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|  | **Proceedings of the 2018 Cincinnati-Dayton INFORMS Symposium** |
|  | October 19, 2018  Wright State University, Dayton, Ohio  *http://isd.eller.arizona.edu/CAI/logo/informs-1.jpgEditor: Trevor Bihl and Matthew JD Robbins*  http://oldwww.cs.wright.edu/graphics/russ-building.jpg |

# http://cecs.wright.edu/sites/default/files/btn_department_bie.png

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# Introduction

## Conference Committee Message

*Now in our fifth year, the organizing committee welcomes you to our annual Cincinnati-Dayton INFORMS Symposium. The symposium is a forum to show the rich OR work being performed in our local area. 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 continued to gain traction every year and we have received more than a sufficient amount of submissions, ranging from Simulation to Medical Applications. The ability to accept online registrations saw an increase in the speed at which we had registrations. 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 2019 Symposium. Additionally, please feel free to thank Wright State University's Biomedical, Industrial, and Human Factors Engineering Department and the Wright State University Raj Soin College of Business. Without their sponsorship, our conference would be infeasible.*

-Cincy-Dayton INFORMS Conference Steering Committee

## 2018 Conference Steering Committee

|  |  |
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| Trevor Bihl, 2018 Chair  Air Force Institute of Technology  [Trevor.Bihl@afit.edu](mailto:Trevor.Bihl@afit.edu) | Matthew JD Robbins, 2018 Co-Chair  Air Force Institute of Technology  [Matthew.Robbins@afit.edu](mailto:Matthew.Robbins@afit.edu) |

## 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>

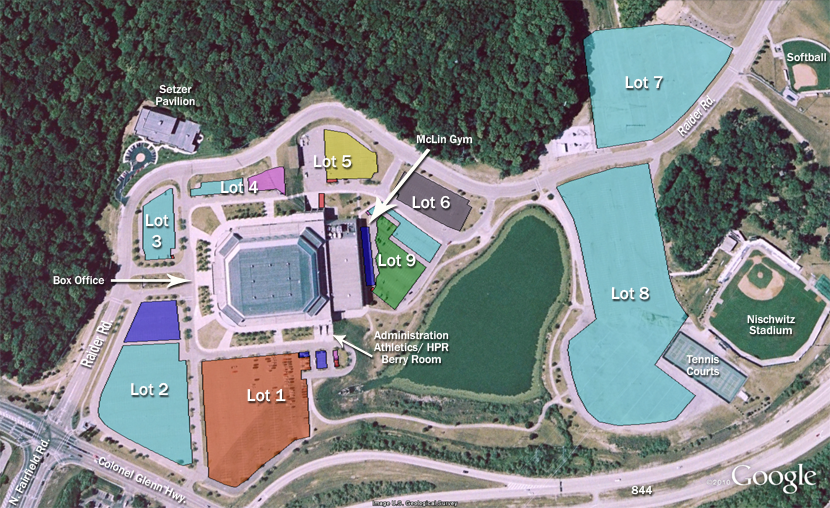
# Directions

The Berry Room is located immediately North of I-675 and North Fairfield Road (exit 17) at the corner of North Fairfield Road and Colonel Glenn Highway on the third floor of Wright State's Nutter Center. When facing the front entrance of Wright State's Nutter Center, the Berry Room is located on the far right.

To enter the Berry Room, it is advisable to park in Lot 1 and walk directly to the Administration/Berry Room door.

**Parking**

Free parking is available in Lot 1, which is conveniently located on the same level as the Berry Room. Both the parking lot and the Berry Room are accessible to persons with physical disabilities.



Berry Room and Parking (Lot 1)



Berry Room and Parking

## Sponsors

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

* Department of Biomedical, Industrial and Human Factors Engineering, Wright State University
* 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.*

**Contact Information:**

Jaime E Ramirez-Vick

Professor and Chair

Department of Biomedical, Industrial and Human Factors Engineering

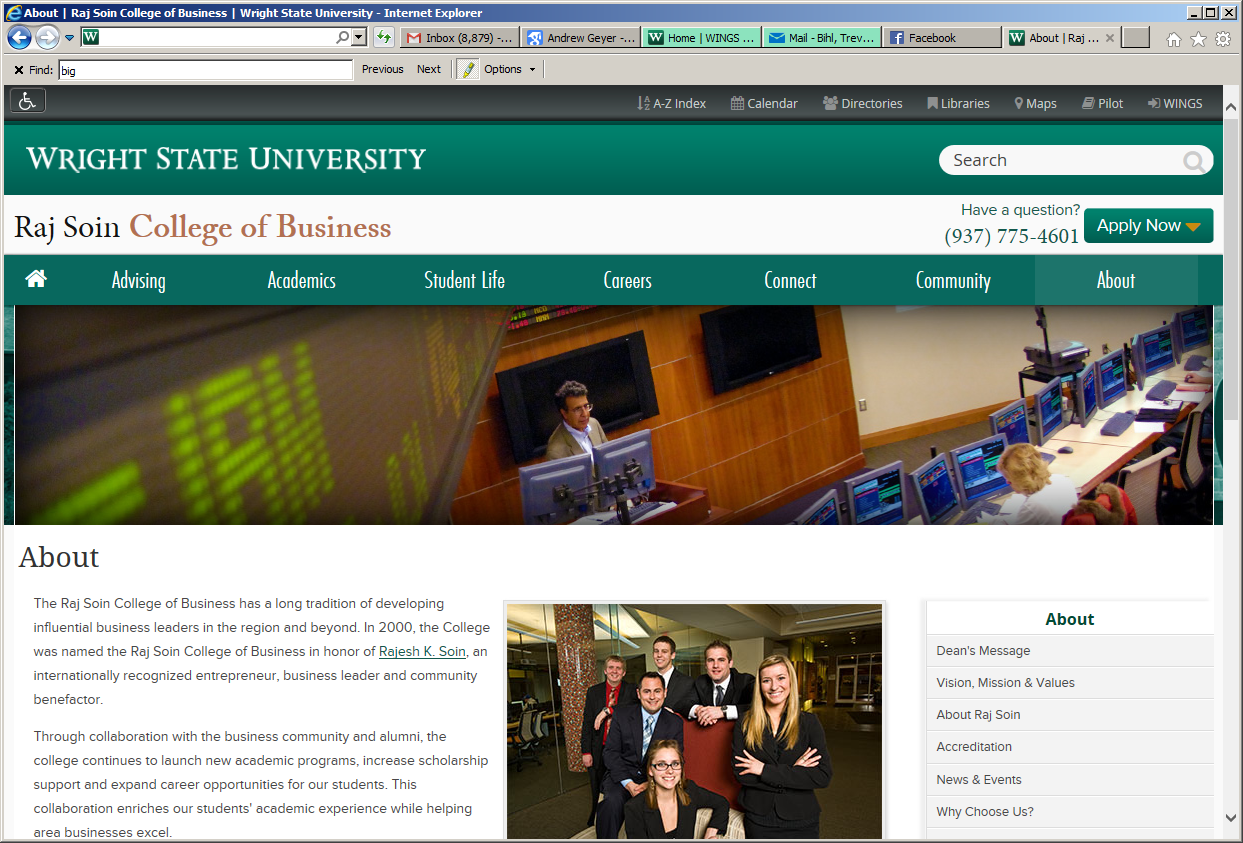
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*With an enrollment of approximately 1,200 undergraduate students and 500 graduate students, we offer the benefits of a comprehensive business program and a diverse student body. At the same time our small class sizes and supportive faculty offer students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

