Cover Sheet for 2018 UFII-CTSI Pilot Project Award Application
(Advanced Data Integration and Analytics for Translational Health Research)

Project Title	Development of a FHIR-compliant data integration hub for real-time risk prediction in Intra-Operative period

Please select the thematic area in which you are applying:

☒ Precision medicine ☐ Precision public health

Please indicate whether you have been the PI on a previous UFII or CTSI Pilot Project Award:

UFII Pilot: ☐ No ☒ Yes CTSI Pilot: ☒ No ☐ Yes

Full Name of PI	Azra Bihorac, MD MS
Position/Title	R. Glenn Davis Professor of Medicine
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Total Amount of Funding Requested	$42,042
Start/End Date	April 2, 2018 / April 1, 2019

Co-Investigator	Mohcine Madkour, PhD[1]; Tezcan Ozrazgat-Baslanti, PhD[2]; Xiaolin Andy Li, PhD[3]; Parisa Rashidi, PhD[4]
College/Department	[1,2]Department of Medicine, College of Medicine; [3]College of Engineering/ Department of Electrical and Computer Engineering; [4]College of Engineering/ J. Crayton Pruitt Family Department of Biomedical Engineering

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Human Subjects and Proprietary/Privileged Information

Note: For projects requiring IRB approval, applicants should demonstrate they have taken preliminary steps to prepare submissions so minimal time will be lost in securing approvals.

1) Are human subjects involved? ☐ Yes ☒ No
   a) If YES, does this project require IRB approval? Yes No

   If YES,
   Is the IRB's review of your protocol in progress? ☐ Yes ☐ No

   IRB approval date (mm/dd/yyyy): __/__/_____

   IRB project # (if known): _____

   Note: for assistance with determining the need for IRB approval for projects, you may contact Tiffany Pineda, CTSI Research Navigator, at tiffany.danielle@ufl.edu

2) Is proprietary/privileged information included in the application? ☐ Yes ☒ No

Signatures

Principal Investigator:

Azra Bihorac — Azra Bihorac — Date: 26 Feb 2018

Printed Name — Signature

Department Chair (or designee):

Belinda Nacionales for:
Jamie Conti ,MD,FACC
Interim Chair, Dept of Medicine

Printed Name — Signature — Date: 2/26/2018

Application Checklist and Submission

Upload your application to the UFII portal by 5pm on Monday, February 26, 2018: https://informatics.institute.ufl.edu/2017/12/ufii-ctsi-request-for-pilot-project-application/. Applications that do not follow the instructions or are submitted after the deadline will not be reviewed. Contact for questions: UFII-CTSI_Pilot-l@lists.ufl.edu. Please confirm the following documents are included:

Uploaded as a single PDF in the following order (max file size of 2MB):

- ☒ 1. Signed Cover Sheet
- ☒ 2. Abstract, Translational Impact, External Funding Plan, Mentoring Plan
- ☒ 3. Project Proposal/ Research Plan
- ☒ 4. Key Personnel & Biosketches
- ☒ 5. Budget, Justification & Cost Estimates
- ☒ 6. Letters of Support

Uploaded as a separate Excel spreadsheet: ☒ 7. Metadata for Project Dataset(s)

UF Informatics Institute UNIVERSITY of FLORIDA

UF Clinical and Translational Science Institute UNIVERSITY of FLORIDA

2018 UFII-CTSI Pilot Project Award Application
(Advanced Data Integration and Analytics for Translational Health Research)

Formatting Your Application

Applications must be formatted as follows:

- *Number all pages*
- *Use Arial font, size 11, single spaced, left justified*
- *Use ¾" margins and standard 8.5x11 paper*

Abstract (200 words or less)

The past decade of biomedical research has borne witness to rapid growth in data and computational methods. A fundamental challenge for the scientific community in the 21st century is learning how to turn this deluge of data into evidence that can inform decision-making about improving care and preventing risks at the individual level. The emerging field of real-time intraoperative risk assessment is a prime example of a research area with great potential for leveraging modern analytical methods to maximize the impact on individual health. In hospital settings, the integration and interoperation of large amount of data scattered throughout the continuum of perioperative care will help to identify adaptable intraoperative strategies for an individual patient that could offset the risk of a life-threatening complication. IDEALIST, our platform for real-time risk prediction and assessment, use perioperative data in its entirety to enrich the performance of risk predictive modeling for different complications, in all patient perioperative periods. In this project we sought to develop a FHIR-enabled data hub that assist

IDEALIST in real-time risk prediction in the Intra-Operative period. We will develop IDEALIST Commun Data Model (standardized data format) and will use this data model on FHIR to enable risk prediction-as-a-service in our MySurgeryRisk web framework.

Translational Impact (200 words or less)

In the United States, the average American can expect to undergo seven surgical operations during a lifetime, each year at least 150,000 patients die and 1.5 million develop a medical complication within 30 days after surgery. Also, healthcare cost for treatment of critically ill patients requiring intensive care unit (ICU) admission exceeds 80 billion dollars annually. Reducing postoperative complications (PC) by 20% could potentially save thousands of lives and significantly reduce healthcare costs. Current risk prediction methods is limited to prospective risk assessment or calculated scores with modest accuracy and limited usability. The main goals of this project are to utilize data continuously imported into electronic health records to predict the real time risk for a patient to develop a PC. Practitioners could then immediately act upon this information to improve subsequent clinical decision making in the intra-op period. Many researchers suggest that the implementation of early detection and proper intervention, when applied to patients at risk, may reduce postoperative complications, improve patient outcomes and decrease the life-long complications and costs. Our using of FHIR based modeling for enabling real time prediction has been proved reasonably fast with one second total response time per patient prediction.

External Funding (one page or less)

With this pilot study, using FHIR-based data integration and standardization and machine learning techniques and large volumes of clinical data from a retrospective database, we plan to develop and validate real time risk prediction models. These models will predict the risk for a patient to develop post-operative complications. The proposed project has great potential for obtaining external funding in clinical research and intelligent environments, using the models internally validated in this pilot study and then implemented to identify intraoperative strategies in real-time using readily available data in electronic health records. The junior faculties will apply for a K25 Mentored Quantitative Research Development Award in June 2018 with this support, and plans to develop a more comprehensive detection model by enriching the models developed with other possible data sources and modelling techniques. Due to the interdisciplinary nature of our work, we plan to submit multi-PI grants to various organizations, including NIH in June 2018 and PCORI in October 2018.

Mentoring Plan (200 words or less)

Throughout the grant period the co-Is will continue to participate in a well-structured plan developed in close relationship with their mentors Dr. Azra Bihorac and Dr. Andy Li where 80% effort of his time is dedicated to research career activities. The Co-Is have worked together in many projects as part of various grants with the PI. The proposed project will allow the Co-Is to initiate a pilot study that can ultimately result in obtaining external funding and to help the Co-Is to develop their careers. The mentors will assist in this process by identifying career opportunities, helping in writing resulting grants, and helping the Co-Is to develop their current skills and strengths. The mentors and mentees will have frequent informal meetings where the progress of career development and projects will be discussed. In the context of this project, there will also be formal, 1-hour, monthly sessions to discuss the status of the research project. They will also meet formally on a quarterly basis to review publications and

participation in national leadership committees, as well as to discuss career development. Finally, the mentor will help in writing and reviewing future external grants resulting from the proposed study.

Project Proposal/ Research Plan (5 pages or less)

A. Hypotheses & SPECIFIC AIMS

The past decade of biomedical research has borne witness to rapid growth in data and computational methods. A fundamental challenge for the scientific community in the 21st century is learning how to turn this deluge of data into evidence that can inform decision-making about improving care and preventing risks at the individual level. The emerging field of real-time intraoperative risk assessment is a prime example of a research area with great potential for leveraging modern analytical methods to maximize the impact on individual health. In hospital settings, the integration and interoperation of large amount of data scattered throughout the continuum of perioperative care will not only help gain knowledge out of sparse information but also identify adaptable intraoperative strategies for an individual patient that could offset the risk of a life-threatening complication. IDEALIST, our platform for real-time risk prediction and assessment, was among the first to utilize perioperative data in its entirety to enrich the performance of perioperative risk predictive modeling [1]. IDEALIST was from its early design geared towards using an extensive approach for improving real-time surgical risk prediction, for different complications, in all perioperative periods. In this context, the risk in the intraoperative period is very important as it arises from the interactions between a patient's preoperative health and physiologic capacity to withstand surgery-related stress, modulated by the type and quality of surgery and anesthesia that the patient undergoes. These risk factors, in addition, are not linear, nor accumulative, thus by predicting adaptable strategies accounting for timely available clinical event information we can arrive at the safest modality for offsetting the risk for an individual patient. Effective quantifying of intraoperative strategies however, requires real-time observational information on health status and behaviors and ongoing health information of patients as the surgeons and doctors perform surgical procedures. Accurate, timely information for these activities is notably absent from the current healthcare system. Providing real-time data would help surgeons and medical stuff better understand risk surgery dynamics, develop adaptive approaches to prevent risk aggravation, and deliver personalized care when it is most needed. Emerging health information exchange technologies may advance effective care delivery in intraoperative environment. FHIR, or Fast Health Interoperability Resources, is an open source framework envisioned to be a modern approach to data integration and interoperability in healthcare. The FHIR standard is a leap forward in the communication of health data in a way that is consistently formatted and semantically rich. FHIR supports the new concept of CI / CD (continuous integration, continuous deployment) and it leverages a stack of underlying modern web standard technologies such as XML, JSON, HTTP, Atom, OAuth, and REST. The central research activities of this project are (1) to build FHIR-enabled integration capabilities into our IDEALIST system along with the other FHIR aspects of authentication and security, (2) we will develop a common data model that will transform data contained within the EHR system into a common format (data model) as well as a common representation (terminologies, vocabularies, coding schemes), and also an intraoperative database that will persist the deidentified health data associated with intraoperative care period of patients undergoing major surgical procedures, and (3) to develop and validate a suite of robust, real-time statistical prediction models for intraoperative intervention strategies. We propose three specific aims:

Specific Aim 1. Build a FHIR facade for EHR EPIC. We will implement a FHIR façade to EHR system to open up the real time intraoperative data to IDEALIST. We need to bridge the gap between the IDEALIST intraoperative data requirements and FHIR resources, map search parameters and apply authorization based on the OAuth2 token for the patient. We will provide the setup of the solution. We will use Mirth Connect. Mirth Connect is an open source integration engine that has connectors built-in for all major transmission protocols as well as all the major evolving data standards including FHIR.

Specific Aim 2. Develop IDEALIST Common data model and leverage data for individualized prediction We will design an extract, transform, load (ETL) process to map source values from EHR to the appropriate vocabularies used for IDELAIST. We will use Python and Cassandra NoSQL database to implement the ETL. We will clean the data source from EHR and evaluate the quality of data in the ETL process.

Specific Aim 3 Develop and validate a robust, real-time statistical prediction model for intraoperative intervention strategies. We will develop a predictive model that predict in a timely fashion, accurate strategies or procedural intraoperative interventions using IDEALIST training dataset. We will use the IDEALIST Live Platform for the dissemination and evaluation of our predictions.

B. Background and Significance

Electronic health record (EHR) systems have been tremendous investments for hospitals and health systems—some of the biggest Epic implementations range from tens of millions to upwards of a billion dollars . EHRs have changed the way care is delivered and have been proven to have a positive effect on patient safety. They're good at generating, storing, and recalling data, and supporting many clinical workflows. **However**, EHRs are not ideal for real-time care coordination or sharing actionable information in time-sensitive situations. The problem of interoperability of digital systems leads to many challenges in data integration . As a result, the potential that hospital data offers in terms of understanding and improving care is yet to be fully realized.

FHIR is a new and emerging standard being developed under the auspices of the Health Language 7 (HL7) organization and intended to be the next generation of healthcare interoperability. In a recent survey, FHIR and APIs were overwhelmingly seen as the tech with the most transformative potential over the next two years (50 percent of respondents), followed much further down the list by natural language processing (16.1 percent), cloud computing (14.3 percent), machine learning (12.5 percent) and blockchain (1.8 percent). Earlier in 2017, Google announce its commitment to FHIR by partnering with the HL7 FHIR Foundation. The vision of Google Cloud behind this support is to "pave the way for data interoperability in the healthcare ecosystem." In a similar movement, in January 2018, Apple announced they will launch Health Records app with HL7's FHIR specifications at 12 hospitals.

