1 - Predicting the Risk of Critical Events in ALS Disease Using Data Analytics

Ozden Onur Dalgic, Harvard Medical School, Boston, MA, United States, Osman Ozaltin, F. Safa Erenay, Kalyan Pasupathy, Mustafa Y. Sir, Brian Crum

ALS is a neuro-degenerative disease causing continuous decay of motor neurons and muscle atrophy. Patients suffer from losing their abilities to speak, eat, move and breath. Due to having no permanent treatment, ALS eventually affects all abilities in a large size imbalanced data. We develop a natural history model to predict the risk of critical events (e.g., using wheelchair) over the course of the disease.

2 - Using Partially Observable Markov Decision Processes to Improve阿尔茨海默病的诊断

Saiedeh Mirghorbani, University of Alabama, Tuscaloosa, AL, 35401, United States, Sharif Melouk, John Mintenthal

Family history, genetics, Down syndrome, head injury, high cholesterol levels, high blood pressure, and diabetes are some of the factors that place individuals at a higher risk of developing Alzheimer’s disease (AD). To manage this risk and its complications, persons more susceptible to AD should be regularly screened. To determine an optimal screening plan, we develop a finite horizon, partially observable Markov decision process model for individuals transitioning through different stages of AD. The model aims to maximize the Quality Adjusted Life Years (QALY) for an individual.

3 - The Role of Big Data in System Dynamics Modeling

Hamed Kianmehr, Binghamton University, Binghamton, NY, 13905, United States, Nasim S. Sabourouch, Lina Begdache

Our objective in this research is to use big data techniques to enhance system dynamics (SD) modeling regarding the relationship between diet and mental health. We apply our approach to study the relationship between diet and mental health. We estimate the parameters of the system dynamics model by applying some novel big data techniques on a large data set. Then, we feed the calibration parameters in SD models with the new estimations using big data analytics. Big data techniques and SD models can contribute to investigating the causal relationships between nutrition and mental health. The future achievement will enable big data analytics to assist other modeling techniques in the healthcare domain.

4 - Developing Predictive Models for Parkinson’s Disease by Analyzing an Imbalanced Dataset

Saeed Piri, University of Oregon, 443 Lillis Business Complex, Eugene, OR, 97403, United States

Parkinson’s disease (PD) is a neurodegenerative disorder that affects about one million Americans. In this study, we develop diagnostic models, which use only demographic, lab, and clinical events data. To develop these models, we analyzed a large size imbalanced data. To enhance our models’ accuracy, we applied synthetic informative minority oversampling (SIMO) algorithm and extended it to machine learning techniques such as decision tree, logistic regression, and neural network. Finally, we developed an ensemble model by applying confidence margin ensemble approach.

HEALTH APPLICATIONS
INFORMS Phoenix – 2018

SA60
West Bldg 102B
Joint Session HAS/Practice Curated: Data and Models in Healthcare Analytics
Sponsored: Health Applications
Sponsored Session
Chair: Joel Goh, NUS Business School, 119245, Singapore
Co-Chair: Shasha Han, National University of Singapore, National University of Singapore, Singapore, Singapore

1 - The Analytics of Bed Shortages: Coherent Metric, Prediction and Optimization
Jingui Xie, University of Science and Technology of China, School of Management, 96 Jinzhai Road, Hefei, 230026, China, Gar Gowy Loke, Melvyn Sim, Shao Wei Lam
In practice, healthcare managers often use bed occupancy rates (BOR) as a metric to understand bed utilization, which is insufficient in capturing the risk of bed shortages. Based on the riskiness index of Aumann and Serrano (2008), we propose the entropic bed shortage metric, which captures the facets of bed shortage risk than traditional metrics such as the occupancy rate, the probability of shortages and expected shortages. We also propose optimization models to control the risk of bed shortages and plan for bed capacity via this metric. These models have linear program reformulations which can be solved efficiently on a large scale.

SB57
West Bldg 101B
Joint Session HAS/Practice Curated: Experiments in Health Care Operations
Sponsored: Health Applications
Sponsored Session
Chair: Hummy Song, Philadelphia, PA, 19104, United States

1 - The Effects of Occupancy Information Hurdles and Physician Admission Decision Noise on Hospital Unit Utilization
Song-Hee Kim, University of Southern California, Los Angeles, CA, United States, Jordan D. Tong, Carol Peden
Hospital units usually have high demand that exceeds their capacity, requiring physicians to make admission decisions. Under reasonable conditions, the optimal admission policy should depend on the arriving patient’s severity and the occupancy upon a patient’s arrival. In practice, the occupancy is not always readily accessible and there may exist occupancy information hurdles. We recruit physicians and MTurk workers to study how occupancy information hurdles may systematically affect admission decision behavior. We also examine how random error (in the policy selection and policy execution) may drive predictable biases of over- or under-occupied units depending on the system parameters.

2 - Priority & Predictability: The Differential Effects of Emergent and Scheduled Hospital Admissions
Jillian Berry Jacker, Boston University, 595 Commonwealth Avenue, Room 657A, Boston, MA, 02215, United States
Using experimental and patient-level data, this study focuses on the impact of incoming patient admission type (scheduled or emergent) on the probability of admission and LOS, and the moderating effect of high workload. We also provide a counterfactual analysis of the possible savings achieved through higher predictability in demand.