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# Schedule: Friday October 19, 2018

|  |  |  |
| --- | --- | --- |
| Time |  | |
| **0800-0830** | **Registration and Coffee** | |
| 0830-0840 | ***Welcome and Agenda***  **Authors**: Matthew JD Robbins, AFRL | |
|  | **Morning Session** |  |
| 0840-0900 | ***Panel on Emerging Issues in Supply Chain Management***  **Panelists:**  Ben Rhinehart, Crown Equipment Co.  Angela Moeder, Midmark Corp.  Josh Brown, Honda  Kevin Cordonnier, Honda  **Moderator**: James Hamister, WSU **Abstract-P (page 8)** | |
| 0900-0920 |
| 0920-0940 |
| 0940-1000 | ***Insights into the Aircraft Availability Conundrum***  **Presenter**: Tamiko Ritschel, AFMC/A9 **Abstract-1 (page 9)** | |
| 1000-1020 | ***Big Data Analysis with Topological Data Analysis (TDA)***  **Presenter**: Elizabeth Campolongo, OSU, Trevor Bihl, AFRL, Juan Ramirez, Ball, Ryan Kramer, AFRL **Abstract-2 (page 10)** | |
| 1020-1040 | **Coffee Break** | |
| 1040-1100 | ***Effect of Rack Design on Visibility and Profit in a Retail Store***  **Presenter**: Brad Guthrie and Pratik Parikh, WSU **Abstract-3 (page 11)** | |
| 1100-1120 | ***Military Planning Using Robust Markov Decision Processes***  **Presenter**: Andrew Keith and Darryl Ahner, AFIT **Abstract-4 (page 12)** | |
| 1120-1140 | ***Marketing Marketing Analytics in a Government Context: Application Case Studies***  **Presenter**: Amanda Reboulet, AFMC/A9A Ross Jackson, Wittenberg Uni **Abstract-5 (page 13)** | |
| 1140-1200 | ***Optimal Prize Collecting Aircraft Routing***  **Presenter**: Bryan Kolano, Michael Larkin and Jade Baker, AFIT **Abstract-6 (page 14)** | |
|  |  | |
| 1200-1320 | ***Luncheon***  ***Keynote Speaker (1220 – 1320)***  Daniel SteeneckAFIT***---Estimating Demand for Substitutable Products when Inventory Records are Unreliable* Abstract-K (page 7)** | |
|  | **Afternoon Session** | |
| 1320-1340 | ***Sole Source Contracting Timelines***  **Presenter**: Sophia Morrell, AFMC/A9A **Abstract-7 (page 15)** | |
| 1340-1400 | ***Approximate Dynamic Programming for Military Medical Evacuation Dispatching Policies***  **Presenter**: Phillip Jenkins, Matthew Robbins and Brain Lunday, AFIT **Abstract-8 (page 16)** | |
| 1400-1420 | **F*ollowing Instructions: Results and Implications from a Comparative Analysis of Three Air Force Instruction Corpora for Acquisition, Logistics, and Personnel***  **Presenter**: Ross Jackson, Wittenberg Uni Amanda Reboulet, AFMC/A9A **Abstract-9/Paper (pages 17-22)** | |
| 1420-1440 | ***Assessing Partial Association between Ordinal Variables: A General Framework***  **Presenter**: Dungang Liu, University of Cincinnati **Abstract-10 (page 23)** | |
| 1440-1510 | **Heavy Hors d'oeuvres** | |
| 1510-1530 | ***Influence Modeling: Mathematical Programming Representations of Persuasion under Either Risk or Uncertainty***  **Presenter**: William Caballero and Brian Lunday, AFIT **Abstract-11 (page 24)** | |
| 1530-1550 | ***Female STEM Student Mentoring Program***  **Presenter**: Emily Kloos and Sandra Furterer, University of Dayton **Abstract-12 (page 25)** | |
| 1550-1610 | ***Optimizing Aircraft Non-Availability Resourcing to Enable Cost-Effective Readiness***  **Presenter**: Greg Gehret AFLCMC, Mary Godby AFSC, Danielle Beckham AFMC, Jeremy Brogdon AFMC **Abstract-13 (page 26)** | |
| 1610-on | **Closing** | |

# Keynote Address: Outstanding Young OR/MS Award Winner

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| **Abstract-K Berry 1-2**  1220-1320 | **Estimating Demand for Substitutable Products when**  **Inventory Records are Unreliable**  Daniel Steeneck (Department of Operational Sciences, Air Force Institute of Technology) |

1. **Abstract**:

Retailers are plagued by inventory inaccuracy, i.e., the inventory record reports a product is available on-shelf but the product is, in fact, out of stock. We call this as phantom inventory and it has wide-ranging negative impacts on retail operations. The acute problem with phantom inventory is the resulting lost sales. The chronic problem is that stock-outs due to phantom inventory are unobserved and, therefore, zero sales days are mistaken for zero demand days resulting in a biased demand estimate. We present a procedure for estimating demand for substitutable products when the inventory record is unreliable and irregularly validated.

**Keyword**: Analytics, Data Mining and Applied Statistics, Logistics and Supply Chain Management, Marketing

1. **Bio:**

Daniel W. Steeneck, is an Assistant Professor of Supply Chain and Logistics in the Department of Operational Sciences at the Air Force Institute of Technology. Dr. Steeneck earned his Ph.D. from Virginia Tech in Industrial Engineering and was post-doctoral research associate at MIT’s Center for Transportation & Logistics. His dissertation won second place in CSCMP dissertation award competition. His writings have been published in the WSJ MIT Sloan (Frontiers), Supply Chain Management Review, Operations Research Letters, IJPR, IJPE, and JORS. Dr. Steeneck has also worked closely with both industry and the U.S. DoD.

1. **Purpose**

To estimate product demand when inventory records are unreliable.

1. **Method**

We present a procedure for estimating demand for substitutable products when the inventory record is unreliable and validated infrequently and irregularly. The procedure uses a structural model of demand and inventory progression, which is estimated using a modified version of the Expectation-Maximization method. The procedure leads to asymptotically unbiased estimates without any restrictive assumptions about substitution patterns or that inventory records are periodically known with certainty. The procedure converges quickly for large product categories, making it suitable for implementation by retailers or manufacturers who need to run the analysis for hundreds of categories or stores at the same time.