In parallel, with the emerging era of value-based care, there has been a growing interest in quality improvement in EHR-based risk prediction. Such de-facto electronic records allows one to observe more metrics, on more individuals, at more time points, and at a fraction of the cost of prospective cohort studies . One can use the same set of data to predict a wide range of clinical outcomes – something not possible in most cohort studies. In contrast, the current status of prediction modeling reveals an increasingly criticism for the lack of reproducibility of studies. In a systematic review of the actual landscape of risk prediction models based on EHR data, Goldstein et al [2] revealed that over the past 6 years, at least 107 studies have been published creating prediction models using EHR data, with the number of these studies increasing over time. The authors revealed that these models are severely lacking generalizability and transportability assessment. Damen et al [3] provided an overview of prediction models for risk of cardiovascular disease (CVD), considering over 363 different models. The authors found a considerable lack of efforts in tailoring these models to local settings or populations, affirming the necessity for changes regarding CVD risk prediction and a shift in focus from model development to model validation, head-to-head comparison, model improvement, and assessment of modelling impact. Collins et at [4] conducted a systematic review on methodologies of developing risk prediction models for type 2 diabetes using 43 risk prediction models in 39 studies and found that these models, disappointingly, suffer from poor methods in univariate pre-screening of variables (feature selection), categorization of continuous risk predictors and poor handling of missing data. Shariat et at [5] conducted a review of 109 prostate cancer predictive tools that addressed different endpoints, such as disease recurrence, metastasis, and survival and revealed the fact that these models lack in evaluation.

C. Innovation/Potential Impact of Research

Literature review reveals that timely interventions, when applied to patients at risk, may reduce postoperative complications. Examples are numerous, individualized intraoperative blood pressure management, hemodynamic optimization, use of neuraxial anesthesia and volatile agents, glycemic control, non-invasive ventilation, remote ischemic preconditioning , the use of standardized clinical protocols for prevention of AKI and sepsis. IDEALIST sought to develop prediction models to assess surgical complication risks for patients undergoing major surgeries, using EHR data. IDEALIST aims to address some of the problems encountered in previous models such as the challenges inherent to EHR data (e.g. repeated measurements, missing data, loss to follow-up, lack of standardization, etc) and the challenges related with the optimization of the computational analysis of EHR data. In this proposal, we propose to develop a FHIR-enabled data streaming design, and a common data model for EHR data

D. Approach/Research Design

D.1. Specific Aim 1. Build a FHIR facade for EHR EPIC.

Fast Healthcare Interoperability Resources (FHIR) is the new HL7 standard that is intended to address data integration problems and simplify health information exchange from EHR systems. FHIR considers implement-ability as its most fundamental precept. It defines a flexible framework for interoperability, and leverages open source development and common web technologies including HTTP, REST, XML and JSON and simplify healthcare information exchange. FHIR enables a granular way to exchange data by using RESTful style approach. FHIR solutions are built from a set of modular components called “Resources” Data Access Framework (DAF) leverages HL7 FHIR, C-CDA and existing IHE standards to standardize access to Meaningful Use data located in EHR or in other systems of records. FHIR is simple, easy to understand, easy to implement and has wider applicability than all the standards that we had in Healthcare so far for integration and interoperability needs. FHIR is expected to help providers achieve meaningful use in a more efficient manner. FHIR and REST APIs are actually much beyond enabling interoperability; EHR integration saves time by allowing search for information faster, such as searching for specific phenotypic characteristics to identify patients who might be good candidates for a study (medications, demographics, problem lists, physical examination findings, labs, etc.). We will develop the IDEALIST GoFHIR, a fully compliant FHIR server that map EHR elements to FHIR resources. We still use Mirth Connect, a powerful healthcare interoperability engine, which has officially released the FHIR Draft Standard for Trial Use 2 (DSTU2). We will create mirth channels to stream data from the server to the Real Time IDEALIST platform. An Ideal Mirth channel will consist of a FHIR listener connector, a list of filters and transformer rules, and a list of destination connectors as required by the IDEALIST platform. Source connectors will be configured as listening connectors awaiting connections from IDEALIST GoFHIR server, or as polling connectors actively connecting to the server at a specified interval to retrieve messages. Filters will be configured to determine which messages should be accepted and which should be rejected based on a set of rules that will be set. Transformers will be configured to modify incoming messages, or extract data elements from messages and map them to variables. Destination connectors will be configured to connect to IDEALIST database and prediction module connectors for data analysis and persistence.

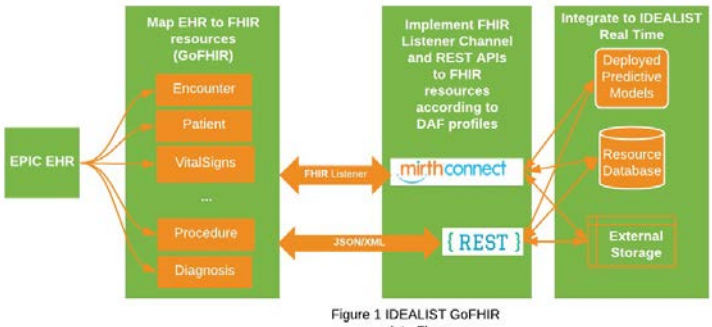

Figure 1 IDEALIST GoFHIR data Flow

D.2. Specific Aim 2. Develop IDEALIST Common data model to leverage data for individualized prediction

The collection of an abundance of real time data from EHR necessitates the use of a common data standard for management and storage of data assets. This data format (data model) will differ in both purpose and design. EHR is aimed at supporting clinical practice at the point of care, while our intention is tailored for predictive modeling and assessing the complex associations between events (e.g. drug exposure, procedures, transitions of care) and risk factors and outcomes. We will design IDEALIST Common Data Model (IDEALIST CDM) as an internal and evolving specification based in structure on the OMOP Common Data Model specifications v5.1. Figure 2 shows the main concepts that will be used in IDEALIST CDM. The Observational Health Data Sciences and Informatics collaborative's (OHDSI), Observational Medical Outcomes Partnership Common Data Model (OMOP CDM) was developed to transform data in disparate databases into a common format and to map EHR data into a standardized vocabulary. The OMOP CDM consists of 37 data tables with predefined conventions for each table. The OMOP CDM focuses strongly on terminology standardization, resulting in use of common standard terminologies such as the Systematized Nomenclature of Medicine (SNOMED-CT), RxNorm, the Current Procedural Terminology (CPT), and the Logical Observation Identifiers Names and Codes (LOINC) for both clinical and demographic facts. The standardized content ensures that research methods can be systematically applied to produce meaningfully comparable and reproducible results.

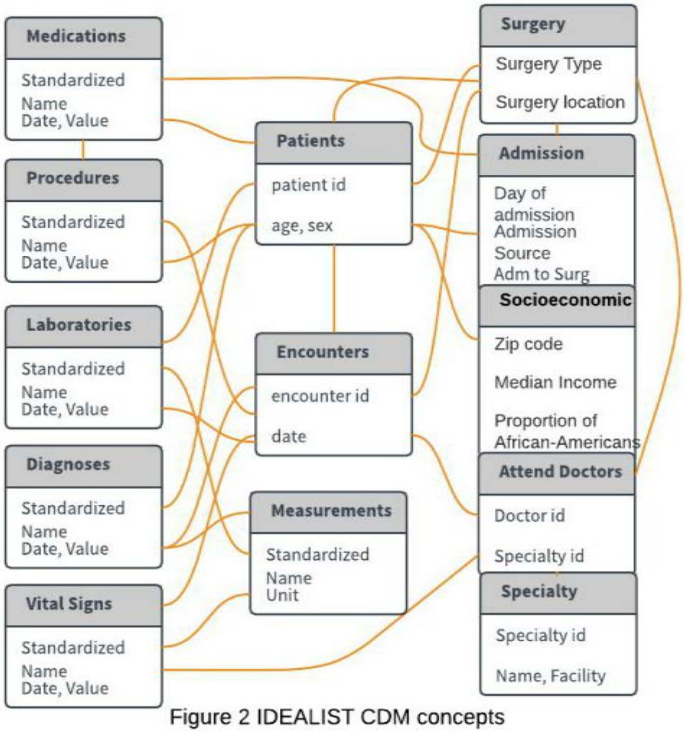

Figure 2 IDEALIST CDM concepts

D.2.3. Standardizing IDEALIST CDM

We will focus our efforts in IDEALIST CDM to enable liquidity of standards-conforming, comparable, and consistent data in order to make the risk prediction models generalizable and reproducible. IDEALIST CDM normalizes the EHR data using the Standardized Vocabularies of Athena Vocabulary, a consistent standard vocabulary adopted by OMOP CDM. Currently, 81 vocabularies are part of the standardized vocabularies. Many of them are adopted from 3rd party sources, which develop and maintain them for specific purposes, such as ICD9CM, ICD10 or SNOMEDCT. OMOP offers a standardized vocabulary by harmonizing disparate coding systems with minimal information loss. OMOP CDM provides a flexible and transparent way in choosing the mapping. We will use Usagi to find correspondent mappings between new concepts in the EHR coding systems and the Vocabulary Standard Concepts. Each Source Concept is mapped to one or more Standard Concepts during the ETL process and both are stored in the corresponding clinical event table. Figure 3 shows a high level overview of the ETL process in which multiple raw EHR data are mapped to their corresponding

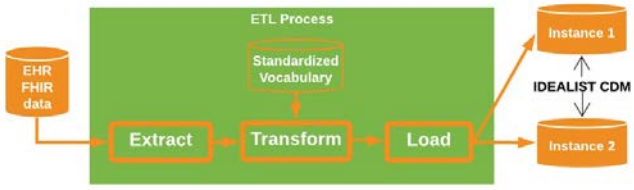

Figure 3 ETL process for data standardization

IDEALIST CDM instances. We will also implement best practices to evaluate the quality of the data in IDEALIST CDM instances

D.3. Specific Aim 3 Develop and validate a robust, real-time statistical prediction model for intraoperative intervention strategies.

The objective in this aim is to detect individual patients that undergo clinical deterioration, by predicting the real-time risk on intraoperative data. The outcome of the prediction is a working strategy that could timely offset the risk of the complication. Our prediction will be disseminated using FHIR standard to streamline predictive model deployment. For implementation we will use an API based predictive modeling service that will be added to our already deployed MySurgeryRisk Interface.

FHIR defines resources represented as JSON or XML objects that can contain health concepts along with reference and searchable parameters. FHIR further defines RESTful API URL patterns for create, read, update, and delete (CRUD) operations. Figure 4 shows how our architecture supports providing real time predictive modeling services to surgeons via the MySurgeryRisk web interface. A prediction request to our GoFHIR server starts by forming the CREATE operation, which is used to request for scoring specific patients in real-time using the deployed risk predictive models. This creates RiskAssessment resources at the server. Client applications then receive a status response with a resource identifier that refers to the newly created resource. Clients can use this resource identifier to read or search the resource database via a FHIR RESTful API. For this example, we used a SEARCH operation as we need to retrieve more than one result. In the end, groups of FHIR resources called bundle are generated from the analyses stored in the resource database and returned to the client interface.