3 - Shared Medical Appointments – An Innovative Approach to Healthcare Delivery
Nazli Sonmez, London Business School, Regent’s Park, London, NW1 3SN, United Kingdom, Kamalini Ramdas, Ryan W. Buell
We examine shared medical appointments (SMAs) as a substitute for regular one-on-one appointments. Under this innovative approach, a group of patients with similar chronic conditions meet with a doctor simultaneously. We conduct a randomized controlled trial at the Aravind Eye Hospital’s Glaucoma Clinic, in Pondicherry, India to assess the effectiveness of shared medical appointments versus traditional one-on-one appointments for glaucoma. Preliminary results obtained with the data suggest that the knowledge and satisfaction level of patients who attend shared medical appointments is significantly higher than that of patients who attend one-on-one appointments.

4 - Optimal Newborn Screening Algorithm for Cystic Fibrosis
Seyedehsahaloumeh Sadeghzadeh, Virginia Institute of Technology Blacksburg, VA, 24060, United States, Hussein El Hajj, Ebroul Korular Bish, Douglas R. Bish
Cystic fibrosis (CF) is one of the most prevalent genetic disorders in the United States. Newborn screening for CF allows for early diagnosis, and can improve health outcomes, whereas a delayed diagnosis may result in severe symptoms or fatality. All 50 states of the United States perform newborn screening for CF, starting with a bio-marker test, followed by a genetic test for newborns with elevated bio-marker levels. We develop a stochastic optimization model to determine an optimal bio-marker threshold and set of CF mutations to be tested, in order to minimize the expected misclassification cost. Our case study shows that the optimal combination can substantially reduce the misclassification cost.

3 - Frustration-based Promotions: Field Experiments in Ride Sharing
Back Jung Kim, NYU Stern, 40 West 4th Street, Tisch Hall, New York, NY, 10012, United States, Michael-David Fiszer, Maxime Cohen
In this talk, we examine whether a firm should proactively send compensation to users who have experienced a frustration (i.e., a poor service quality). In collaboration with one of the leading ride-sharing platforms, Via, we designed and ran three field experiments to investigate how different compensation types affect the engagement of riders who experienced a frustration.

4 - A Dynamic Clustering Approach to Data-Driven Assortment Personalization
Sajad Modaresi, UNC Chapel Hill, Kenan-Flagler Business School, Chapel Hill, NC, 27514, United States, Fernando Bernstein, Denis Saure
A retailer faces heterogeneous customers with initially unknown preferences. The retailer can personalize assortment offerings based on available profile information; however, users with different profiles may have similar preferences, suggesting that the retailer can benefit from pooling information. We propose a dynamic clustering policy that adaptively adjusts customer segments and personalizes the assortment offerings. We test the policy’s performance using a dataset from a Chilean retailer.

5 - Shipping Consolidation Across Two Warehouses with Delivery Deadline and Expedited Options for E-commerce and Omni-channel Retailers
Lai Wei, University of Michigan, Ann Arbor, MI, United States, Stefanus Jasin, Roman Kapuscinski
Shipment consolidation is commonly used to avoid some of the shipping costs. However, when pending current orders are consolidated with future orders it may require more expensive expedited shipment to meet shorter deadlines. In this paper, we study the optimal consolidation policy focusing on the trade-off between economies of scale and expedited shipping cost. The optimal policies and their structures are characterized, where the impact of expedited shipment on both shipping policy and order fulfillment policy are explored. Two easily implementable heuristics are proposed, which perform within 1-2% of the optimal in intensive numerical tests.

6 - Inconvenience, Liquidity Constraints and the Adoption of Off-Grid Lighting Solutions
Bhavani Shanker Uppari, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, Serguei Netessine, Ioana Popescu, Rowan Clarke
One-fifth of humankind living in poverty does not have access to electricity. An off-grid lighting model that is becoming prominent in impoverished countries is rechargeable bulb technology. We examine, both theoretically and empirically, the impact of liquidity constraints and recharge inconvenience on the usage of rechargeable bulbs. Our analysis has implications for both firm-level operational decisions and government-level policy decisions.

SB59
West Bldg 102A
Joint Session HAS/Practice Curated: HIV Prevention, Testing, and Treatment
Sponsored: Health Applications
Sponsored Session
Chair: Pooyan Kazemian, Harvard Medical School, Boston, MA, 02114, United States