1. **Results**

We use the procedure to highlight the importance of considering inventory reliability problems when estimating demand; first through simulation, and then by applying the procedure to a data set from a major U.S. retailer. The results show that for the product category under consideration, ignoring inventory reliability problems leads to significant underestimation of demand and severe underestimation of lost sales.

1. **New aspects of work**

The work presents a novel technique of incorporating inventory uncertainty into demand estimation techniques.

1. **Conclusions**

Ignoring inventory reliability problems leads to significant underestimation of demand and severe underestimation of lost sales.

1. **Acknowledgements**

Fredrik Eng-Larsson (Stockholm Business School, University of Stockholm)

Francisco Jauffred (Center for Transportation and Logistics, Massachusetts Institute of Technology)

# Panel Session

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| **Abstract-P Berry Room**  0840-0940 | Panel Discussion on Emerging Issues in Supply Chain Management Ben Rhinehart (Crown Equipment Co.)  Angela Moeder (Midmark Corp.)  Josh Brown (Honda)  Kevin Cordonnier (Honda)  Moderator: James Hamister (Wright State University) |

Panel Session

1. **Abstract**:

Moderated panel discussion with several local business leaders on emerging issues in supply chain management. The panelists will present their views on issues and opportunities in supply chain management over the next 3 to 5 years. The session is organized by the Center for Supply Chain Transformation at Wright State University. The panelists include representatives form Crown Equipment Co., Honda, and Midmark Corp:

1. Ben Rhinehart, Crown Equipment Co.
2. Angela Moeder, Midmark Corp.
3. Josh Brown, Honda
4. Kevin Cordonnier, Honda

**Keyword**: Supply Chain Management, Emerging Issues

# Abstracts for Presentations and Papers

|  |  |
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| **Abstract-1**  0940-1000 | Insights into the Aircraft Availability Conundrum Tamiko Ritschel (AFMC/A9) |

1. **Abstract**:

*Aircraft Availability (AA) is a key metric for assessing operational readiness. The declining trend in AA is a concern for senior Air Force leaders. This article investigates the components of Non-Available time and subsequently focuses on the largest and fastest growing category: Not Mission Capable Maintenance Unscheduled (NMCMU). Regression analysis reveals drivers of NMCMU include platform type, average age of aircraft, fleet size, breaks, and cannibalization. Implications from the regression show there are remedies to increase AA, but many of these remedies may be costly. Therefore, an analysis of utilization is conducted to determine the readiness benefit of increasing available hours. The results show available aircraft hours is highly correlated with hours flown. The regression analysis indicates that when more hours are made available, five percent of each new hour is used for flying. This could indicate available aircraft hours limits our ability to fly. Additional analysis at the individual platform level shows a strong or moderate correlation between available hours and sorties flown for 93 percent of the platforms.*

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| **Abstract-2 Berry 2**  1000-1020 | Big Data Analysis with Topological Data Analysis (TDA) Elizabeth Campolongo (Ohio State University)  Trevor Bihl (Air Force Research Laboratory)  Juan Ramirez (Ball Aerospace)  Ryan Kramer (Air Force Research Laboratory) |

1. **Abstract**:

*Topological Data Analysis (TDA) provides a data driven discovery method to data mining. TDA is a hypothesis free approach and incorporates clustering and distance-based methods to find similarities between observations and groups of observations. Advantages are seen in using TDA for big data problems, which confound traditional dimensionality reduction methods. This talk will present the general process at work in TDA, along with representative examples.*

**Keyword**: Analytics, Artificial Intelligence, Qualitative & Quantitative Methods

1. **Purpose**

Data mining encompasses a variety of problems and methods, as briefly conceptualized in Table 1. Topological Data Analysis (TDA) offers a new approach to unsupervised data mining wherein both clustering and dimensionality reduction approaches are considered together to understand relationships within data which includes both shape and similarity aspects.

**Table 1: General Data Mining Approaches, adapted from (Bihl, et. al, 2016)**

|  |  |  |  |
| --- | --- | --- | --- |
| **High-level Methods** | **Medium-level Methods** | **Description** | **Examples** |
| Supervised | Classification | Applying methods to create a model that accurately represents the data with respect to known classes, discrete value prediction | Classification Trees, Discriminant Analysis, Logistic Regression, Naïve Bayes, Neural Networks, Template Matching |
| Regression | Developing predictive models that can be used to fit a curve/surface to data observation points for continuous value prediction | Regression Trees, Neural Networks, Least Squares and Total Least Squares |
| Unsupervised | Clustering | Finding patterns in data based on similarity measure and relationships | K-means, Hierarchical clustering, Local Linear Embeddings (LLE) |
| Dimensionality Reduction | Transforms data into a new space (feature extraction) or selects subsets of original data features (feature selection) | Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Factor Analysis (FA), Stepwise, forward, and backward selection methods |

A topological model is a simplification of the shape of data in which information about the data is embedded (Carlsson, 2009). Topological data analysis (TDA) extends upon this concept to create a data mining tool whereby observations are binned based on similarity and then clustered based on shape and relationship. From similarities and clusters, a TDA graph is then computed to show relative similarity and differences between groups of observations.

1. **Method**

TDA as a process extends upon the concepts presented in the Mapper algorithm of Singh et al. (2007). The Mapper process generally works in 4 steps: a) the data is considered as a matrix, b) data observations are placed into overlapping bins based on a metric, c) a clustering algorithm, or lens) is used to group each bin and, d) a network with vertices (clusters) and edges (intersections between clusters) is realized (Singh, et al., 2007). In operation, one generally has multiple TDA models computed for a given dataset, with different metrics and lenses, and their operational settings (resolution and gain), specified. From here, one compares and contrasts different TDA models for the insight they provide. One example, TDA applied to the Fisher Iris dataset (Fisher, 1936) is seen in Figure 1.

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| **Fig. 1: Fisher Iris data analyzed in Ayasdi’s Machine Intelligence Platform with coloring by petal length. Metric: Correlation, Lens: L-infinity Centrality, Resolution: 30, Gain: 3.00** |

1. **Conclusions**

TDA provides a useful approach for data driven discovery with advantages seen for big datasets that are not readily interpretable. TDA is general useful for high dimensional data, and when summaries are needed which relate to how the shape of the data provides insight. However, applying TDA is an exercise in multi-objective optimization wherein the settings of the algorithm that best work on a given problem are unknown without experience and exploration. Thus, when using TDA, work is needed in determining which model is of value, multiple models generally created and results differ based on metric, lens, resolution, and gain settings.