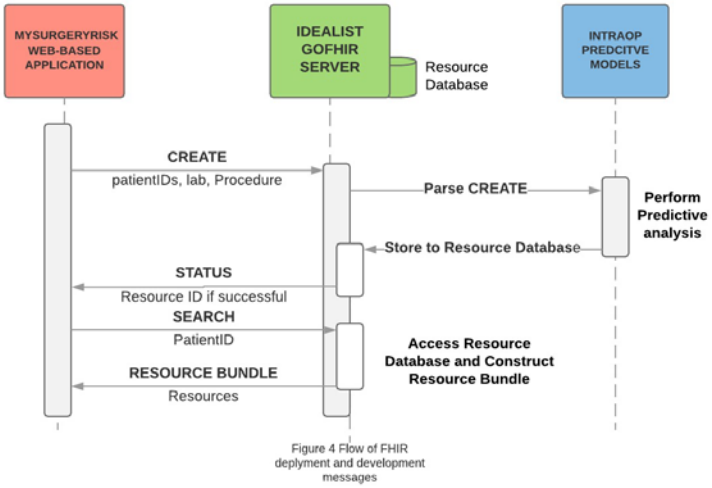

Figure 4 Flow of FHIR deplyment and development messages

References

1. Bihorac A, Ozrazgat-Baslanti T, Ebadi A, Motei A, M Madkour, Pardalos PM, Lipori G, Hogan WR, Efron PA, Moore F, Moldawer LL, Wang DZ, Rashidi P, Li X, Momcilovic A. MySurgeryRisk: Development and Validation of a Machine-Learning Risk Algorithm for Major Complications and Death after Surgery (Annals of Surgery, In press)
2. Huber M, Ozrazgat-Baslanti T, Thottakkara P, Scali S, Bihorac A, Hobson C. Cardiovascular-Specific Mortality and Kidney Disease in Patients Undergoing Vascular Surgery. *JAMA surgery.* 2015:1-10.
3. Hobson CE, Ozrazgat-Baslanti T, Kuxhausen A, et al. Cost and Mortality Associated With Postoperative Acute Kidney Injury. *Annals of surgery.* 2014.
4. Korenkevych D, Ozrazgat-Baslanti T, Thottakkara P, et al. The Pattern of Longitudinal Change in Serum Creatinine and 90-Day Mortality After Major Surgery. *Annals of surgery.* 2015.
5. Ishani A, Nelson D, Clothier B, et al. The magnitude of acute serum creatinine increase after cardiac surgery and the risk of chronic kidney disease, progression of kidney disease, and death. *Archives of internal medicine.* 2011;171(3):226-233.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors. Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Bihorac, Azra

eRA COMMONS USER NAME (credential, e.g., agency login): abihorac

POSITION TITLE: Associate Professor of Medicine, Surgery and Anesthesiology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Sarajevo, School of Medicine	MD	02/1990	Medicine
Brcko County Hospital, Bosnia and Herzegovina		06/1992	Internal Medicine
Marmara University, Istanbul, Turkey		01/1998	Internal Medicine
Marmara University, Istanbul, Turkey		09/1999	Nephrology
University of Florida, Gainesville, FL		06/2001	Nephrology
University of Florida, Gainesville, FL		06/2005	Internal Medicine
University of Florida, Gainesville, FL		06/2006	Critical Care
University of Florida, Gainesville, FL	MS	**05/2011**	Medicine Clinical Investigation

A. Personal Statement

I am an internist, nephrologist and intensivist and my career-long clinical and research interest is in critical care medicine, postoperative complications and in particular acute kidney injury. I also have an abiding interest in complex biological systems, in human - machine interaction and in the use of rapid analytic techniques to optimize the care of the unstable patient in real time. This proposal combines my clinical, research and broader interests and my dedication and experience in team science, precision medicine and bioinformatics. I currently lead large multidisciplinary research partnership group of experts in the field of bioinformatics, predictive modeling and autonomic networks. Our long-term goal is to build upon the unique proximity between the faculties in engineering, computer science and medicine to implement advances in data science and engineering in perioperative, critical care medicine and nephrology. We are developing techniques to use urine and blood for molecular signature of kidney health and sepsis. We are developing machine learning and informatics tool for real-time risk stratification and annotation of sepsis, acute kidney injury and other hospital-acquired complications that would allow management to be tailored to a patients' "personal clinical profile" using clinical and biological data gathered during routine care. We currently run several innovative grant awards, including RO1 and two Informatics Institute Seed Awards. I am also one of the project leaders and a key faculty of the UF Sepsis and Critical Illness Research Center. I have successfully completed a Masters in Clinical Investigation with an emphasis on advanced quantitative research and developed expertise in advanced computational and statistical methods in outcomes research, focused on critical care nephrology that constitutes a large part of my practice in the surgical ICU and nephrology services. I have excelled in the use of machine learning classifiers and predictive model development using techniques like neural networks, support vector machines, decision tree analysis, and Bayesian classifiers. I have led several large clinical trials in AKI biomarkers including the multicenter FDA validation study for the urinary AKI test and have published extensively about the epidemiology and outcomes of perioperative acute kidney injury.

B. Positions and Honors

Positions and Employment

2006-2013	Assistant Professor of Anesthesiology, Surgery and Medicine, University of Florida.
2013-2016	Associate Professor of Anesthesiology, Surgery and Medicine, University of Florida.
2009-2016	Assistant Division Chief for Research, Department of Anesthesiology, University of Florida.
2015-present	Joint Associate Professor, Center for Optimization, Department of Industrial Engineering, University of Florida.
2016-present	R. Glenn Davis Associate Professor of Medicine, Surgery and Anesthesiology, University of Florida.

Other Experience and Professional Memberships

2003-	Member, American College of Physician
2003-	Board Member, Women in Nephrology
2010-	Board of Trustees Member, I. Heermann Anesthesia Foundation
2012-2014	Vice-Chair and Chair, SCCM Adult Current Concepts Course in Critical Care (elected)
2012-2014	Member, AAMC Group on Women in Medicine and Science
2012-2013	Chair, University of Florida Faculty Senate's Research and Scholarship Council
2015-2018	American Society of Nephrology, Acute Kidney Injury Advisory Group
2014-2018	American Society of Nephrology, Postgraduate Education Committee, Acute Kidney Injury
2015-2018	Society of Critical Care Medicine, Working group on personalized medicine.
2015 -2016	Acute Dialysis Quality Initiative, Working group on Big data in Acute Kidney Injury Research
2015 -2016	Acute Dialysis Quality Initiative, Working group on Renal Recovery in Acute Kidney Injury

Honors

1999	Travel grant for young investigators, XV ISN Congress, Buenos Aires, Argentina
1999	International Society of Nephrology (ISN) Fellowship
2000	Fellow grant, 20th Annual Conference on Peritoneal Dialysis, San Francisco
2003	Amgen Young Investigator Award, Southern Regional Meetings, New Orleans, LA
2003	Trainee Research Award, American Federation for Medical Research and the Southern Society for Clinical Investigation, Southern Regional Meetings, New Orleans, LA
2007	Fellow of American Society of Nephrology
2008	Outstanding Critical Care Medicine Teacher Award, Department of Anesthesiology, UF
2010	Faculty Research Award, Department of Anesthesiology, University of Florida
2012	Fellow of Society of Critical Care Medicine
2013	Society of Critical Care Medicine, Vision Grant Awardee for 2013
2013	Society of Critical Care Medicine, Presidential Citation
2013	Awarded tenure in the College of Medicine, University of Florida, and Gainesville.
2016	Endowed R. Glenn Davis Chair in Clinical and Translational Medicine, University of Florida

C. Contribution to Science

1. Epidemiology and outcomes of Postoperative Acute Kidney injury (AKI). In contemporary perioperative practice small changes in creatinine are rarely considered as an early risk factor for hospital mortality. Often times mild AKI remains undiagnosed and untreated until much more severe and less treatable stages of kidney injury are identified. Our work has advanced the understanding and clinical appreciation for postoperative AKI as it has emerged as one of the most prevalent and serious postoperative complications. Lesser severity AKI is now understood to be much more common, and more morbid, than was previously believed. We have published important papers describing the epidemiology of postoperative and posttraumatic AKI. We have also demonstrated that the existing AKI definitions in surgical societies and registries like American College of

Surgeons NSQIP are too crude in comparison to consensus definitions and underestimate the risk for adverse outcomes associated with more prevalent mild and moderate AKI. We have also demonstrated that the association of postoperative change in serum creatinine with adverse outcomes is continuous. Our studies presented an important impetus to incorporate the well validated accepted consensus AKI definition as it has already been done by Society of Thoracic Surgeons.

a. Hobson CE, Ozrazgat-Baslanti T, Kuxhausen A, Thottakkara P, Efron PA, Moore FA, Moldawer LL, Segal MS, **Bihorac A**. Cost and Mortality Associated With Postoperative Acute Kidney Injury. Ann Surg. 2014. PMCID: PMC4247993.
b. **Bihorac A**, Delano MJ, Schold JD, Lopez MC, Nathens AB, Maier RV, Layon AJ, Baker HV, Moldawer LL. Incidence, clinical predictors, genomics, and outcome of acute kidney injury among trauma patients. Ann Surg. 2010;252(1):158-65. PMCID: PMC3357629
c. **Bihorac A**, Brennan M, Ozrazgat-Baslanti T, Bozorgmehri S, Efron PA, Moore FA, Segal MS, Hobson CE. National surgical quality improvement program underestimates the risk associated with mild and moderate postoperative acute kidney injury. Crit Care Med. 2013;41(11):2570-83. PMCID: PMC3812338.
d. Vaught A, Ozrazgat-Baslanti T, Javed A, Morgan L, Hobson C, **Bihorac A**. Acute kidney injury in major gynaecological surgery: an observational study. BJOG. 2014. PMCID: PMC4334755.

2. Long-term outcomes after acute kidney injury. In 2009 in two highly-cited studies published in the Annals of Surgery and Circulation we were first to demonstrate that postoperative acute kidney injury was associated with an increase in all-cause long-term mortality, regardless of other clinical factors. These findings were corroborated in following years by other groups and have changed the paradigm of our thinking and care for patients with postoperative AKI. We and others have hypothesized that this mortality increase was mainly due to the increase in cardiovascular-specific mortality and in our most recent study (in review Annals of Surgery) confirms that hypothesis in a large cohort of both cardiac and non-cardiac surgical patients using a competing risk analysis model. Even more importantly, we compared acute kidney injury patients head to head with chronic kidney disease and end-stage renal disease patients demonstrating that cardiovascular mortality associated with acute kidney injury is comparable to chronic kidney disease and end-stage renal disease. Furthermore we have demonstrated that other major postoperative complications impose additive long-term risk to acute kidney injury (manuscript in preparation). This work demonstrates our research groups' capability for advanced statistical modeling in survival analyses, competing risk analyses and risk modeling for long term outcomes.
    a. **Bihorac A**, Yavas S, Subbiah S, Hobson CE, Schold JD, Gabrielli A, Layon AJ, Segal MS. Long-term risk of mortality and acute kidney injury during hospitalization after major surgery. Ann Surg. 2009;249(5):851-8.
    b. Hobson CE, Yavas S, Segal MS, Schold JD, Tribble CG, Layon AJ, **Bihorac A**. Acute kidney injury is associated with increased long-term mortality after cardiothoracic surgery. Circulation. 2009;119(18): 2444-53.
    c. **Bihorac A**, Schold JD, Hobson CE. Acute kidney injury and long-term outcomes: more to learn. Kidney Int. 2010;77(8):745.
    d. **Bihorac A**, Schold JD, Hobson CE. Long-term mortality associated with acute kidney injury requiring dialysis. JAMA. 2010;303(3):229.

3. Risk stratification for acute kidney injury. Current efforts to understand and manage AKI in surgical patients focus on prevention, mitigation of further injury when AKI has occurred, treatment of associated conditions and facilitation of renal recovery. Prevention of AKI is of paramount importance, and consensus guidelines outline a stage–wise approach for multiple interventions depending on patients risk or stage of AKI. The ability to detect AKI within hours of onset would be helpful for early preventive strategies to protect the kidney and halt the progression to more severe stages. My research group was the leading US center in three multi-center trials that led to the validation of two urinary cell-cycle arrest proteins as early biomarkers for AKI risk. These

biomarkers led to the first FDA approved AKI risk biomarker available for clinical use in USA and Europe. The biomarker however performs best among patients identified at risk for AKI based on clinical risk stratification. The Vision Grant award by the Society of Critical Care Medicine supported our work on developing predictive risk models for AKI using perioperative electronic health records and physiologic intraoperative time series data. The same approach was expanded to address other major postoperative complications (four manuscripts submitted). Using the machine learning approach developed for these models we have calculated the non-linear risk function between serum creatinine time series and 90-day morality to show the important effect of renal recovery after AKI.

a. Korenkevych D, Ozrazgat-Baslanti T, Thottakkara P, Hobson CE, Pardalos P, Momcilovic P, **Bihorac A**. The Pattern of Longitudinal Change in Serum Creatinine and 90-Day Mortality After Major Surgery. Ann Surg. 2015.
b. **Bihorac A,** Chawla LS, Shaw AD, Al-Khafaji A, Davison DL, Demuth GE, Fitzgerald R, Ng Gong M, Graham DD, Gunnerson K, Heung M, Jortani S, Kleerup E, Koyner JL, Krell K, Letourneau J, Lissauer M, Miner J, Nguyen HB, Ortega LM, Self WH, Sellman R, Shi J, Straseski J, Szalados JE, Wilber ST, Walker MG, Wilson J, Wunderink R, Zimmerman J, Kellum JA. Validation of Cell-Cycle Arrest Biomarkers for Acute Kidney Injury Using Clinical Adjudication. Am J Respir Crit Care Med. 2014.
c. **Bihorac A.** Guiding AKI Prevention Using Biomarkers. Critical Connections. 2015;14(2):1.
d. Kashani K, Al-Khafaji A, Ardiles T, Artigas A, Bagshaw SM, Bell M, **Bihorac A**, Birkhahn R, Cely CM, Chawla LS, Davison DL, Feldkamp T, Forni LG, Gong MN, Gunnerson KJ, Haase M, Hackett J, Honore PM, Hoste EA, Joannes-Boyau O, Joannidis M, Kim P, Koyner JL, Laskowitz DT, Lissauer ME, Marx G, McCullough PA, Mullaney S, Ostermann M, Rimmele T, Shapiro NI, Shaw AD, Shi J, Sprague AM, Vincent JL, Vinsonneau C, Wagner L, Walker MG, Wilkerson RG, Zacharowski K, Kellum JA. Discovery and validation of cell cycle arrest biomarkers in human acute kidney injury. Crit Care. 2013;17(1):R25.

