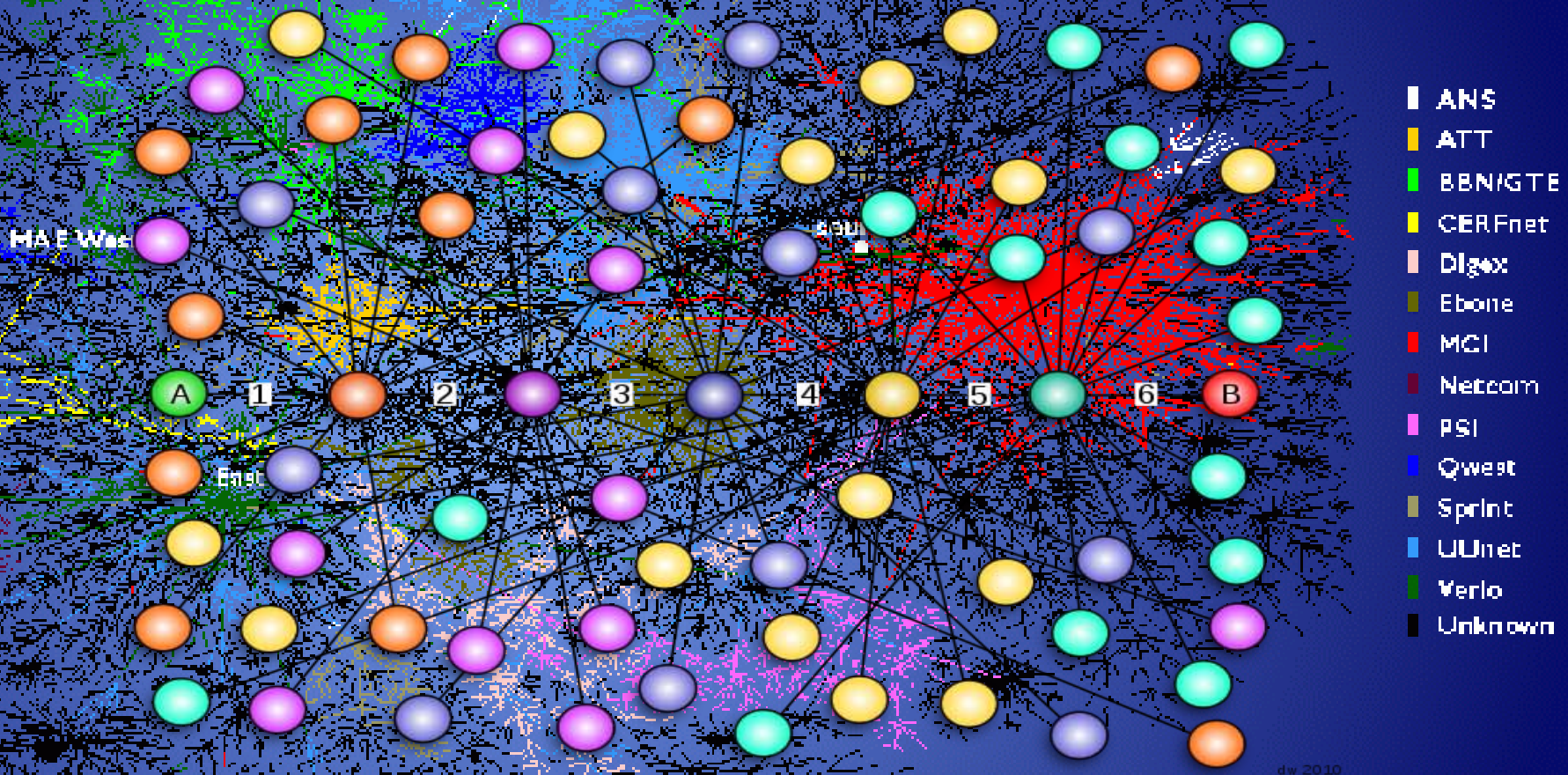
Königsberg



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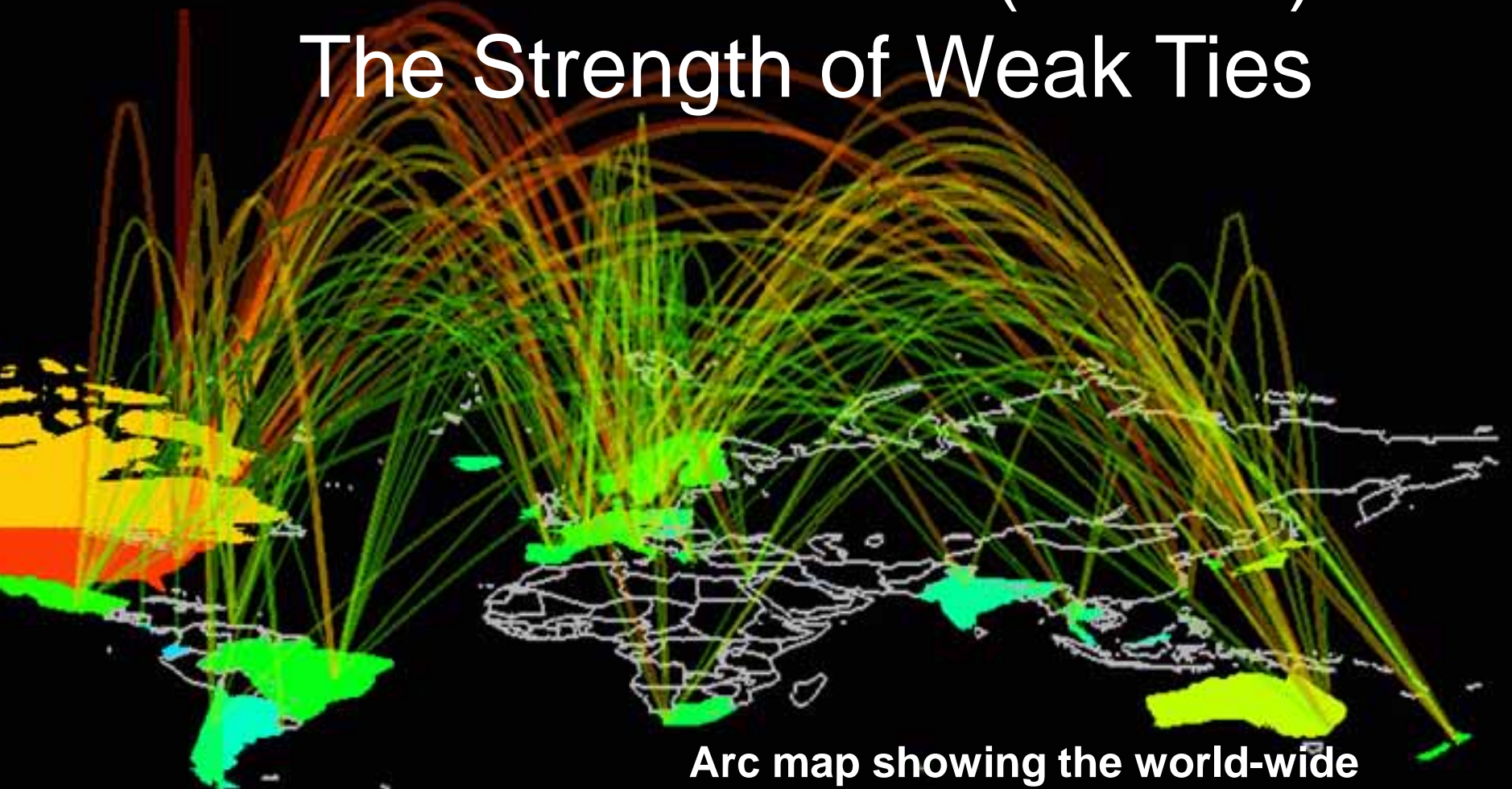
# Stanley Milgram (1933-1984)