1. **References**

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| **Abstract-3**  1040-1100 | Effect of Rack Design on Visibility and Profit in a Retail Store Bradley Guthrie (Wright State University, Dayton, OH)  Pratik J. Parikh (Wright State University, Dayton, OH) |

1. **Abstract**:

*Optimizing a layout to increase product visibility in a retail store will directly benefit both the retailer (e.g., increased revenue) and the shopper (e.g., increased satisfaction). We introduce the Rack Orientation and Curvature Problem, which determines the rack orientation and curvature to maximize marginal impulse profit (after discounting for floor space cost). We present an optimization model for ROCP and solve it using a Particle Swarm Optimization approach. Our findings suggest that layouts with either high-acute and straight-to-medium-curved racks, or high-obtuse and high-curved racks tend to increase profit ranging from 70-233% over common rack layouts (orthogonal and straight racks).*

**Keyword**: Modeling, Logistics and Supply Chain Management, Optimization, Marketing

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| **Abstract-4**  1100-1120 | Military Planning Using Robust Markov Decision Processes Capt Andrew Keith (Air Force Institute of Technology)  Dr. Darryl Ahner (Air Force Institute of Technology) |

1. **Abstract**:

*Military operations planning involves sequential decision making under model uncertainty and partial state observability. Robust and partially observable Markov decision processes extend traditional Markov decision processes to address this complex setting. We present an application of robust and partially observable Markov decision processes to military planning. We briefly compare the performance of the modeling techniques in terms of solution value and computational cost. We also discuss the cost in terms of modeling complexity.*

**Keyword**: Military OR Applications

1. **Purpose**

The purpose of this work is to make military planning models more robust to departures from assumed model form and state knowledge.

1. **Method**

We use robust Markov decision processes and partially observable Markov decision processes.

1. **Results**

This is ongoing work but early results indicated that partial observability introduces more computational cost than robustness. Furthermore, distributionally robust MDP are feasible for small problems.

1. **New aspects of work**

Previous assessment planning work has modeled the problem as a static optimization problem. Military planning models in other related fields have used MDPs but not distributionally robust MDPs or POMDPs.

1. **Conclusions**

Distributionally robust MDPs and POMDPs can be used in the military planning setting for small-sized problems. These models protect against out-of-sample or unexpected adversary dynamics.

1. **References**

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| **Abstract-5**  1120-1140 | Marketing Marketing Analytics in a Government Context: Application Case Studies Amanda Reboulet (HQ AFMC/A9A)  Ross Jackson (Wittenberg University) |

1. **Abstract**:

*Marketing analytics is well established in the private sector. Within the public sector, the applications for and the utility of marketing analytics is less clear. This perhaps stems from a limited view of marketing in the public sector more than an underappreciation of the roles for analytics. In a rhetorical doubling, practitioners wanting to unlock the value of these approaches in a government context will likely need to engage in marketing marketing analytics to senior, organizational managers. This study describes microapplications of marketing analytics to highlight both how one might use marketing analytics techniques and overcome institutional biases against its application in a government context.*

**Keyword**: Analytics, Cognitive bias, Marketing, Military Applications, Organizations

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| **Abstract-6**  1140-1200 | Optimal Prize Collecting Aircraft Routing Bryan M. Kolano (Air Force Institute of Technology)  Michael T. Larkin (Air Force Institute of Technology)  Jade F. Baker (Air Force Institute of Technology) |

1. **Abstract**:

*An integer programming model formulation is proposed to route an aircraft to visit and observe fixed points in a proximate geographic region, wherein points have different relative values to the decision maker and aircraft fuel limits the total distance traveled. Considering an unclassified, representative instance having 40 points of synthetically-generated values within the Military District of Washington and using a Robinson R-22 helicopter, the commercial solver LINGO is used to generate an optimal tour and explore excursions related to both the value of fixed points and required station time. Disregarding aircraft limitations, an extension seeks to identify an optimal Traveling Salesman Problem tour and compares the results with the optimal solutions to the prize collecting tours.*

**Keyword**: Student Projects

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| **Abstract-7**  1320-1340 | Sole Source Contracting Timelines Sophia Morrell (AFMC/A9A)  Amanda Reboulet (AFMC/A9A) |

1. **Abstract**:

*The AF collects significant amounts of data particularly within the contracting community. This project utilized contracting data mixed with a data analytics approach to reveal the landscape of AFMC center-level contracting actions. Senior leaders within the contracting community were able to use he data analytics created from this project to help pinpoint areas of focus for potential improvements in contracting timeline.*

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| **Abstract-8**  1340-1400 | Approximate Dynamic Programming for Military Medical Evacuation Dispatching Policies Phillip Jenkins (USAF/AFIT)  Dr. Matthew J. Robbins (USAF/AFRL)  Dr. Brian J. Lunday (USAF/AFIT) |

1. **Abstract**:

*Military medical planners must consider how aeromedical evacuation (MEDEVAC) assets will be dispatched prior to engaging in combat operations. We formulate a Markov decision process model to examine the MEDEVAC dispatching problem. We develop and test two distinct approximate dynamic programming (ADP) solution techniques. The first technique utilizes least-squares temporal differences (LSTD) learning, whereas the second technique leverages neural network (NN) learning. A notional planning scenario is examined to determine the efficacy of our ADP solution techniques. Results indicate that the NN policies substantially outperform both the LSTD and currently practiced policies.*

**Keyword**: Military OR Applications

1. **Purpose**

This research examines the MEDEVAC dispatching problem wherein a dispatching authority must decide which available MEDEVAC unit (if any) to dispatch to prioritized requests for service (i.e., 9-line MEDEVAC requests). The intent of this research is to determine dispatching policies that improve the performance of a deployed Army MEDEVAC system and ultimately decrease the case fatality rate (i.e., percentage of fatalities among all combat casualties)

1. **Method**

We develop a discounted, infinite horizon Markov decision process (MDP) model of the MEDEVAC dispatching problem to maximize the expected total discounted reward attained by the system. The MDP model provides an appropriate framework for solving the MEDEVAC dispatching problem; however, the large size of the motivating problem instance yields an uncountable state space, rendering classical dynamic programming methods (e.g., value iteration, policy iteration) inappropriate. As such, we employ ADP solution techniques to produce high-quality dispatching policies relative to the currently practiced (i.e., closest-available) dispatching policy. We develop and test two distinct ADP solution techniques that both utilize an approximate policy iteration (API) algorithmic framework. The first API algorithm utilizes LSTD learning for policy evaluation, whereas the second API algorithm leverages NN learning for policy evaluation. Given the MEDEVAC dispatching problem features, we define a set of basis functions to approximate the value function around the post-decision state for both of our proposed algorithms. We construct a notional, representative planning scenario based on high-intensity combat operations in southern Azerbaijan to demonstrate the applicability of our MDP model and to examine the efficacy of our proposed ADP solution techniques. Moreover, we design and conduct computational experiments to determine how selected problem features and algorithmic features impact the quality of solutions attained by our ADP-generated dispatching policies.

