

Proceedings of the 2016 Cincinnati- Dayton INFORMS Symposium

October 14, 2016

Wright State University, Dayton, Ohio

informs

*Institute for Operations Research
and the Management Sciences*



Department of Biomedical, Industrial & Human
Factors Engineering

**THE
PERDUCCO
GROUP**

WRIGHT STATE UNIVERSITY

Raj Soin **College of Business**

Contents

1.	Introduction	3
	Conference Committee Message.....	3
	Presented Research and Keyword Index	4
	Sponsors.....	5
2.	Schedule: Friday October 14, 2016.....	8
3.	Keynote Address: Competitive Decision-making Frameworks in Optimization	9
4.	Workshop and Tutorial: Power: Perspective, Platforms and Paradigms (Leadership Workshop)	11
5.	Abstracts for Presentations and Papers	12
	Optimal Selection of Parsimonious ARIMA Forecasting Models	12
	Visualization and Verification of Extended Lead Forecasts of Hurricane/Tropical Cyclone Formation	12
	Agent Based Models of Passenger Boarding for Commercial Aircraft	12
	State of the Art of Simulation Model Validation	13
	Using High Performance Computers for Modeling, Simulation, and Analysis.....	13
	Performance Analysis of Various Hash Functions.....	14
	What's New in JMP 13	14
	The n-by-T Inpatient Discharge Policy under Various Occupancy Rate.....	14
	INFORMS Social Media Analysis Section.....	15
	From Data to Decisions - the Value of Extraordinary User Interfaces.....	15
	U.S. Air Force Cross-Core Function Analysis	16
	Contextualizing an Organizational Role for Craft Analytics	16
	Monitoring and Improving Quality via Consumer Comments	16
	Operations Research Applications in Lifecycle Management.....	17
6.	Abstracts for Posters.....	19
	Infarct Volume Analysis with a post-stroke combination Drug Treatment	19
	Integrated Systems Approach for Investigation of Human Cognition	19
	Improving access to fresh produce through sustainable urban agriculture: A systems engineering approach to garden design and management.....	20
	Improving access to fresh produce through sustainable urban agriculture: A data driven approach for produce production planning.....	21
	The n-by-T Inpatient Discharge Policy under Various Occupancy Rate.....	21

Corticosterone effects on spatial working memory in juvenile rats.....	22
7. Full Papers.....	23
Okonkwo, C. and Drager, S. (2016) “Performance Analysis of Various Hash Functions” <i>Proceedings of the 3rd Annual Cincinnati-Dayton INFORMS Conference</i> , pp. 24 - 31	23
Hawkes, T.D., Bihl, T. J., and Woolacott, M. H. (2016) “Interacting Systems Approach to Investigation of Human Cognitive Capacity” <i>Proceedings of the 3rd Annual Cincinnati-Dayton INFORMS Conference</i> , pp. 32 - 39	32

1. Introduction

Conference Committee Message

The organizing committee welcomes you to our third annual Cincinnati-Dayton INFORMS Symposium. The symposium is hosted by Wright State University's Biomedical, Industrial, and Human Factors Engineering Department, with The Perduco Group graciously being our corporate sponsor. Without this sponsorship, our conference would be more expensive and likely infeasible.

We feel that the scientific and social exchange among symposium attendees will give us a much needed opportunity to interact in the Miami Valley area. To further facilitate collaboration we have expanded the number of talks as well as the student poster session.

We have been pleased by the expansion of interest, volume and breadth of submissions and attendees since 2014. Our symposium has doubled since 2014 and we have received more than a sufficient amount of submissions, ranging from Simulation to Biomedical Engineering. We had to work diligently to fit every talk into a single day.

We hope that you will thoroughly enjoy the day. Please do not hesitate to let us know if you need anything during your attendance and we hope to see you again at the 2017 Symposium.

-Cincy-Dayton INFORMS Conference Steering Committee

2016 Conference Steering Committee

Trevor Bihl, 2016 Chair Air Force Institute of Technology Trevor.Bihl@afit.edu	Carl Parson, 2016 Co-Chair Air Force Institute of Technology Carl.Parson@afit.edu
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Cincinnati-Dayton INFORMS Chapter and the Symposium

The Cincinnati-Dayton Chapter of INFORMS was established in 1995 as one of the regional chapters of INFORMS. Regional chapters are separate from student chapters and encourage interchanges between professionals, faculty, researchers, and students; regional chapters are relatively few in number and the Cincinnati-Dayton chapter is the only local regional INFORMS chapter in Ohio, Indiana, Kentucky or West Virginia. The Cincinnati-Dayton chapter has been successful in its mission by sponsoring the annual Arnoff lecture, offering chapter awards and social events, and encouraging facility tours, guest speakers and symposiums. Our chapter current has approximately 100 active members. By patronizing the symposium, you are both helping us to expand our chapter and facilitate needed technical interchanges in the Miami Valley area.

More details can be found on our chapter webpage:

<https://www.informs.org/Community/Cincinnati-Dayton-Chapter>

Presented Research and Keyword Index

2016 Keyword List	
Keyword	Abstract Numbers
Biostatistics/Biomedical	8, P1, P2
Business Analytics	P3, P4
Computing	5, 6, 7
Consumers	13
Craft Analysis	12
Data Mining and Applied Statistics	13
Forecasting	1, 2
Healthcare	K, 8, P1, P6, P7
Leadership	W
Local Companies in OR	2, 5, 10, 11, 13
Logistics and Supply Chain Management	11, 14
Optimization	1
Philosophical Implications	12
Power	W
Programming	K, 6
Simulation	K, 1, 2, 3, 4, 5, 8, P5, P6
Social Media	9
Sports/Hospitality and Recreation	P3, P4
Student Projects	3, 6, 8, P1, P3, P4, P5, P6, P7
Transportation	3
Visualization	4, 10

Sponsors

The Cincinnati/Dayton Chapter would like to thank the following sponsors:

- Department of Biomedical, Industrial and Human Factors Engineering, Wright State University
- The Perduco Group
- Raj Soin College of Business, Wright State University



The Department of Biomedical, Industrial & Human Factors Engineering (BIE) is the only academic unit, nationally, to share programs in these disciplines. Our programs are human-centered and focused on improving today's complex human-technical systems.

The BIE Department vision is to be nationally recognized for excellence in education and for cutting-edge research in specific engineering areas of biomedical, industrial and systems, human factors and operations research. Students experience a variety of engineering-related educational experiences through bachelor's degree programs in Biomedical Engineering and Industrial & Systems Engineering.

Our Master of Science features programs in the Biomedical Engineering and Industrial & Human Factors Engineering. Also, research is prominent in the Ph.D. in Engineering program in three focus areas: Industrial & Human Systems, Material and Nanotechnology, and Sensor and Signal Processing. The Master of Science in Industrial & Human Factors Engineering can be earned entirely online through Distance Education.

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The Perduco Group is a high-end data analytics company.

Perduco supports a broad range of clients in the DoD and commercial spaces and specializes in senior-level decision support applications. A unique blend of corporate expertise and creativity leads to customized solutions specific to each client's challenge.

Our Operations Research, Software Development, and Data Architecting teams of experts work closely with the client to design, execute, and deliver the required solution.

Perduco has specific technical, academic, and research expertise in Operations Research, Logistics, Systems Engineering, and Behavioral Modeling.

Over 25% of the Perduco staff hold doctoral degrees and have specific background and experience in conducting DoD research across the joint services.

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WRIGHT STATE UNIVERSITY

Raj Soin College of Business

The Raj Soin College of Business has a long tradition of developing influential business leaders in the region and beyond. In 2000, the College was named the Raj Soin College of Business in honor of Rajesh K. Soin, an internationally recognized entrepreneur, business leader and community benefactor.

Through collaboration with the business community and alumni, the college continues to launch new academic programs, increase scholarship support and expand career opportunities for our students. This collaboration enriches our students' academic experience while helping area businesses excel.

With an enrollment of approximately 1,200 undergraduate students and 500 graduate students, we offer the benefits of a comprehensive business program and a diverse student body. At the same time our small class sizes and supportive faculty offer students the individual attention they need to excel.

