

University of Louisville New Academic Program Proposal Template

Certificate Programs

After approval of the Letter of Intent, certificate programs are to complete the New Academic Certificate Program Proposal template.

All forms are available at:

<http://louisville.edu/oapa/new-academic-program-approval-page/new-academic-program-approval>

Please ensure all questions are addressed clearly and completely to avoid unnecessary delays. Questions can be directed to the Office of Academic Planning and Accountability through the Program Approval Service Account (PROGAPPR@louisville.edu).

Financial Aid for Certificate Programs:

Students enrolled in stand-alone certificate program are not eligible for federal financial aid. The university elected on 6/30/2012 to opt out of participation in gainful employment requirements with the Department of Education (DOE). UofL students must be enrolled in a degree granting program in conjunction with the certificate program to receive federal aid.

**Send the following materials to the
Program Approval Service Account (PROGAPPR@louisville.edu):**

- Completed Proposal Template
- Proposed Program Curriculum (complete the table found in Appendix A of this proposal template)
- Course syllabi for any new course offerings
- Faculty Roster Form
- CV for Program Director/Coordinator
- Proposal Budget Form
- Letter of Support from the unit Dean
- Letter of Support from the UofL Libraries
- Letter(s) of Support from any units, departments, or internal or external entities that will be supporting the certificate program

The program approval process will not begin until all of the above documents are received. Please submit all materials listed above at the same time.

General Program Information	
Date: February 29, 2020	
Program Name: Certificate in Artificial Intelligence in Medicine	
Degree Level: M.Eng. and M.S. engineering students	<u>Undergraduate:</u> _____ <u>Graduate</u> (select one of the following): Post-Baccalaureate <u> X </u> Post-Master's _____ Post-Professional _____
Minimum and Maximum Number of Credit Hours required: 15	
Accreditation or Licensure Requirements (if applicable): None	
CIP Code: Forthcoming	
Department and Department Chair: Bioengineering, Dr. Ayman El-Baz	
School/College: J. B. Speed School of Engineering	
Program Director and Contact (if different); Dr. Hermann Frieboes, Associate Professor (please also include title):	
Is an approval letter from the Education Professional Standards Board (EPSB) required for this program? No If so, attach a copy to this proposal.	
Proposed Implementation Date for Program (semester and year): Fall 2020	
Anticipated Date for Granting First Degree: Spring 2020	
Identify whether the program is 100% online, 100% face-to-face, or a combination of the two: The program can be completed solely online. Some students may choose to complete it via a combination of in-class and online courses.	

A. Centrality to UofL's Mission and Strategic Plan

The certificate program is to adhere to the role and scope of the University of Louisville as set forth in its mission statement and as complemented by UofL's strategic plan.

<p>1. Provide a brief description of the program (copy the abstract provided in the program's Letter of Intent here). (250 words or less; program's purpose/focus, primary areas of study, intended audience, degree level, length of the program, goals/objectives, rationale for program, skills or knowledge that students will acquire, relationship of program to general field).</p> <p>The primary focus of this Certificate is Artificial Intelligence in Medicine, which is succinctly defined as the application of computational methods and machine learning techniques to the analysis of medical problems. The intended audience of this certificate is students in the workforce as well as students pursuing a professional degree, including M.Eng. and M.S. engineering students who will be trained to apply these engineering techniques to medicine. Students may take the courses in the</p>

program on campus (in class) or online, or a combination of both. The population may include regional, national, and international students.

The length of the program is envisioned to be two semesters. The focus of the program is an emphasis on the mastery of skills required to analyze medical data related to patients, which include big data, medical imaging, physiological and disease progression modeling, experimental (clinical and laboratory), and healthcare information. The academic goals of the certificate program are mastery of methods for efficient and precise analysis of medical data. The rationale for creating the certificate program are the benefits to healthcare that would be gained through the use of modern computational techniques to manage and investigate the ever-increasing volume of patient data and the wide variety of diseases. Purely manual or empirical assessment is no longer adequate due to the large size and complex relationships embedded within these data. Students will acquire skills and knowledge in computation, modeling and simulation, machine learning, medical data management, and advanced statistical analysis, with an emphasis on interdisciplinary collaboration. The certificate's relationship to the general field of engineering is to provide specialized training in the automated analysis of medical data.

A unique feature of the program designed to attract students is the unique focus on applying computation to study biomedical problems that leverage the research at the Dept. of Bioengineering and the Health Sciences at UofL. The research areas include spinal cord injury, cancer, infectious diseases and aging, which are all considered especially strong in Louisville. Further, the Dept. of Bioengineering has established international partnerships with prestigious institutions that enable students from abroad to obtain this training. Additional attractants include the flexibility in the selection of courses, reasonable pricing, and the convenience of online coursework.