## Small-World Experiment



# Mark Granovetter (1943 - )

## The Strength of Weak Ties



**Arc map showing the world-wide internet traffic By Stephen G. Eick**

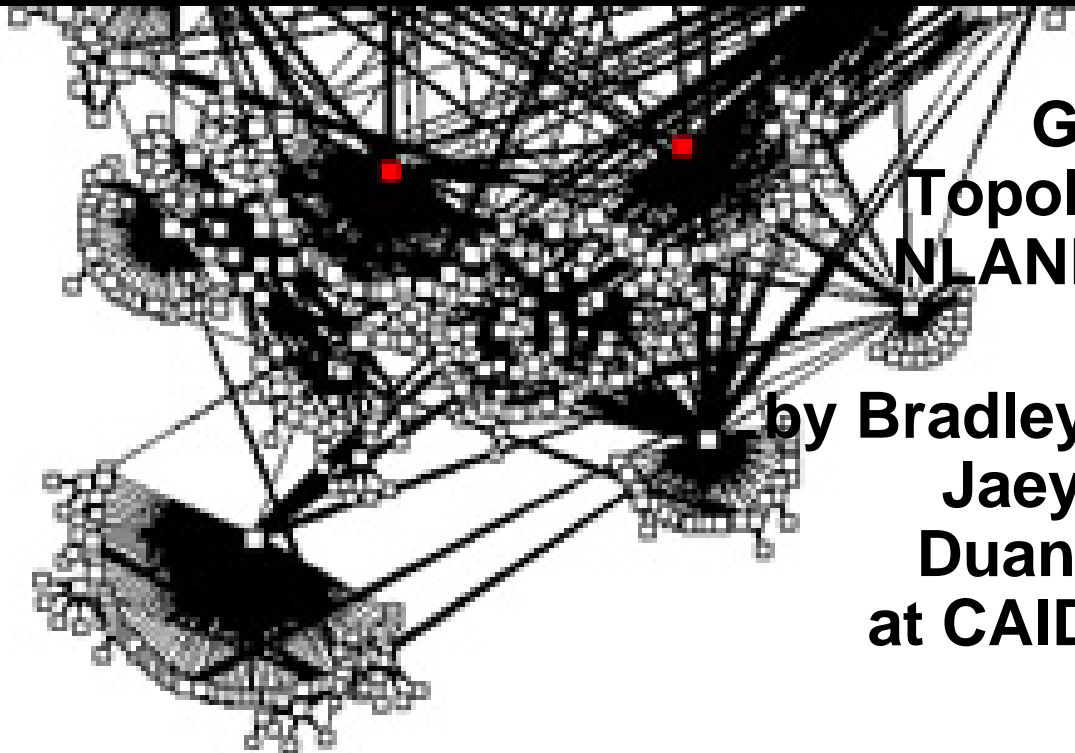
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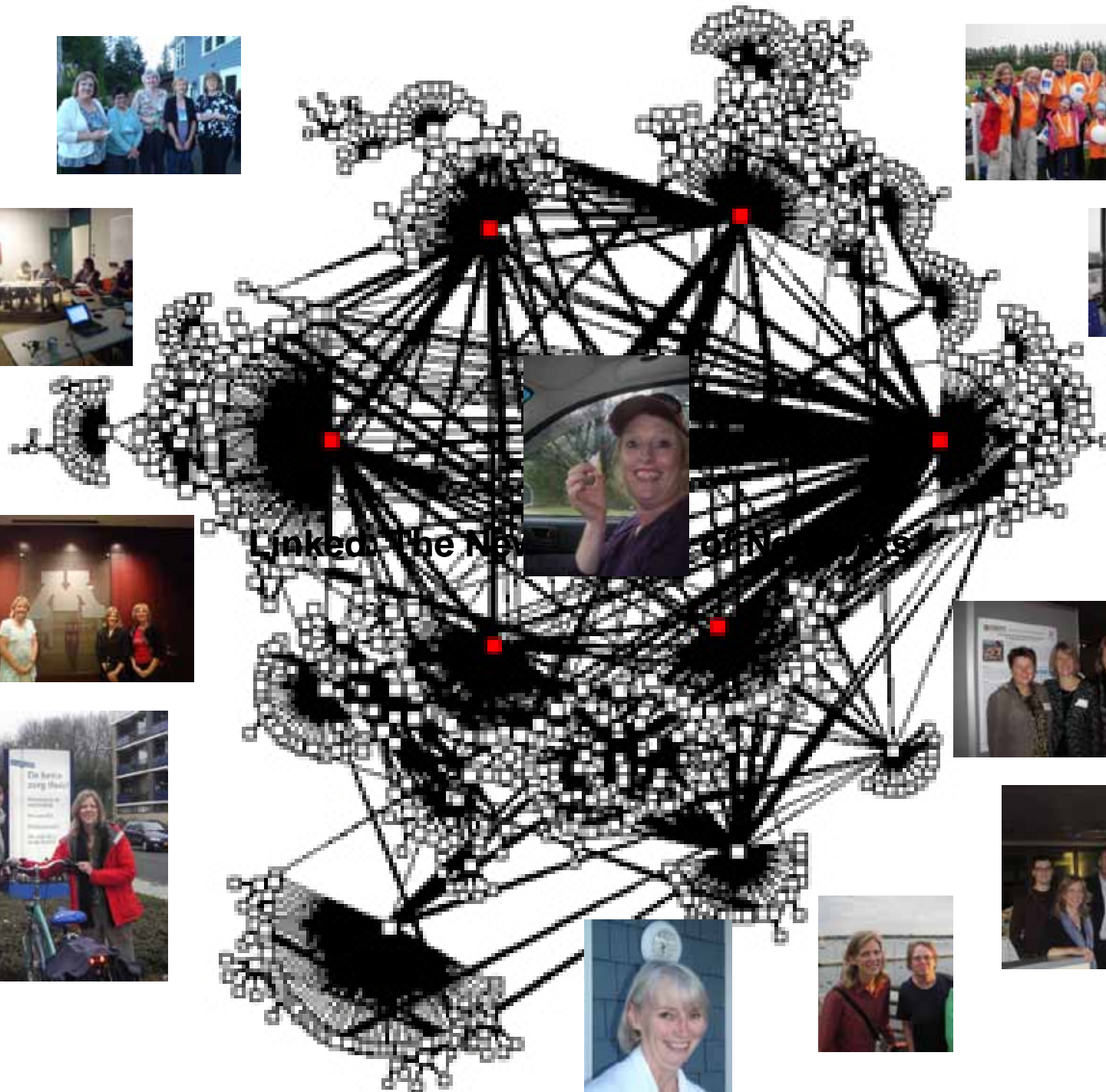


<http://barabasilab.com/gallery/g1.php>

# Albert-Laszlo Barabasi (1967 -) The New Science of Networks



**Growth and  
Topology of the  
NLNR Caching  
Hierarchy**  
by **Bradley Huffaker,  
Jaeyeon Jung,  
Duane Wessels  
at CAIDA/NLNR**