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2. Schedule: Friday October 14, 2016

Time	Berry 1	Berry 2	Berry 3
0800-0830	Registration and Coffee in Berry 3		
0820-0830	Welcome and Agenda (in Berry 3) Authors: Trevor Bihl and Carl Parson, AFIT		
	Track 1		Registration, Coffee and Snacks (on-going)
0830-0930	Power: Perspective, Platforms and Paradigms (Leadership Workshop) Author: Terry Oroszi, Wright State University Abstract-W (page 11)		
0930-0950	Transition and Snack Break (Berry 3)		
	Track 2	Track 3	Registration, Coffee and Snacks (on-going)
0950-1010	Optimal Selection of Parsimonious ARIMA Forecasting Models Author: Bogdan Bichescu, UT-Knoxville, George Polak, Wright State University Abstract-1 (page 12)	Analysis of Various Hash Function Author: Christopher Okonkwo, Norfolk State University, Steven Drager, AFRL - Rome, NY Abstract-6 (page 14 & pages 24 – 31)	
1010-1040	Visualization and Verification of Extended Lead Forecasts of Hurricane/Tropical Cyclone Formation Author: David Meyer, Statistical Solutions LLC Abstract-2 (page 12)	What's New in JMP 13 Author: Bill Worley, SAS Institute, Inc. Abstract-7 (page 14)	
1040-1100	Agent Based Models of Passenger Boarding for Commercial Aircraft Author: Kerry Ward, Wright State, Frank Ciarallo, Wright State, Ray Hill, AFIT Abstract-3 (page 12-13)	The n-by-T Inpatient Discharge Policy under Various Occupancy Rates Author: Nicholas Ballester, Wright State, Pratik Parikh, Wright State University Abstract-8 (page 14-15)	
1100-1120	State of the Art of Simulation Model Validation Author: Andrew Atkinson, AFIT, Scott Storm, AFIT Abstract-4 (page 13)	INFORMS Social Media Analysis Subdivision Author: Christopher Smith, AFIT Abstract-9 (page 16)	
1120-1140	Using High Performance Computers for Modeling, Simulation, and Analysis Author: David Meyer, Applied Research Solutions in Support of AFIT Abstract-5 (page 13)	From Data to Decisions - the Value of Extraordinary User Interfaces Author: Michael Fisher, The Perduco Group Abstract-10 (page 16)	
1140-1300	Lunch Buffet in Berry 3		
	Track 4		Track 2 – Posters
1300-1330	U.S. Air Force Cross-Core Function Analysis Author: Brandon Mills, The Perduco Group, Jenni Thompson, The Perduco Group Abstract-11 (page 16)		Registration, Coffee and Snacks (on-going)
1330-1400	Contextualizing an Organizational Role for Craft Analytics Author: Ross Jackson, AFMC Abstract-12 (page 16)		
1400-1430	Monitoring and Improving Quality via Consumer Comments Author: Alex Gutman, P&G, William Brenneman, P&G Abstract-13 (page 16 - 17)		
1430-1500	Operations Research Applications in Lifecycle Management Author: Christina Obergfell, AFLCMC/OZA, Allison Rehg, AFLCMC/OZA Abstract-14 (page 17 - 18)		Poster setup
1500-1630	Snack Break and Student Posters in Berry 3 Abstracts P1 – P7 (pages 19 – 22 & 32 - 39)		
1630-1730	Keynote Address for Outstanding Young OR/MS Award (Berry 1): “Competitive Decision-making Frameworks in Optimization” Author: Brian Lunday, AFIT Abstract-K (pages 9 - 10)		
1730 - on	Awards presentation, then Social and Networking		

3. Keynote Address: Outstanding Young OR/MS Award Winner

Abstract-K
Berry 1
1630-1730

Competitive Decision-making Frameworks in Optimization

Brian J. Lunday (Air Force Institute of Technology)

Presentation

Abstract: *Competition is a natural part of our human existence, as is the goal to optimize one's outcomes. Taken together, these characteristics motivate many problems to which operations research methods can lend insights to improve the performance of the competitors and/or collaborators. Within the context of these goals, this talk will provide an overview of research to date conducted by the presenter and some of his research collaborators in the fields of bilevel and trilevel optimization. We highlight four papers within this research thread and provide an overview of three ongoing endeavors. Motivated by coalition military operations in Baghdad, the first two papers examine the collaborative application of resources by agents to interdict a competitor seeking to traverse a network, respectively either to maximize the net flow reaching a terminus node or to maximize the probability of evading detection en route to a terminus node. Adopting a trilevel optimization framework, the third paper examines the problem of a defender seeking to optimally locate air defense interceptor batteries to protect cities, given that an attacker will subsequently (and optimally) attack with a fixed set of ballistic missiles, which the defender will seek to intercept. In the application of private sector pediatric vaccine pricing, the fourth paper seeks to identify the optimal pricing strategy for a vaccine manufacturer's products, given competitors' prices and a rational customer who seeks to minimize their own expenditures. This presentation concludes with a discussion of ongoing efforts that respectively extend the air defense modeling to incorporate greater complexity, consider the optimal disruption of an enemy's air defense network, and interdict (potentially collaborative) terrorist organizations in achieving their aims.*

Keyword: Health Care, Simulation, Programming

Bio: *Dr. Brian J. Lunday is an Associate Professor of Operations Research with the Department of Operational Sciences, Air Force Institute of Technology (AFIT), with a Ph.D. in Industrial and Systems Engineering from Virginia Tech, an M.S. in Industrial Engineering from the University of Arizona, and a B.S. in Mechanical Engineering from the U.S. Military Academy. Prior to beginning service as a USAF Civilian faculty member in 2016, he served for 24 years as an active duty Army officer in a variety of leadership, combat engineering, military planning, and educational assignments. In addition to service in units based in Hawaii, Germany, and Kentucky with deployments to Bosnia-Herzegovina and Iraq, he taught undergraduate mathematics and operations research in the Department of Mathematical Sciences at West*

Point, NY from 2001-2004 and from 2010-2013, concluding his Army service as an Assistant Professor in the Department of Operational Sciences at the Air Force Institute of Technology from 2013-2016. Dr. Lunday's technical research emphasizes theoretical developments in math programming, game theoretic models, and algorithmic design for global optimization, as well as applications to the areas of network design, network optimization, network interdiction, network restoration, facility/resource location, and resource location/allocation & assignment. He also serves on the Editorial Board for the journal Military Operations Research.

4. Workshops and Tutorials

Abstract-W
Berry 2
0830-0930

Power: Perspective, Platforms and Paradigms (Leadership Workshop)

Terry Oroszi (Wright State University)

Workshop/Tutorial

Abstract: *Myers/Briggs for Power. You may not realize it but you exercise power in your organization. Identifying and understanding your personal power promotes personal and professional growth will help you to set and accomplish goals within your organization. Through what lens do you see your work-world? From where do you draw your personal power? What is the model for your unique leadership style? This hands-on workshop will introduce you to the concept of 4/5/6 power platform, where you, the attendee, will learn about:*

4 - Reframing-defining lens through which you see yourself and your environment.

5 - The Bases, finding footholds on the foundation from which you operate, and

6 - Style, Knowing your personal leadership style.

This new concept will not only help you identify your own power, but also give you an understanding of your coworkers and how to optimize your relationships.

Keyword: Leadership, Power

5. Abstracts for Presentations and Papers

Abstract-1
Berry 1
0950-1010

Optimal Selection of Parsimonious ARIMA Forecasting Models

Bogdan Bichescu (University of Tennessee, Knoxville)
George Polak (Wright State University)

Presentation

Abstract *In a parsimonious ARIMA Forecasting model the total number of terms chosen is constrained, and treatment for nonstationarity is limited to differencing of a pre-specified order. Accordingly, a term for non-stationary variation is included along with autoregressive, moving average and white noise terms in a decomposition of the time series. Mixed integer optimization problems are then formulated for prescribing model parameters. Walsh functions and Haar wavelets are employed to represent white noise and non-stationary variation, respectively.*

Keyword: Forecasting, Optimization, Simulation

Abstract-2
Berry 1
1010-1040

Visualization and Verification of Extended Lead Forecasts of Hurricane/Tropical Cyclone Formation

David Meyer (Statistical Solutions LLC)

Presentation

Abstract *Since 2007, Statistical Solutions LLC, in conjunction with the Naval Postgraduate School, has been engaged in the research of hurricane/tropical cyclone formation forecasting in the Northern Hemisphere. To date, experimental models have been built, which, when forced with long lead forecasts of large scale environmental factors, appear to create skilled forecasts at extended leads. In this presentation we discuss the building of the statistical models that are used, differences between the different models, and how experimental forecasts are created. Perhaps most importantly, we will also discuss visualization of the forecast products (and the multiple unanticipated human factors that were encountered along the way), as well as the verification of results and the level of complexity involved in verification.*

Keyword: Forecasting, Local Companies in OR, Simulation

Abstract-3
Berry 1
1040-1100

Agent Based Models of Passenger Boarding for Commercial Aircraft

Kerry K. Ward (Wright State University)
Frank W. Ciarallo (Wright State University)
Raymond Hill (Air Force Institute of Technology)