4. Development of machine learning approaches for prediction and classification of complex clinical outcomes. Our multidisciplinary team has developed automated predictive analytics framework using machine learning and deep learning algorithms to develop foundation for real-time risk assessment of postoperative complications using solely electronic health records data (**Bihorac A et al.** MySurgeryRisk: Development and Validation of a Machine-Learning Risk Algorithm for Major Complications and Death after Surgery. In review at Ann Surg). We are currently completing two manuscripts describing the architecture of the intelligent platform that will be able to implement our algorithms in real time and provide interactive exchange with surgeons. We have also submitted manuscript that outlines the development of the first deep learning acuity model.
   a. **Bihorac A**, Ozrazgat-Baslanti T, Ebadi A, et al. MySurgeryRisk: Development and Validation of a Machine-Learning Risk Algorithm for Major Complications and Death after Surgery *Ann Surgery.* 2018.
   b. Thottakkara P, Ozrazgat-Baslanti T, Hupf BB, Rashidi P, Pardalos P, Momcilovic P, **Bihorac A.** Application of Machine Learning Techniques to High-Dimensional Clinical Data to Forecast Postoperative Complications. PLoS One. 2016;11(5):e0155705.
   c. Shickel B, Tighe P, **Bihorac A**, Rashidi P. Deep EHR: A Survey of Recent Advances on Deep Learning Techniques for Electronic Health Record (EHR) Analysis. IEEE Journal of Biomedical and Health Informatics (accepted).

5. Persistent inflammation and immunosuppression in sepsis. Chronic critical illness characterized by dismal long-term outcomes is now the predominant clinical trajectory among critical illness survivors. Through my collaboration with Fred Moore and Lyle Moldawer we have proposed that chronic inflammation, immunosuppression, and catabolism constitute the underlying mechanism of chronic critical illness. Among patients with AKI in the Promises study and the Glue grant trauma study we have shown an increase in both early and late pro- and anti-inflammatory cytokines occurring in parallel to distinct changes in levels of angiogenic factors such as erythropoietin,

vascular growth factor and angiopoietins (manuscript in preparation). This increase was associated with the decreased mobilization of bone marrow derived progenitors and an increase in urinary tubular injury markers. These findings support the hypothesis that forms the basis for one of the main projects of the P50 grant on which I serve as a Project Leader.

a. Gentile LF, Cuenca AG, Efron PA, Ang D, **Bihorac A**, McKinley B, Moldawer LL, Moore FA. Persistent inflammation and immunosuppression: A common syndrome and new horizon for surgical intensive care. J Trauma Acute Care Surg. 2012;72(6):1491-501..
b. White LE, Hassoun HT, **Bihorac A**, Moore LJ, Sailors RM, McKinley BA, Valdivia A, Moore FA. Acute kidney injury is surprisingly common and a powerful predictor of mortality in surgical sepsis. J Trauma Acute Care Surg. 2013;75(3):432-8. PMCID: PMC3823059.
c. Vanzant EL, Lopez CM, Ozrazgat-Baslanti T, Ungaro R, Davis R, Cuenca AG, Gentile LF, Nacionales DC, Cuenca AL, **Bihorac A**, Leeuwenburgh C, Lanz J, Baker HV, McKinley B, Moldawer LL, Moore FA, Efron PA. Persistent inflammation, immunosuppression, and catabolism syndrome after severe blunt trauma. J Trauma Acute Care Surg. 2014;76(1):21-9; discussion 9-30.
d. **Bihorac A**, Efron P, Agudelo A, Ungaro R, Marquez K, T OB, Moldawer L, Moore F, Segal MS. Early angiogenic balance and adverse long-term outcomes in sepsis. Shock. 2015;43(6):88.

Complete list of published work:

http://www.ncbi.nlm.nih.gov/sites/myncbi/azra.bihorac.1/bibliography/40029491/public/?sort=date&direction=ascending

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D. Additional Information: Research Support and/or Scholastic Performance

Bihorac, A.

ACTIVE

NSF-CNS-1747783 Li (PI) 2/1/2018-1/31/2023 0 Calendar Months

Phase I IUCRC University of Florida: Center for Big Learning

NSF Center for Big Learning (CBL) is an industry/university collaborative consortium. It consists of four sites: University of Florida as the lead, Carnegie Mellon University, University of Missouri at Kansas City, and University of Oregon with about 50 industry partners. The vision is to create intelligence towards intelligence-powered society. The mission is to explore and pioneer research frontiers in emerging large-scale deep learning for a broad spectrum of big data applications, design novel intelligent platforms to enable big learning research and applications, transfer research discoveries to meet urgent needs in industry with our diverse center members, and nurture our next generation talents in a mixed academic and industry setting with real-world relevance and significance via the industry-university consortium.

Role: Co-I (or Senior Personnel)

R01 GM-110240 3/01/2016-12/31/2020 3 Calendar Months
NIH-NIGMS $321,543

Integrating data, algorithms and clinical reasoning for surgical risk assessment

The goal of this multidisciplinary project is to develop, implement and validate a plug and play, scalable open-source intelligent system that combines electronic health data, computer algorithms and clinical reasoning to provide real-time risk stratification for surgical complications.

Role: Principal Investigator

P50 GM-111152 09/01/2014-05/31/2019 4 Calendar Months

NIH/NIGMS $1,301,768

PICS: A New Horizon for Surgical Critical Care

The goal of this Program is to describe the epidemiology of chronic critical illness and a persistent, inflammation, immunosuppression and catabolism syndrome in sepsis patients, identify early biomarkers that can predict its incidence and outcome, explore mechanisms that drive these processes, and examine potential interventions to prevent their development.

Role: Principal Investigator Project 003 (Multi-PI), Co-Investigator (Human Core and Data and Biostatistics Core)

LJPC-501 07/012016-10/01/2018 .12 Calendar Months
LaJolla Pharmaceutical $29,619

A Phase 3, Placebo-Controlled, Randomized, Double-Blinded, Multi-Center Study of LJPC-501 in Patients with Catecholamine-Resistant Hypotension

The goal of this project is to prospectively evaluate efficacy of novel vasopressors agent for catecholamine resistant shock.

Role: Principal Investigator

PENDING

None

Completed During Last Three Years

Informatics Institute Seed Fund 07/2016-08/2017 0.0 Calendar Months

University of Florida $47,500

Data science techniques for studying patient-specific risk assessment for acute kidney injury

The goal of this project is to utilize novel machine learning techniques for the development of risk assessment tools for acute kidney injury using electronic health records.

Role: Co-Principal Investigator

Informatics Institute Seed Fund 07/2016-11/2017 0.0 Calendar Months

University of Florida $40,000

DeepVital: Multimodal Data-Driven Predication and Diagnosis of Sepsis via Deep Learning

The goal of this project is to develop sepsis warning score using deep-learning algorithms applied to multidimensional electronic health records.

Role: Principal Investigator

W. Martin Smith Interdisciplinary Patient Quality and Safety Award (Bihorac) 06/2016-12/2017 $24,961 0.0 Calendar Months

Automated Algorithm Identifies and Communicates Risk of Acute Kidney Injury among Health Care Providers and Patients

The goal of this project is to develop electronic alert within the EPIC electronic health records for the diagnosis of acute kidney injury and implement it in surgical intensive care unit.

Role: Principal Investigator

OVERLAP

None

BIOGRAPHICAL SKETCH

NAME: Mohcine Madkour

eRA COMMONS USER NAME (credential, e.g., agency login): mmadkour

POSITION TITLE: Assistant Professor, Department of Medicine

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Ibn Zohr University, Agadir, Morocco	B.S.	07/2006	Applied Mathematics
Ibn Zohr University, Agadir, Morocco	Post- Graduate	10/2008	Applied Mathematics
Telecom Bretagne, France - Morocco	Post-Master	04/2012	Computer Science
University of Mohamed 5th, Rabat, Morocco	PhD	07/2013	Computer Science
University of Houston	Post-doc fellow	05/2015	Computer Science
University of Texas Health Science Center at Houston	Post-doc fellow	05/2017	Biomedical Informatics

A. Personal Statement

My research background falls primarily into two major areas. One is clinical data modeling and reasoning where I worked with computational approaches for information representation and inference to transition data into information and knowledge. The other area is data analytic where I worked with statistical modeling and machine learning tools to get insights from large scale data. As a postdoctoral fellow at the School of Biomedical Informatics, University of Texas Health Science Center at Houston, I made contributions to different projects. 1) In an IRB exemption, we have built a problem/task oriented system and collected encounter operation sequences in a family practice setting for 30 months. We started with three basic operations: accessing a problem, adding information to a problem, and adding a task to a problem. We have done some exploratory and explanatory analysis on the data and we used statistical learning technics to predict user computer interactions in the course of encounters. We analyzed and got insights from clinical encounters log which can enhance physician-patient interpersonal flow. 2) In a R01 project supported by NIH, I worked with Dr. Cui Tao (PI) to develop an automatic approach to temporal data representation, normalization and reasoning for large, diverse, and heterogeneous EHR data. I participated in development of TIMER (Temporal Information Modeling, Extracting, and Reasoning) framework, which provides an end-to-end, open-source, standard-conforming software package to normalize and integrate patient's medical history from EHR. I also helped developing features in the Temporal Event Ontology to semantically define the time domain and represent temporal data structures in complex EHR data. In addition, I developed a temporal clinical event clustering and visualization dashboard (presented in VIS 2016), and a human cognition based evaluation display of uncertainty in temporal events (presented in BIBM 2016). 3) In a R01 project granted by AHRQ, I worked with Dr Keith A. Butler (PI) for highly advanced modeling of clinical care and Health Information Technology improvement. In this project, I led the effort of bridging the critical gap between clinical workflows and EHR use that hinders the development of rigorous specifications to verify complex systems in IT healthcare. I modeled essential features and requirements of conceptual work products and the specifications required by system's functions. I used the consistency checking of

an ontology reasoner engine along with model checking to innovate verification tools and methodology for healthcare information systems.