2. Explain how the proposed program relates to the institutional mission and academic strategic plan.

Establishing this Certificate will address a number of goals of the University's Strategic 2020 Plan and the 21st Century Initiative. Specifically, as related to the relevant goals stated in these initiatives, the Certificate will:

University 2020 Plan

1. Increase the quality and quantity of graduates in the health sciences to improve the health and well-being of the general population
2. Emphasize commercialization opportunities for clinical research and translational science

University 21st Century Initiative

1. Revenue Enhancement: "Strategically grow enrollment in high demand fields".

The Certificate relates to the University's Mission as follows:

1. Teach a diverse group of graduate students in order to develop engaged citizens, leaders, and scholars by providing the opportunity to specialize in the computational analysis of medical and health care data
2. Enable students to practice and apply research, scholarship and creative activity

3. List the objectives of the proposed program.

Explain how the objectives support the university and unit mission, strategic priorities, and institutional and societal needs.

In addition to the university-wide goals listed in **Subsection A.2**, the Certificate will also address several objectives outlined in the JB Speed School of Engineering 2020 Strategic Plan:

1. Establish areas of research excellence in engineering human health and cyber enabled discovery
2. Attract motivated, prepared and talented students into all Speed engineering degree programs
3. Provide a wide variety of outstanding experiential learning experiences
4. Engage students with state-of-the-art accredited engineering curricula
5. Greatly increase the national and international recognition of Speed School research activities

4. Clearly state the admission, retention, and degree completion standards designed to encourage high quality.

Please be clear and specific.

The Speed School of Engineering has rigorous standards for admission into graduate programs, and these standards will apply to the Certificate Program as well. Applicants must meet Speed School admission requirements along with the following program requirements. Applicants must, at a minimum, have completed the requirements for the engineering courses they select to take for this certificate. In addition, students are expected to have completed the course BE 340 (Computational Methodologies in Bioengineering), or equivalent. Successful applicants will typically have a 3.00 cumulative GPA in their Engineering courses. Applicants with a GPA of 2.75 will be considered for provisional acceptance; however, they must maintain a 3.00 GPA at a minimum in their first semester of study or they will not be allowed to continue in the program.

Applicants must submit a transcript showing the baccalaureate degree as well as successful completion of prerequisite courses based on the courses they wish to take for this program. Students lacking prerequisite courses may take them at UofL or another institution before they are officially admitted to the program. Students whose native language is non-English or the degree is from a non-US accredited institution are required to prove proficiency in the English language as specified for admission by the Speed School of Engineering.

Students must complete the courses in the Certificate Program with a 3.00 GPA or higher in all the required courses that satisfy the program requirements. Students must complete a minimum of 15 credits. All program requirements must be completed within three years from admission into the program.

The full program is expected to be offered online and, as such, can be completed by distance education students subject to the same admission and graduation requirements as in-class students.

B. Program Quality and Student Success

1. What are the intended student learning outcomes of the proposed program?

All of the currently identified Bioengineering MEng ABET student learning outcomes apply to the proposed Certificate:

1. An ability to identify, formulate, and solve complex engineering problems by applying advanced principles of engineering, science and mathematics.
2. An ability to apply engineering design to produce advanced solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental and economic factors.
3. An ability to develop and conduct appropriate experimentation using scientific methods to collect, analyze and interpret data, and to use engineering judgment to draw conclusions.
4. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

2. Describe how each program-level student learning outcome will be assessed (including when data will be collected and how assessment results will be used to improve the program).

The outcomes will be assessed as part of the courses, which are already being assessed for these outcomes. This program does not add any additional outcome or requirement to the already established assessment procedures. To summarize the current process, the grades for the student assignments and exams for each of the courses are collected, and linked according to assignment type to the student learning outcomes identified in **Subsection B.1**. Each course already has ABET-related rubrics with specific ranges. The target is for each outcome to be assessed at least at 75/100 for 75% of the students. This metric is used to assess results and to drive improvement of the program during the annual ABET retreat meeting of the Dept. of Bioengineering and follow-up discussions by the faculty throughout the year.

3. For each learning outcomes, provide direct indicators (and indirect, where possible) of achievement of the outcome, target(s) for the outcome, and frequency of data collection.

As described in **Subsection B.3.**, indicators of achievement will be based on meeting the target of assignment and exam grades to be a least 75/100 for 75% of the students. The data will be collected depending on when the assignments and exams are scheduled in each course. This means that the data are collected with each measurable occurrence.

4. Course Delivery Methods.

Please answer the following:

- a) Will this be a 100% distance learning program? Yes No
Some students may choose to complete the program via a combination of online and in-class courses.
- b) Will this program utilize alternative learning formats (e.g. distance learning, technology-enhanced instruction, evening/weekend classes, accelerated courses)? Yes No

If yes, please check all that apply below.