Presentation

Abstract *The efficiency of commercial aircraft operations is an area of increasing interest because of its importance in the customer-service oriented and very competitive airline industry. Boarding of passengers for commercial flights impacts both of these aspects of performance for aircraft operations. We use an agent-based simulation methodology to study airline passenger boarding using measures that reflect both the customer experience and airline efficiency.*

Keyword: Simulation, Student Projects, Transportation

Abstract-4
Berry 1
1100-1120

State of the Art of Simulation Model Validation
Andrew Atkinson (Air Force Institute of Technology)
Scott Storm (Air Force Institute of Technology)

Presentation

Abstract *High-resolution computer models can simulate complex systems and processes to evaluate a solution quickly and economically. However, before relying upon the results of a computer model, validation is required to ensure model accuracy. Over the years, researchers have developed a variety of validation techniques that range from the informal comparison of system and model data to more rigorous, statistically-based methods. This presentation includes an introduction to the history of simulation and early validation efforts by seminal authors such as Sargent and Balci. We also survey recent work and developments in model validation, including techniques for validating functional data and techniques for validating a model across the design space.*

Keyword: Simulation, Visualization

Abstract-5
Berry 1
1120-1140

Using High Performance Computers for Modeling, Simulation, and Analysis
David Meyer (Applied Research Solutions in Support of AFIT)

Presentation

Abstract *As computers grow ever faster and more powerful, the kinds of problems that can be run, and the depth at which they can be explored, also grow. When trying to solve problems in Operations Research or other disciplines for that matter, it is rare that the scientist doing the problem solving is also a computer scientist. However, to truly take advantage of the power of today's hardware and software, the scientist and benefits from computer science knowledge. This presentation is the author's attempt to help the scientists better understand the overarching approaches available for the modeling and simulation of space (ie satellites) scenarios, and the strengths and weaknesses of various hardware and software options. The author's own experiences in modeling and simulation on a variety of platforms to solve a variety of problems provide the foundation of this presentation.*

Keyword: Computing, Local Companies in OR, Simulation

Abstract-6
Berry 2
0950-1010

Performance Analysis of Various Hash Functions
Christopher Okonkwo (Norfolk State University)
Steven Drager (Air Force Research Laboratory)

Paper and Presentation

Abstract: *The Air Force Research Laboratory sponsored Software Epistemology (the study or theory of the nature and grounds of knowledge especially with reference to its limits and validity) project developed an approach for determination by generating new information from data produced by an artifact extraction process, incorporating scalable computation capabilities present in TitanDB, and successfully extending the research to support the DARPA Mining and Understanding Software Enclaves (MUSE) program through the use of advanced machine learning for derivation of new knowledge to significantly advances the state of the art in automated vulnerability discovery. The approach taken utilizes a sieve analysis concept and application of a hashing scheme to a large corpus of open source software for mining information. The custom hashing scheme deployed was developed to enable fast, but fuzzy, matching of basic blocks in a module or function. The hashing algorithm is reasonably accurate and fast but saturates when exposed to large basic blocks. This paper summarizes consideration of other hashing schemes. For a database structure with a huge amount data, it can be almost next to impossible to search all of the index values before reaching the location of the required value, a hash table will likely be used for quick access to the desired data. Hashing is an effective technique to calculate the direct location of a data without using the index structure. This paper analyzes 16 non-cryptographic and 2 cryptographic hash functions. Based on the results, hash functions which show great performance, distributes hash keys randomly over the hash range, and are uniformly distributed with low bias are recommended for use.*

Keyword: Computing, Student Projects

Abstract-7
Berry 2
1010-1040

What's New in JMP 13
Bill Worley (SAS Institute Inc.)

Presentation

Abstract *JMP 13 is the latest release from the JMP division of SAS. This presentation will show of many of the newer data analysis tools in JMP 13 including Text Explorer, Non-normal Capability Analysis, improvements in Definitive Screening Designs (DOE), and Process Screening to name a few..*

Keyword: Computing

Abstract-8
Berry 2
1040-1100

The n-by-T Inpatient Discharge Policy under Various Occupancy Rate
Nicholas Ballester (Wright State University)
Pratik Parikh (Wright State University)

Presentation

Abstract *Poor inpatient discharge planning results in discharge lateness and overnight stays and is a major cause of upstream patient boarding and diversion. However, there is no optimal or even accepted best practice for organizing discharge workload. To this end, we propose a novel discharge strategy, the n-by-T policy. We examine the impact of this approach on discharge delays and upstream patient boarding through a simulation study validated using data from a local hospital. We further examine the sensitivity of this policy based on the inpatient unit's occupancy rate, which indicates that the benefits of this strategy increase considerably for higher occupancy rate units. We also discuss a trial implementation of our strategy at this hospital unit and the resulting findings.*

Keyword: Medical and Biomedical, Simulation, Student Projects

Abstract-9

Berry 2

1100-1120

INFORMS Social Media Analysis Section

Christopher Smith (Air Force Institute of Technology)

Presentation

Abstract *This presentation will outline the importance and current progress in the section as well as a quick review of the 23 sessions in the upcoming INFORMS annual conference. Presentation will not go into specifics on the topics, but will offer POCs for the presentation pending at the annual conference.*

Keyword: Social Media

Abstract-10

Berry 2

1120-1140

From Data to Decisions - the Value of Extraordinary User Interfaces

Michael Fisher (The Perduco Group)

Presentation

Abstract *Understanding and analyzing data is not enough. With the growing ease of creating visually appealing software interfaces, the opportunities to effectively convey information to end users has never been more abundant. The Perduco Group's foundation is data analytics but customer demand is expanding requirements well beyond the simple ingestion and aggregation of data. As a result, our data visualization development process integrates data scientists, interface designers, graphic artists, and programmers to create interactive environments for intuitive insights and understanding. This presentation will discuss the evolution from early programs, where visualization was an add-on, to the current practice where dynamic user interfaces are designed and built to leverage analytics from the start.*

Keyword: Local Companies in OR, Visualization

Abstract-11
Berry 1
1300-1330

U.S. Air Force Cross-Core Function Analysis
Brandon Mills (The Perduco Group)
Jenni Thompson (The Perduco Group)

Presentation

Abstract *The procurement of material solutions for the department of defense requires an objective and transparent methodology to assess cost effectiveness across a wide variety of portfolios and operational requirements. This presentation implements a multi-criteria decision analysis approach to quantify acquisition value and tradeoffs for the United States Air Force (USAF) across all service Core Functions (CFs). The Perduco Group and its partners developed a web based analytic application to provide insights to USAF leadership during acquisition and resource allocation decisions. The analytical application provides a consistent framework to identify USAF acquisition programmatic impacts to USAF Core Functions and their required capabilities. The demonstrated methodology and case study highlights mission impacts across a set of mission effects chains (MEC) in a variety of illustrative scenarios.*

Keyword: Local Companies in OR, Logistics and Supply Chain Management

Abstract-12
Berry 1
1330-1400

Contextualizing an Organizational Role for Craft Analytics
Ross A. Jackson (Headquarters Air Force Materiel Command)

Presentation

Abstract *Frustrations ensue from disconnects between desires and obligations. Interrogating roles for analysis hold the potential to improve the efficacy of analytics and reduce some irritation that frequently exists between analysts and managers. Central to this endeavor is awareness that organizations seldom have analytic problems. Rather, managers selectively apply analysis to a few of their most wicked problems. Such selectivity betrays alternatives to analysis are readily available (if not organizationally dominant). So, when managers request analysis what is desired on their part, and what is required on the part of analysts? “Craft analytics” is proposed as a way to define a looser form of analysis-infused thinking which is less constrained by the technique and praxis of traditional analysis and more cognizant of the strategic milieu of management. Such a contextualizing holds potential to address organizational concerns in such a way that analytic results are actually adopted while replacing tension with harmony.*

Keyword: Craft Analysis, Philosophical Implications

Abstract-13
Berry 1
1400-1430

Monitoring and Improving Quality via Consumer Comments
Alex Gutman (The Proctor & Gamble Company)
William Brenneman (The Proctor & Gamble Company)

Presentation

Abstract Procter & Gamble (P&G) receives millions of consumer comments each year and requires an efficient data-mining algorithm to identify products with unexpectedly high complaint counts, as these suggest potential quality or safety issues (aka “signals”). This talk will present an overview of P&G’s adopted signal detection method, the Multi-Item Gamma Poisson Shrinker (MGPS), an empirical Bayesian method for disproportionality analysis. It will also discuss the application of text mining on consumer comments to find misclassified adverse events and identify fraudulent complaints.