B. Positions and Honors

2007 – 2008 Adjunct Professor, Ibn Zohr University, Agadir, Morocco
2010 – 2013 Adjunct Professor, Mohamed 5th University, Rabat, Morocco
2012 – 2013 Visiting Professor, Mohamed 5th University, Rabat, Morocco
2013 – 2015 Postdoctoral Research Fellow, University of Houston, Houston, TX
2014 – 2015 Adjunct Professor, University of Houston, Houston, TX
2015 – 2017 Postdoctoral Fellow, University of Texas Health Science Center at Houston, Houston, TX
2015 – 2017 Teaching Assistant, University of Texas Health Science Center at Houston, Houston, TX
2017 – Present Assistant Professor, Department of Medicine, Division of Nephrology, Hypertension, and Renal Transplantation, University of Florida, Gainesville, FL

Other Experience and Professional Memberships

2014 Member of the organization team of the ICBO 2014 at Houston
2015 Reviewer for the American Medical Informatics Association (AMIA)
2015 Reviewer for Computer Methods and Programs in Biomedicine
2016 PC of the 3th IEEE International Conf on Computer Systems and Applications (AICCSA)
2015 Reviewer for International Conference on Intelligent Biology and Medicine (ICIBM 2016)

Honors

2013 Best paper Award in the10th IEEE AICCSA'13 - Track: Cloud and Distributed computing

2015 Teaching Assistantship, Advanced Database Concepts for Health Informatics (HI 5304-UTHealth)

2016 Teaching Assistantship, Knowledge Representation in Biomedical Informatics (BMI 6306-UTHealth)

C. Contributions to Science

1. Context-aware service selection and adaptation in ubiquitous computing environments: My PhD dissertation work was primary focused on using the information of context to select suitable services in a pervasive computing environment taking into consideration different objectives within the system and the need to reason in the presence of uncertainty. I have explored how adaptive systems - intelligent systems that use machine learning to adapt their behavior over time - integrate context-awareness to improve usability, effectiveness, and end-user satisfaction. I used a formal modeling approach based on workflow process models and an innovative graph matching algorithms for searching structural and behavioral similarity aspects. The approach provided high scores in user satisfaction and responding to dynamic change of the context and human behavior. I published several research papers in the field of ontology-based service orchestration (selection, adaptation and composition) and adaptation and control in context-aware environment:

    a. **Madkour M**, El Ghanami D, Maach A, Hasbi A . Context-aware service adaptation: an approach based on fuzzy sets and service composition. Journal of Information Science and Engineering, 29 (1), 1-16, 2013

b. **Madkour M**, El Ghanami D, Maach A . QoS-based approach for context-aware service selection with fuzzy preferences handling. International Journal of Computer Applications in Technology 47 (4), 379-391, 2013

c. **Madkour M**, Maach A, El ghanami D. Context-aware middleware for services retrieval and adaptation. International Review on Computer and Software 7 (1), 166-176, 2012

d. **Madkour M**, Maach A . Ontology-based context modeling for vehicle context-aware services. Journal of Theoretical and Applied Information Technology Vol 34 No2, 2011

2. Data-Driven Modeling, Control and Tools for University of Houston Smart Campus: The goal of the postdoctoral research fellowship at the University of Houston was to conduct rigorous and objective research on software and data analytics techniques that can be applied to optimize energy use in the university campus, and give decision-makers the real-world analysis they need to make smart choices. This project was founded by the Smart Grid Energy Training Coalition Grant from the Department of Energy's program for workforce training in the electric power sector. My research in particular involved building data analytic applications, middleware and tools that programmers, designers and end-users can use to build applications in the cross-section of human-computer interaction and ubiquitous computing. I have participated in the development of the Context-Aware Living Campus (CALC) Middleware for the inter-operation of energy related applications running on University of Houston's campus (web Services, data analytic applications, and Multi Agent Systems). I have developed a real-time control and optimization methodology that helps make dynamic decisions on optimal operations of campus energy management system. The methodology is a complex hybrid optimization tool that use subjective parameters (occupant behavior) and objective parameters (weather conditions, dynamic pricing of energy, etc.). I used the Artificial Intelligence's technique of Case-Based Reasoning to learn from past situations and to generate solutions for new problems based on solutions provided for earlier problems. I developed a data driven approach to find a better way to automate energy demand - response in the university campus to make it more reliable and cost-effective over the long term. I used a regression tree algorithm to adjust the chiller plant production (response) to building consumption (demand), The approach allowed to choose the best demand response strategy that best optimize the sequence of chiller and therefore lead to more efficiency and better reliability. Some articles that I have published :
   a. **Madkour M**, Benhaddou D, Khalil N, Burriello M, Cline Jr RE. Living Campus: Towards a Context-Aware Energy Efficient Campus Using Weighted Case Based Reasoning Workshops at the Twenty-Ninth AAAI Conference on Artificial Intelligence 2015
   b. Halhoul Merabet G, Essaaidi M, Talei H, Riduan Abid M, Khalil K, **Madkour M**, Benhaddou D. Applications of multi-agent systems in smart grids: a survey. International Conference on Multimedia Computing and Systems (ICMCS),. 14 Apr - 16 Apr 2014

3. Patient Medical History Representation, Extraction, and Inference from EHR Data: This project aims at developing tools for automatically harvesting temporal constraints of clinical events from Electronic Health Records (EHR). I worked with Dr. Cui Tao to develop Time Event Ontology (TEO) in order to provide a formal conceptualization of temporal structures in both structured data and textual narratives. TEO provides core semantic components for representing temporal events and relations to enable reasoning capacities in temporal relations. While the previous developed ontology, Clinical Narrative Temporal Relation

Ontology (CNTRO), was focused on annotating clinical narratives, TEO was designed with the goal of annotating a very general category of temporal relationships; it expands CNTRO's meta-level semantics classification and reasoning capabilities. Also I helped building new reasoning and extraction capacities on the TIMER (Temporal Information Modeling, Extracting, and Reasoning) framework to provide an end-to-end, open-source, standard-conforming software package. On top of TEO, I implemented temporal relation reasoning capacities to automatically normalize temporal expressions, compute and infer temporal relations, and resolve ambiguities. I also created a visualization tool that shows the timeline of events and allows summarizing of events by different types of event information. The tool also allows a cluster analysis using K-Means clustering and temporal ordering of events.

a. **Madkour M**, Benhaddou D, Tao C. Temporal data representation, normalization, extraction, and reasoning: A review from clinical domain. Computer methods and programs in biomedicine 128, 52-68, 2016
b. **Madkour M**, Song H, Du J, Tao C. A representational analysis of a temporal indeterminancy display in clinical events. IEEE International Conference on Bioinformatics and Biomedicine (BIBM), 2016
c. **Madkour M**, Song H, Du J, Tao C. Temporal clinical events clustering and visualization. IEEE VIS 2016 Workshop on Temporal & Sequential Event Analysis

4. Modeling and Analysis of Clinical Care for HIT Improvement: There is critical, nation-wide need to reduce the cost of health care while increasing access and quality. In order to exploit the potential of HIT its designs must be based on an understanding of how care is actually performed, including an analysis of constraints and problem areas to prioritize how HIT should be applied to achieve measurable gains in efficiency and quality. We have modeled and analyzed clinical care work flows, networks, and decision making and we have demonstrated how an improved understanding of clinical work, task distribution and decision making, can methodically guide HIT design to increase care efficiency, reduce cost, and improve quality. As an application, many clinical workflows depend on interactive computer systems for highly technical, conceptual work products, such as diagnoses, treatment plans, care coordination, and case management. I worked with Dr Keith Butler, Dr Eric Mercer, Dr Cui Tao, and Dr Ali Bahrami to describe an automatic logic reasoner to verify objective specifications for these highly technical, but abstract, work products that are essential to care. The conceptual work products specifications serve as a fundamental output requirement, which must be clearly stated, correct and solvable. There is strategic importance for such specifications because, in turn, they enable system model checking to verify that machine functions taken with user procedures are actually able to achieve these abstract products. For our implementation, we chose case management of MS outpatients as our use case for its challenging complexity. As a first step, we illustrate how graphical class and state diagrams from UML can be developed and critiqued with subject matter experts to serve as specifications of the conceptual work product of case management. Our Work Domain Ontology with tools from Semantic Web is needed to translate UML class and state diagrams for verification of solvability with automatic reasoning. The solvable model will then be ready for subsequent use with model checking on the system of human procedures and machine functions. We used the expressive rule language SPARQL Inferencing Notation to develop formal representations of the UML class diagram, the state machine, and their interactions. As result we demonstrated that web semantic based modeling of UML class and state machine can perform consistency and constraint checking capabilities for complex, abstract conceptual work products. This ability can then be utilized by a system model checker to perform the correctness

verification of an interactive system. In addition the leadership of the SysML standard and the health care software standards communities have taken a strong interest to incorporate our work. We have submitted an article on this project for publication:

a. **Madkour M**, Butler K, Bahrami A, Mercer E, Tao C. Semantic based model of Conceptual Work Products for formal verification of complex interactive systems

D. Additional Information: Research Support and/or Scholastic Performance

No current research support.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Ozrazgat Baslanti, Tezcan

eRA COMMONS USER NAME (credential, e.g., agency login): tezcan

POSITION TITLE: Assistant Professor, Department of Medicine

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Bogazici University; Istanbul, TURKEY	B.S.	08/2000	Department of Mathematics
University of Florida; Gainesville, FL	Ph.D.	08/2011	Department of Statistics
University of Florida; Gainesville, FL	Postdoctoral	04/2015	Department of Anesthesiology, College of Medicine

A. Personal Statement

I earned my Ph.D. degree in Statistics at the University of Florida. My first experience in medical research occurred during postdoctoral associate program in Anesthesiology, under the supervision of Azra Bihorac, MD in Department of Anesthesiology. Dr.Bihorac's research focused on outcome studies after postoperative complications, mainly acute kidney injury. During postdoctoral associate program, I have been involved in many projects that used various statistical methods to analyze the effects of patient demographic and clinical characteristics on hospital complications, mortality, costs and long-term survival. We have been developing and validating risk prediction algorithms for various postoperative complications and have been awarded grant support to develop a platform for real-time data integration and risk prediction that would help improve medical care by allowing early application of specific preventive strategies. I have provided statistical consulting to all faculty, residents and fellows in the Departments of Anesthesiology and Surgery for manuscripts and grant proposals, and continuing to do so in the Department of Medicine. I serve as a key faculty in the Data Management and Biostatistics Core of the University of Florida Sepsis and Critical Illness Research Center (SCIRC) and as the liaison between the research in perioperative outcomes in critical illness led by Dr.Bihorac at the Department of Medicine and the director of the Data Management and Biostatistics Core, Dr.Brumback. In the last five years, I gained extensive experience in various statistical analysis methods including categorical data analysis, longitudinal data analysis, survival analysis, and predictive models, and collaborated with team members on this proposal. I will offer my expertise in statistics and experience in relevant projects and in project management to accomplish the objectives of the proposed study.

B. Positions and Honors

2000 – 2002 Assistant Specialist, Risk and Data Management Department, Alternatif Bank, TURKEY

2002 – 2003 Assistant Executive, Project Management Department, Oyakbank, TURKEY

2004 – 2011 Teaching Assistant, Lab Instructor, Instructor, Statistical Consultant, UF, Gainesville, FL

2011 – 2012 Adjunct Assistant Professor, Santa Fe College, Gainesville, FL
2011 – 2013 Statistical Consultant, Department of Anesthesiology, UF, Gainesville, FL

2012 – 2015 Statistical Consultant, Department of Surgery, University of Florida, Gainesville, FL

2011 – 2015 Postdoctoral Associate, Department of Anesthesiology, UF, Gainesville, FL

2015 – 2016 Assistant Professor, Department of Anesthesiology, University of Florida, Gainesville, FL

2016 – present Assistant Professor, Department of Medicine, Division of Nephrology, Hypertension, and Renal Transplantation, University of Florida, Gainesville, FL

Other Experience and Professional Memberships

2010	Member, American Statistical Association
2010	Member, Institute of Mathematical Statistics
2010	Member, International Biometric Society
2012	Member, Society of Critical Care Medicine
2013	Member, National Postdoctoral Association
2015	Associate Faculty Member for F1000
2016	Member, Shock Society

Honors

1996 - 1997	Istanbul Municipality Scholarship for high academic achievement at the university
1996 - 1999	SANKO Scholarship for high achievement in Nationwide University Entrance Exam
1997 - 1998	Ministry of Education Scholarship
1998 - 2000	Bogazici University Scholarship for holding a high GPA
2000	Ranked second in the Department of Mathematics, Bogazici University
2004 – 2011	Teaching Assistantship, University of Florida
2011	Joint Statistical Meetings, Student Travel Grant
2012	Outstanding Research Award at UF PHHP Research Fair (coauthor)
2012	Research Award at Gulf Atlantic Anesthesia Residents' Research Conference (coauthor)
2016	UAB's Short course on Statistical Genetics and Genomics, NIGMS Partial Travel Fellowship
2016	Top translational and clinical sciences abstract at UF Department of Medicine Celebration of Research Day (coauthor)
2016	Top quality/educational improvement abstract at UF Department of Medicine Celebration of Research Day (coauthor)

