



**THE HOMELAND SECURITY CENTER  
FOR **DYNAMIC DATA ANALYSIS**  
AT RUTGERS UNIVERSITY**

AT&T Labs – Research

Bell Labs/Lucent Technologies

Princeton University

Rensselaer Polytechnic Institute

Rutgers, the State University of New Jersey

Texas Southern University

Texas State University, San Marcos



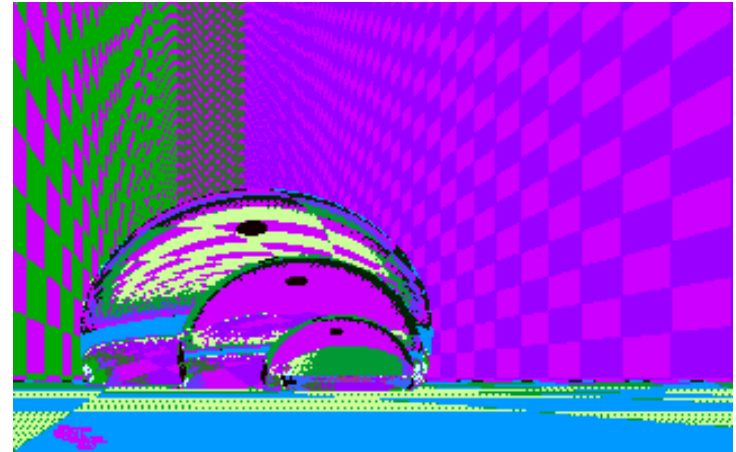
# History

- 2006: The Center for Dynamic Data Analysis (DyDAn) is created and is named a Department of Homeland Security “university center of excellence”
- DyDAn is one of four DHS centers dealing with “discrete science”
- Other centers: Univ. of Illinois Urbana-Champaign, Univ. Southern Cal., U. Pittsburgh
- DyDAn is the “coordinating” discrete science center.



# What is Discrete Science

- Discrete Science deals with
  - Patterns
  - Arrangements
  - Assignments
  - Schedules
- Discrete Science
  - Seeks patterns in large amounts of data
  - Analyzes connections between entities such as people and groups
  - Develops efficient ways to quickly spot changes in standard patterns



# Why DyDAn?

- Homeland Security requires inferences from massive flows of data, arriving continuously.
- Buried in data are: quickly changing patterns.
- DyDAn: *is developing novel technologies to find patterns & relationships in dynamic, nonstationary, massive datasets.*
- DyDAn: *is producing pioneering educational programs to nurture the homeland security workforce of the future*



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# Why DyDAn?

- *Much of DyDAn's work is relevant to port security problems:*
  - Data from container inspection
  - Radiation portal monitoring data
  - Algorithms for container inspection
  - Optimal allocation of funds for protection of port infrastructure
  - Risk assessment



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# DyDAn Application Areas

- DyDAn methods are applicable to a wide variety of homeland security applications.
  - Intelligence Analysis of Text
  - Disease Event Detection
  - Port of Entry Inspection





# DyDAn Application Areas

- DyDAn methods are applicable to a wide variety of homeland security applications.
    - Author Identification
    - Response to Natural Disasters
    - Bioterrorism
- ## Sensor Location