Distance Learning

- Courses that combine various modes of interaction, such as face-to-face, videoconferencing, audio-conferencing, mail, telephone, fax, e-mail, interactive television, or World Wide Web
- Technology-enhanced instruction
- Evening/weekend/early morning classes
- Accelerated courses
- Instruction at nontraditional locations, such as employer worksite
- Courses with multiple entry, exit, and reentry points
- Courses with "rolling" entrance and completion times, based on self-pacing
- Modularized courses

5. Is there a specialized accrediting agency related to this program? Yes No

a. If yes, please identify the agency.

b. If yes, will the program seek accreditation?

6. Describe the library resources available to support this program.

Please also submit a letter of support from the UofL Libraries.

Access to the qualitative and quantitative library resources must be appropriate for the proposed program and should meet recognized standards for study at a particular level or in a particular field where such standards are available.

No additional library resources are required to support this program. The courses of the program are currently supported by the Ekstrom (Main) and Kornhauser Libraries which house over 2.1 million volumes, approximately 16,000 current journal subscriptions, special collections, media and microforms. In addition, the library has an on-line virtual library that provides faculty, staff and students access to over 20,000 full text electronic journals, inter-library loan services, electronic books and databases, reference materials and other library resources. The library resources are more than adequate to support the needs of the faculty and students in the proposed Certificate Program.

C. Program Demand/Unnecessary Duplication

1. Provide the projected enrollment and graduation numbers for the first five years.

Academic Year	Degrees Conferred	Headcount Enrollment (Fall term)
2020-2021	3	5
2021-2022	8	12
2022-2023	14	19

2023-2024	19	25
2024-2025	24	31

2. Indicate any efforts to address student educational and workforce needs or to maximize student success, for both traditional and non-traditional students.

Include any data on student demand; career opportunities at the regional, state, and national levels; and any changes or trends in the discipline(s) that necessitate a new program.

The field of computation and, in particular, machine learning, has experienced a renewed interest in the past five years with the advancement of deep learning and artificial intelligence technologies. The confluence of increased computer hardware capabilities, e.g., via GPU architectures, and the advancement of computational algorithms, are opening up a broad application of such technologies in a diversity of fields, including transportation, retail business, and telecommunications. Consequently, most major universities in the U.S. have implemented machine learning certificate programs, including Stanford, Harvard, Cornell, and Johns Hopkins. The number of courses required to tackle these challenges has correspondingly mushroomed, with the projected growth of jobs for computer and information research scientists expected to grow 19% within the next 9 years, according to the University of California, Irvine. Additionally, these certificates are also being offered by large companies driving this innovative field, including IBM and Google.

This certificate program provides an area of concentration for students currently pursuing a professional degree. For students who are already in the workforce, the certificate offers an opportunity for professional enhancement to acquire new skills or promote an established career. The skills attained include the ability to analyze biomedical data via modeling and computational tools, such as machine learning. This narrow focus means that graduates interested in further education may most likely attend biomedical or bioengineering programs focused on the application of computational methodologies. Graduates seeking employment may eventually seek positions that require skills for the automated analysis of biomedical data, as may occur with health care, insurance, pharmaceutical, and laboratory employers.

The program requires students to complete 15 credit hours. We anticipate approximately half of the students will be from international universities taking the program online as visiting students, leveraging existing partnerships established by the Department of Bioengineering, e.g., with the University of Abu Dhabi.

Based on similar programs across the country and faculty resources during the first five years of the program, as well as expected enrollment by students residing internationally, we project an initial enrollment of 3-5 students, with the number of students admitted and enrolled increasing yearly by this same number. The first graduates are expected during the first year of the program. Thus, an enrollment of approximately 15-25 students is projected by Year 5.

3. Specify/highlight any distinctive qualities of the proposed program.

Artificial intelligence and computation applied to medicine represent a subset of computation and machine learning applied to medicine, with a specific focus on the analysis of medical data. As such, specialization in the analysis of medical data represents an under-developed potential. In the

past five years, the volume of data has exploded. The collection of patient information from electronic medical records and connected medical devices (e.g., wearable monitors) requires integration and analysis. Significant increases in the number of programs that address the computational analysis of big data clearly indicate the student demand for such programs, mirroring the rapid adoption of these techniques for the medical field.

Obtaining the proposed certificate will enhance a student's engineering skillset in a demonstrable manner, specifying the ability to perform at a highly specialized level in the computational analysis of medical data.

The program is designed for students currently pursuing a professional degree, or for students already in the workforce. The certificate augments a student's current academic or professional pursuits by enhancing their skills to analyze biomedical data via modeling and computational tools.

4. Does the proposed program serve a different student population (e.g., students in a different geographic area, non-traditional students, etc.) from existing programs?