C. Contributions to Science

5. Introduction of partial stereotype model and theorems on existence of maximum likelihood estimates: My dissertation work focused on two main topics: the stereotype model that is appropriate for modeling the degree of an illness and the existence of maximum likelihood estimates in categorical regression models. Despite the many appealing features, the stereotype

model has not been widely used because of the problems in estimation due to nonlinearity in the parameters. However, it can be easily fit with current software. We compared standard confidence interval methods for the odds ratios. We also introduced a new model “partial stereotype model” which is more parsimonious than the multinomial logistic model, but yet, more flexible than the stereotype model. We examined some properties of the partial stereotype model and showed how the standard confidence interval methods extend to the partial stereotype model. It is of interest to determine necessary and sufficient conditions for the existence of maximum likelihood estimates for categorical regression models. We first reviewed the literature on the existence of maximum likelihood estimates for dichotomous response models, logistic regression models using baseline-category logits, and categorical regression models using cumulative links. We then extended the definitions of separation and overlap to the stereotype model and the adjacent-categories logit model. We then generalized and modified some of the theorems on the existence of maximum likelihood estimates and examined connections between the different approaches. I have not published articles from my dissertation yet due to starting to work on other projects intensely as a Postdoctoral Associate right after graduation. However, I am currently working on drafts of two manuscripts from my dissertation, one on existence of maximum likelihood estimates in categorical regression models and one on partial stereotype model.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Li, Xiaolin

eRA COMMONS USER NAME: andyli

POSITION TITLE: Associate Professor of Electrical and Computer Engineering

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE	Completion Date	FIELD OF STUDY
Qingdao University	B.S.	07/1995	Mechatronics
Zhejiang University	M.S.	03/1998	Intelligent CAD
National University of Singapore	Ph.D.	10/2001	Communication and Information Engineering
Rutgers University	Ph.D.	10/2005	Computer Engineering

A. Personal Statement

The mission of my research is to create intelligent big data ecosystems towards intelligent platforms and intelligence-driven society. My group (S3Lab) is one of the first teams to enable large-scale deep learning, software-defined ecosystems, and cyber-physical systems (CPS/IoT) in clouds. I led the design and deployment of the first SDN-enabled campus cloud GatorCloud (with over $2M NSF grants) with 200Gbps networks, the best campus research network in 2012. As the founding director, I have been leading the nation-wide effort to establish the **NSF I/UCRC Center for Big Learning (CBL)** as the lead PI with Carnegie Mellon University, University of Oregon, and University of Missouri. The planning grant for CBL has been awarded (the center poster is available at http://www.andyli.ece.ufl.edu/docs/NSFCBL-poster-UF.pdf). We have attracted support from about 50 industry partners, including Google, IBM, Intel, Microsoft, DeepMind, OpenAI, Harris, LinkedIn, Tencent, Pingan, Amazon, VMWare, Verizon, and many others. The total budget for the Phase 1 center is about $6M (half from NSF and half from industry partners). The CBL is expected to be the largest industry/university consortium on large-scale deep learning, with about 50 professors and 50 industry partners.

My research focuses on designing large-scale software systems to enable big-data sciences, high-performance applications, and cyber-physical systems. I am the founding director of Scalable Software Systems Laboratory. With the NSF CAREER Award, we have been designing the SMART scalable adaptive runtime management algorithms and toolkit for large-scale dynamic scientific applications. The SMART framework has enabled applications running on over 1000 processors, e.g., oil-reservoir simulation, combustion simulation, and shockwave formation. With the NSF PetaApps grant, we have designed the Mammoth software platform and enhanced the iterative MapReduce programming model to support big data sciences, particularly data-assimilation-based severe weather forecasting. With 100s terabytes of data collected from weather radars in real time, efficient data streaming, data assimilation, processing, and prediction is critical. We have been designing a large-scale deep-learning platform, CognitiveEngine**,** for high-impact big-data applications in health, business, science, and engineering. With the NSF-GENI grant, we have built a ceiling grid called GemsCloud of 120 smart sensor networks to support cyber-physical system (CPS) as-a-service and enable remotely programmable slices of

sensor networks. With colleagues at the UF College of Medicine, we have been building a VitalCloud to enable noncontact vital-sign detection and a Guoguo ecosystem to enable high-precision indoor localization, location-based patient monitoring, and activity recognition (achieving the world-leading result with 5cm precision). I have graduated seven Ph.D. students (one female), and over 20 M.S. students with theses (five female graduates). One PhD graduate will start his tenure-track assistant professor career. Five other PhD students have joined Apple, Facebook, Google, and Qualcomm research, working on data science and engineering projects. I am currently advising 8 Ph.D. students and 20 MS students. With years of experiences in building large-scale parallel and distributed software systems and cyber-physical systems, I believe our multidisciplinary team is well positioned to undertake the proposed high-impact project.

B. Positions and Honors

Positions and Employment

1998-2001 Research Scholar, Department of Electrical and Computer Engineering, NUS
2001 Research Staff, Center for Wireless Communications (now I2R), Singapore
2001-2005 Research Assistant, Department of Electrical and Computer Engineering, Rutgers
2003 Extreme Blue Intern, IBM Austin Research Lab
2005-2010 Assistant Professor, Department of Computer Science, Oklahoma State University
2006 Visiting Scholar, Department of Computer Science, University of Texas at Austin
2009 Visiting Professor, Nokia Research Center Beijing
2010- Associate Professor, Area Chair of Computer Engineering Division
Director, Scalable Software Systems Laboratory (S3Lab), http://www.s3lab.ece.ufl.edu/
Department of Electrical and Computer Engineering, University of Florida
Teaching: Cloud Computing, Big Data Ecosystems, and Cyber-Physical Systems

Other Experience and Professional Memberships

2006- Executive Committee of IEEE Technical Committee on Scalable Computing (TCSC)
2006- Coordinator of Technical Areas on Sensor Networks, IEEE TCSC
2012-2013 Chair, IEEE Gainesville Section
2012- Coordinator of Technical Areas on Big Data and MapReduce, IEEE TCSC
2012- Area Chair, Computer Engineering Division, Department of ECE, University of Florida
2014- Steering Committee Chair and Program Chair, ACM International Workshop on Software-Defined Ecosystems (BigSystem)
2014- Associate Editor, IEEE Transactions on Parallel and Distributed Systems

Honors

2007 Best Paper Award, the 2007 IEEE International Symposium on Ubisafe Computing
2007 Outstanding Service Award, 21st IEEE AINA 2007
2008 Outstanding Service Award, the 17th IEEE ICCCN 2008
2009 The 2nd IEEE International Scalable Computing Challenge (SCALE 2009) (finalist), "HiCloud: Taming Clouds on the Clouds"
2010 National Science Foundation CAREER Award
2013 Best Paper Award, the ACM Cloud and Autonomic Computing Conference (CAC 2013)
2013 Internet2 Innovative Application Award
2014 Technology Innovator Award, Office of Technology Licensing, University of Florida

2015 NSF I-Corps Top/Representative Team Award (No. 1 in 24 teams including Berkeley, MIT, Harvard, etc.), Winter Cohort, 2015

C. Contribution to Science

1. I helped build one of the first SDN-enabled campus clouds, GatorCloud (one of the top five in the nation in 2012). As the PI and architect, I led the design, development, and deployment of the 100Gbps SDN across dozens of data centers at UF and five sites in the state of Florida, and led the design and development of the SDN-enabled campus cloud GatorCloud with novel cloud stacks and a SDN app store. I helped design the Mammoth software platform and enhanced the iterative MapReduce programming model to support big-data sciences, particularly data assimilation based on severe-weather forecasting.
    a) Yu, Z., Li, M., Yang, X., Zhao, H. & Li, X. (2015). Taming non-local stragglers using efficient prefetching in MapReduce. IEEE Cluster 2015. (Acceptance: 24%)
    b) Yu, Z., Li, M., Yang, X. & Li, X. (2014). GatorCloud: A fine-grained and dynamic resource sharing architecture for multiple cloud services. The 1st International Workshop on Software-Defined Ecosystems (BigSystem 2014), in conjunction with the 23rd ACM HPDC 2014.
    c) Yu, Z., Li, M., Yang, X. & Li, X. (2014). Palantir: Reseizing network proximity in large-scale distributed computing frameworks using SDN. The 7th IEEE International Conference on Cloud Computing (CLOUD 2014). (Acceptance: 20%)
    d) Yang, X., Yu, Z., Li, M. & Li, X. (2013). Mammoth: Autonomic data processing framework for scientific state-transition applications. The ACM Cloud and Autonomic Computing Conference (CAC 2013). (**Best Paper Award**)

2. I helped design the SMART high-performance toolkit and runtime framework for sophisticated structured adaptive mesh refinement applications. SMART has enabled applications with dramatic physical phenomena running on over 1000 processors, e.g., oil-reservoir simulation, combustion simulation, and shockwave formation.
    a) Li, X. & Qiu, J. (Eds.) (2014). Cloud computing for data intensive applications. NY, NY: Springer.
    b) Li, M., Yang, X. & Li, X. (2013). Domain-based MapReduce programming model for complex scientific applications. The 15th IEEE International Conference on High Performance Computing and Communications (HPCC 2013). (Acceptance: 29.3%)
    c) Parashar, M. & Li, X. (Eds.) (2009). Advanced computational infrastructures for parallel and distributed adaptive applications. NY, NY: John Wiley & Sons.
    d) Li, X. & Parashar, M. (2007). Hybrid runtime management of space-time heterogeneity for parallel structured adaptive applications. IEEE Transactions on Parallel and Distributed Systems, 18(9).

3. I helped achieve the world-leading precision of 5cm on smartphone indoor localization and indoor GPS with Guoguo as the major inventor and architect. Three patents have been filed and three licenses have been granted to three companies.
    a) Liu, K., Li, X. (2015). Enabling Context-Aware Indoor Augmented Reality via Smartphone Sensing and Vision Tracking. (Accepted) ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM).
    b) Liu, K., Li, M. & Li, X. (2015). Hiding media data via shaders: Enabling private sharing in the clouds. The 8th IEEE International Conference on Cloud Computing (CLOUD 2015). (Acceptance: 15%)
    c) Xu, K., Guo, Y., Guo, L., Fang, Y. & Li, X. (2015). My privacy my decision: Control of photo sharing on online social networks. IEEE Transactions on Dependable and Secure Computing (TDSC).
    d) Liu, K., Liu, X & Li, X. (2014). Guoguo: Enabling fine-grained smartphone localization via acoustic anchors. IEEE Trans on Mobile Computing (TMC).

4. I helped build VitalCloud to enable noncontact vital-sign detection, big-data-stream analytics, and deep learning with knowledge fusion from health practitioners. With adaptive recurrent deep neural networks, time-series data from medical monitors are fed into the deep-learning models. This is one of the first deep-learning solutions in real-time monitoring, diagnosis, and knowledge exchange and

fusion with doctors. With limited labeled data, through primarily unsupervised learning, we are ushering in a new era of noncontact vital-sign sensing, learning, and decision-making.

a) Liu, K., Li, X. (2014). FindingNemo: Finding Your Lost Child in Crowds via Mobile Crowd Sensing," the 11th IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS). (Acceptance: 26.5%)
b) Yan, C., Yang, X., Yu, Z., Li, M. & Li, X. (2012). IncMR: Incremental data processing based on MapReduce. The 5th IEEE International Conference on Cloud Computing (CLOUD 2012).
c) Zhao, H., Pan, M., Liu, X., Li, X. & Fang, Y. (2012). Optimal resource rental planning for elastic applications in cloud market. The 26th IEEE International Parallel and Distributed Processing Symposium (IPDPS 2012).
d) Reyes, G., Wang, D., Nair, R., Li, C., Li, X. & Lin, J. (2012). VitalTrack: A doppler radar sensor platform for monitoring activity levels. The 2nd Annual IEEE Topical Conference on Biomedical Wireless Technologies, Networks, and Sensing Systems (BioWireleSS 2012).