Keyword: Consumers, Data Mining and Applied Statistics, Local Companies in OR

Abstract-14
Berry 1
1430-1500

Operations Research Applications in Lifecycle Management

Christina J. Obergfell (AFLCMC/OZA)
Allison M. Rehg (AFLCMC/OZA)

Presentation

Abstract As part of the Air Force Life Cycle Management Center (AFLCMC,) the Operations Research and Analysis Division (AFLCMC/OZA) provides critical, game-changing analysis to inform timely, effective life cycle management decisions within the center and across the Air Force (AF.) AFLCMC/OZA is a team of thirteen analysts applying operations research techniques and critical thinking to inform mission-critical decisions affecting the AF, its weapons systems, and the warfighter. AFLCMC/OZA is organized into two teams: The Cost Capability Analysis Team and the Product Support Team. The Cost Capability Analysis (CCA) Team serves as the Air Force Center of Excellence for CCA and promotes the development of an Air Force Culture aimed at providing leadership with the cost versus capability information to make the most informed resource decisions while meeting warfighter requirements. CCA members use mathematical techniques and decision analysis to inform decision makers about the relative military worth of alternatives in terms of warfighting capability. The Product Support Analysis Team provides game-changing analytic support to the AFLCMC enterprise to enable more effective product support, sound corporate decision making, and rigorous life cycle management planning. The purpose of the presentation is to provide insights into operations research analyses in the context of Air Force Life Cycle Management with real world examples impacting AF systems and the warfighter. The presentation will provide real world examples as executed by both the CCA and Product Support Teams. In more detail, the examples will introduce the CCA execution and decision analysis application to support AF systems and inform acquisition, requirements, and lifecycle management decisions. The presentation will also provide an example of ways to strategically optimize resources utilized to mitigate aircraft non-availability and advance cost-effective readiness to inform AF leadership decision making. These diverse analytic efforts contribute to the cost-effectiveness of weapons systems, inform critical acquisition decisions, and shape the culture of the AF to improve life cycle agility while maintaining essential support to the warfighter.

Keyword: Logistics and Supply Chain Management

6. Abstracts for Posters

Abstract-P1
Berry 3

Infarct Volume Analysis with a post-stroke combination Drug Treatment

Nooralhuda Arkan (Wright State University)
Sayali Dharmadhikari (Wright State University)
Deviprianka Nagarajan (Wright State University)
Adrian M. Corbett (Wright State University)

Poster

Abstract *The purpose of this study was to confirm a previous finding in female Sprague Dawley Rats: a combination of Fluoxetine (5 mg/kg), Simvastatin (1 mg/kg) and Ascorbic Acid (20 mg/kg) (FSA) did not show reduced infarct volumes but showed a little functional recovery, whereas removal of the ascorbic acid resulted in reduced infarct volume with a p value of 0.053. In the previous study, the number of rats was smaller in each group, so we wanted to determine if the result would be the same with an increased N in each group. Although we found that the overall size of the infarct volumes was greater in this study (due probably to a different source of endothelin-1), the ratio between the control animal infarct volumes and the FSA group infarct volumes was remarkably similar. Both control and FSA treated rats had similar poststroke functional recoveries, which was unusual. Generally, the control animals are post-menopausal and show very little functional recovery (about 11%), whereas the FSA treated animals usually show 25-35% functional recovery. In Figure 3, we show representative images of both the infarcted region in these animals and the Ki67 staining, which shows the amount of stem cell/progenitor cell proliferation in the Subventricular zone of the lateral ventricles. The control animal (top panel) has greater Ki67 staining than the FSA treated animals, which indicates that these animals were likely pre-menopausal, as estrogen can increase stem cell proliferation and neurogenesis in this region, as well as the functional recovery.*

Keyword: Biostatistics/Biomedical, Health Care, Student Projects

Abstract-P2
Berry 3

Integrated Systems Approach for Investigation of Human Cognition

Teresa D. Hawkes (University of Oklahoma)
Trevor J. Bihl (Wright State University)
Marjorie H. Woollacott (University of Oregon)

Poster and Paper

Abstract *Human cognitive capacity is mediated by synergistic interactions between multiple physiological variables: including genetic and epigenetic potential, nutrition status, gender, race, age, cardiovascular capacity, neural function, and physical activity type and amount. These affect attention, memory, decision-making, educational outcomes, personality/temperament, and socio-economic potential. This suggests cognitive capacity arises from our physiology interacting with exogenous and endogenous stimuli. Since cognition originates from physiology, which consists of an integrated set of systems operating at nested time scales with spatial relationships consistent across subjects, research into human cognition requires multivariate experimental designs which take this into account.*

Keyword: Biostatistics/Biomedical

Abstract-P3
Berry 3

Improving access to fresh produce through sustainable urban agriculture
A systems engineering approach to garden design and management

Mark Rasmussen (University of Dayton)
Hassan Alhashim (University of Dayton)
Venkat Rajeev Reddy Malipeddi (University of Dayton)
Kellie Schneider, PhD (University of Dayton)

Poster and Presentation

Abstract *Many people in the greater Dayton area, particularly people in Green, Montgomery, and Preble counties are food insecure, which means they do not have sufficient access to affordable and nutritious food. To combat food insecurity in the Miami Valley, The Foodbank, Inc. distributes food to over 70 thousand people through more than 100 partner agencies. In 2015, they distributed more than 9.8 million pounds of food including almost 2 million pounds of fresh produce. To further improve access to fresh produce, the Foodbank began an urban garden in summer 2016. Recently, the land on which the garden was built has been reallocated for another purpose; thus, the garden must be moved. In this project, we use a system engineering approach to designing a garden that contributes to community beautification efforts, includes space for educational outreach, and incorporates sustainable technologies while maximizing space for food production.*

Keyword: Business Analytics, Sports/Hospitality and Recreation, Student Projects

Abstract-P4
Berry 3

Improving access to fresh produce through sustainable urban agriculture
A data driven approach for produce production planning

Venkat Rajeev Reddy Malipeddi (University of Dayton)
Mark Rasmussen (University of Dayton)
Hassan Alhashim (University of Dayton)
Kellie Schneider, PhD (University of Dayton)

Poster and Presentation

Abstract *Many people in Green, Montgomery, and Preble counties of the greater Dayton region do not have access to sufficient amount of affordable and nutritious food. The Foodbank, Inc., a nonprofit organization, distributes food to over 70 thousand people through more than 100 partner agencies to address the food insecurity problem of Dayton. In 2015, they distributed more than 9.8 million pounds of food including almost 2 million pounds of fresh produce. To further improve access to fresh produce, the Foodbank began an urban garden in summer 2016. In this project, we utilized a systems engineering approach to develop an easy-to-use survey to gain information on clients' produce preference and cooking habits. The results of this survey will be used for produce production planning as well as the development of educational materials including recipes.*

Keyword: Business Analytics, Sports/Hospitality and Recreation, Student Projects

Abstract-P5
Berry 3

The n-by-T Inpatient Discharge Policy under Various Occupancy Rate

Nicholas Ballester (Wright State University)
Pratik Parikh, PhD (Wright State University)

Poster and Presentation

Abstract *Poor inpatient discharge planning results in discharge lateness and overnight stays and is a major cause of upstream patient boarding and diversion. However, there is no optimal or even accepted best practice for organizing discharge workload. To this end, we propose a novel discharge strategy, the n-by-T policy. We examine the impact of this approach on discharge delays and upstream patient boarding through a simulation study validated using data from a local hospital. We further examine the sensitivity of this policy based on the inpatient unit's occupancy rate, which indicates that the benefits of this strategy increase considerably for higher occupancy rate units. We also discuss a trial implementation of our strategy at this hospital unit and the resulting findings.*

Keyword: Health Care, Simulation, Student Projects

Corticosterone effects on spatial working memory in juvenile rats

Munjed Milhelm (Wright State University)
A. Schmidt (Wright State University)
N. A. Koraym (Wright State University)
P. Schiml (Wright State University)
M. B. Hennessy (Wright State University)
D. I. Claflin (Wright State University)

Poster

Abstract *In two experiments we examine the ability of 27-day-old rats to perform two spatial working memory problems (delayed alternation and discrete-trials delayed alternation) and a reference memory problem (position habit) in a T-maze. In the delayed alternation problem, each animal will be presented with a series of free-choice trials and rewarded for regularly alternating responses to the left and right arms of the T-maze. In the discrete-trials delayed alternation problem, each animal is forced to one maze arm and rewarded (forced run) and then placed back into the start box and given a choice of arms (choice run). The direction of forced runs followed an irregular, counterbalanced series, and animals will be rewarded for choosing the alternate maze arm on choice runs. In the position habit problem, animals are rewarded for consistently choosing one of the two arms of the T-maze. Performance on these problems is assessed about control conditions in which reward is not contingent on choice behavior. At 27-day-old, rat pups will be able to perform the delayed alternation and position habit problems. However, we hypothesis 27-day-old rats can learn the discrete-trials delayed alternation problem as a result of the high level of Corticosterone hormone due to early life stress.*