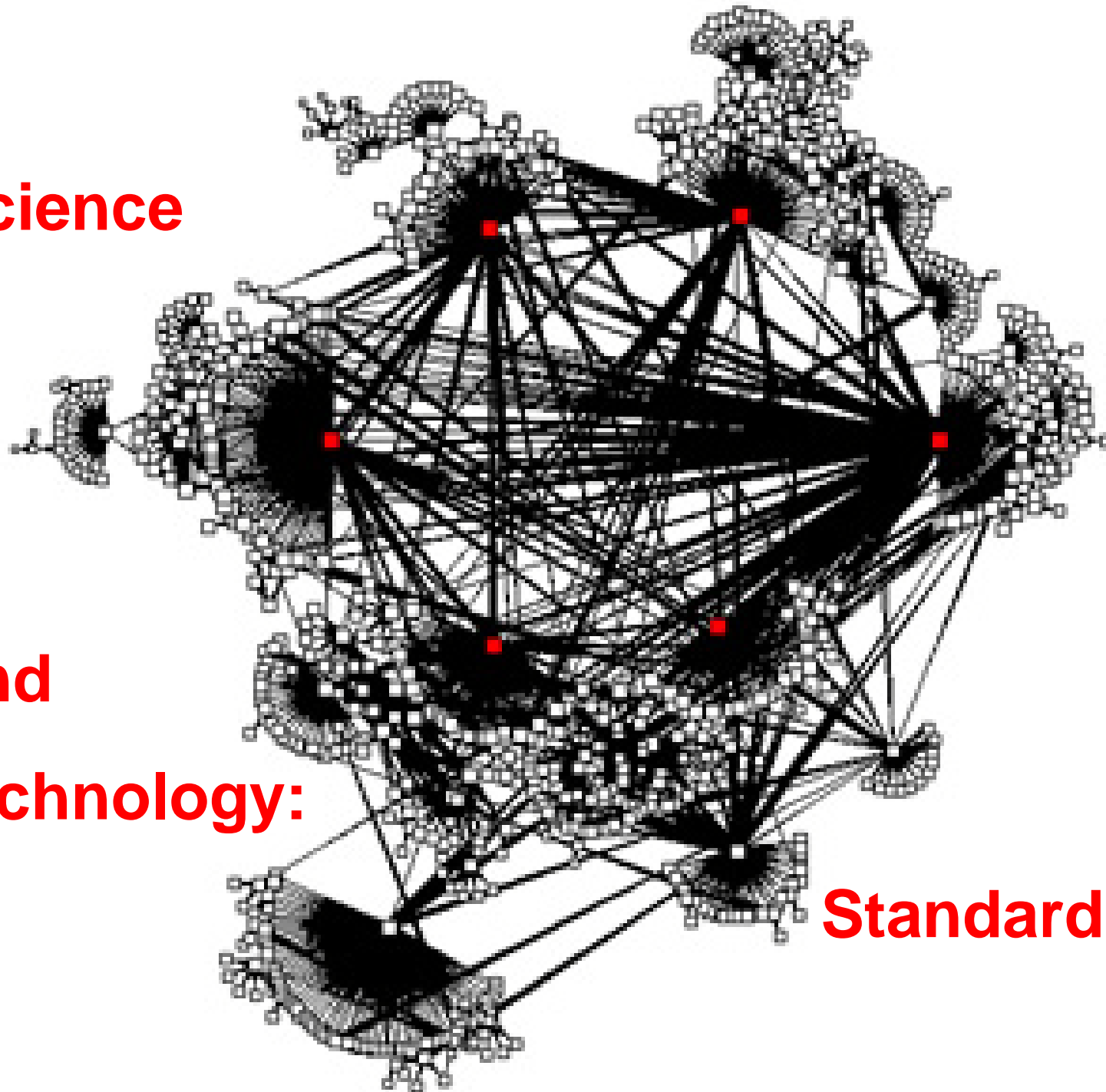
Linked: The New World of Networks





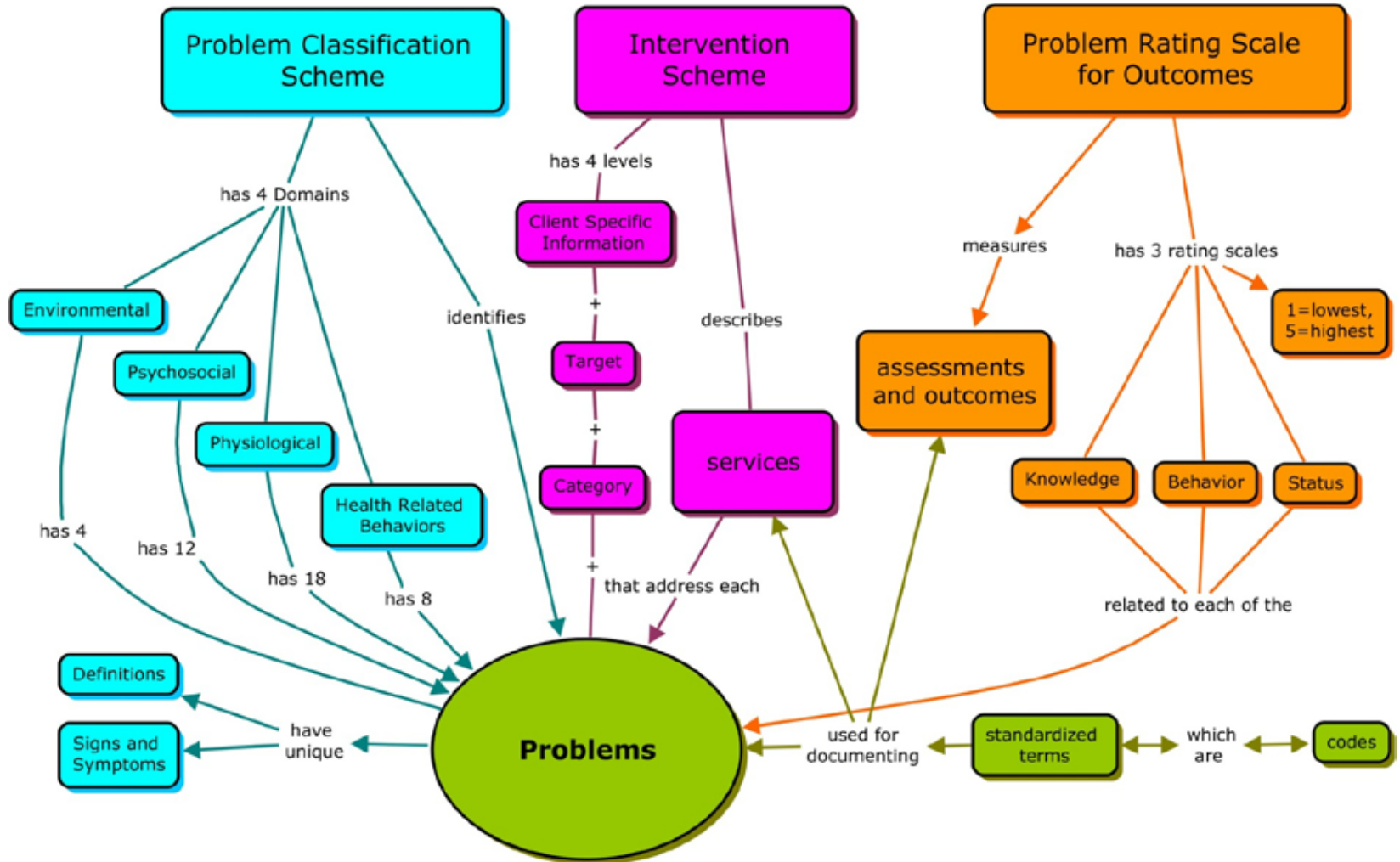
**Science**

**and  
technology:**

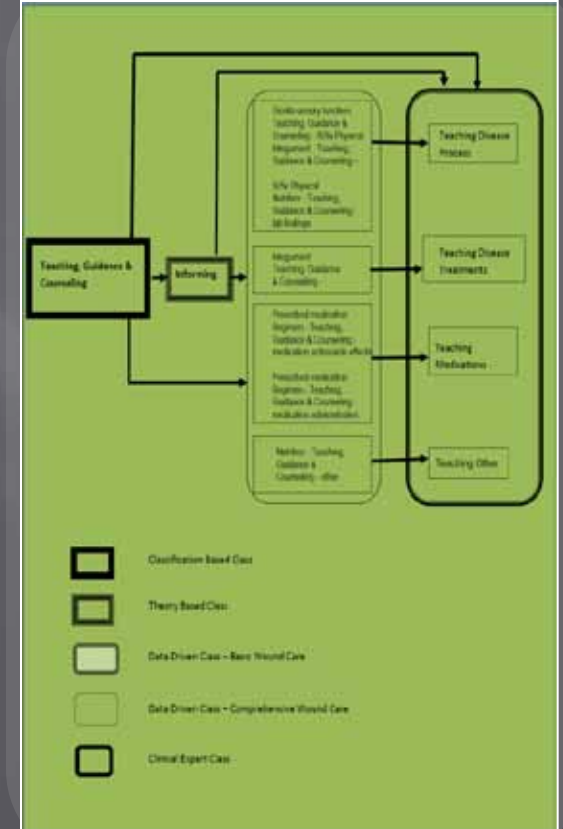
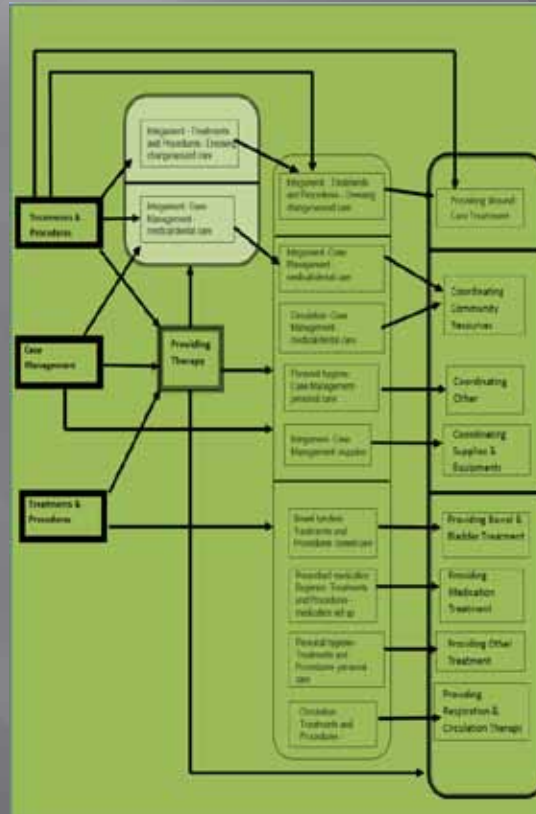
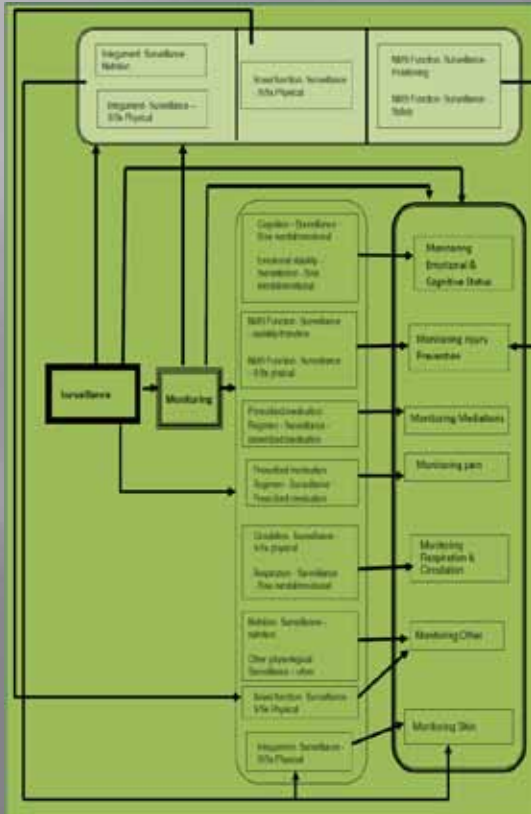


**Standards**

# The Omaha System (Martin, 2005)

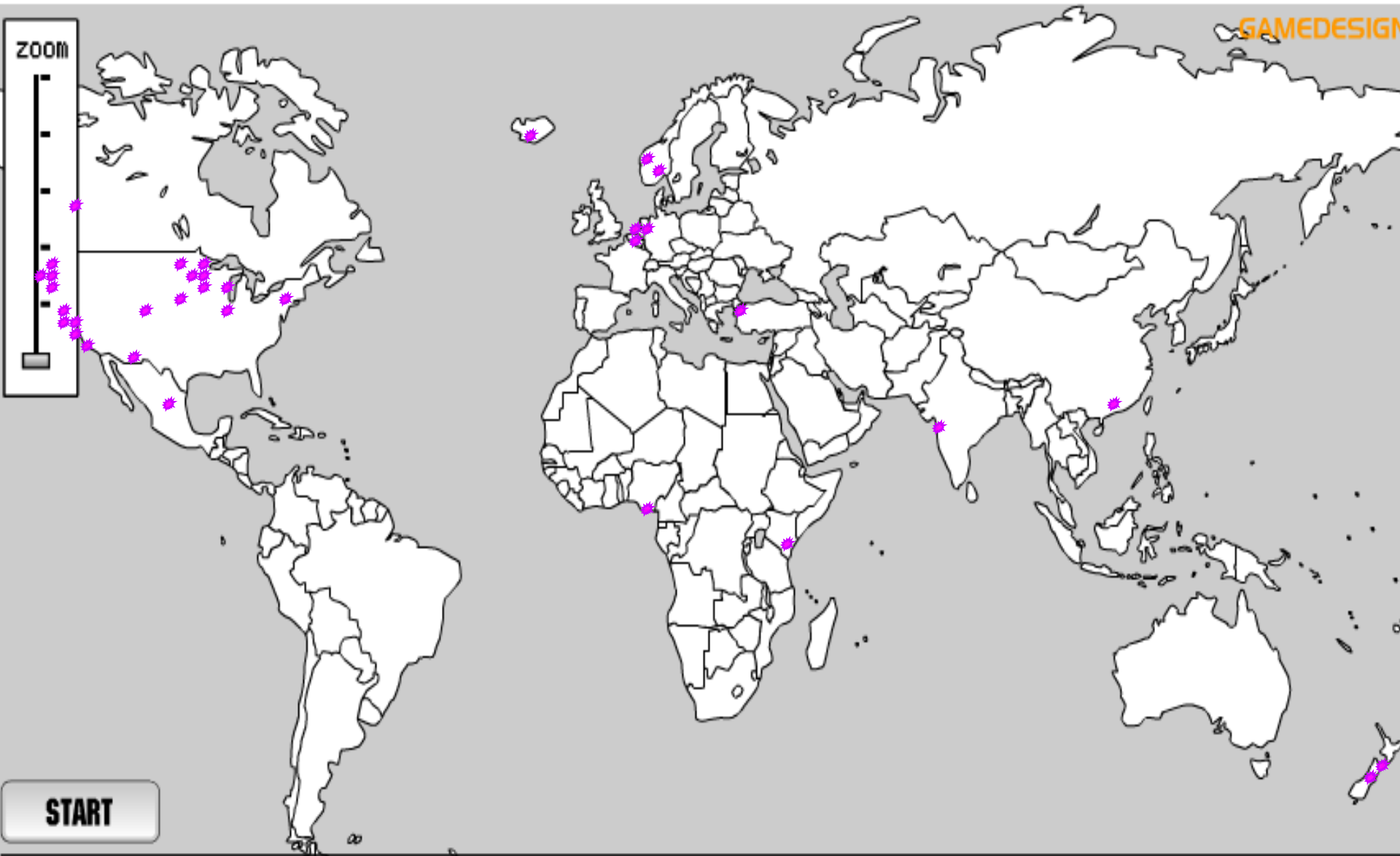


# Science and technology: Data



-  Classification Based Case
-  Theory Based Case
-  Data Driven Case - Basic Wound Care
-  Data Driven Case - Comprehensive Wound Care
-  Clinical Expert Case

# Omaha System Partnership



# Proposed or Current Research






# New Data-driven Paradigm

- New cyber infrastructure
- New data-driven paradigm of research in which the data generate the hypotheses
- James Hey (2009). *The Fourth Paradigm*. Microsoft Science. Available at:
  - [http://research.microsoft.com/en-us/collaboration/fourthparadigm/4th\\_paradigm\\_book\\_complete\\_lr.pdf](http://research.microsoft.com/en-us/collaboration/fourthparadigm/4th_paradigm_book_complete_lr.pdf)



# Data = Opportunity

- The Omaha System Data Warehouse originally proposed by Dean Delaney is a gold mine of health care quality knowledge
- Clinically relevant questions are being answered on a daily basis
- Students, faculty, and clinicians are partnering in practice-based research
- New metrics and methods are evolving with every study



# Past, Current, and Future Research

- 23 completed studies with manuscripts published (19), submitted (4)
- 11 studies in progress
- 3 grants awaiting decisions
- 5 studies in development

# A Health Care Quality Research Agenda

- New data sets, methods, models, and metrics are needed in all areas of health care research
- We are developing exemplars that can be used with any structured data sets
- All studies use data from clinical settings and involve clinical and/or scholarly experts as partners

# New Metrics

- Problem stabilization
- Benchmark attainment
- Maternal Risk Index



# Stabilization: a proposed interim improvement indicator

- Problem stabilization is an intervention pattern for a client problem that is characterized by:
- co-occurring interventions with more than one category during a nurse-client encounter (i.e. teaching, guidance, and counseling; treatments and procedures; case management; and/or surveillance)
- followed by surveillance only (for that problem) during a subsequent nurse-client encounter.