1. **Results**

The results from our computational experiments reveal that policies derived from both of our proposed ADP solution techniques significantly outperform the closest-available policies for each of the average request arrival rates examined. Moreover, the NN-API policies significantly outperform the LSTD-API policies with respect to a measure related to response time, improving upon the closest-available policies by 329.8%, 124.3%, and 24.4% for the three instances, in contrast to lesser respective improvements of 138.9%, 82.1%, and 11.6% attained via the LSTD-API policies. Compared to the closest-available policy for the baseline problem instance, the NN-API policy decreases the average response time of important urgent (i.e., life-threatening) requests by 39 minutes

1. **New aspects of work**

An important difference between this research and research in this area is the incorporation of partial dynamic rerouting. This aspect gives the dispatching authority the ability to task a MEDEVAC unit to service incoming or queued requests directly after the MEDEVAC unit completes service at an MTF's co-located MEDEVAC staging area (i.e., completes refuel and re-equip of MEDEVAC supplies). This relaxes the restriction that MEDEVAC units must return to their own staging areas to refuel and re-equip after delivering combat casualties to an MTF prior to being tasked with another service request. In addition to the incorporation of partial dynamic rerouting, this paper considers the relevant problem features examined in earlier research efforts, including admission control, queueing, and explicitly modeling the number of casualties per casualty event. Lastly, this paper provides the first proposal and demonstration of the relative efficacy of an NN-ADP solution technique for the MEDEVAC dispatching problem.

1. **Conclusions**

This research is of interest to both military and civilian medical planners. Medical planners can apply our MDP model and ADP solution techniques to compare different dispatching policies for a variety of planning scenarios that have fixed medical treatment facility and MEDEVAC staging locations (i.e., hospital and ambulance locations for the civilian sector). Moreover, medical planners can evaluate different location schemes for medical assets to determine the best allocation of resources if they are not already fixed or the emplacement of new assets is being considered.

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| **Abstract-9**  1400-1420 | **Following Instructions: Results and Implications from a Comparative Analysis of Air Force Instruction Corpora for Acquisition, Logistics, and Personnel**  Ross Jackson (Wittenberg University)  Amanda Reboulet (Headquarters Air Force Materiel Command)  Paper and Presentation |

**Abstract**:

*Documented instructions exist to clarify and standardize the execution of tasks and functions. Within the Air Force such directives are codified through documents known as Air Force Instructions (AFIs) and are published by the Air Force Departmental Publishing Office (AFDPO). In 2017, Air Force Secretary Wilson released a two-year plan for reducing the number of AFIs. Midway through this process, it is opportune to assess a subset of these AFIs in terms of timeliness and rhetorical content. A comparative analysis of three corpora was conducted for the AFIs covering acquisition, logistics, and personnel. These three areas were selected for this initial focus as each domain is significantly broad in its content and collectively central in the execution of the mission of Air Force Materiel Command (AFMC). Twisting the rhetoric slightly, one might question both if following instructions is still what is needed institutionally, and what will follow instructions if it is determined that instructing the workforce is now antiquated.*

**Keyword**: Analytics, Corpus linguistics, Military applications, Organizations

**Bios:**

* **Ross Jackson**, Ph.D. is an assistant professor of business at Wittenberg University. Dr. Jackson has a doctorate in applied management and decision sciences from Walden University. Ross’ research interests include linguistic and existential facets of the military-industrial complex and the potential intersectionality among analysis, data visualization and *détournement.*
* **Amanda Reboulet** is a senior operations research analyst in HQ AFMC. Ms. Reboulet has a master’s degree in Operations Research from the Air Force Institute of Technology, and an MBA from Wright State University. Amanda’s research interests include accession planning, marketing analytics, and the integration of analytics with business decision-making.

1. **Introduction**

Instructions, broadly defined, inform organizational behavior (Tosi & Pilati, 2011). Across a spectrum of potential forms, from manuals to regulations or from procedures to policies, documented instructions clarify and standardize the execution of tasks and functions within organizations and can provide a basis for organizational sensemaking (Weick, 1979). Furthermore, such documents can reflect, create, and sustain the dominate social constructions of reality (Berger & Luckmann, 1967) operating within and behind organizations. While admittedly formative along the lines just mentioned, the degree to which such instructions are essential is influenced both by the nature of the work being accomplished and the context in which it is being executed. Examining the use of instructions can provide a useful point of inquiry for understanding one of the limits of this form of rhetoric. Given that “for centuries, military leaders have recognized that discipline is a fundamental basis for military effectiveness,” (Weber, 2017, p. 127) defense instructions, as one part of maintaining good order and discipline, could reasonably be considered to be enacted in such a critical environment. Though if overly detailed, they could reduce innovation.

Examining the use of instructions within the United States Air Force (USAF) is particularly timely and relevant because in 2017, Air Force Secretary Wilson released a two-year plan for reducing the number of Air Force Instructions (AFIs) (Bunch, 2017). These open-source documents are published by the Air Force Departmental Publishing Office (AFDPO) and are available online (<https://www.af.mil/About-Us/Fact-Sheets/Display/Article/1407777/air-force-departmental-publishing-office/>). Currently, the USAF is midway through the process of reducing its AFIs. As of August 2018, the USAF has revoked 226 instructions, which represents about 15% of the total number of AFIs in place at the start of this initiative (Losey, 2018). As such, it is an opportune time to assess a subset of the remaining AFIs in terms of rhetorical content. A comparative analysis of corpora was conducted for the AFIs covering acquisition, logistics, and personnel. These areas were selected for this initial focus as each domain is significantly broad in its content and collectively central in the execution of the mission of Air Force Materiel Command (AFMC). Analyzing these corpora benefits from the use of analytic techniques from the field of Corpus Linguistics (CL).

Within CL, one is able to execute a range of analytic techniques (Motschenbacher, 2016; Solan & Gales, 2017). While expansive in terms of both techniques and applications, analyses within CL are primarily based on an evaluation of word frequency (Gries, 2009; Lijffijt et al., 2016). While useful as a frame for one’s study, such evaluations do not require theoretical underpinnings. As Gries explained, “a large body of corpus-linguistic work has a rather descriptive or applied focus and does actually not involve much linguistic theory” (p. 2). For the purpose of this initial study, descriptive characteristics and frequencies of the corpora were explored without placing these findings within a particular linguistic theory or critical perspective.

This introduction presented the initial context of our corpus linguistics-based approach for analyzing a subset of AFIs. The remainder of this paper consists of the study background (section 2), an overview of the methodology (section 3), results (section 4), and conclusion (section 5). Turning to the background will help contextualize the subsequent results and conclusion.

1. **Background**

Organizational documents are consequential, in part, because they define, constrain and reflect reality within institutions. According to Weick (1979), “organizing is first of all grounded in agreements concerning what is real and illusory” (p. 3). Linguistically and symbolically, formalized communications form a fulcrum point of understanding. Such a situation is consequential because organizations, “have their own languages and symbols that have important effects on sensemaking” (Weick, 1995, p. 3). This insight can be extended further by taking a turn towards a social constructivist perspective. Berger and Luckmann (1967) explained that “institutions…by the very fact of their existence, control human conduct by setting up predefined patterns of conduct, which channel it in one direction as against the many other directions that would theoretically be possible” (p. 55). Organizational documents, including regulations and instructions, are a form of control which institutions use to predefine the patterns of conduct which are desired. Given the centrality of regulations in the administration of government agencies, and their potential use in both organization sensemaking and the social construction of reality, it is useful to narrow the focus to those types of organizations. This can be done philosophically and pragmatically.