B-T sensor,  
Salt Lake  
City Olympics



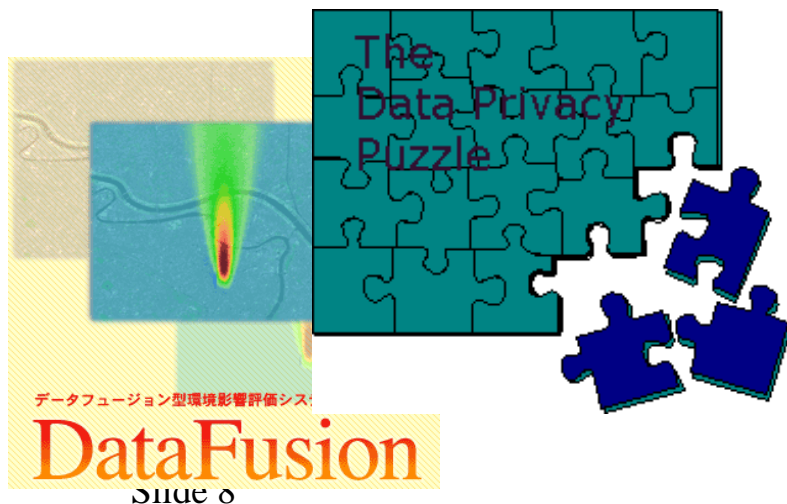
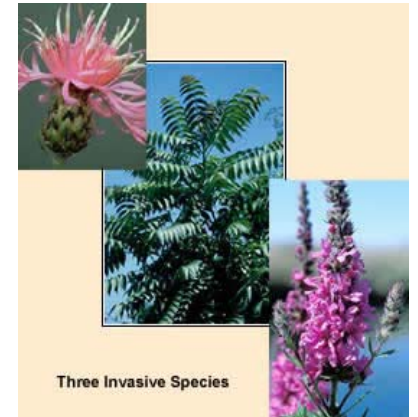
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# DyDAn Application Areas

- DyDAn methods are applicable to a wide variety of homeland security applications.
  - Protection Against Invasive Species
  - Customs and Border Protection
  - Privacy-Preserving Data Sharing



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# DyDAn Researchers Work On:

- Counter-terrorism
- Intelligence analysis
- Disease surveillance (natural/man-caused)
- Customs and border protection
- Law enforcement
- Data management in emergency situations
- Nuclear detection/sensors
- Image, audio, text, gait analysis



Avian flu



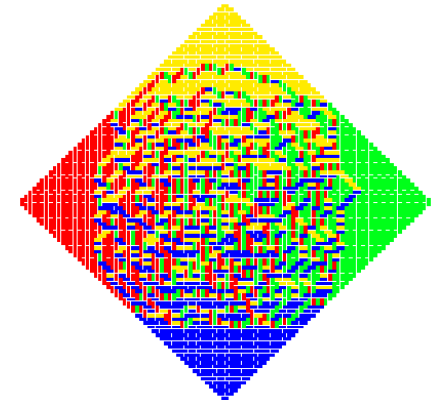
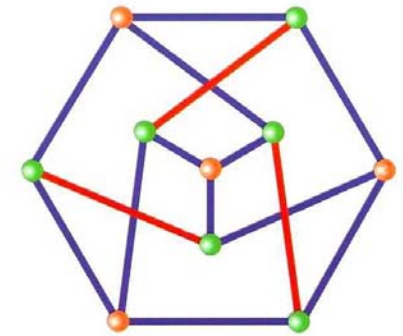
Containers for Inspection

*We hope to make DyDAn an informatics resource for the homeland security enterprise*



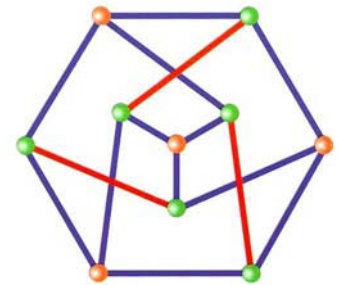
# DyDAn Research

- Three research themes:
  - **Analysis of Large, Dynamic Multigraphs**
  - **Continuous, Distributed Monitoring of Dynamic, Heterogeneous Data**
  - **Applications to Real Homeland Security Problems**



# DyDAn Research I: Analysis of Large, Dynamic Multigraphs

- Need to understand interactions between entities: people, objects, groups
- Interactions often modeled as *graphs*
  - Linking nodes (entities) with edges (connections)
- Multiple relationships between entities suggests *multigraphs*
- Add new entities, new & changing connections suggests *dynamic multigraphs*
- Develop methods to represent, analyze, interrogate, & navigate dynamic multigraphs.