Keyword: Health Care, Student Projects

7. Full Papers

Okonkwo, C. and Drager, S. (2016) “Performance Analysis of Various Hash Functions” *Proceedings of the 3rd Annual Cincinnati-Dayton INFORMS Conference*, pp. 24 - 31

Hawkes, T.D., Bihl, T. J., and Woolacott, M. H. (2016) “Interacting Systems Approach to Investigation of Human Cognitive Capacity” *Proceedings of the 3rd Annual Cincinnati-Dayton INFORMS Conference*, pp. 32 - 39

Paper and Presentation

Abstract: *The Air Force Research Laboratory sponsored Software Epistemology (the study or theory of the nature and grounds of knowledge especially with reference to its limits and validity) project developed an approach for determination by generating new information from data produced by an artifact extraction process, incorporating scalable computation capabilities present in TitanDB, and successfully extending the research to support the DARPA Mining and Understanding Software Enclaves (MUSE) program through the use of advanced machine learning for derivation of new knowledge to significantly advances the state of the art in automated vulnerability discovery. The approach taken utilizes a sieve analysis concept and application of a hashing scheme to a large corpus of open source software for mining information. The custom hashing scheme deployed was developed to enable fast, but fuzzy, matching of basic blocks in a module or function. The hashing algorithm is reasonably accurate and fast but saturates when exposed to large basic blocks. This paper summarizes consideration of other hashing schemes. For a database structure with a huge amount data, it can be almost next to impossible to search all of the index values before reaching the location of the required value, a hash table will likely be used for quick access to the desired data. Hashing is an effective technique to calculate the direct location of a data without using the index structure. This paper analyzes 16 non-cryptographic and 2 cryptographic hash functions. Based on the results, hash functions which show great performance, distributes hash keys randomly over the hash range, and are uniformly distributed with low bias are recommended for use.*

Keywords: Computing, Programming

1. Introduction

In 1953, the idea of hashing was originated by H. P. Luhn. The basic idea is to use a function $h: U \rightarrow V$, called a hash function, that mimics a random function. This way a random value $h(x)$ can be associated with each element from the domain U [18]. According to Konheim [5], the history of the hashing concept was described in Donald Knuth, third volume seminal work, The Art of Computer Programming and in the paper Hashing by D.G. Knott.

Over the years in computer science, researcher have actively pursued the development of new and better algorithms to significantly advance the performance of code and data structures. Hashing functions are a prime example of successful activity of this kind. With a hash function, we can search a file of n records in a time which is, for all practical purposes, independent of n . Thus, when n is large, a hash function method is faster than a linear search method, for which the search time is proportional to n , or a binary search method, whose timing is proportional to $\log n$ [15]. Hashing is an important tool in algorithms and data structures, with applications in such diverse fields as information retrieval, complexity theory, data mining, cryptology, and parallel

algorithms. This paper gives an evaluation of 16 non-cryptographic and 2 cryptographic hash functions.

According to Mao [17] the hash functions which is denoted by f should have several basic characteristics. The first characteristics, the function converts any number of input data to an output data of fixed length. The output data are normally referred to as hash or hash value. The second characteristic is a small change of an input data during the hashing process will achieve a big change of output data. This process is referred to as an avalanche effect. The third, the function should be uniformly distributed, which means unique inputs should provide unique outputs to avoid collision. The existence of collisions in hash function is inevitable, which meaning a pair of input data (x, y) ; $x \neq y$ have the same hash values $f(x) = f(y)$. Collisions are undesirable, but in hashing they cannot be avoided, it can only be reduced. If a collision should be completely eliminated (perfect hashing), it would be a hash of the same length as the input data, which would affect the efficiency and performance of that hash function.

2. Hash Function

In a database structure with a huge amount data, it can be next to impossible to search all the index values before reaching the location of the required value. A hash function will likely be used to quickly access hash table or buckets for the desired data. Hashing is an effective technique to calculate the direct location of a data. Although calculating the location of a data requires a hashing function. A Hash function is function that map bit value (usually a string) of arbitrary length often call key or message and outputs another bit value often known as hash, message digest, hash value, or checksum. The output hash value is usually shorter than the original input key and usually of fixed length for a particular function. The hash function should produce a unique output for a given input. There are four characteristics required in a hash function. First, the hash function should be efficient to compute, because a hash value is generated for each data in a huge database so speed will be a necessity for a hash function. Second, a hash function should be deterministic meaning similar keys must produce the same hash value. Third, a hash function should uniformly distribute the input keys. Otherwise, hash inputs with similar hash values will be mapped closely together which will introduce a high probability to experience collisions. The fourth characteristic is applying only to cryptographic hash function, stating, hash functions should be a one-way function suggesting that similar input key produce very different output hash values.

3. Collection of Hash Functions

We analyzed a collection of 16 non-cryptographic and 2 cryptographic hash functions (SHA and MD5). All hash functions have a 32-bit digest hash value, a character hash input and variable hash input length. The functions were written to 32 bits in python programming language. Table 1 shows a list of all the hash functions. In this project we focus on the non-cryptographic hash functions. Non-cryptographic hash functions have proven to suffer from

some security weakness compared to cryptographic functions that have been proven to show better security quality.

Table 1: Hash Functions

Hash function	Inventor
Bernstein_djb2	Daniel Bernstein
Bernstein_djba	Daniel Bernstein
CRC32	Wesley Peterson
ELF Hash	
FNV32 Hash	Fowler Noll
FNV32a Hash	Fowler Noll
PJW Hash	Peter Weinberger
Jenkins Hash	Robert Jenkins
JOAAT	Robert Jenkins
Pearson Hash	Peter Pearson
JSW Hash	
SDBM Hash	
SuperFast Hash	Paul Hsieh
Murmur Hash	Austin Appleby
CityHash	Google
Universal Hash	
MD5	Ronald Rivest
SHA256	

4. Probability of Hash Function Collision

We say that we have a collision when we hash an input key to a location that already contains a hash value. Two different input keys x_1, x_2 produce a collision for hash function f if $f(x_1) = f(x_2)$ while $x_1 \neq x_2$. For hash tables, this means that the second table insertion will be slower because an alternate location will need to be used. There are two methods to resolving hash collision by open addressing which places the colliding key in the next empty slot on the hash table and by separate chaining which uses link list to link colliding keys. We will use this formula to evaluate the probability of a collision.

$$1 - e^{\frac{-k(k-1)}{2N}}$$

Where N is the possible hash value ($2^{32}, 2^{64}, \dots$) and k are the input keys to be hashed.

5. Evaluation of Hash Functions

In this paper we evaluate 18 hash functions on their suitability. We define following quality criteria for a hash function.

5.1 Performance

The performance of 18 hash functions is measured by a performance analysis tool written in python. The tool analyzes the programs performance by measuring how fast the function running. An average of a hundred repeated calculation is measured. The analysis tool is run on a Mac OS X laptop (2.9 GHz, 8 GB RAM). Fig. 1 and Fig. 2 shows the performance result for different input keys lengths. From Fig. 1 we can observe that the non-cryptographic hash functions have an exponential increase of computation time for FNV32, CRC32 and SDBM when the hash input length is increased from 4 to 32 bytes. Also from Fig. 1 one can that the most of the hash functions have a linear increase in computation time. The performance time of MD5 and SHA256 from Fig. 2 show a constant linear rate over 32 Bytes of input key. These results from Fig. 1 and 2 show that non-cryptographic hash functions are faster than SHA256 and MD5 with an exception to some functions that display an exponential increase.