1 - Optimal Scale-up of HIV Treatment Programs in Resource-limited Settings Under Supply Uncertainty
Sameer Meltia, PhD Student, UT Dallas, TX, United States, Sarang Din, Charles J. Cortez
In this paper, we study the challenge of scaling-up HIV treatment programs faced by clinics in sub-Saharan Africa. The key trade-off underlying this allocation is between the marginal health benefit obtained by initiating an untreated patient on treatment and that obtained by avoiding treatment interruption of a treated patient. We cast the clinic’s problem as a stochastic dynamic program and provide a partial characterization of the optimal policy, which consists of dynamic prioritization of patient segments and is characterized by state-dependent thresholds.
2 - Treatment Optimization of Using Darunavir Versus Lopinavir in a Resource Limited Setting with an Unknown Price Ceiling
Jennifer Campbell, Clinton Health Access Initiative, P.O. Box 51071 Ridgeway, Lusaka, Zambia, Marta Prescott, Paul Domanico
The analysis quantifies the value of second-line HIV drugs in complex market settings by addressing treatment sequencing, clinical efficiencies, programmatic heterogeneity and nuanced market paradigms in resource limited countries. The model estimates patient outcomes linked to probabilities of transitioning to different HIV treatment and health states in the medium and long term. The model uses country and region-specific data and clinical outcomes from published sources. Costs and impact, including secondary infections, are included. This work is shared with Ministries of Health and helps set treatment policy priorities, clinical trainings, and procurement for second line treatment.

3 - The Cost-effectiveness of HIV Pre-exposure Prophylaxis (PrEP) in High-risk Groups in India
Pooyan Kazemian, Harvard Medical School, 100 Cambridge St, 1695, Boston, MA, 02114, United States, Sydney Costantini, A. David Paliil, Kenneth A. Freedberg
We leveraged a detailed microsimulation model of HIV prevention and treatment to evaluate the cost-effectiveness of HIV pre-exposure prophylaxis (PrEP) and regular HIV testing for two high-risk groups in India: adult men who have sex with men (MSM) and people who inject drugs (PWID). We conducted sensitivity analyses on multiple parameters related to PrEP and assessed different HIV testing frequencies. Results suggest that a PrEP strategy targeted to these high-risk groups can be cost-effective in India.

4 - Surveillance and Control in Networked Disease Dynamics with Individual Response
Ceyhun Eskin, Assistant Professor, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States
Disease spread is a complex system in which the outcome of intervention policies depends on the disease state, network structure and individual behavior. We consider the viewpoint of a policy-maker that aims to minimize the spread of an infectious disease under budget constraints and unknown disease severity. Daily, the policy-maker decides to spend its funds on information collection or on targeted campaigns that change individual behavior. We characterize optimal policies based on the accuracy of the disease estimate and time horizon for simple networks such as a line, star, and ring. Based on these optimal policies, we design an algorithm that approximates the solution in arbitrary networks.

West Bldg 102C
Joint Session HAS/DM/Practice Curated: Predictive Analytics in Clinical Settings
Sponsored: Health Applications
Sponsored Session
Chair: M. Samie Tootooni, Mayo Clinic, Rochester, MN, 55906
1 - Outcome-Driven Personalized Treatment Design for Managing Diabetes
Eva Lee, Georgia Tech, Industrial & Systems Engineering, Ctr for Operations Research in Medicine, Atlanta, GA, 30332-0205, United States
This work is joint with Grady Health Systems and Morehouse School of Medicine. Diabetes affects 422 million people globally, costing over $825 billion per year. In the United States, about 30.3 million live with the illness. Current diabetes management focuses on close monitoring of a patient’s blood glucose level, while the clinician experiments with dosing strategy based on clinical guidelines and his/her own experience. In this work, we describe a model for designing a personalized treatment plan tailored specifically to the patient’s unique dose-effect characteristics. Such a plan is more effective and efficient for both treatment outcome and treatment cost than current trial-and-error approaches. Implementation results will be discussed.

2 - A Machine Learning Based Personalized Intervention Model to Reduce COPD Readmissions
Sujeec Lee, University of Wisconsin-Madison, 402 N. Eau Claire Avenue, Unit 302, Madison, WI, 53705-2820, United States, Philip A. Bain, Jo Golfni-net, Christie Baker, Jingshin Li
In this talk, we introduce a machine learning based personalized intervention model to reduce COPD readmissions. Specifically, a machine learning predictive model is trained to predict the readmission risk of a COPD patient based on his/her status at discharge. Using this model, the impact of potential intervention policies is analyzed. Then, the predictive health systems in the medium and long term. The model uses country and region-specific data and clinical outcomes from published sources. Costs and impact, including secondary infections, are included. This work is shared with Ministries of Health and helps set treatment policy priorities, clinical trainings, and procurement for second line treatment.

3 - Mapping Free Text Chief Complaints using an Adaptive Natural Language Processing Approach
Mohammad Samie Tootooni, PhD, Mayo Clinic, Rochester, MN, 55906, United States, Mustafa Y. Sir, Kalyan Pasupathy, Heather Heaton, Casey Clements
We provide a comprehensive structure list to categorize the [free-text] chief complaints. We also develop a heuristic algorithm, equipped with an iterative enhancement procedure to map the recorded chief complaints into the structured list. The data includes all chief complaints recorded at the emergency department of Mayo Clinic in Rochester, MN in 2016 and 2017. Using a bi-level validation process a total sensitivity of 94.2% with specificity of 99.8% and F-score of 94.7% are obtained. The result is reported individually for each main syndrome group as well. In conclusion, the proposed mapping can help the field’s researchers to incorporate the chief complaints into their models.

