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Supporting C2 Research and Evaluation: An Infrastructure and its Potential Impact

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16th ICCRTS, Quebec City, Canada
21-22 June, 2011

Topic 6: Experimentation, Metrics, and Analysis

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Why?

- The incredible, time-consuming, difficulty of getting test data.
  - Searching for data…
  - Organizing data…
  - Storing data…
  - Reusing data…
  - Maintaining data…
- Bottleneck for:
  - Development.
  - Testing.
  - Integration.
  - Fielding.
  - Maintenance.

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C4ISR Empirical Studies & Experiments

- Four (4) empirical studies.
- One (1) controlled experiment.
- Our Thesis:
  - A common body of test data that can be used for varying experimentation will provide researchers and practitioners with greater power to evaluate
    - algorithms,
    - architectures,
    - implementations.
- Our Proposal:
  - A common repository of unrestricted, open source data sets and supporting infrastructure.

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Challenges for Research and Evaluation

- Replicability of findings.
- Supporting aggregation of findings.
- Reducing costs.
- Obtaining representative operational profiles.
- Isolating the effects of individual factors.

Survey of Data Sources

[1] P. Baldi, P. Frasconi, and P. Smyth, *Data sets for the Book Modeling the Internet and the Web*, http://ibook.ics.uci.edu/datasets.html
[2] Carnegie Mellon University Language Technologies Institute, *The ClueWeb09 Dataset,* http://boston.lti.cs.cmu.edu/Data/clueweb09/
[3] CDISS, *Database of Terrorist Incidents, 1940 – 1999,* http://www.cdiss.org/pages/Programmes/ Revolutionary_Warfare_Counter_Insurgency/ Publications.asp
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[13] H. Chen and C. Yang, eds. Terrorism Informatics: Knowledge Management and Data Mining for Homeland Security, Springer, New York, NY. 2008. http://ai.arizona.edu/research/ terror/
[14] DARPA, Message Understanding: Evaluation and Conference: Proceedings of the 3rd-6th DARPA Workshops, Morgan Kaufman Publishers, 1996.
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[16] J. O. Engene, Terrorism in Western Europe: Events Data (TWEED), http://folk.uib.no/sspje/tweed.htm
[17] Fondation pour Recherche Stratégique, Base De Donnes Sur Les Actes Terroristes, Paris, France, https://bdt.frstrategie.org/
[18] A. Frank and A. Asuncion, UCI Machine Learning Repository, University of California, Irvine, School of Information and Computer Science, 2010. http://archive.ics.uci.edu/ml/
[19] A. Frank and A. Asuncion, UCI Machine Learning Repository, University of California, Irvine, School of Information and Computer Science, 2010.
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[23] L. Jasny, C.S. Marcum, and C.T. Butts, "improv: A Dataset of Disaster Response Microevents," 2009, R package version 0.05. Contact Carter Butts (buttsc@uci.edu) for availability.
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[25] J. Leskovec, The Stanford Large Network Dataset Collection, http://snap.stanford.edu/ data/
[26] J. Leskovec, L. Backstrom and J. Kleinberg, MemeTracker, http://www.memetracker.org/data.html
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[30] B. Mendelsohn, *Global Terrorism Resource Database* http://people.haverford.edu/bmendels/ Mendelsohn also maintains a list of terrorism data sources: http://people.haverford.edu/ bmendels/terror_attacks
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[32] National Counterterrorism Center (NCTC), Worldwide Incidents Tracking System (WITS), https://wits.nctc.gov/
[33] National Institute of Justice (NIJ), Terrorism Databases for Analysis, http://www.ojp.usdoj.gov/nij/topics/crime/ terrorism/databases.htm
[34] National Institute of Standards and Technology (NIST), Information Access Division (IAD), Introduction to Information Extraction, MUC Archive Site, http://www-nlpir.nist.gov/ related_projects/muc/index.html
[35] M.E. Nissen, "Enterprise Command, Control, and Design: Bridging C2 Practice and CT Research," The International C2 Journal, Vol. 1, No. 1, 2007. Defense Technical Information Center, http://handle.dtic.mil/100.2/ADA486841
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[37] RAND Corporation, Database of Worldwide Terrorism Incidents, http://www.rand.org/nsrd/ projects/terrorism-incidents/index.html
…
[40] SEMVAST Project, Scientific Evaluation Methods for Visual Analytics Science and Technology, http://www.cs.umd.edu/hcil/semvast/
[41] SEMVAST Project, Visual Analytics Benchmarks Repository, http://hcil.cs.umd.edu/localphp/hcil/ vast/archive/index.php
[42] University of Chicago, Joint Threat Anticipation Center (JTAC), http://jtac.uchicago.edu/resourceTerror.shtml
[43] University of Michigan, Inter-University Consortium for Political and Social Research (ICPSR), http://www.icpsr.umich.edu/icpsrweb/ICPSR/
[44] University of Michigan, Terrorism and Preparedness Data Resource Center (TPDRC), http://www.icpsr.umich.edu/icpsrweb/TPDRC/
[45] University of Pennsylvania, The Linguistic Data Consortium, http://www.ldc.upenn.edu/
[46] U.S. Department of Homeland Security, National Consortium for the Study of Terrorism and Responses to Terrorism (START), http://www.start.umd.edu/start/
…