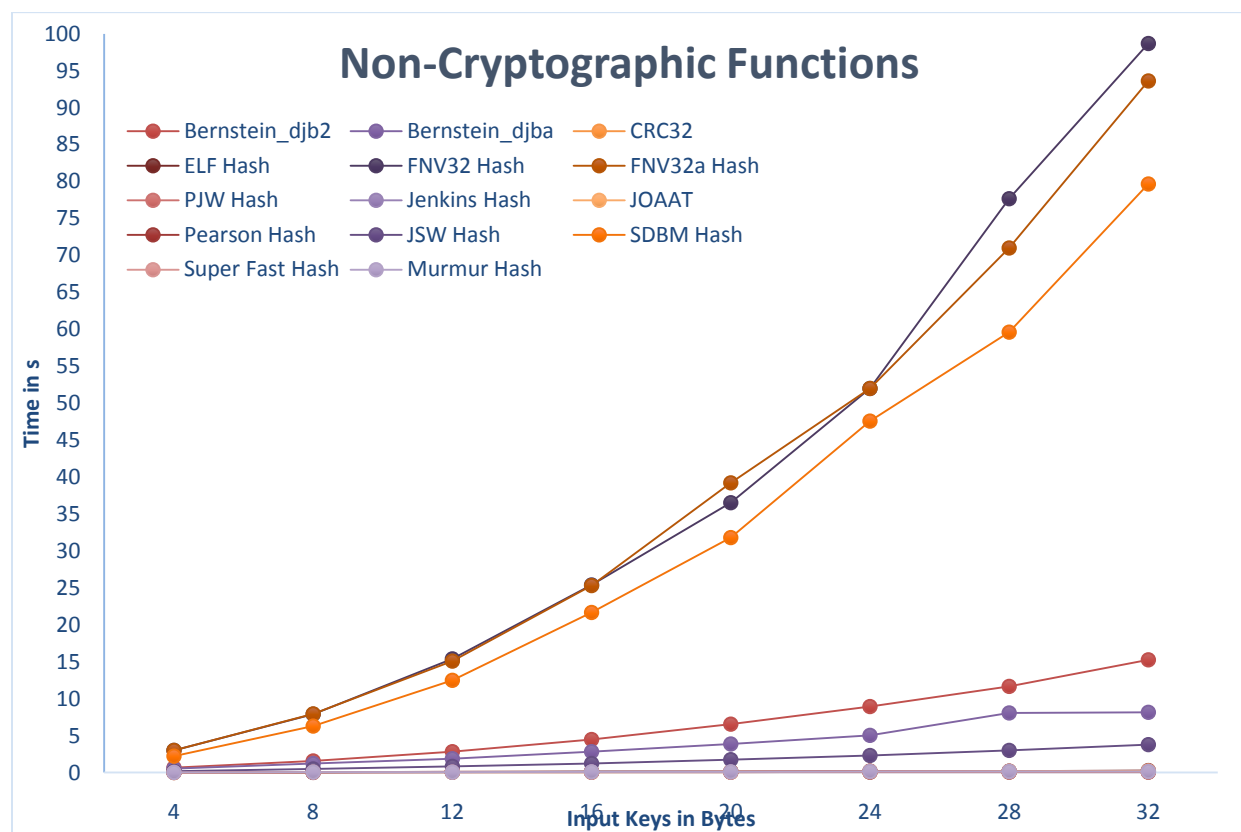


Figure 1: Non-Cryptographic Functions

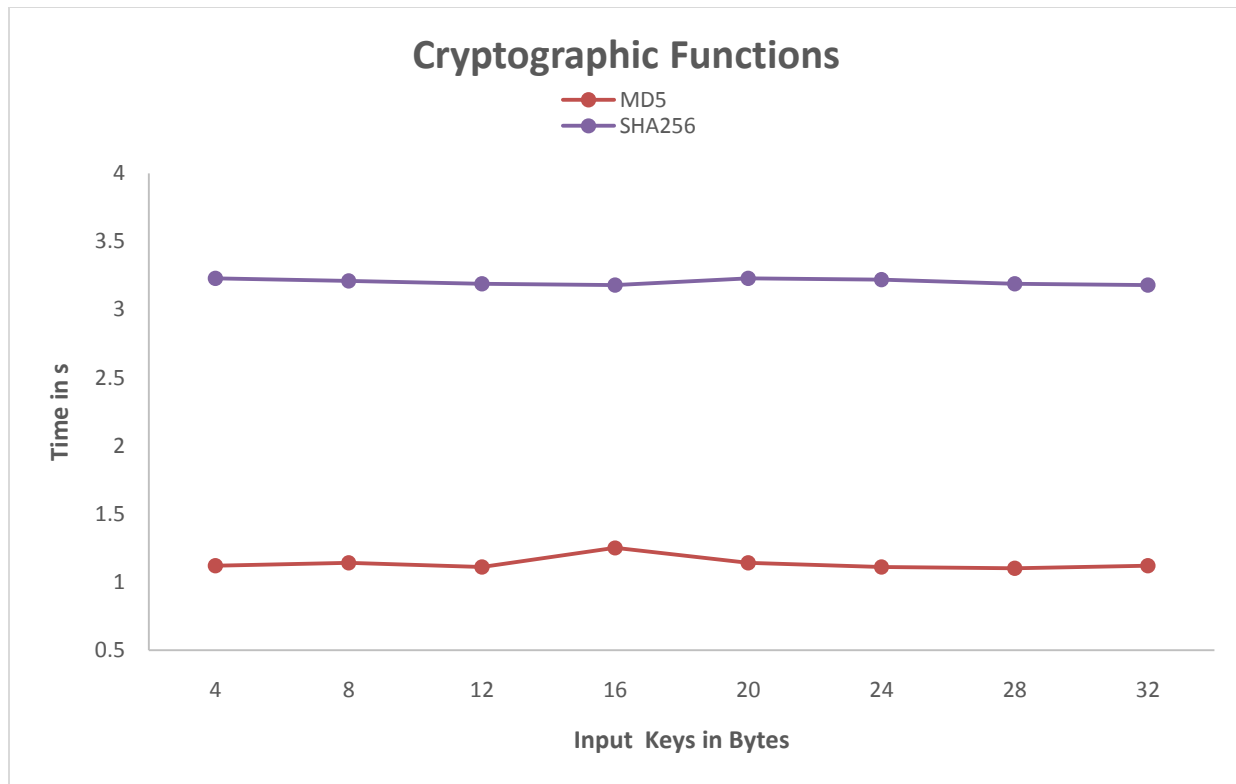


Figure 1: Cryptographic Functions

5.2 Non-linearity

It is required that hash values are distributed randomly over the hash range. Linearity is also undesired because input keys which only differ in some bits of the hash input are placed closely together on the hash table. The non-linearity criteria test of a hash function is measured with the avalanche analysis, on how well a hash function mixes the bits of the input key to produce the bits of the output hash. The avalanche test proposed by [9] to measure randomness of hash output values. Avalanche is the property that with the change of one input bit all output bits change with a probability of 50%. This implies that hash inputs that only differ in one bit disperse randomly. The closer this avalanche test is to 50% the more random the hash values. We modified the C# code implementation of the avalanche test available in [14] to Python. Fig. 3 shows an avalanche result of the Jenkins hash function. In Fig.3, the row represents the input bit while the columns represent the 32 output bits. The numbers are the results of the change in that output bit caused by the input bit. The Jenkins hash function depicted on Fig. 3 a nearly perfect avalanche, we observed that all single bit cause change to all output bits with a probability close to 50%.

50 49 53 52 49 49 50 50 53 49 52 50 53 49 47 49 52 50 50 52 48 49 51 49 47 49 47 49 50 50 50 47
50 53 59 44 49 46 53 48 54 53 50 49 50 47 49 49 50 49 48 54 50 50 50 50 49 49 49 54 52 52 47 48
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49 49 48 50 50 50 49 54 50 49 56 53 49 51 50 51 49 49 53 50 50 52 49 50 50 49 50 52 51 51 50 49

Figure 2: Avalanche Test

5.3 Unbiasedness (Uniform distribution)

The unbiasedness can be tested by the chi-square independence test. We used the chi square formula to test the probability of how distributed two hash outputs are. For each test we'll call the hash function repeatedly with random keys, and look to see which location on the hash table we are assigned. We counted the hits to each location, and compare the result to the expected result for a truly uniform distribution. The result of each chi-square test will be a p-value, which is a number from 0.0 to 1.0. If the two distributions are identical, the chi-squared statistic is 0. The further a hash key strays from the probability $p=0.5$ of being a one, the less uniformly distributed it is.

$$X^2 = \sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i}$$

The chi-square test statistics X^2 is the summation between expected E_i and observed O_i frequency of output hash value where n is the hash table size.

6. Conclusion

In this work we analyzed 18 hash functions to determine which hash function performs better for hashing in a huge database. The hash functions were evaluated on 3 criteria: performance, non-linearity and unbiasedness. The Jenkins hash, CityHash and Murmur hash function performed good on all the tests (performance, avalanche, and chi-square tests) and are strongly recommended. The SuperFast hash and CityHash function is the fastest of the 18 hash functions.