West Bldg 102A
Joint Session HAS/Practice Curated: Stochastic models of Hospital Admission and Discharge Services
Sponsored: Health Applications
Sponsored Session
Chair: Non Kong, Purdue University, West Lafayette, IN, 47906-2032, United States
Co-Chair: Michelle M. Alvarezado, University of Florida, Gainesville, FL, 32611-6595, United States
1 - Stochastic Models for Inpatient Discharge Planning
Maryam Khatami, Texas A&M University, College Station, TX, USA; Michelle M. Alvarezado, Non Kong, Pratik J. Parikh, A. Mark Lawley
The inpatient discharge planning problem requires the efficient assignment and sequencing of readier-for-discharge patients to resources. Delay in discharge processes deteriorates patient satisfaction and increases hospital costs. We model and solve the inpatient discharge planning problem as a two-stage stochastic program with uncertain inpatient discharge processing time and bed request times. The objective is to minimize patient dissatisfaction, discharge lateness, and patient boarding. We derive managerial insights by comparing the results of a two-stage stochastic program, the mean value problem, and two heuristics from current practice using simulation modeling.

2 - Missed Opportunities in Preventing Hospital Readmissions: Redesigning Post-discharge Checkup Pricolice
Xiang Liu, University of Michigan, Ann Arbor, MI, United States, Mariel Lavieri, Jonathan Helin, Ted Skolarus
Hospital readmissions affect hundreds of thousands of patients, placing a tremendous burden on the healthcare system. Post-discharge checkup can reduce readmissions through early detection of conditions. Our work develops optimal checkup plans to monitor patients following hospital discharge using methods including phone calls and office visits. By analyzing the structure of optimal policies, we develop checkup schedules that mitigate 32% more readmissions.

3 - Improving Discharge Process at a University Hospital: A System-theoretic Method
Xiaolei Xie, Tsinghua University, 614 Shunde Building, Beijing, 100084, China, Nan Chen, Zexian Zeng, Xiang Zhong, Maria Brenny-Fitzpatrick, Barbara A. Liegel, Li Zheng, Jingshin Li
This paper introduces a systems-theoretic approach to improve inpatient discharge process at a university hospital. The complex hospital discharge process is modeled by a stochastic process with parallel sub-processes, splits, and merges. A system analysis method is introduced to approximate the discharge time and evaluate the mean, variability, and discharge-time performance. It is shown such a method results in a high accuracy in performance evaluation. To improve the discharge process at the university hospital, bottleneck and what-if analyses are carried out and improvement recommendations are discussed.

4 - Admission Planning Problem with Stochastic Length of Stay
Jorge Vera, Universidad Catolica de Chile, Dept. Industrial and System Engineering, Santiago, 7820436, Chile, Ana Celeste Batista, David Pozo
Effective admission planning process can improve inpatient throughput and waiting times. The uncertain in the patient’s length of stay complex the admission process and may cause bottlenecks and long waiting times in the patient’s flow. We study the admission planning problem considering uncertain in the length of stay. Classically length-of-stay is modeled as a sum over a time window constraint. This makes it very complex to consider uncertainty on this variable. In this work, we developed a new formulation in which the length of stay is on the right hand of the constraint by employing a single binary variable.
How individuals manage their tasks is central to operations. Recent research focuses on how increasing workload individuals can increase service time. As the number of tasks increases workers may also manage their workload by a different process - task selection. We theorize and test that under conditions of increased workload individuals may choose to complete easier tasks to manage their load. We label this behavior Task Completion Bias (TCB). Using 2 years of data from an emergency department we find support for TCB and show it improves short-term productivity. However, we find that an overreliance on this task selection strategy hurts performance in the long run.

2 - Heuristic Thinking in Patient Care
Diwas S. KC, Emory University, 1300 Clifton Road, Goizueta Business School, Atlanta, GA, 30322, United States
This paper studies heuristic thinking and cognitive bias using a natural experiment from the field. The setting for the study is a set of acute care hospitals, where we examine the care process and discharge decisions for individual patients. Determining a patient’s suitability for discharge is cognitively taxing, calling for the decision maker to draw on up-to-date clinical expertise and detailed information. We postulate that bounded rationality in decision making leads the care provider to substitute clinical readiness for discharge - a more cognitively complex attribute, with a more easily accessible heuristic.

3 - Recovering from Distress: The Impact of Critical Incidents on Operational Performance
Jonas Oddur Jonasson, Assistant Professor, MIT Sloan School of Management, 30 Memorial Drive, E62-588, Cambridge, MA, 02142, United States, Hessim Bavafa
In service operations settings, where the difficulty of jobs can be unpredictable, workers sometimes encounter critical incidents (CIs) — tasks or situations which are previously ignored aspects of compliance with hand-hygiene regulations in a hospital context of ambulance services we find that encountering a CI negatively affects subsequent operational performance. The effect is strong for patient-pickup (a complex, non-standardized task) and weaker for patient handover to the hospital (a more standardized task).