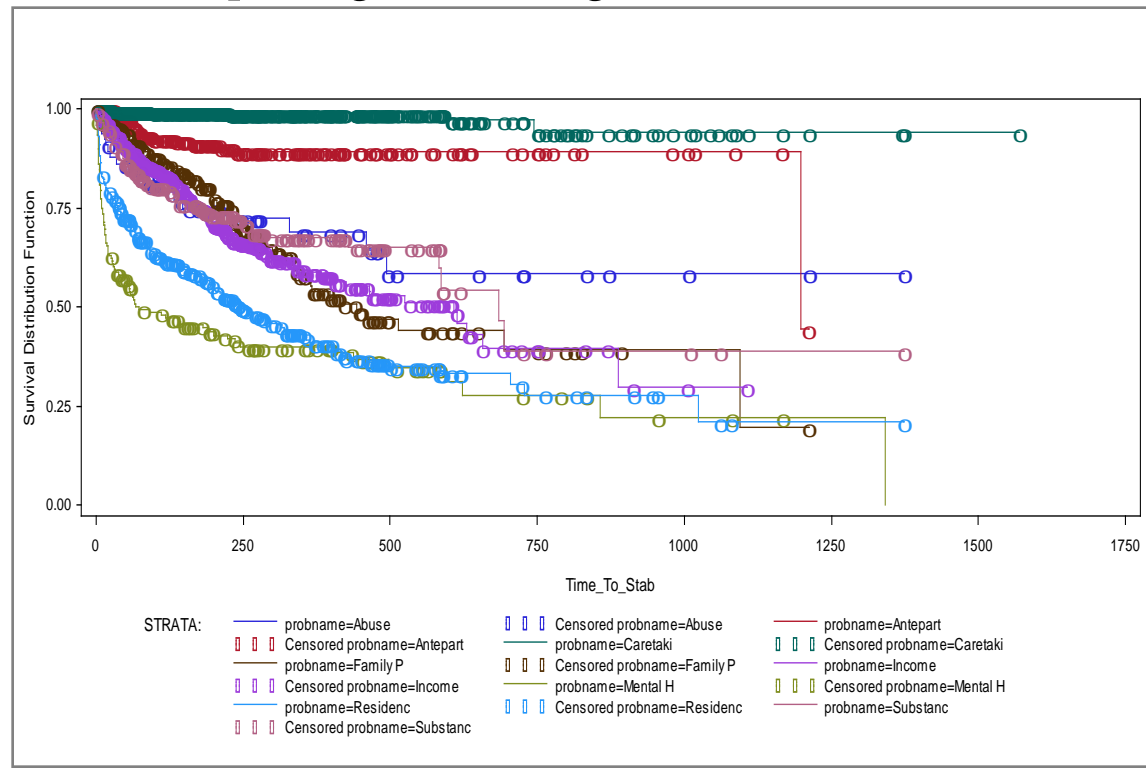
# Problem Stabilization

(mean values across all problems)

	<b>Adult</b>	<b>Children</b>
Percent Stabilized	30.1%	20.1%
Time to Stabilization	158 days	116 days
Length of Care	286 days	273 days

# Survival Analysis (Kaplan-Meier Curves)

- *Graphing methods for depicting the timing and occurrence of events*



•was supported by the National Institute of Nursing Research (Grant #P20 NR008992; Center for Health Trajectory Research). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Nursing Research or the National Institutes of Health.

# Benchmark Attainment

*improvement process used to discover (and incorporate)  
best practices into operations*

**Concepts and Ratings of the Problem Rating Scale for Outcomes:**

Concepts	1	2	3	4	5
<b>Knowledge:</b> Ability of the client to remember and interpret information	No knowledge	Minimal knowledge	Basic knowledge	Adequate knowledge	Superior knowledge
<b>Behavior:</b> Observable responses, actions, or activities of the client fitting the occasion or purpose	Not appropriate behavior	Rarely appropriate behavior	Inconsistently appropriate behavior	Usually appropriate behavior	Consistently appropriate behavior
<b>Status:</b> Condition of the client in relation to objective and subjective defining characteristics	Extreme signs/symptoms	Severe signs/symptoms	Moderate signs/symptoms	Minimal signs/symptoms	No signs/symptoms

# Benchmarking PHN Outcomes

County 1																		
2005	open/close	Knowledge						Behavior					Status					
Problem		N actual & potential	Admission	Discharge	Difference	Significance	% Improved	Admission	Discharge	Difference	Significance	% Improved	n actual problems	Admission	Discharge	Difference	Significance	% Improved
Growth and development		95	3.10	3.77	0.67	0.010	55.3%	4.05	4.31	0.25	0.000	27.1%	15	3.63	4.12	0.49	0.005	43.8%
Antenatal/postpartum		86	2.88	3.72	0.84	0.034	66.9%	3.54	4.36	0.72	0.064	62.9%	21	3.57	4.67	1.00	0.000	66.7%
Caretaking/parenting		75	3.04	3.65	0.61	0.002	53.3%	3.67	4.04	0.37	0.000	36.0%	12	3.42	4.25	0.83	0.010	60.0%
Family planning		47	2.64	3.38	0.74	0.050	53.2%	3.00	3.74	0.74	0.048	38.3%	8	2.00	3.88	1.88	0.022	62.5%
Emotional stability		46	2.87	3.46	0.59	0.017	47.8%	3.13	3.63	0.50	0.001	34.8%	20	3.25	3.95	0.70	0.005	40.0%
Substance use		29	3.00	3.48	0.48	0.003	41.4%	3.28	3.52	0.24	0.000	27.6%	12	3.25	3.67	0.42	0.054	33.3%
Abused child/adult		26	2.85	3.15	0.30	0.002	26.9%	3.42	3.50	0.08	0.000	7.7%	8	3.00	3.25	0.25	0.361	12.5%
Neglected child/adult		15	2.93	3.33	0.40	0.019	40.0%	4.07	3.87	-0.20	0.000	0.0%	1	4.00	5.00	1.00	0.000	100.0%
Income		11	2.45	3.27	0.82	0.366	54.5%	2.54	3.27	0.63	0.315	54.5%	7	2.29	3.14	0.85	0.018	57.1%
Residence		3	2.67	3.67	1.00	0.667	66.7%	2.67	3.67	1.00	0.212	66.7%	0					