Starting with a philosophical focus, Meine and Dunn (2017) explained that, “societal concern regarding military ethics predates modern history” (p. 551), and “each generation is inevitably confronted with ongoing as well as newly emerging military ethical issues” (p. 552). Situating military ethics within such a social construction is view shared by Schulzke (2016) when he noted that, “codes of military ethics are contextually situated” and that “they develop in relation to sociological and strategic conditions” (p. 188). Collectively, these works are suggestive of conceptual linkages to the social constructivist views previously developed. This topic, while developed here academically, is far from an esoteric concern. Given the extreme nature of operations, “when ethics violations occur within the military environment, people oftentimes die” (Asencio, Byrne & Mujkic, 2017, p. 415). In the determination of what constitutes military ethics, Coleman (2009) explained that, “doing one’s duty is obviously a vitally important part of serving in the military” (p. 105). An important aspect of duty is the determination as to what one “must” do. The notion of what one “must” do reoccurs as a significant point in this research. While these issues can be explored to some benefit philosophically, resolving this issue in a real sense requires a more pragmatic focus (Meine & Dunn).

More pragmatically, managing government bureaucracies and military organizations can pose a unique set of administrative challenges (Downs, 1994; Mises, 1996; Wilson, 2000). Dissecting these quandaries requires an appreciation for how texts operate as part of an overarching approach to workforce management. In their analysis of corpora based on position classification standards from the United States Office of Personnel Management (OPM), Reboulet and Jackson (2018) found that government work could be potentially split between those tasks requiring a methods-based and procedures-based approach, and suggested further study to see “if lower-echelon organizations tend to generate extra requirements in the management of their workforce” (p. 7). The USAF, as a singular Department covered by OPM, is such a lower-echelon organization. The degree of autonomy afforded the workforce and management strategy determined ethically appropriate is potentially influenced by the organization’s aggregate education level (Ledwith, Jackson, Reboulet & Talafuse, 2018).

Sensemaking and social constructivist perspectives suggest that institutional documents not only inform employees, but potentially define the very notions of organizational reality available to the workforce. Given the requirement for duty-based action within military organizations, the role for instructions is both clear and consequential. Focusing on corpora for AFIs will improve the understanding of the relative degree autonomy afforded to the workforce. With this background in place, it is possible now to progress to the methodology, which is presented next (section 3).

1. **Methodology**

Methodologically, the approach of this study is similar to that used to analyze OPM occupational series corpora (Reboulet & Jackson, 2018). This study makes use of eight “mini-corpora” (Banks, 2005) to comparatively assess the content of AFIs covering the occupational fields of acquisition, logistics, and personnel. For this study, the acquisition corpus is defined by the 63-series AFIs, the logistics corpora are comprised of the AFIs for logistics (20-series), maintenance (21-series), materiel management (23-series), transportation (25-series), and logistics staff (25-series), and the personnel corpora consist of the AFIs of both personnel (36-series) and manpower (38-series). While small by CL standards, mini-corpora are considered of value if beneficial insights can be derived through analysis (Anthony, 2013).

AFI files were obtained from the AFDPO website as Portable Document Format (pdf) documents. These pdf documents were transformed into text files using a free, online, batch conversion application from RootRise Technologies Pvt. Ltd. Corpora were built and analyzed for each of the eight mini-corpora by uploading the text files into #LancsBox (Brezina, McEnery & Wattam, 2015). Based on the low error rate found previously (Reboulet & Jackson, 2018), no structured assessment of file conversion errors was conducted. File conversion from pdf to text was assumed to be of sufficient accuracy for the purposes of this study.

Corpus comparisons, collocations, word distributions, and Key Words in Context (KWIC) are among the more common CL techniques (Pollach, 2012). In order to retain sufficient space to explore the results of this study, those interested in exploring the statistical techniques used in #LancsBox are encouraged to examine section 6 of the #LancsBox 3.0 manual (Brezina, McEnery & Wattam, 2015). While brief, this sketch of the methodology is minimally sufficient for understanding the basic contours of the analytic approach. With this established, it now possible to present the results of this study.

1. **Results**

Results for this study are presented by way of three overarching sections: a) descriptive analysis of mini-corpora, b) initial career series partitioning based on the degree of autonomy suggested by the relative frequency of “May” and “Must”, and c) analysis of KWIC. Collectively these results are useful for understanding the use of this particular subset of AFIs within the USAF.

*Descriptive Analysis of Mini-Corpora*

Observable similarities and differences among the eight AFI mini-corpora studied here can be found in terms of tokens (i.e., number of words), types (i.e., number of unique words), and lemma (i.e., root form of word class). Table 1 contains a summary of the respective values for these four elements.

*Table 1: Summary of AFI series corpora*



The most salient observation to be drawn from the information contained in Table 1 is the degree of difference associated with the Personnel corpus in comparison to the other corpora. At 160 files and 2,909,994 tokens, the personnel corpus is an order of magnitude larger than the other corpora in this study. Given this imbalance in terms of size between the corpora it is essential to conduct the comparative analysis of word frequencies in relative terms so any size-based distortions in results are avoided.

Information in Table 1 is presented in descending order based on the number of files included in each of the respective eight mini-corpora. It is worth noting that while there is a degree of consistency in order among the four elements of interest (i.e., files, tokens, types and lemma), the exact listing of series documents would change depending on which element is selected for prioritization. The overall strength of the relationship among the four corpora elements was established through a correlation analysis, the results of which are presented in Table 2.

*Table 2: Correlation among corpora elements*



The strength of relationship among the four corpora elements is both strong and consistent. Each relationship was determined to be significant at the 95% confidence level. The weakest relationships were found between the files and the linguistic elements (0.95 < *r* < 1.00). The relationship among the linguistic elements was found to be even stronger (0.98 < *r* < 1.00). These results are consistent with those found by Reboulet and Jackson (2018) in their study of OPM mini-corpora.

Structural similarities, in terms of the four elements assessed, were found to exist among the eight AFI mini-corpora of this study. While similar in terms of correlation, it is worth noting again that the personnel corpus is significantly larger than the other mini-corpora. Based on this finding, the subsequent analysis of content frequency is presented in terms of relative frequency. The following section contains an initial assessment of the terms “may” and “must.”

*Initial Career Series Partitioning based on the Degree of Autonomy Suggested by the Relative Frequency of “May” and “Must”*

It is possible to make comparisons among the eight mini-corpora. Given the centrality of duty within military organizations, it is useful to focus attention on the role of “must” (i.e., obligation) in comparison to “may” (i.e., discretion). The information contained in Figure 1 is based on the relative frequency of “may” and “must” (per 10K words) in the respective corpora.