7. Acknowledgements

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Poster and Paper

Abstract *Human cognitive capacity is mediated by synergistic interactions between multiple physiological variables: including genetic and epigenetic potential, nutrition status, gender, race, age, cardiovascular capacity, neural function, and physical activity type and amount. These affect attention, memory, decision-making, educational outcomes, personality/temperament, and socio-economic potential. This suggests cognitive capacity arises from our physiology interacting with exogenous and endogenous stimuli. Since cognition originates from physiology, which consists of an integrated set of systems operating at nested time scales with spatial relationships consistent across subjects, research into human cognition requires multivariate experimental designs which take this into account.*

Keyword: Biostatistics/Biomedical

1. Introduction

Human cognitive capacity is dependent on nested, interacting physiological components beginning at the genetic/epigenetic level. Gene transcription by allele [1] [2] and epigenetic regulation of such instantiate neuron structure and function [3] [4] and interact with nutritive factors (e.g. iron status) and physical activity [5] to up- or downregulate [6] brain structure and function in humans [7] and rat [8]. At the next system level, neurons are organized into over 200 specialized groups called microcircuits [9] that assemble dynamically in response to task demands [10] [11] [12] [13] [14] [15] [16] [17] [18] (see Figure 1). Microcircuits that participate in transient task-specific networks include the dorsolateral prefrontal cortex, anterior and posterior cingulated cortices, orbitofrontal cortex, insula, perirhinal cortex and hippocampus. VO₂Max (a gold standard proxy for cardiovascular capacity) [19] has been associated with better cognitive capacity in the study described herein [20] [21] and in a recent fMRI study of brain activation during an executive function task in older adults [22].

The study described here was specifically designed to assess differential effects of chronic exercise-type on executive function and took into account the integrated systems subserving cognitive output (see Figure 2). Subjects were recruited based on their exercise type and were required to have practiced or been sedentary for five or more years: Tai Chi (TC in charts), Meditation + Exercise (M in charts), Aerobic Fitness (A in charts), and Sedentary (S in charts). Requirements for group membership are presented in Figure 2 and were based on three categories: exercise exertion, attentional focus required, and complexity of motor output required. The Aerobic Fitness (A) group served as an active control and the Sedentary (S) group served as an overall control with the Tai Chi (TC) and Meditation + Exercise (M) regimes, permitting isolation of attention, exertion, and motor output effects on complex executive function.

This paper further explains the structure of the study presented in [21] and further analyzes the collected data. This paper is organized as follows: Section 2 presents the overall

experimental design structure, Section 3 presents results and interpretation, Section 4 provides a summary and conclusion.

Interacting Systems Components Cognitive Output

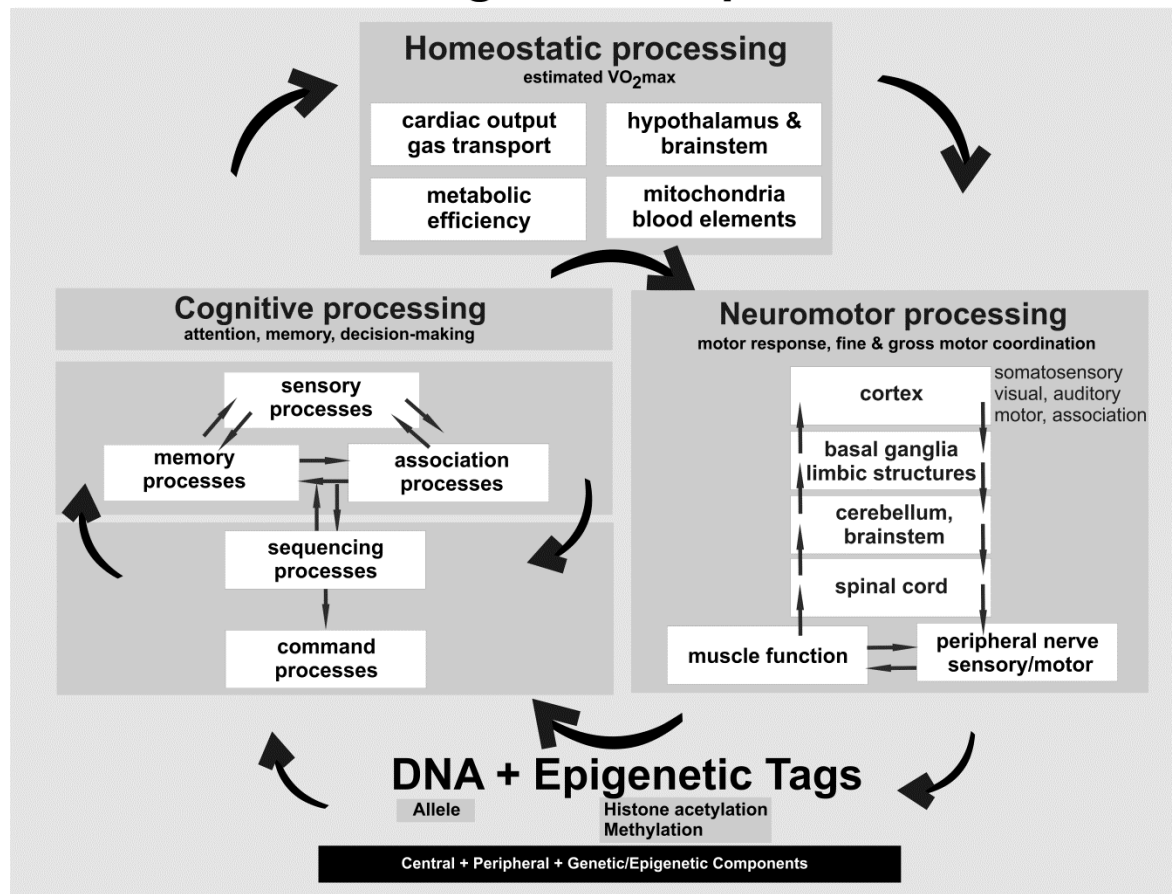


Figure 1. Major physiological processing components instantiating cognitive output. Arrows indicate flow of information between components .

2. The Design Structure

The three exercise groups, TC, A, and M, each required 4-8 metabolic equivalents (METs) of exertion, with METs indexing energy expenditure relative to resting metabolic rate. Tai Chi is a martial art which requires 1) complex gross motor coordination, 2) shifts of visual focus, 3) control of breath relative to movement, and 4) memorization of complex movement sequences. Aerobic Fitness subjects were those exerting 4-8 METs through various exercises requiring only relaxed attention. The Meditation + Exercise group consisted of subjects whose regime required 4-8 METs exertion plus sustained, exclusive mental focus on a specific sensation, image, goal, or syllable(s).

Exercise Type	Integrated System Requirements		
	Exertion*	Attentional Focus**	Motor Function***
Tai Chi	Moderate	Complex	Complex Coordination
Meditation + Exercise	Random	Concentrated	Simple Coordination
Aerobic Fitness	Moderate	Relaxed	Simple Coordination
Sedentary	Random	Random	Random

*Cardiovascular/respiratory requirements

**Integrated brain network requirements

***Neuromuscular/skeleto-muscular requirements

Figure 2. Integrated system requirements for execution of each exercise type.

This approach leveraged multivariate statistical procedures to go beyond traditional yes/no null hypothesis tests and investigate sets of associations between system indexes (e.g. electroencephalographic event-related potentials) and proxies (e.g. VO_2 Max). For this research, the following steps were performed [21]. These steps are suggested as a template for human studies research into cognitive capacity.

Step one: Select a key evidence-based group to compare (IV or quasi-IV). Inclusion of one key covariate is permitted, but it must be a covariate known to explain significant variance on any included dependent variable (DV). In the study presented, since age is known to strongly affect VO_2 Max [24] and cognitive capacity [25], age was included as a covariate. The literature behind any cognitive hypothesis can provide enough guidance to permit such winnowing of possible IVs and covariates. Always include an active control. The active control in this case was the aerobics group (exercise with no consistent focused attention requirement). The passive control was the sedentary group (no exercise, no activities requiring exercise exertion accompanied by an attentional requirement).

Step two: Identify key physiological systems affected by group membership. The study presented illustrates this approach [20] [21]. Each type of exercise placed different requirements on key systems, thus based on the literature could be expected to produce different cognitive outcomes.

Step Three: State integrated systems hypotheses. In the exercise study presented here, we had two hypotheses: 1) All exercise groups would outperform sedentary controls on estimated VO_2 Max, and thus outperform Sedentary subjects on the complex executive function test (including ERPs). 2) Exercise requiring attentional focus was hypothesized to produce better cognitive outcomes compared to exercise permitting relaxed attentional focus (active control), thus we expected the TC and M groups to outperform A and S groups on neural and behavioral indices of complex executive capacity.

Step Four: Do the research.

Step Five: Perform multivariate analyses to obtain p -values, effect size profiles, correlations, and z-score profiles.