5. I am helping design CognitiveEngine, one of the largest big-data platforms for large-scale deep learning with both massive data and model parallelism. As the lead PI, the ongoing plan of the project is to build a nationwide cloud for collaborative deep-learning research and applications, called DeepCloud, starting from CMU, UC Irvine, BBN, and UF. DeepCloud is expected to be the largest specialized cloud for deep learning in the nation, with tremendous impacts.
    e) Yu, Z., Li, M., Wang, J., Liu, Z., Liu, K., and Li, X. (2015). CognitiveEngine: Enabling Large-Scale Deep Learning Cloud Platforms with Extreme Parallelism and Software-Defined Ecosystems. Technical Report TR-2015-02-01, Scalable Software Systems Laboratory, University of Florida.
    f) Zhao, H. & Li, X. (2013). Resource management in utility and cloud computing. NY, NY: Springer.
    g) Zhao, H., Yu, Z., Tiwari, S., Mao, X., Lee, K., Wolinsky, D., Li, X. & Figueiredo, R. (2012). CloudBay: Enabling an online resource marketplace for open clouds. The 5th IEEE/ACM International Conference on Utility and Cloud Computing (UCC 2012).
    h) Zhao, H., Liu, X. & Li, X. (2010). Hypergraph-based task-bundle scheduling towards efficiency and fairness in heterogeneous distributed systems. The 24th IEEE International Parallel and Distributed Processing Symposium (IPDPS 2010).

Links to other peer-reviewed publications (total 90+): (DBLP for Computer Science) http://dblp.uni-trier.de/pers/hd/l/Li_0001:Xiaolin, and (S3Lab homepage) http://www.s3lab.ece.ufl.edu/publication.htm.

D. Research Support

Ongoing Research Support

R01 GM110240 (Bihorac/Li) 04/01/2016 – 03/31/2021 2.0 calendar

NIH R01 ($487,878)

Integrating data, algorithms and clinical reasoning for surgical risk assessment

The major goal of this project is to implement technological advances in data science and engineering in innovative steps to develop an intelligent perioperative system (IPS) composed of computers and physicians interacting in real time, which can generate usable medical knowledge with both increased speed and accuracy using complex clinical data obtained in the perioperative period.

Role: MPI

NSF-MRI ($1.7M) Li (PI) 2012-2017

MRI: Acquisition of GatorCloud: Enabling high-impact scientific research and collaboration via software-defined networks and cloud services

The goal of this study is to boost campus research network from 10G to 100G with SDN solutions, offer novel cloud services, efficiently manage the future Internet, and enable high-impact big-data applications (e.g., the CMS that discovered the Higgs boson, weather forecasting, bioinformatics, health, and others).

Role: PI

NSF-CAREER ($430K) Li (PI) 2010-2016

CAREER: SMART: Scalable adaptive runtime management algorithms and toolkit for large-scale dynamic scientific applications

The goal of this study is to design a scalable and adaptive runtime environment, SMART, to support large-scale dynamic scientific applications. The broader impact is that an easy programming model and automatic parallelization will be enabled to help develop effective and complex scientific applications in a sequential manner.

Role: PI

UFID Seed Grant ($40K) Li (PI) 2016-2017

DeepVital: Multimodal Data-Driven Prediction and Diagnosis of Sepsis via Deep Learning.

The goal of this study is to design deep learning models to extract spatial and temporal features from multiple inputs of medical data, including EHR and real time diagnosis.

Florida Cybersecurity Seed grant ($70K) Li (PI) 2016-2017

DeepSky: Extremely-fast and Accurate Discovery of New Planets in Kepler Big Data via Large-Scale Deep Learning

The goal of this study is to design large-scale deep learning models and big data platforms to enable end-to-end scientific discovery of new planets based on Kepler data.

Florida Cybersecurity Seed grant ($35K) Li (PI) 2016-2017

Securing the Internet of Things (IoT) from the Hardware and Architecture Perspectives

The goal of this project is to design security systems and algorithms to protect IoT devices and networks.

Harris ($50K) Li (PI) 2015-2016

SmartCloud: Software-Defined Data Centers for Smart Big Data Engines

The goal of this study is to make datacenters/clouds smarter and make big data analytics smarter. SmartCloud features (1) Closing the loop of datacenter/cloud management through novel software-defined ecosystems (software-defined networking, computing, and app store); (2) Deepening insights distilled from big data through novel deep learning and knowledge graph (unsupervised learning of massive data and statistical knowledge graph and inference engine).

ETRI ($95K) Li (PI) 2014-2015

Cloud-based Distributed Video Processing Using Big Data Technologies

The goal of this project is to design and implement video stream analytics and video delivery services. We adopt big data solutions: Apache Kafka for data stream publish/subscribe and meta-data exchange, Apache Spark/Hadoop for big data analytics, and deep learning for recommendations and predictions.

Completed Research Support

NSF-PetaApps ($1.2M) 2009-2013

Enabling peta-scale ensemble-based data assimilation for numerical analysis and prediction of high-impact weather

The goal of this study was to enable peta-scale applications to achieve high-resolution numerical weather forecasting and prediction through ensemble-based data assimilation. A software toolkit with a suite of management algorithms to intelligently manage the peta-scale applications in high-end computing systems of thousands of processors was designed and implemented.

Role: Co-PI, PI at the University of Florida

NSF-CC-NIE ($385K) 2009-2013

CC-NIE Network Infrastructure: 100Gig connection to Florida LambdaRail (FLR)

The goal of this study was to enhance the campus research network by connecting to the Internet2 with 100G bandwidth.

Role: Co-PI

NSF-GENI ($100K) Li (PI) 2009-2012

OKGems: A GENI-federated cyber-physical system with multimodalities

The goal of this study was to create a multimodal CPS that provides a novel programmable virtual laboratory platform for experiments on sensor networks, mobile robotics, and hybrid CPS systems. This CPS system (now called GemsCloud) is integrated with the global GENI testbed for shaping the future Internet.

Role: PI

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES**.

NAME: Rashidi, Parisa

eRA COMMONS USER NAME (credential, e.g., agency login): parisarashidi

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Tehran, Iran	B.S.	09/2005	Computer Engineering
Washington State University	M.S.	12/2007	Computer Science
Washington State University	Ph.D.	05/2011	Computer Science

A. Personal Statement

I will be serving as the coordinating PI of the proposed project. I am an Early Stage Investigator making my first R01 as the coordinating PI. In the past, I have been involved in other R01 applications as a key Co-I, collaborating on R01 project with Dr. Bihorac (NIGMS R01GM-110240), and we have published multiple manuscripts together. I have been trained as a computer scientist with specific expertise in developing machine learning and data science techniques. Because of my expertise and current position, I consider myself an interdisciplinary researcher, who can translate problems in the biomedical and healthcare domain into solutions drawn from computer science and data science. My recent positions in University of Florida and Northwestern University, and my close collaboration with my clinical colleagues, have complemented my computational background by exposing me to the world of patient care in acute and critical settings. The expertise to carry out the proposed research, began to develop while pursuing my M.S. and Ph.D. degrees in computer science under the supervision of Dr. Diane J. Cook. I contributed to developing machine learning algorithms for a large-scale “smart home” project (CASAS) for monitoring the cognitive and functional status of older adults suffering from Alzheimer’s diseases. In that project, I developed several machine learning algorithms for autonomous human activity recognition from sensors deployed throughout the home to infer patient’s cognitive and functional status and trajectory. I received the 2011 outstanding PhD dissertation award for my contributions. In my current position, I have continued to apply my knowledge of machine learning and data science to healthcare problems, especially in the acute and critical care setting. I am currently serving as PI, Co-PI and Co-I on several federal, state, and internal grants, including from National Science Foundation (NSF) and National Institute of Health (NIH), and I have excellent record of project oversight and management. In 2016, I also obtained the internal seed funds from UF Informatics Institute for developing our initial prototype, which has resulted in our preliminary results. I have led multiple workshops and symposiums on machine learning in biomedical applications, and have been teaching the *NIH training session on “Machine Learning for m-Health*”. In the last four years, I have been building a multidisciplinary research lab, the Intelligent Health Lab (iHeal), aimed at using novel machine learning and sensing technology to address key biomedical and healthcare problems. I have supervised 1 postdoc fellow, 5 PhD students, and 15+ masters and undergraduate students. Related to current proposed study, me and my students have published several peer-reviewed manuscripts on pain pattern analysis, postoperative outcome prediction using deep learning techniques, and inferring human activity using sensor technology. The current proposed project naturally builds on my extensive expertise in machine learning and smart environment,

applied in the critical care domain. I will contribute to all the work related to development, refinement, and evaluation of algorithms. In addition to my unique training and professional background, I believe that I have the leadership and motivation necessary for carrying out the proposed work successfully.

In summary, I have a demonstrated record of accomplished and productive research, and my expertise have prepared me to contribute to the proposed project.

a. Tighe, P. J., Nickerson, P., Fillingim, R. B., & **Rashidi, P.** (2017). Characterizations of temporal postoperative pain signatures with symbolic aggregate approximations. The Clinical journal of pain, 33(1), 1-11. PMCID: 27153359
b. Wanigatunga A., Nickerson P., Manini T., & **Rashidi P.** (2016) Using symbolic aggregate approximation (SAX) to visualize activity transitions among older adults. Physiological Measurement 37, no. 11: 1981. PMCID: PMC5099975
c. Gopalswamy, S., Tighe, P. J., & **Rashidi, P.** (2017). Deep recurrent neural networks for predicting intraoperative and postoperative outcomes and trends. In Biomedical & Health Informatics (BHI), pp. 361-364. IEEE. PMCID: 28268935
d. Ozrazgat-Baslanti, T., Blanc, P., Thottakkara, P., Ruppert, M., **Rashidi, P.,** Momcilovic, P., & Bihorac, A. (2016). Preoperative assessment of the risk for multiple complications after surgery. Surgery, 160(2), 463-472. PMCID: PMC5114020

B. Positions and Honors

Positions and Employment

2006-2011 Research Assistant, Computer Science Department, Washington State University, WA
Summer 2009 Research Intern, Microsoft Research, Health Systems, Washington DC
2011-2012 Research Scientist, Department of Computer Science, University of Florida, FL
2012-2013 Assistant Professor, Health and Engineering Center, Northwestern University, IL
2013-Present Assistant Professor, Department of Biomedical Engineering, University of Florida, FL
2013-Present (Affiliated) Assistant Professor, Department of Electrical & Computer Engineering, University of Florida, FL
2016-Present (Affiliated) Assistant Professor, Department of Computer & Information Science & Engineering, University of Florida, FL
2013-Present Assistant Professor, Department of Biomedical Engineering, University of Florida, FL

Other Experience and Professional Memberships

2006- Present Member, Knowledge and Data Discovery, Association for Computing Machinery (ACM)
2006- Present Member, Computer Society, Institute of Electrical and Electronics Engineers (IEEE)
2012- Present Member, American Medical Informatics Association (AMIA)
2014 Co-Chair, Smart Health Workshop
2015 Program Committee, ACM Conference on Knowledge Discovery and Data Mining (KDD)
2011-2017 NSF Panelist, Computer and Information Science and Engineering

Honors

2015 BMES Innovation and Career Development Award
2015 Invited participant, Microsoft Faculty Summit
2014 National Science Foundation Travel Award, Computing Challenges in Future Mobile Health (mHealth) Systems and Applications Workshop
2011 The outstanding dissertation award, Washington State University, WA
2006 Graduate Research Award, Washington State University, WA

C. Contribution to Science

1. Intelligent Patient Monitoring: Monitoring patient status has been traditionally done through manual assessments and diagnoses. While this is still considered as the gold standard, manual assessments impose serious limitations in terms of time and personnel resources. The recent advances in sensing technology along with machine learning methodology has allowed us to automating certain aspects of patient monitoring. I have been extensively involved in developing intelligent health environments. It started with my work on developing smart home for monitoring cognitive and functional status of elderly suffering from Alzheimer's' diseases using novel machine learning models. My manuscripts and literature review papers in the area are highly cited, and I hold a related patent. We are currently completing two manuscripts describing the preliminary results of our work on the concept of intelligent Intensive Care Unit (ICU). The intelligent patient monitoring concept provides an opportunity for integrating and fusing data from sensors, medical history, and surrounding environment to provide comprehensive information on patient status in real-time.

    a. Wanigatunga A., Nickerson P., Manini T., & **Rashidi P.** (2016) Using symbolic aggregate approximation (SAX) to visualize activity transitions among older adults. Physiological Measurement 37, no. 11: 1981. PMCID: PMC5099975
    b. Mohr, D. C., Schueller, S. M., Montague, E., Burns, M. N., & **Rashidi, P**. (2014) An integrated conceptual and technological framework for eHealth and mHealth interventions. Journal of medical Internet research, 16(6). PMCID: PMC4071229
    c. Cook, D. J., Krishnan, N. C., & **Rashidi, P.** (2013). Activity discovery and activity recognition: A new partnership. IEEE transactions on cybernetics, 43(3), 820-828. PMCID: PMC3772991
    d. Acampora, G., Cook, D. J., **Rashidi, P**., & Vasilakos, A. V (*alphabetically ordered author list, equal contribution*). (2013). Ambient intelligence in healthcare. Proceedings of the IEEE, 101(12), 2470-2494. PMCID: PMC3890262