County 2																		
2005	open/close	Knowledge						Behavior					Status					
Problem		N actual & potential	Admission	Discharge	Difference	Significance	% Improved	Admission	Discharge	Difference	Significance	% Improved	n actual problems	Admission	Discharge	Difference	Significance	% Improved
Growth & Development		1011	2.74	3.37	0.63	0.000	55.7%	3.42	3.95	0.53	0.000	38.8%	385	3.17	3.75	0.58	0.000	48.3%
Caretaking/parenting		838	2.75	3.37	0.61	0.000	54.3%	3.47	3.79	0.32	0.000	39.1%	441	3.17	3.61	0.44	0.000	48.4%
Antenatal/postpartum		770	2.72	3.52	0.80	0.000	63.6%	3.42	3.95	0.53	0.000	48.8%	465	3.25	4.18	0.93	0.000	69.5%
Family Planning		625	2.67	3.26	0.59	0.000	50.7%	3.26	3.69	0.33	0.000	37.3%	372	2.90	3.60	0.60	0.000	46.8%
Income		471	2.55	3.01	0.46	0.000	43.3%	3.19	3.39	0.20	0.000	28.0%	427	2.88	3.10	0.22	0.000	32.3%
Abused child/adult		391	2.62	3.12	0.50	0.000	42.7%	3.25	3.64	0.29	0.000	30.2%	194	3.09	3.85	0.76	0.000	53.1%
Residence		286	2.61	3.05	0.44	0.000	39.5%	3.03	3.34	0.31	0.000	36.1%	234	2.67	3.38	0.51	0.000	44.4%
Emotional stability		280	2.55	2.92	0.37	0.000	33.2%	2.86	3.10	0.14	0.012	26.1%	233	2.82	3.21	0.39	0.000	39.9%
Neglected child/adult		269	2.58	3.07	0.49	0.000	42.0%	3.19	3.39	0.20	0.000	29.4%	134	3.11	3.60	0.49	0.000	47.0%
Substance use		175	2.62	2.99	0.37	0.003	34.9%	2.93	3.10	0.17	0.001	25.7%	152	2.87	3.11	0.24	0.003	27.6%

County 3																		
2005	open/close	Knowledge						Behavior					Status					
Problem		N actual & potential	Admission	Discharge	Difference	Significance	% Improved	Admission	Discharge	Difference	Significance	% Improved	n actual problems	Admission	Discharge	Difference	Significance	% Improved
Antenatal/Postpartum		95	2.98	4.03	1.05	0.000	78.9%	3.38	4.27	0.89	0.000	71.6%	88	3.51	4.42	0.91	0.000	72.7%
Growth & Development		67	2.66	3.73	1.07	0.000	74.6%	3.73	4.49	0.76	0.000	58.2%	47	3.43	4.32	0.89	0.000	72.3%
Family Planning		63	2.73	3.79	1.06	0.000	63.3%	2.87	4.05	1.17	0.000	58.3%	63	2.71	4.03	1.32	0.000	66.7%
Income		54	2.81	3.69	0.87	0.000	64.8%	3.02	3.83	0.81	0.000	68.9%	52	3.10	3.77	0.67	0.000	57.7%
Caretaking & Parenting		44	2.93	3.85	0.93	0.000	75.0%	3.48	4.14	0.66	0.000	66.8%	35	3.34	3.94	0.60	0.004	45.7%
Emotional Stability		22	3.05	3.59	0.55	0.000	50.0%	3.45	4.00	0.55	0.004	45.5%	19	3.32	4.05	0.74	0.001	62.6%
Residence		15	2.87	3.53	0.67	0.007	60.0%	3.20	3.73	0.53	0.027	46.7%	15	3.13	3.87	0.73	0.003	66.7%
Substance Use		13	2.54	3.69	1.15	0.001	76.9%	3.00	3.46	0.46	0.053	30.8%	12	3.08	3.58	0.50	0.063	33.7%
Abused Child/Adult		9	3.33	3.89	0.56	0.139	44.4%	3.33	4.22	0.89	0.009	66.7%	8	2.75	4.00	1.25	0.002	87.5%
Neglected Child/Adult		4	3.25	3.75	0.50	0.182	60.0%	3.75	4.25	0.50	0.182	60.0%	2	3.50	4.50	1.00	0.000	100.0%

County 4																		
2005	open/close	Knowledge						Behavior					Status					
Problem		N actual & potential	Admission	Discharge	Difference	Significance	% Improved	Admission	Discharge	Difference	Significance	% Improved	n actual problems	Admission	Discharge	Difference	Significance	% Improved
Growth & Development		179	2.87	3.33	0.46	0.000	40.7%	4.50	4.70	0.10	0.011	13.7%	28	3.25	3.71	0.46	0.001	45.4%
Caretaking/parenting		165	2.87	3.33	0.46	0.000	39.8%	3.97	4.17	0.20	0.000	24.1%	31	3.10	3.65	0.55	0.003	48.4%
Income		146	2.80	2.95	0.35	0.000	33.6%	3.30	3.53	0.23	0.000	26.0%	119	2.94	3.30	0.36	0.000	32.8%
Antenatal/postpartum		141	2.73	3.30	0.57	0.000	48.2%	3.73	4.18	0.45	0.000	39.0%	61	3.18	4.18	1.00	0.000	67.2%
Residence		123	2.80	3.11	0.31	0.000	28.8%	3.60	3.98	0.18	0.001	22.4%	27	2.85	3.26	0.41	0.013	33.3%
Family Planning		93	2.72	3.14	0.42	0.000	40.9%	3.34	3.63	0.29	0.003	31.2%	53	2.04	3.02	0.98	0.000	60.9%
Emotional stability		75	2.87	3.08	0.21	0.000	21.3%	3.55	3.79	0.24	0.001	28.0%	39	3.13	3.62	0.49	0.001	43.6%
Substance use		69	2.96	3.10	0.14	0.003	13.0%	3.14	3.43	0.29	0.002	18.8%	55	2.84	3.11	0.27	0.015	23.6%
Abused child/adult		42	2.86	3.17	0.31	0.000	31.0%	4.00	4.14	0.14	0.135	19.0%	14	3.38	3.93	0.57	0.026	60.0%
Neglected child/adult		17	3.24	3.24	0.00	1.000	11.8%	4.29	4.41	0.12	0.163	11.8%	3	3.33	3.67	0.33	0.423	33.3%



# Benchmarking Outcomes for Mothers with Intellectual Disabilities

- For mothers with ID, the benchmark of 4 was attained by 50% of the sample for 10 of 21 outcomes.
- For the comparison group, the benchmark of 4 was attained by 50% of the sample for 16 of 21 outcomes

# Maternal Risk Index

*-method of assessing and stratifying entities based on the likelihood of occurrence of an event*

Maternal Risk =  
(number of problems (weighted))/  
(average baseline knowledge score)

# Maternal Risk Index Results

<i>N</i> = 486	Low-risk <i>n</i> = 243	High-risk <i>n</i> = 243	
Mean age (years)	25.6	22.1	
	Percentages		
Racial/ethnic minority ( <i>n</i> = 114)	23.5%	23.5%	
Unmarried ( <i>n</i> = 377)	65.4%	89.7%	
Male ( <i>n</i> = 12)	4.5%	0.4%	
Pregnant ( <i>n</i> = 190)	26.7%	51.4%	n.s.
	Mean numbers		
Visits	7.7	11.9	
Interventions	53.1	143.1	
Problems	3.2	6.4	
Categories	2.4	2.7	
Targets	12.5	17.3	