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Survey of Data Sources

Terrorism Data Sets	Sources	Size	Formats
Dark Web Terrorism Research Project [13]	Web crawls	Large	Text, video
Haverford Database of Terrorist Acts [30]	News, propaganda	Medium	Text, pdf
(CDISS), Database of Terrorist Incidents, 1940 – 1999 [3]	CDISS	Large	Text
French Database of Terrorist Acts [17]	French agencies	Meduim	Text
Message Understanding Conference (MUC) Archives [34]	Synthetic	Small	Text
RAND Database of Worldwide Terrorism Incidents [11]	RAND	Medium	Text
Scientific Evaluation Methods for Visual Analytics Science and Technology (SEMVAST) [40, 41]	Synthetic	Medium	Formatted text
National Consortium for the Study of Terrorism and Responses to Terrorism (START) [46]	START	Large	Databases, text
Terrorism and Preparedness Data Resource Center [44]	START	Medium	Text
NIJ Terrorism Databases for Analysis [33]	NIJ	Small	Databases
Terrorism in Western Europe: Events Data (TWEED) [16]	TWEED	Medium	Database
Joint Threat Anticipation Center (JTAC) [42]	JTAC	Medium	Database
Worldwide Incident Tracking System (WITS) [32]	NCTC	Medium	Database
Ali Baba Data Set [22]	Synthetic	Small	Text
Counter-Terror Social Network Analysis and Intent Recognition (CT-SNAIR) [48]	Govt agencies	Medium	Text
World-Trade Center Event Sequence Data [23]	UC Irvine [23]	Small	R-archive

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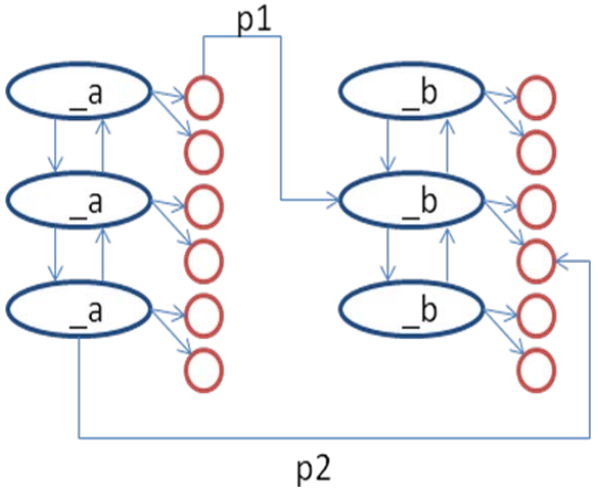
Survey of Data Sources

Non-Terrorism Data Sets	Sources	Size	Formats
Inter-University Consortium for Political and Social Research, ICPSR [43]	Research studies	Many small sets	Various
Modeling the Internet and the Web: Probabilistic Methods and Algorithms [1]	Research studies	Small	Formatted text
ClueWeb09 Dataset [2]	Web crawls	Large	Text
Linguistic Data Consortium (LDC) [45]	LDC	Small	Text
Stanford large network dataset collection	Various	Large	Formatted text
MemeTracker data	News, blogs	Large	Formatted text
UC Irvine Machine Learning Repository	Research studies	Small	Formatted text

Required Infrastructure

Our proposed repository contains:

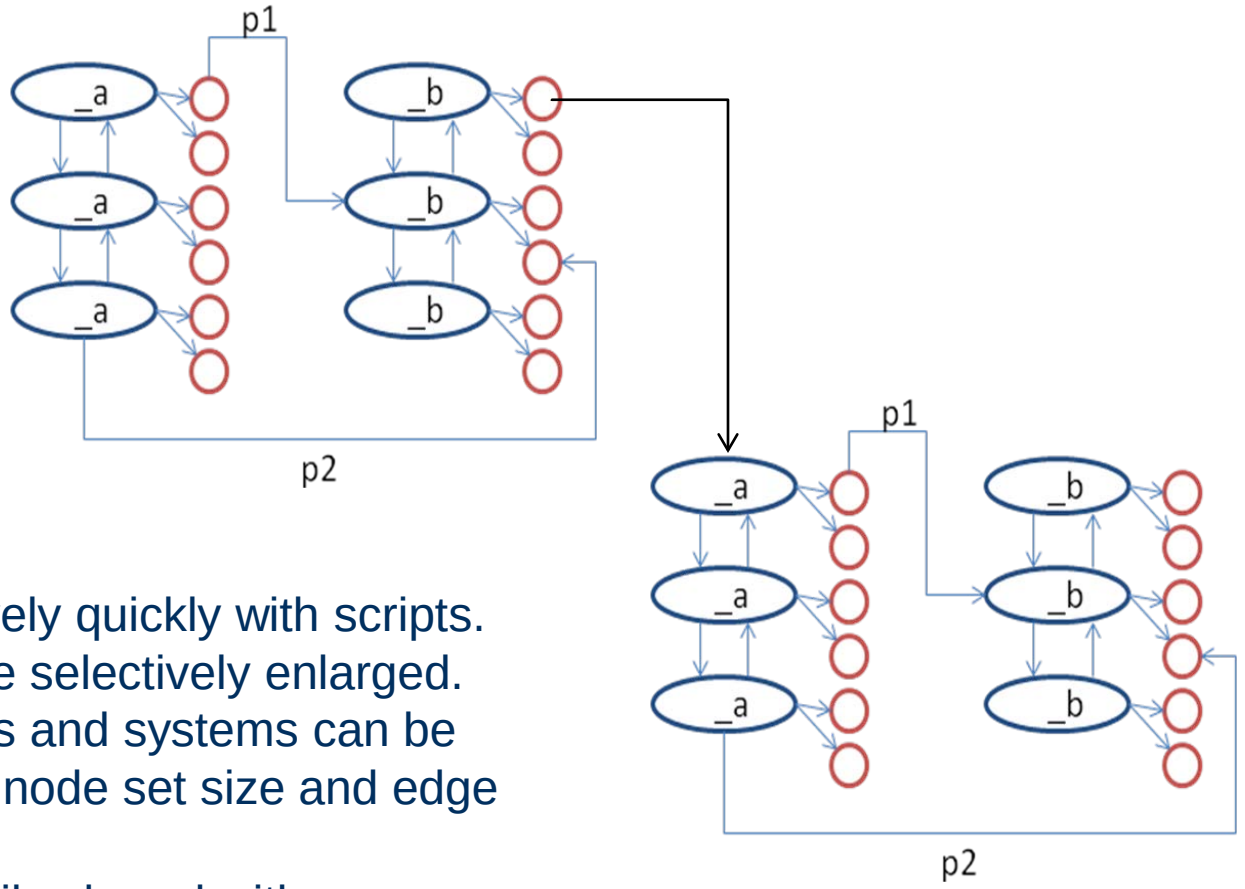
- Data Sets (RDF)



- Documentation and Supporting Tools

Data Sets

- Synthetic
- Mashups
- Real



Benefits of mashups:

- Can be created relatively quickly with scripts.
- Small data sets can be selectively enlarged.
- Prospective algorithms and systems can be tested for sensitivity to node set size and edge density.
- Data sets can be readily shared with collaborators.

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Documentation and Supporting Tools

- A complete specification of formats (including standard formats)
- Date-time group (e.g. day, hour, minute, sec.) of data-element or data-set
- Latitude and longitude or other location specification of data collection
- Data pedigree, e.g. the origin of the data (e.g. sensor ID)
- The means (e.g. sensors, observations, etc.) used to collect the data sets
- The provenance or processes involved in producing or delivering the data
- The algorithms that were used to integrate and fuse the data
- Standard metrics such as data-set size
- Transformation scripts

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Concerns

- Threats to validity
  - Internal - how well the experiment controls the dependent variables and, therefore, how strong the causal relationships in the experiment can be trusted.
  - External - extent to which the results of the experiment can be generalized to other experimental subjects.
- Extension and integration
  - How will existing data sets be maintained?
  - How will new data sets be integrated?
  - How will the infrastructure be adapted as systems and practice change?

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Repository State

Current:

- Several example mashups.
  - Expect to be available for unrestricted release soon.
- Example Python scripts for transforming to RDF.

Future:

- XML and RDF validation support.
- Visualization support.
- Feedback from internal users.

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