# DyDAn Research II: Continuous, Distributed Monitoring of Dynamic, Heterogeneous Data

- Need to understand *massive* amounts of data.
- Data inherently *distributed* (multiple sources)
- Data arrives rapidly – “*continuously*”
- Seek anomalies, patterns, “*emerging events*”
- Run *continuous queries* to monitor incoming data stream.
- Data takes *numerous forms*; requires data mining methods that span the modalities.



# DyDAn Research III: Applied Work

- Builds on earlier work at Rutgers on
  - Port security
  - “Monitoring message streams”
  - Locating bioterrorism sensors
  - Syndromic surveillance
- Works with
  - Coast Guard
  - DNDO
  - Port Authority of NY/NJ
  - NJ Office of Homeland Security and Preparedness
  - CDC
  - Intelligence community





# DyDAn Research Portfolio I: Large Graphs

- Universal Information Graphs
- Adding Semantics to and Interconnecting Semantic Graphs
- Statistical and Graph-theoretical Approaches to Time-Varying Multigraphs
- Analyzing Large, Dynamic Multigraphs Arising from Blogs



# DyDAn Research Portfolio II: Monitoring of Dynamic, Heterogeneous Data

- Optimization and Learning
- Privacy Preserving Data Analysis



# DyDAnResearch Portfolio III:

## Some Applied Topics

- Uses of Entropy in Biosurveillance (with MSI's Howard and Morgan State)
- Enabling and Enhancing Crime Prevention and Analysis at the Port Authority of NY&NJ (with PANYNJ & PNNL & START)
- Algorithms for Container Inspection in Ports (sponsored by ONR, NSF)
- Sensor Management for Nuclear Detection (funded by Domestic Nuclear Detection Office) (collaborations with LANL, PNNL, Sandia)



# DyDAn Data



- Emphasis on publicly available data.
- Research on how to acquire, publish, analyze, store data in a private, secure way.
- Research on privacy-preserving data analysis.
- **Director of Data Analysis** works on all aspects of acquiring, sharing, publicizing analyzing data: privacy, legal, technical, etc.



# DyDAn Educational Programs

- We have initiated educational programs from K-12 to postgraduate





# Workshops: Sample Topics

- Semantic Graphs Computational Methods for Dynamic Interaction Networks
- Mathematical and Computational Methods for Information Security
- Privacy-Preserving Data Analysis
- Secure Internet Routing
- Climate and Disease
- Disease Clusters
- Internet Tomography
- Network Models of Biological and Social Contagion
- Streaming, Coding, Progressive Sensing



# Training Programs, Tutorials, Shortcourses

- ***“Reconnect”***: for faculty teaching undergraduates and government employees seeking new areas of expertise
  - Data Analysis in Law Enforcement and Homeland Security (August 2007)
  - Biosurveillance (June 2008)
  - Visual Analytics (Summer 2009)
- ***Tutorial***: Statistical De-Identification of Confidential Health Data (April 2009)



Law enforcement:  
Situational awareness



Anthrax



# Other Educational Programs

- *DHS Scholars and Fellows Program:* Funding 6 Graduate Student Fellows at Rutgers
- *DHS MSI Summer Research Program:*
  - Biosurveillance
  - (Howard, Morgan State): Summer 2007
  - Another opportunity for summer 2009
- *Research Experiences for Undergraduates*
  - Since Summer 2007
  - Students study 1-on-1 with DyDAn mentor
  - Students from all over the U.S.
  - Projects planned for Summer 2009
- *Internships:*
  - At Rutgers, Bell Labs, & with national lab partners



# Other Educational Programs

- *High School Teacher Program:*

- Theme: Discrete math and homeland security
- Connecting homeland security research to the classroom



- *Middle School Program:*

- Collaborates with Port Authority Project
- Development of written materials to be usable in classrooms
- Pilot testing of materials and teacher training to use them



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The numerous applications of discrete science form the basis of DyDAn's work.



We look forward to partnering in numerous DHS applications.