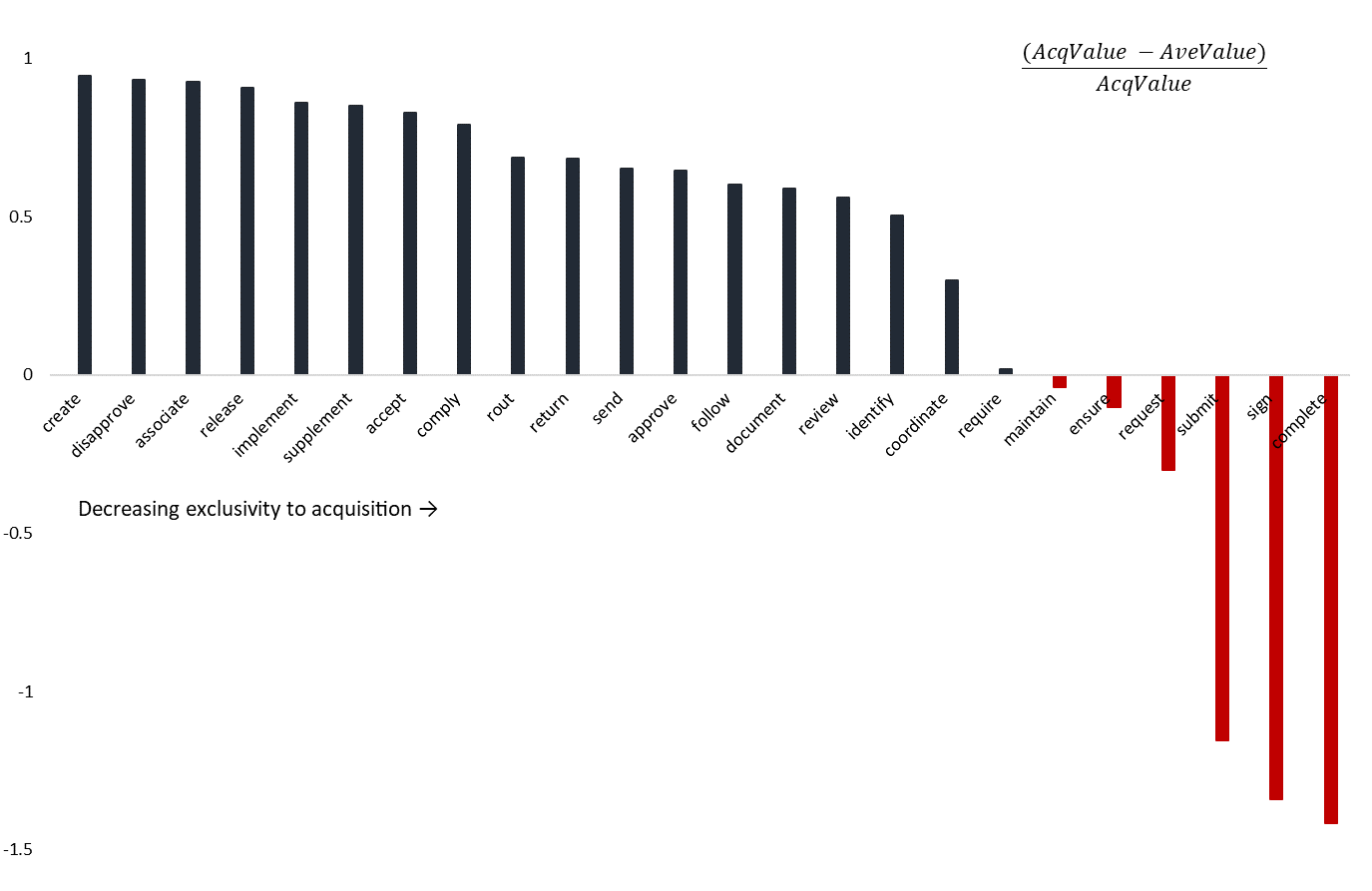
*Figure 1: Relative Frequency of “May” & “Must” across AFI Corpora*

As indicated in Figure 1, the acquisition corpus reflects more discretion than that which is found in the logistics corpora, and also exhibits a low frequency of the use of both “may-must” terms. The transportation corpus exhibits a particularly high level of “must” usages compared to its “may” value. Also, worth noting is that the personnel and manpower corpora exhibit a high frequency of the usage of the term “may.” A degree of similarity can be seen among the corpora associated with logistics (i.e., logistics, logistics staff, maintenance, materiel management, and transportation), and those corpora associated with personnel (i.e., personnel and manpower). Based on the observed commonality, meta-corpora were created for the KWIC analysis for these two groups, the results of which are presented in the following section.

*Analysis of Key Words in Context*

Similarity was found to exist among the corpora in terms of the relative frequency of “may” and “must” (Figure 1). Based on the exhibited similarity, two meta-corpora were created: a) meta-logistics corpus (i.e., logistics, logistics staff, maintenance, materiel management, and transportation), and b) meta-personnel corpus (i.e., personnel and manpower). The acquisition corpus was compared to these two meta-corpora for KWIC analysis associated with key verbs associated with the term “must.”

There were 111 instances of the term “must” in the acquisition corpus, 2,588 instances in the meta-logistics corpus, and 9,092 instances in the meta-personnel corpus. The output from this KWIC analysis was tagged for parts of speech, and high-frequency verbs were compared in terms of relative word frequency. The results of this comparison are presented in Figure 2.



*Figure 2: Decreasing Exclusivity of “Must”-Verbs in the Acquisition Corpus when Compared to Average Meta-Corpora Values*

So, what “must” acquisition professionals do? In terms of this comparative analysis, tasks which are more exclusively acquisition when compared to meta-logistics and meta-personnel are “create,” “disapprove,” “associate,” “release,” and “implement.” Terms which are less exclusively acquisition are “complete,” “sign,” “submit,” and “request.” From this finding, one might conclude that those in acquisition are directed to execute higher-order functions and are less encumbered by administrative tasks. Informed by these results, it is possible to summarize some of the key points in the following conclusion.

1. **Conclusion**

Secretary of the Air Force Wilson set the goal of reducing the number of AFIs over the years 2017 to 2019. While progress has been made on this effort, such a goal might suggest either that these instructions are not as essential as they once were, or that they are not as effective as first envisioned. There is potential ambiguity associated with *following instructions* here. Lenticular insights emerge from slightly twisting this rhetorical phrase, as one might question both if following instructions is still what is needed institutionally within the USAF, while also asking what will follow these instructions if it is determined that directing the workforce in this fashion is now antiquated. Answering these questions benefits from an incremental accumulation of context.