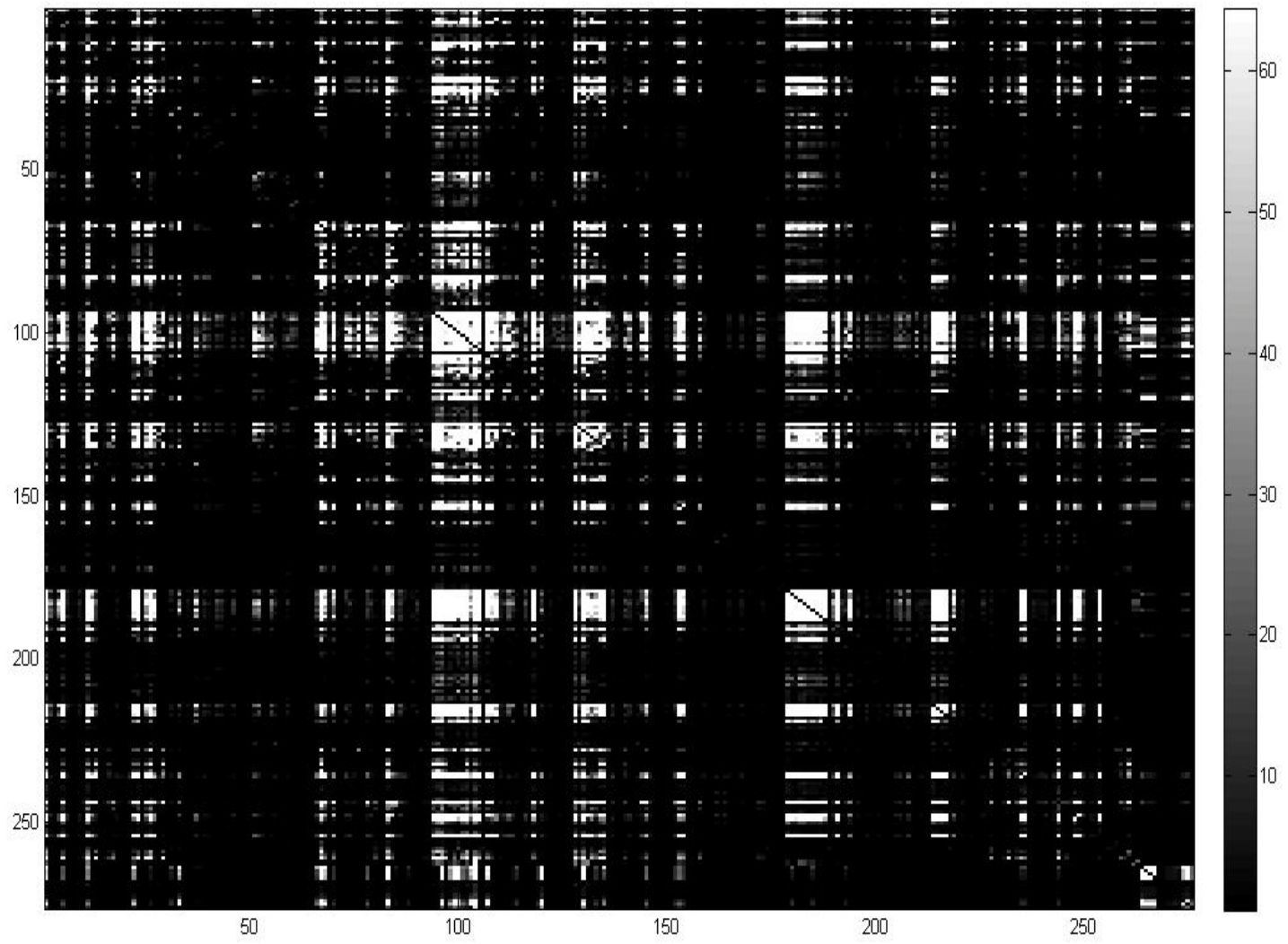
# New Methods

- Data mining with structured data
- Overlapping clusters
- Intervention pairs/graphs
- Mining text with structured data
- Semantic equivalence
- Data visualization

# Creating intervention clusters using graphing methods with multilevel Kway partitioning



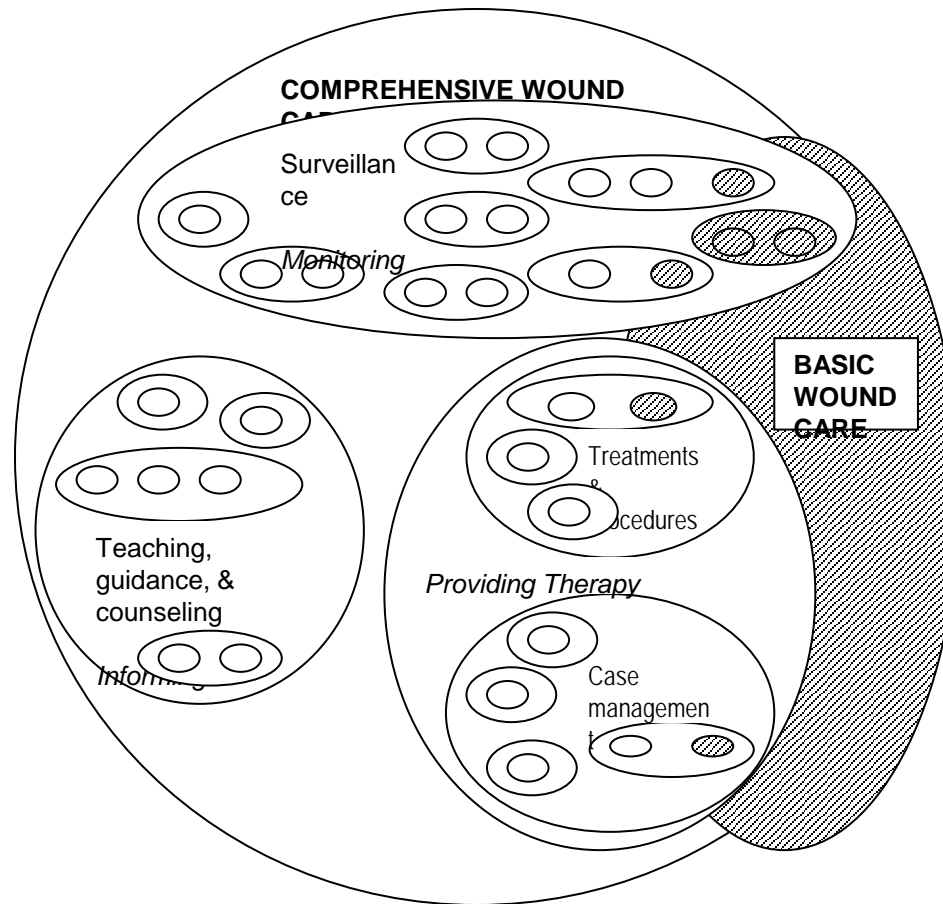
If a triplet  $p1-c1-t1$  and  $p2-c2-t2$  are associated with first visit of a patient and  $p3-c3-t2$  with his second visit. An edge will be added between respective nodes of  $p1-c1-t1$  and  $p2-c2-t1$ , say  $e1$ . Also between  $p3-c3-t2$  and  $p1-c1-t1$  (say  $e2$ ) and between  $p3-c3-t2$  and  $p2-c2-t2$  say ( $e3$ ). But the weight assigned to  $e1$  will be more than that for  $e2$  for this patient. This is because  $p1-c1-t1$  and  $p2-c2-t2$  occur for the same visit while  $p3-c3-t2$  occur for a different visit. The more the separation between the number of visits, the less the weight assigned to an edge between a pair of P-C-T triplet.



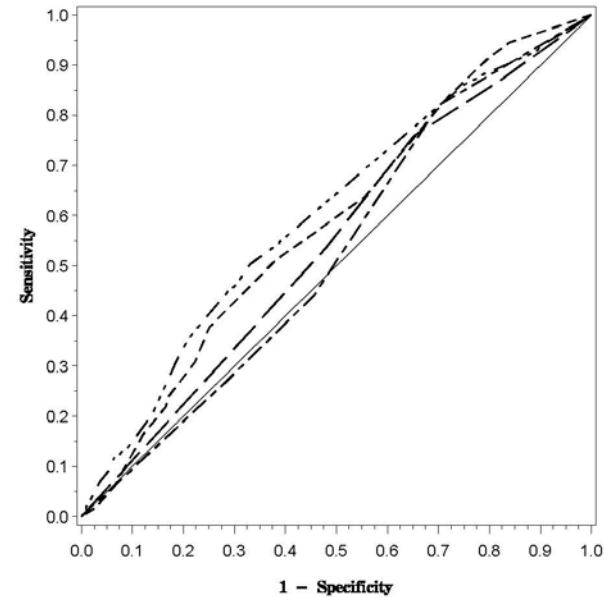
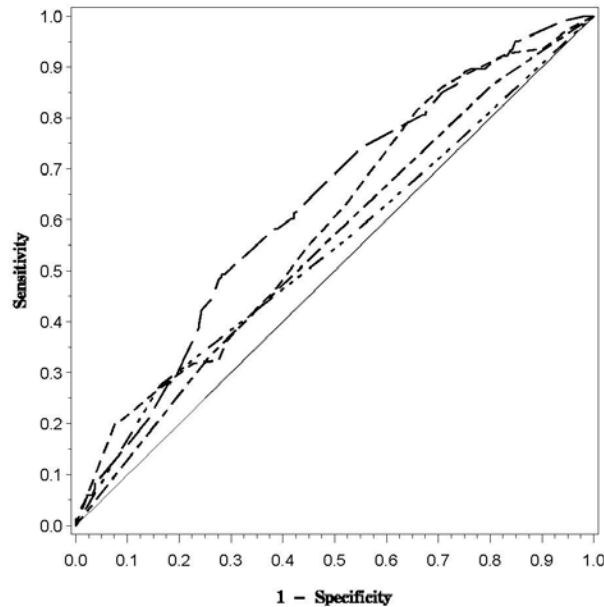
# Associating Family Home Visiting Interventions and Outcomes for High Risk MCH Clients