4 - Timeliness and Compliance with Standard Operating Procedures
Reidar Hagvedt, University of Alberta School of Business, 2-43 Business Bldg, Edmonton, AB, T6G 2R6, Canada, Kenneth L. Schultz, Trish Reay, Sarah Forgie
Compliance with standard operating procedures when looking ahead, or in the very short term, is notoriously difficult to measure. In this paper, we examine two previously ignored aspects of compliance with hand-hygiene regulations in a hospital setting. First, we allow teleological cues to prompt hand-hygiene by re-coding the time of the cue forward. Second, we examine the time immediately after a disruption, to see if a reduction in hand-hygiene is measurable. We use data from a tertiary Canadian teaching hospital.

1 - Task Selection and Workload
Bradley R. Staats, University of North Carolina at Chapel Hill, Campus Box 3490, McColl 4720, Chapel Hill, NC, 27599-3490, United States, Diwas S. KC

2 - Cost-effectiveness and Decision Analysis of Genetic Testing in Cholesterol Treatment Planning
Wesley J. Marrero, University of Michigan, Ann Arbor, MI, United States, Mariel Sofia Lavieri, Rodney A. Hayward, Suzanne C. Butler, Amit Khera, Sekar Kathiresan, James Burke, Jeremy B. Sussman
We present a simulation-based framework to estimate the risk of heart attacks due to clinical and genetic factors. Additionally, we develop cholestrol treatment plans using risk thresholds (current practice) and a Markov decision process (MDP). By simulating the health status of patients, we determined the cost-effectiveness of genetic testing to guide cholesterol treatment.

3 - Statin Initiation Decision Modeling for Prediabetes Patients
Shengfan Zhang, University of Arkansas, 4207 Bell Engineering Center, Department of Industrial Engineering, Fayetteville, AR, 72701, United States, Muhenned Abdulshlib
While there is much research on statin initiation policies on prevention of heart disease for diabetes, studies on statin initiation policies for prediabetic patients are limited. The goal of this research is to examine the risk of heart disease and risk of diabetes on the decision of statin therapy for prediabetes patients. We develop an optimal statin initiation policy to meet both the need to control cholesterol levels and the need to minimize the risk of diabetes, which will provide insights for future treatment guidelines for prediabetes.

4 - Modeling Comprehensive Medication Reviews for Complex Patients in Community Pharmacies
Kathryn N. Smith, North Carolina State University, Raleigh, NC, 27606, United States, Julie Simmons Ivy, Anita Vila-Parish
Adherence to long-term medication therapies is approximately 50% in developed countries. Patient and provider engagement has been found to be a contributor to improved adherence. One enhanced service aimed at engaging patients is a comprehensive medication review (CMR) provided by pharmacists. CMRs allow a pharmacist to identify drug therapy problems that may be interfering with adherence. In order to incorporate CMRs into the workflow, pharmacies must streamline the CMR process and prioritize complex patients. We developed a simulation model and a dynamic programming model to analyze the integration of the operational and clinical workflows and determine how to prioritize patients.
3 - Calling for Care? The Risky Proposition of Teletriage for Healthcare Demand Management
Ozden Engin Cakici, American University, Washington, DC, United States, Alex Mills
We investigate the effect of adding teletriage to a healthcare system with traditional or open access primary care and an Emergency Department (ED). Using a partially observable Markov decision process model, we find that while teletriage would benefit patients, it could be costly for the payer and even increase ED usage. We conclude by providing conditions under which teletriage would be beneficial.

4 - Dynamic Personalized Patient Classification via Learning Progression in Chronic Diseases: Application to Glaucoma
Esmaeil Keyvanshokooh, University of Michigan, Ann Arbor, Ann Arbor, MI, 48108-1020, United States, Mark P. Van Oyen, Joshua Stein, Mariel Sofia Lavieri, Chris Andrews
We design a dynamic and personalized classification method for classifying a patient with Glaucoma at each visit as either a “fast” or “controlled” progressor. “Fast” refers to relatively rapid deterioration with respect to visual field mean deviation. To this aim, we combine a random forest algorithm with a classification method. We also develop online learning methods to help manage a patient’s progression.

TB59
West Bidg 102A
Joint Session HAS/Practice Curated: Applications of Decision-Making Models in Healthcare
Sponsored: Health Applications
Sponsored Session
Chair: Alireza Boloor, Arizona State University, Tempe, AZ, 85283, United States
1 - Bias in Sensitivity Analysis of Comparative Analyses for Medical Decision Making
Michael J. Hintlian, University of Southern California, 1029 South Westmoreland Avenue, #102, Los Angeles, CA, 90006, United States, Julia L. Higle
Comparative analyses for MD M are undertaken examine the cost/benefit impact of various treatment alternatives. These impacts are estimated via model-based analyses after which sensitivity to model parameters is examined. We illustrate the existence of bias in the sensitivity analysis that results from the methods used to select model parameters. We discuss methods for mitigating this bias.

2 - Optimal Genetic Testing Schemes for Cystic Fibrosis
Hussein El Hajj, Virginia Tech, Blacksburg, VA, United States, Ebru Korular Bish, Douglas R. Bish
Cystic fibrosis (CF) is a highly prevalent life-threatening genetic disorder, but early diagnosis can save lives and reduce healthcare expenditures. To date, over 3000 CF-causing mutations are identified, and all 50 states conduct newborn screening for CF, typically starting with a bio-marker test, followed by genetic testing on selected mutations for newborns with elevated bio-marker levels. We develop a stochastic optimization model to determine an optimal genetic testing scheme for CF that minimizes the probability of misclassification under a testing budget. Our case study for California shows that the optimal scheme can substantially reduce misclassification over current practices.