2. Advanced Machine Learning for Pain Pattern Analysis: In the past, linear regression techniques have been used for analyzing various factors associated with postoperative pain. However, linear regression techniques face difficulty in analyzing complex, high-dimensional, and multimodal datasets. Recent machine learning techniques, such as deep learning models, can address the shortcomings of linear regression models, and can analyze such complex datasets easily. The application of such models in the postoperative pain analysis domain has been very limited in the past. In my collaborations with Dr. Tighe, I have developed advanced machine learning and time series analysis techniques for analyzing complex pain signatures. These findings improve our understanding of the postoperative pain, and can point to possible interventions.

    a. Tighe, P. J., Nickerson, P., Fillingim, R. B., & **Rashidi, P.** (2017). Characterizations of temporal postoperative pain signatures with symbolic aggregate approximations. The Clinical journal of pain, 33(1), 1-11. PMID: 27153359
    b. Nickerson, P., Tighe, P., Shickel, B., & **Rashidi, P.** (2016). Deep neural network architectures for forecasting analgesic response. Engineering in Medicine and Biology Society (EMBC), (pp. 2966-2969). IEEE. PMID: 28268935
    c. Tighe, P. J., Bzdega, M., Fillingim, R. B., **Rashidi, P.**, & Aytug, H. (2016). Markov chain evaluation of acute postoperative pain transition states. Pain, 157(3), 717-728. PMCID: PMC4979073

3. Machine Learning for Complex Perioperative Data Analysis: Outcome prediction and decision support in the perioperative settings has been studied extensively in the past. However, most previous studies do not utilize the full extent of available complex and high-dimensional data, due to limitations of traditional methods for analyzing such dataset. My research addresses discovering patterns from complex and high-dimensional data using advanced machine learning techniques. These finding can

help to inform new interventions, as well as increase our understanding of the interconnected factors impacting patient recovery after surgery.

a. Gopalswamy, S., Tighe, P. J., & **Rashidi, P.** (2017). Deep recurrent neural networks for predicting intraoperative and postoperative outcomes and trends. In Biomedical & Health Informatics (BHI), pp. 361-364. IEEE. PMID: 28268935
b. Ozrazgat-Baslanti, T., Blanc, P., Thottakkara, P., Ruppert, M., **Rashidi, P.**, Momcilovic, P., & Bihorac, A. (2016). Preoperative assessment of the risk for multiple complications after surgery. Surgery, 160(2), 463-472. PMCID: PMC5114020
c. Ebadi, A., Tighe, P. J., Zhang, L., & **Rashidi, P.** (2017). DisTeam: A decision support tool for surgical team selection. Artificial Intelligence in Medicine, 76, 16-26. PMID: 28363285
d. Thottakkara, P., Ozrazgat-Baslanti, T., Hupf, B. B., **Rashidi, P**., Pardalos, P., Momcilovic, P., & Bihorac, A. (2016). Application of Machine Learning Techniques to High-Dimensional Clinical Data to Forecast Postoperative Complications. PloS one, 11(5), e0155705. PMCID: PMC4883761

Complete list if Published Work in My Bibliography:
https://www.ncbi.nlm.nih.gov/sites/myncbi/parisa.rashidi.1/bibliography/43907202/public/?sort=date&direction=ascending.

D. Research Support

Ongoing Research Support

NSF-SBIR-Phase II #1448967 Benton, Rashidi (PI) 09/01/2016 – 09/01/2018
An Intelligent Mental Health Therapy Tool
The major goals of this project are to utilize the wealth of collected data and novel data mining and machine learning techniques to provide highly personalized treatments to mental health patient.
Role: Co-PI

R01 GM114290-01 Tighe (PI) 07/01/2015 - 06/30/2020
Time Series Analysis of TEMporal PostOperative pain Signatures
This project examines how postoperative pain scores change with respect to time using machine learning and advanced data analysis techniques.
Role: Co-Investigator

NCI-SBIR-Phase II HHSN261201500014C Manini, Albinali (PI) 09/15/2015 - 09/14/2017
PEAKS Validation of mobile technologies for clinical assessment, monitoring and intervention
This project examines how wearable accelerometers can be used for clinical assessment and monitoring.
Role: Co-Investigator

National Institute of Health (NIH) Bihorac, Li (PI) 03/01/2016 - 12/31/2020
R01**:** Integrating data, algorithms and clinical reasoning for surgical risk assessment
Project Goal: This project examines how surgical risk can be assessed using machine learning and advanced data analysis techniques.
Role: Co-I

UF Informatics Institute (UFII) Rashidi (PI) 01/01/2016 - 12/31/2017
Automatic Real-Time Detection of Delirium in Intensive Care Units using Pattern Recognition
Project Goal: This project examines how delirium can be detected using machine learning and advanced data analysis techniques.
Role: PI

PRICE-CTSI Rashidi (PI) 09/01/2016 - 08/31/2018
Real-Time Patient Reported Outcome of Pain in Community-dwelling Older Adults
Project Goal: This project aim is to provide an ecological momentary assessment (EMA) tool for capturing patient reported outcome (PRO) in real time within daily life, using a smartwatch for collecting pain intensity, fatigue level, and mood.
Role: PI

Departmental Startup Grant, University of Florida Rashidi (PI) 09/01/2013 - 09/01/2018
Research Startup Funds
Project Goal: The purpose of this grant is to support PI's laboratory and fund preliminary studies needed to be competitive for extramural research support.
Role: PI

Completed Research Support

Informatics Institute Seed Grant Manini (PI) 06/23/2014 - 06/23/2015
Analysis of actigraphy patterns for improved physical activity intervention and preventing mobility incidents in older adults
The major goal of this project is to analyze the temporal patterns in accelerometer data to identify mobility impairment using high-resolution movement data measured from accelerometer.
Role: Co-Investigator

NSF-SBIR-Phase I #1448967 Benton, Rashidi (PI) 01/01/2014 – 01/01/2015
An Intelligent Mental Health Therapy Tool
The major goals of this project are to utilize the wealth of collected data and novel data mining and machine learning techniques to provide highly personalized treatments to mental health patient.
Role: Co-PI

National Science Foundation Rashidi, Benton (PI) 03/01/2016-06/30/2016
BRIDGE Phase I to II: TAO: An Intelligent Mental Health Therapy Tool
Project Goal: The major goals of this project are to further develop the natural language processing techniques developed in Phase I using techniques such as word embedding and deep learning.
Role: PI (Private Partner: Benton, Tao Connect Inc.)

Florida High Tech Corridor Rashidi(PI) 06/01/2015 - 11/30/2016
Intelligent Mental Health Treatment Recommendations
The goal of this project is to automatically recommend treatments and interventions based on personalized patient profiles and their recovery trajectory.
Role: PI

Budget, Justification and Cost Estimates

Program Director/Principal Investigator (Last, First, Middle): Bihorac, Azra

DETAILED BUDGET FOR INITIAL BUDGET PERIOD DIRECT COSTS ONLY	FROM 04/02/2018	THROUGH 04/01/2019

List PERSONNEL *(Applicant organization only)*
Use Cal, Acad, or Summer to Enter Months Devoted to Project
Enter Dollar Amounts Requested *(omit cents)* for Salary Requested and Fringe Benefits

NAME	ROLE ON PROJECT	Cal. Mnths	Acad. Mnths	Summer Mnths	INST.BASE SALARY	SALARY REQUESTED	FRINGE BENEFITS	TOTAL
Azra Bihorac	PI	0.6						
Mohcine Madkour	Co-I	2.4						
Tezcan Ozrazgat Baslanti	Co-I	0.6						
Xiaolin (Andy) Li	Co-I	0.6						
Parisa Rashidi	Co-I	0.6						
Lasith Adhikari	Analyst	2.4				10000	1020	11,020
Ben Shickel	Analyst	1.2				4672	477	5,149
Sabyasachi Bandyopadhyay	Analyst	1.2				5330	543	5,873
								22,042
SUBTOTALS →						20002	2040	22,042

CONSULTANT COSTS	
EQUIPMENT *(Itemize)* Quantum TXR2311000R-Deep Learning Dev Box (4x Titan X, 128GB DDR4)	10,000
SUPPLIES *(Itemize by category)*	
TRAVEL AMIA 2019 Conference (*4)	6000
INPATIENT CARE COSTS	
OUTPATIENT CARE COSTS	
ALTERATIONS AND RENOVATIONS *(Itemize by category)*	
OTHER EXPENSES *(Itemize by category)* UF Health Integrated Data Repository/EPIC	4,000

CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS	
SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD *(Item 7a, Face Page)*		**$**
CONSORTIUM/CONTRACTUAL COSTS	FACILITIES AND ADMINISTRATIVE COSTS	
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD		**$** 42,042

UF UNIVERSITY of FLORIDA

College of Medicine
Division of Nephrology, Hypertension, & Renal Transplantation
A Culture of Caring, a Commitment to Investigation

1600 SW Archer Road
PO Box 100224
Gainesville, FL 32611-0224
352-273-8821
352-392-5465 Fax

UFII/CTSI

Dear Grant Review Committee,

I would like to strongly support an application for a UFII/CTSI junior faculty grant by Mohcine Madkour, Ph.D. Mohcine started as a post-doctoral fellow four years ago at a the University of Houston and then at the University of Texas Health Science Center at Houston. He has joined U.F. as a junior faculty member in May of last year.

Mohcine has a strong computer science and engineering background by training and under my mentorship has developed into an expert in the field of health care data integration and risk prediction research. He is a key member of our PRISMA^{P} research partnership that encompasses faculty members from engineering and medicine backgrounds. Our goal is to develop and implement new computational and statistical methods in the arena of predictive modelling for acutely ill patients. We were awarded a large NIH funded grant that supports real-time application of such models in the clinical work flow. Our existing infrastructure includes a HIPPA compliant high-performance computing network, Research Vault, that will be used in the development and deployment of the complex modelling proposed in this grant. We have excellent collaboration with the Integrated Data Repository and we have a secure loop for data flow between the IDR and Research Vault.

The core of his research program is focused on the study of real-time risk prediction of postoperative complications, and use of electronic health records for its clinical characterization among hospitalized patients using novel machine learning and real time data integration techniques. This UFII/CTSI grant, if awarded, will serve as the basis for a K25 career award grant planned for next year. As his mentor and co-PI on this grant I will provide all necessary mentoring support and expertise for both clinical context and computational modelling.

Sincerely

Azra Bihorac

Azra BIhorac

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UFII and CTSI Grant Review Committee

Dear Grant Review Committee,

I am writing this letter to show my dedication to the project being submitted as UFII and CTSI Advanced Data Integration and Analytics for Translational Health Research grant. I have been a mentor for Tezcan Ozrazgat Baslanti, Ph.D. , a co-investigator on this grant, for the past seven years. She started as a post-doctoral fellow in my research group in 2011 and has joined U.F. as a junior faculty member two years ago.

Tezcan has a strong statistical background by training and under my mentorship has developed into an expert in the field of critical care and nephrology outcome research. She is a key member of our PRISMA^{P} research partnership that encompasses faculty members from engineering and medicine backgrounds. Our goal is to develop and implement new computational and statistical methods in the arena of predictive modelling for acutely ill patients. We were recently awarded a large NIH funded grant that supports real-time application of such models in the clinical work flow. Our existing infrastructure includes a HIPAA compliant high-performance computing network, Research Vault, that will be used in the development and deployment of the complex modelling proposed in this grant. We have excellent collaboration with the Integrated Data Repository and we have a secure loop for data flow between the IDR and Research Vault.

The core of this research program is focused on development of a system for data integration and analytics for real-time risk prediction. This UFII- CTSI grant, if awarded, will serve as the basis for a K25 career award grant planned for next year for Tezcan. As her mentor and PI on this grant I will provide all necessary mentoring support and expertise for both clinical context and computational modelling.

Sincerely

Azra BIhorac