Outcome	<i>p</i>	Intervention cluster
Lower		
Knowledge	0.031	all but Monitoring & supporting behavior change
Highest		
Knowledge	0.019	Monitoring parent mental health and support system
Status	0.094	Monitoring & supporting behavior change

# Venn Diagram: Overlapping Intervention Clusters



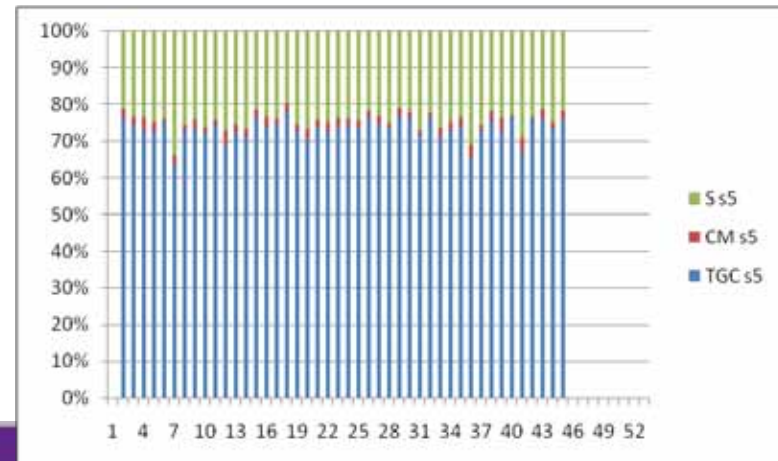
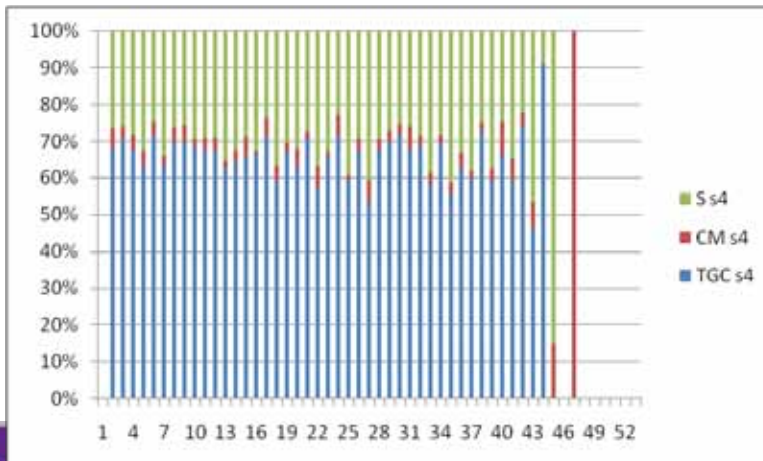
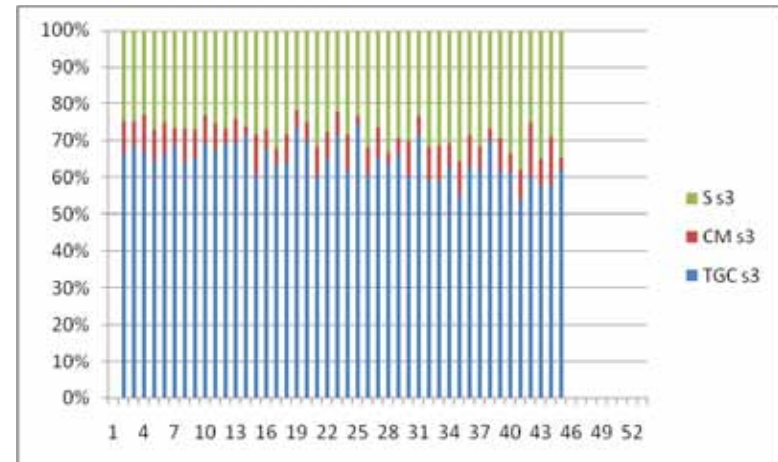
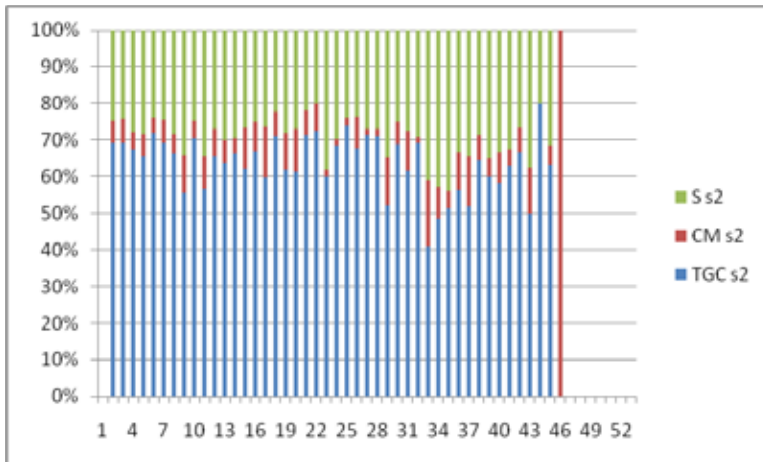
# Associating Interventions and Hospitalization Outcomes for Frail and Non-frail Elderly Home Care Patients



# Data Visualization: Learning from Seeing

- *processes that transform large quantities of raw data into graphical representations that exploit the superior visual capability of the human brain to detect patterns and draw inferences*

# Intervention Patterns by Baseline Status



# Snapshots

- New partners
- New possibilities

# Washington State Children with Special Health Care Needs Program

- Principal Investigator: Scott Elsbernd
- Purpose: to determine the frequency of problems, interventions and outcomes for children with special health care needs in Washington State (pilot study of initial data)
- Partners: State CSHCN Program Staff Barnhart, L., Stock, J.

# Home Care in Istanbul, Turkey

- Co Principal Investigators: Erdogan S., Secginli S., Istanbul University, Florence Nightingale SON
- Purpose: To identify the most frequent problems of people receiving home health care services, and to measure clients Initial and final knowledge, behavior and status outcomes related to the top identified problems for evaluation the provided care in home care centers.

# Time-Motion Study

- Principal Investigator Yi Zhang
- Tool development for inpatient nursing observations
- Partners in Fairview-University hospital and University of Minnesota Institute for Health Informatics
- Potential for translation into Chinese

# Public Health Functions of 1-2 time Home Visits

- Principal Investigator: Monsen
- Purpose is to describe outcomes of clients receiving 1-2 visits
- Third research project of the Minnesota Omaha System Users Group

# Pilot Test of the Omaha System in Kenya, Nigeria, and Tanzania

- Principal Investigator: Eunice Areba
- Purpose is to determine fit of the Omaha System to describe public health nursing practice in African countries
- Pilot test using paper-based data collection in English and Swahili

# Thank you!

- Questions?
- [mons0122@umn.edu](mailto:mons0122@umn.edu)