2.1 Data Collection

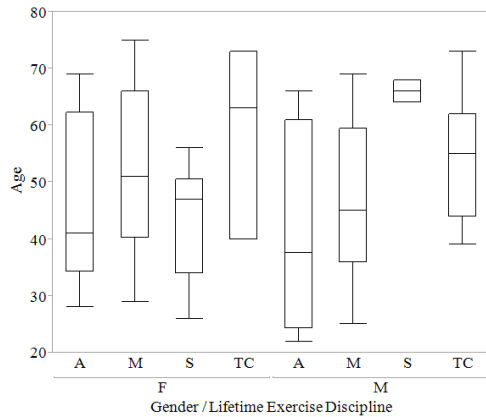
Besides demographic and exercise regimen data, participants were tested with the Rockport 1-Mile Walk (a well-validated estimated VO_2 Max test), body-mass index, and dense-array EEG P300 event-related potential during a demanding task switch test of complex executive function (see Methods in [20] [21]).

2.2 Subject Characteristics

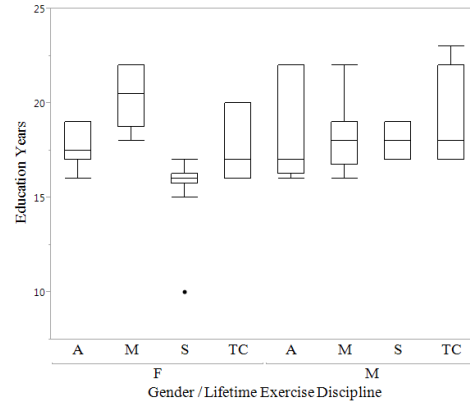
For the study, 54 subjects completed all tests and were included in this analysis. Descriptive statistics for subject physiological measures by group are presented in Table 1 and Figure 3. While similar groups would be ideal, it was not possible to ensure that each group was identical. Figure 3 presents boxplots for age based on pairs of Gender and Lifetime Exercise Discipline, Figure 3a, Education Years versus Gender and Lifetime Education Discipline, Figure 3b, BMI (kg/m^2) vs Gender and Lifetime Exercise Discipline, Figure 3c, and VO_2 Max (mL/kg/min O_2) versus Gender and Lifetime Exercise Discipline, Figure 3d. Noticeably, for age, paired groupings differ across both Gender and Lifetime Exercise Discipline types; however, overlap is largely seen with the exception being Males who are Sedentary. The Education Years versus Gender and Lifetime Exercise Discipline shows more homogenous groups, with the exception of Sedentary Females and Meditation + Exercise Females. In this cross-sectional study, the effects of different ages between groups worked to our advantage, as it allowed us to see that the TC and M groups, though older than the A and S groups, outperformed them on our key cognitive and physiological variables (complex executive attention and ERP neural indices of brain activity during such, estimated VO_2 Max and body-mass index).

Table 1. Subject Physiological Scores, from [21]

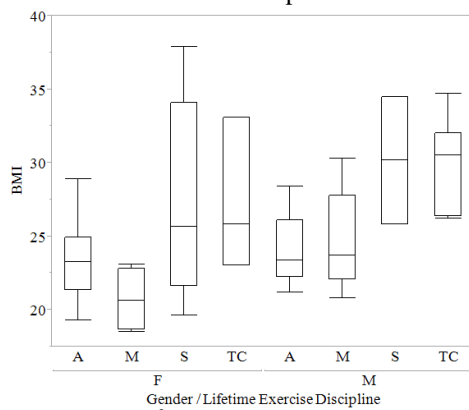
Group	N	Females	Age, years		VO_2 Max, mL/kg/min O_2		BMI, kg/m^2	
			Mean	S.D.	Mean	S.D.	Mean	S.D.
TC	10	3	55.4	12.99	34.14	6.34	29.3	3.77
M	16	6	48.63	15.00	41.83	9.04	23.3	3.53
A	16	8	44.09	16.2	45.66	9.67	23.78	2.62
S	12	10	46.92	12.81	28.68	5.76	27.93	6.37



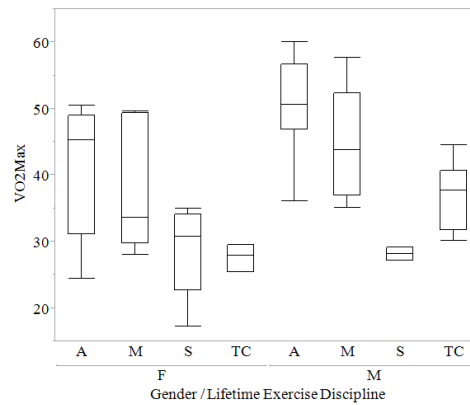
a) Age vs Gender and Lifetime Exercise Discipline



b) Education Years vs Gender and Lifetime Exercise Discipline



c) BMI (kg/m²) vs Gender and Lifetime Exercise Discipline



d) VO₂ Max (mL/kg/min O₂) versus Gender and Lifetime Exercise Discipline

Figure 3. General Characteristics of Subjects

2.3 Key Results

Figure 4 presents the effect size profile for variance explained by group and age for the significant variables as determined in [21].

3. Results Interpretation.

While *p*-values shed light on differential distributions associated with IV effects on each DV, effect size profiles can tease apart the differential effects of IV and covariate on systems

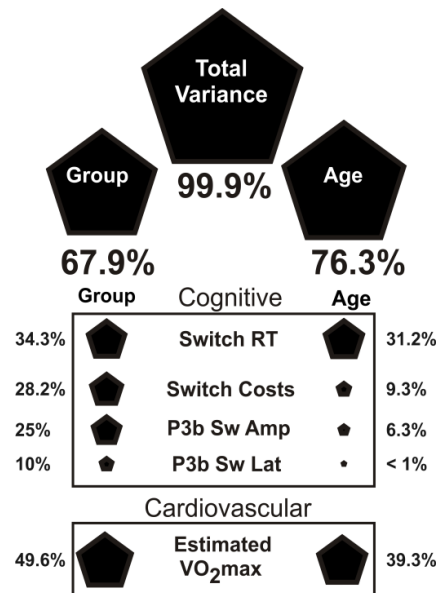


Figure 4. Effect size profile of group (TC, M, A, and S) and age in years for key cognitive and physiological variables, from [21].

represented by each DV. Normalized system profiles, Figure 5, by DV allow quick identification of individual performance within group performance. In the study illustrated here, we see in Figure 5 that Group has more effect on key DVs than age, even though age is known to strongly affect human physiological and cognitive capacity.

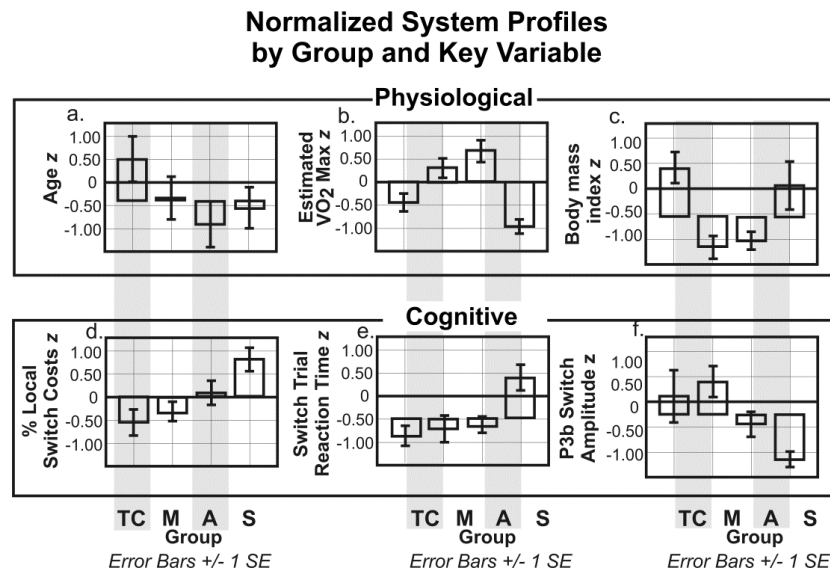


Figure 5. Z-score profiles for each key variable show the distribution of scores by exercise group

4. Conclusions.

This simple interacting systems study showed that exercise group had more effect on key outcome variables than age. Further, TC and M groups, though older than the S or A groups, outperformed them. But, this study did not include key epigenetic or genetic variables that may explain some of these effects. A more complete variable panel should include such in follow-on studies. Additionally, this cross-sectional study could not establish causation. Future longitudinal training studies could shed more light on the differential effects of exercise + attention on cognitive outcomes. More importantly, this approach can tease apart the interaction between endogenous (physiological) and exogenous (training or other types of experiences) variables on human cognitive capacity. This should yield valuable data for use in clinical, training and research settings.

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