Prior research suggested that one could potentially split the workforce in terms of procedure-based and methodology-based work execution and that this partitioning might be related to the educational requirements of the respective work being accomplished (Reboulet & Jackson, 2018). Given an increasingly educated workforce in AFMC, such determinations hold implications for both ethics and management (Ledwith, Jackson, Reboulet & Talafuse, 2018). The results of this study suggest that useful insights might be established by a comparative analysis of key functional areas in terms of the suggested degree of autonomy (e.g., relative frequency of “may” and “must”) afforded through their respective AFIs. As indicated by the KWIC analysis, the acquisition corpus reflects more exclusivity towards mandatory tasks like creating, associating, and implementing, and less prevalence towards administrative tasks like signing, submitting, and requesting. Subsequent analysis could be useful in developing these insights and potential organizational implications further.

Given its narrow focus, this study could be extended in several beneficial ways. Future research could analyze corpora for all the AFIs remaining after the completion of the USAF reduction initiative. Such an extension could more fully establish the relative degree of autonomy among USAF functional areas. Along these lines, it would be informative to examine instructions from other Defense Services (e.g., Army, Navy, etc.) to determine if significant differences exist among them in terms of the discretion and direction afforded to its workforce. One could further extend this study to analyze the instructional documents used either within foreign militaries or domestic/foreign businesses. As indicated in the introduction, this study focused on descriptive characteristics of the corpora and relative word frequencies without the context of theory. Future studies might draw additional insights through the use of linguistic or critical theories.

Paradoxically those who fight for freedom are potentially afforded less autonomy in the execution of their work. Determining the proper balance between obligation and discretion is at the core of defining the role of instructions within the USAF. The results of this study provide some insight into how one might approach informing these decisions and could be useful as the USAF starts the second half of its effort to reduce its number of AFIs. Determining what follows instructions is more complex.

1. **Disclaimer**

These are the views of the authors, and do not represent the policy or position of the USAF, DOD, or the US Government.

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| **Abstract-10**  1420-1440 | Assessing Partial Association between Ordinal Variables: A General Framework Dungang Liu (University of Cincinnati Lindner College of Business)  Shaobo Li (University of Kansas School of Business )  Yan Yu (University of Cincinnati Lindner College of Business) |

1. **Abstract**:

*Partial association measures the relationship between two variables Y1 and Y2 after adjusting a set of covariates X. It has remained unknown how to fully characterize such an association if both Y1 and Y2 are recorded on ordinal (or binary) scales. A classical approach is to use as a substitute the partial correlation between two latent continuous variables. This so-called polychoric correlation is inadequate, as it requires the bivariate normality of the latent variables and it only reflects linear association. In this paper, we propose a new framework for studying ordinal-ordinal partial association, by using surrogate residuals (Liu and Zhang, JASA, 2018) derived from fitting ordinal regression models. We justify that Y1 and Y2 are partially independent if and only if the corresponding surrogate residual variables are independent. Based on this theoretical result, we develop a general measure to quantify the size and shape of ordinal-ordinal partial association. As opposed to the polychoric correlation, our measure has the following properties: (1) its size reflects the strength of association for ordinal data, rather than the latent ``data''; (2) it does not rely on the normality assumption or models with the probit link, but instead it broadly applies to models with any link functions; and (3) it can capture non-linear association and has potential to detect dependence of any complex structures. Our measure can be complemented by visualization methods, such as partial regression plots and P-P plots, which were otherwise unavailable for ordinal data. Simulated and real examples demonstrate that our numerical and graphical assessment can reveal microstructure of partial association, which can give us deeper insights into the association of interest.*

**Keyword**: Analytics, Data Mining and Applied Statistics, Qualitative & Quantitative Methods, Visualization

1. **Bio**

Dungang Liu is Assistant Professor of Statistics and Business Analytics at the University of Cincinnati Lindner College of Business. Prior to joining the College, Dr. Liu obtained his Ph.D. degree in statistics from Rutgers University and then had two-year postdoctoral experience in biostatistics at Yale University. Dr. Liu's research interests include meta-analysis and discrete data analysis. His research outcomes have been published in leading statistical journals, such as the Journal of American Statistical Association. Driven by his strong interest in statistical applications in business and industry, Dr. Liu has been actively involved in consulting projects for healthcare, aviation, and insurance companies.

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| **Abstract-11**  1510-1530 | Influence Modeling: Mathematical Programming Representations of Persuasion under Either Risk or Uncertainty William N. Caballero (Air Force Institute of Technology)  Brian J. Lunday (Air Force Institute of Technology) |

1. **Abstract**:

*We define a new class of decision analysis problems for modelling persuasion. Utilizing Cumulative Prospect Theory, we transform this model from a bilevel to a single level mathematical programming formulation, adaptable to conditions of risk or uncertainty. These generalized models allow for the malleability of prospects as well as Cumulative Prospect Theory parameters through persuasion update functions. We detail the literature that supports the quantification of such effects which, in turn, establishes that such update functions can be realized. Finally, the efficacy of the model is illustrated through three use cases under varying conditions of risk or uncertainty.*

**Keyword**: Decision Analysis; Optimization; Economics

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| **Abstract-12**  1530-1550 | Female STEM Student Mentoring Program Emily Kloos (University of Dayton)  Dr. Sandra Furterer (University of Dayton) |

1. **Abstract**:

*Many female STEM students struggle during their first and second years of college. It has been shown that mentoring programs can help encourage women to stay in STEM and we want to create a program at University of Dayton to retain more female STEM students. This program will be able to provide mentorship throughout their college career as well as support them for a career in STEM. A pilot program will be created this semester and analyzed using the Six Sigma DMAIC method to measure results and come up with program improvements for the next group of mentors and mentees.*

**Keyword**: Pedagogy, Student Projects

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| **Abstract-13**  1550-1610 | Optimizing Aircraft Non-Availability Resourcing to Enable Cost-EffectiveReadiness Dr. Greg Gehret (AFLCMC/OZA)  Mary Godby (AFSC/LGSA)  Danielle Beckham (AFMC/A9A)  Jeremy Brogdon (HQ AFMC/A9A) |

1. **Abstract**:

*The three words, “cost-effective readiness”, are simple, straightforward, and very intuitive to members of and supporters of the Department of Defense. However, modeling and quantifying Cost-Effective Readiness (CER) is not trivial. In an attempt to advance CER, we are developing a mathematical optimization approach to maximize Aircraft Availability (AA) in a cost effective manner. In the Air Force, each major fleet has a targeted AA standard; thus, a complementary ‘target’ also exists for non-availability (i.e. 1-AA). There are five discrete areas of non-availability: Depot Possessed (DP), Non Mission Capable Supply (NMCS), Non Mission Capable Maintenance (NMCM), Non Mission Capable Both (NMCB), and Unit Possessed Not Reported (UPNR). Each of these non-availability areas drives/requires management decisions on resources/costs such as spare parts, maintainers, facilities, utilities, etc. Our model will optimize across areas of AA, constrained by common financial resources, to advance AF planning beyond sub-optimization within a single area of AA. This paper discusses our current optimization modeling methodology which includes previous lessons learned on a B-1 case study and applies an advanced optimization model on the fleet of KC-135 Tankers and additional fleets.*