3 - Incentive-Driven Readmission Management with Patients Facing Compliance Barriers
Aditya Mahadev Prakash, University of Florida, Gainesville, FL, 32608, United States, Qiaoche He, Xiang Zhong
We aim to quantify the impact of non-compliance of patients on their post-acute care management, and assist healthcare stakeholders in improving the overall well-being of patients through the most efficient and effective allocation of resources. We establish a game-theoretic model where patients’ lack of compliance is modeled by incorporating their heterogeneous and bounded rationality in the context of a congested service system. The optimal structure of subsidies that can monetarily incentivize patients and result in a minimum overall cost for an insurer is developed. The insights obtained from this study would support clinical and operational decision-making by healthcare practitioners.

4 - Impact of Physician’s Ambiguity on Management of Medications
Alireza Boloor, Arizona State University, Tempe, AZ, 85283, United States, Soroursh Saghaflan, Harini A. Chakkeria, Curtiss B. Cook
Patients after organ transplantations receive high amounts of immunosuppressive drugs (e.g., Tacrolimus) to reduce the risk of organ rejection. However, this practice has been shown to increase the risk of New-Onset Diabetes After Transplantation (NODAT). We propose an ambiguous POMDP framework to generate effective medication management strategies for tacrolimus and insulin. Our approach increases the patient’s quality of life while reducing the effect of transition probability estimation errors. We also provide several managerial and medical implications for policy makers and physicians.

TD58
West Bidg 101C
Joint Session HAS/Practice Curated: Decision Analytics and Models for Medical Diagnostics
Sponsored: Health Applications
Sponsored Session
Chair: Chun-An Chou, Northeastern University, Boston, MA, 02115, United States
1 - SD-CNN: A Shallow-Deep CNN for Improved Breast Cancer Diagnosis
Fei Gao, Arizona State University, 886 N. Colfo Center Court, Unit 1017, Phoenix, AZ, 85008, United States, Teresa Wu, Bhavika Patel, Yanze Xu
Deep learning has been widely implemented in practices for imaging based diagnosis. In this research, we first develop a shallow CNN to learn the mapping between low energy digital mammography (LE) and a more advanced breast imaging (recombined image) to tackle the less accessible issue of Contrast Enhanced Digital Mammography for broader clinical uses. A pre-trained deep CNN then takes both LE and “virtual” recombinated image to generate novel features for improved breast cancer diagnosis. Experimental results indicate significant improvement from this proposed Shallow-Deep CNN approach.

2 - Using Logical Analysis of Data as a Tool in Medical Decision Making
Ruilin Ouyang, Northeastern University, Boston, MA, United States, Chun-An Chou
Transparent results (e.g., if symptom A and symptom B, then outcome C) in addition to achieving high accuracy are desirable as a priority goal in building decision tools for medical diagnosis or health care. In our study, we present a logical analysis approach to build a rule-based decision model for Unplanned ICU transfer. We formulate and solve a mixed-integer programming model to generate effective logical rules with maximum margins iteratively, and in turn form a compact rule-based decision model. We also compare our computational results with other state-of-the-art supervised learning methods (logistic regression and decision tree).

3 - Autism Risk Genes Prediction Using Spatiotemporal Gene Expression Data
Ying Lin, University of Houston, Houston, TX, 77204, United States
Autism Spectrum Disorder is a constellation of neurodevelopmental presentations characterized by impairments in social and communication behavior. Finding causal autism genes is challenged by small effect of single gene and the lack of common risk loci. Although recent large exome sequencing studies of autism families have identified ~65 autism risk genes, they represent only a fraction of the estimated genes involved in autism susceptibility. In this study, a gene ranking model is developed based on the identified genes and their brain specific spatiotemporal gene expression and applied to rank more than 25,000 unknown genes. The top ranked genes are potential to enrich the autism risk genes.

4 - The Effect of Indeterminate Findings on the Cost-effectiveness of Lung Cancer Screening
Lakovos Tournazis, Stanford University, Department of Radiology, James H. Clark Center, Room S255, Stanford, CA, 94305-5446, United States, Tsai B. Emily, Ayca Erdogan, Summer Han, Ann Leung, Sylvia Plevritis
The US Preventive Services Task Force recommends lung cancer (LC) screening for high risk individuals, yet the effect of indeterminate findings on the cost-effectiveness of LC screening is not established. We use a microsimulation model to estimate the cost-effectiveness of alternative LC screening strategies for the US general population under alternative levels of dustility associated with indeterminate findings. We find that as the effect of the dustility of indeterminate findings increases, the eligibility criteria for LC screening become more stringent and if large enough then biennial screening is cost-effective whereas, annual screening is cost-ineffective.

5 - Improving Community Paramedicine via Data Science and Optimization: Selective, Proactive Management of ED Patients
Andrew C. Trapp, Worcester Polytechnic Institute, School of Business, 100 Institute Rd., Worcester, MA, 01609, United States, Shima Azizi, Renata Konrad, Sharon A. Johnson, Brenton Faber
Community paramedicine is a recent healthcare innovation that empowers proactive visitation for chronically ill patients, often as follow-up visits shortly after ED discharge. However, we are unaware of any studies that have considered it from the viewpoint of analytics. To that end, we propose to reduce ED costs and increase patient welfare via our data-driven optimization approach. We use real hospital and community data to inform key decisions concerning provision of service, including vehicle and personnel scheduling and routing. We conclude by discussing computational findings.
Joint Session HAS/Practice Curated: OR Applications in Cancer Care

Sponsored: Health Applications
Sponsored Session

Chair: Murat Kurt, Bristol-Myers Squibb, 3401 Princeton Pike, Lawrence Township, NJ, 08648, United States
Co-Chair: Iakovos Tournazis, Stanford University, Stanford, CA, 94305-5446, United States

1. A Generalized Latent Disease Detection Problem with Application to Active Surveillance of Prostate Cancers
Zheng Zhang, University of Michigan, Ann Arbor, MI, United States, Brian T. Denton
We describe a generalized latent disease detection problem with patient-specific risk factors, a customized number of detection strategies for patients, and a general reward function. We formulate an integer programming model that considers patient-to-strategy assignment decisions and the test planning decision for each strategy. We develop a decomposition-based algorithm as a solution method for the model. We also provide insights based on the application of this model to optimize strategies for active surveillance of low-risk prostate cancers.

2. A Markov Decision Process Model to Define the Role of Active Surveillance for Small Renal Masses
Jennifer Mason Lobo, University of Virginia, Charlottesville, VA, United States, Tracey L. Krupski
While the majority of small renal masses (SRMs) are indeed kidney cancer, a considerable proportion are either benign or demonstrate indolent behavior. Recent guidelines recommend active surveillance (AS) over definitive treatment for patients with limited life expectancy. In order to determine precisely which patients should be considered for AS, we developed a Markov decision process model to maximize life years or quality-adjusted life years for SRM patients over a ten year horizon, comparing AS, ablation, and surgical treatments. We present personalized treatment recommendations for patients based on demographics, comorbidities, and mass characteristics.

3. Evaluating the Effectiveness of Supplemental Breast Cancer Screening in Women with High BI-2 Rads Density
Mahboubeh Madadi, Louisiana Tech University, Ruston, LA, 712720029, United States, Sevda Molani
Since the enactment of the breast density notification law, there have been controversial debates over the necessity of this law. The law requires physicians to inform women with heterogeneously or extremely dense breasts of their breast density results, and the potential effect of high breast density on the sensitivity of mammography. In some states, the physicians are required to notify their patients of the possibility of using more sensitive supplemental screening tests. We develop a partially observable Markov model to evaluate the effectiveness of supplemental screening in terms of the expected quality-adjusted life years (QALYs), number of falsenegative detections, and number of biopsies.

4. Personalized Lung Cancer Screening Strategies Using a Partially Observable Markov Decision Process
Iakovos Tournazis, Stanford University, Department of Radiology, James H. Clark Center, Room S255, Stanford, CA, 94305-5446, United States, Oguzhan Alagoz, Ann Leung, Sylvia Plevritis
The US Preventive Services Task Force recommends lung cancer (LC) screening for high-risk individuals aged 55-80 with at least 30 pack-years, and no more than 15 years since smoking cessation. Many other risk factors are associated with LC incidence, yet screening eligibility is solely based on age and smoking history, leading to sub-optimal screening strategies. We propose a partially observable Markov decision process (POMDP) that provides individualized optimal screening strategies for current and former smokers. Decisions are made based on the risk of the individuals accounting for previous screening results and changes in individuals’ smoking behavior.

Joint Session HAS/Practice Curated: Emerging Issues in Treatment Planning and Management

Sponsored: Health Applications
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Chair: Shengfan Zhang, University of Arkansas, Fayetteville, AR, 72701, United States

1. Opioid Overdose and the Role of Comorbidity in US Emergency Departments
Nisha Nataraj, Centers for Disease Control and Prevention, 4770 Buford Highway, MS - F62, Atlanta, GA, 30319, United States, Kun Zhang, Gery Guy, Christina Mikosz
The United States is in the midst of an opioid overdose epidemic with 42,249 opioid overdose-related deaths in 2016. Certain medical comorbidities may increase the risk for opioid overdose. We use regression and variable clustering models on national-level hospital discharge data to identify comorbidities most associated with opioid overdose in patients presenting to emergency departments. Results show that the overall number of comorbid chronic conditions is increasing in this population and that comorbid psychiatric, neurologic, and fluid/electrolyte disorders are especially associated with overdose.

Maryam Aminomhamadi, University of Arkansas, Fayetteville, AR, 72701, United States, Shengfan Zhang, Art Chaovilaiwongse
Emphysema is a chronic lung disease that can be treated with lung volume reduction surgery (LVRS). Despite the advantages of LVRS in specific patients, it has mortality and morbidity risks and costs more than other treatments which makes it crucial to determine the subgroup of patients that can benefit the most from LVRS and assign them to surgery at the best time. To develop an optimization model that maximizes the quality-adjusted life time of the patients, we used Markov Decision Process (MDP) based on the National Emphysema Treatment Trial (NETT), a comprehensive dataset that collected the data of 1218 patients with severe emphysema who were randomized to undergo surgery or have medical treatment.

3. Characterizing the Uncertainty Associated with Treatment Outcomes for Tuberculosis Patients
Shengfan Zhang, University of Arkansas, 4207 Bell Engineering Center, Department of Industrial Engineering, Fayetteville, AR, 72701, United States
The goal of this research is to use data analytics and stochastic modeling approaches to characterize patient recovery pathway from treatment for tuberculosis (TB). This research will use an existing anonymous data that contain information about follow-up test results for TB patients in Moldova upon initiation of treatment. Specifically, we aim to (1) characterize the pattern of recovery as denoted by the smear and culture test results at follow-ups; and (2) predict patient disposition (i.e., recovered to died) based on the recovery pattern.

4. Enhancing Community Resilience to Combat Crisis of Opioid Addiction
MD Noor E. Alam, Assistant Professor, Northeastern University, 334 Snell Engineering Center, 360 Huntington Avenue, Boston, MA 02115, United States, MD Mahmudul Hasan, Gary Young, Alicia Modestino
This study focuses on detecting the variation of opioids prescribing pattern by leveraging the Massachusetts All Payer Claim Data (MA APCD) set. Based on the meaningful insights obtained from the data mining, we will devise a set of optimal policies to improve the community resilience to combat the opioid addiction epidemic.
2 - Development of Immortal Mortality Predictor for Advanced Cancer, a Tool to Predict Short-term Mortality in Hospitalized Advanced Cancer Patients
Junchao Ma, Yale School of Management, New Haven, CT, United States; Edieal J. Pinker, Donald Lee
End-of-life care for advanced cancer patients is aggressive and costly. Although cancer patients rely on oncologists for information about prognosis to make decisions about end-of-life care, physicians tend to over-estimate life expectancy and inconsistently initiate goals of care discussions. We developed and evaluated a novel prognostic tool, which generates life expectancy probabilities in real time using EHR time series to support oncologists in counseling patients about end-of-life care. We will also discuss use of similar decision-support tools to improve quality of care in intensive care units.

3 - Do Hospital Closures Improve the Efficiency and Quality of Other Hospitals?
Lina Song, Harvard University, Soroush Saghafian
We study the impact of hospital closures on the surrounding hospitals' efficiency and the mechanisms through which the changes occur. We also investigate the implications of hospital closures on quality. We do these by examining the efficiency, bed utilization, service duration, patient experience, readmissions, and mortality using a nationally representative panel data of Medicare patients. We find that the closure of a hospital in a market results in improvement in efficiency at the remaining hospitals, but this happens at an expense of reducing the service duration. Furthermore, hospital closures are associated with an increase in 30-day mortality of the surrounding hospitals.

4 - Can Public Reporting Cure Healthcare? The Role of Quality Transparency in Improving Patient-provider Alignment
Soroush Saghafian, Harvard University, Kennedy School of Government, 79 John F. Kennedy Street, Cambridge, MA, 02138, United States; Wallace J. Hopp
Public reporting of medical treatment outcomes is being widely adopted by policymakers in an effort to increase quality transparency and improve alignment between patient choices and provider capabilities. We examine the soundness of this approach by studying the effects of quality transparency on patient choices, hospital investments, societal outcomes (e.g., patients' social welfare and inequality), and the healthcare market structure (e.g., medical or geographical specialization). Our results offer insights into why previous public reporting efforts have been less than fully successful and suggest ways in which future efforts can be more effective.
3 - A Multi-column Generation Approach for Radiation Therapy Treatment Planning
Gazi Md Daud Iqbal, University of Maryland School of Medicine, Baltimore, MD, United States, Jay Michael Rosenberger, Hao Howard Zhang

Both intensity modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT) delivery use multileaf collimator to shape the radiation beam in order to achieve modulation. Column Generation approaches have been proposed to generate these shapes (called apertures) to deliver the radiation therapy treatment. Due to large number of candidate columns (feasible apertures), column-generation-based algorithm is computationally expensive, which affects the achievable solution quality within a clinically acceptable time frame. Instead of adding columns one at a time, this research uses a multi-column generation approach to obtain deliverable apertures for both IMRT and VMAT.

4 - Adjusting for Time Varying Confounding with Multiple Treatment Variables
Aera Leboulluec, University of Texas-Arlington, Arlington, TX, 76013, United States, Nilabh Ohol, Victoria C. P. Chen, Jay Michael Rosenberger

Time varying confounding plays a critical role in longitudinal studies. In medical research, estimating an effect of treatment on an outcome of interest is biased due to presence of time varying confounders. This bias results in inconsistent treatment estimates. Most of literature on handling time varying confounding demonstrates the implementation of methods such as inverse probability of treatment weighting to estimate consistent estimates of a single treatment. This presentation extends this approach to multiple treatments and considers both uncorrelated and correlated treatments.