If yes, please explain.

No

5. Will this program replace or enhance any existing program(s) or tracks, concentrations, or specializations within an existing program? Yes No

If so, please specify.

N/A

6. How will the program support or be supported by other programs and/or units within the institution? Please also describe potential for collaboration with other programs within the institution.

The courses available for this program may include assignments and projects in collaboration with researchers at the School of Medicine. In particular, BE faculty have established collaborations with the Cardiovascular Innovation Institute, the Kentucky Spinal Cord Injury Research Center, the Brown Cancer Center, the Center for Predictive Medicine, and the Departments of Oncology and Radiology. Distance and international students, not physically located at UofL, are expected to participate in these collaborations via teleconferencing and sharing of data and results. The data is expected to be provided from experiments performed by the BE faculty and their collaborators at UofL.

7. Describe the proposed program's relationship with programs at other institutions or external organizations (if applicable).

The Bioengineering Department is in process of establishing partnerships with universities in Egypt, U.A.E. and Germany. The faculty are planning to participate in research, publications, trainings, and sharing of courses with these institutions.

D. Cost

1. Will this program require additional resources? Yes No

If so, please provide a brief summary of new or additional resources that will be needed to implement this program over the next five years. Document the expected cost/expenditures in the table below.

Since this certificate is financially integrated with the current graduate programs in BE, the program does not require additional funding. The program courses are already available and being offered. No other programs are expected to be affected. The proposed program is considered an efficient and effective use of funds because it does not require additional funds in order to be implemented.

There is no expectation of special financial agreements with the Provost. No internal allocation or reallocation has been committed to the program. No graduate teaching assistants are requested for this program.

No additional facilities, technology or equipment are required for this program. As most of the resources for this program are computing-based, distance and international students, not physically present at UofL, will be able to access these resources remotely via the internet.

Software – Courses in the program use software and programs that are freely available online (such as Python and R), or that are made available to registered students via the Speed School technology website. No additional software or computational platforms are envisioned for this program.

Offices - The Bioengineering Department is located on the University of Louisville Belknap campus in Lutz Hall, which contains the department office, two teaching classrooms, two instructional laboratories, a conference room, and faculty research laboratories. Offices for faculty and staff are located in buildings across the Belknap Campus (Lutz Hall and Shumaker Research Building) and Health Sciences Campus (Cardiovascular Innovation Institute, Clinical Translation Research Building and Health Sciences Research Tower). Department and faculty offices for other Speed School of Engineering departments are located in Ernst Hall (Chemical Engineering), Duthie Center (Computer Engineering & Computer Science), J.B. Speed Building (Industrial Engineering), Sackett Hall (Mechanical Engineering), W.S. Speed Building (Electrical & Computer Engineering).

Classrooms and Instructional Laboratories – The program-specific courses are offered primarily in Lutz Hall. All classrooms have adequate lighting, climate control and acoustic characteristics, and are equipped with computers that interface with overhead LCD projectors. All buildings on the Belknap Campus are equipped with wireless internet access.

Computing Resources - The University of Louisville central research computing or Cardinal Research Cluster (CRC) is housed in the UofL Information Technology Data Center located in the Miller IT Center on the university's Belknap campus. This facility provides over 5000 square feet of secure, environmentally controlled data center space including a FM200 fire suppression system. The data center is fed by 1000kVA electrical service with backup power provided by a large UPS and an 1125 kVA diesel generator. The research cluster is equipped with its own dedicated in-row cooling systems, and utilizes cold aisle containment to improve cooling efficiency. The facility is

physically secure with limited keycard access and is monitored 24 hours a day. The UofL CRC infrastructure became available in spring 2009 and was upgraded in spring 2011. This infrastructure includes multiple systems serving the research needs of the entire university, including a general-purpose high-performance distributed-memory computation cluster, a high-memory SMP system and several general-purpose web and software servers. The general-purpose compute cluster is composed of 312 IBM iDatplex nodes each equipped with two Intel Xeon L5420 2.5 GHz quad-core processors for a total of 2496 processor cores. Each node has 16 or 32 GB of memory, and the node interconnects are a mixture of Gigabit Ethernet (1Gbps) and InfiniBand (16 Gbps) technology. The cluster is estimated to have a peak performance rating of 20+ TFLOPS. The University of Louisville's campuses are served by a 40 Gigabit per second (Gpbs) campus backbone network. This backbone is comprised of over 80 miles of fiber in a dual ring configuration. The wired network can provide 100Mbps and 1Gbps Ethernet service for faculty and staff communications needs. With the recently completed Pervasive Wireless Project, the U of L campus wireless network provides 802.11n wireless connectivity to wireless devices at speeds up to 300Mbps. This wireless connectivity is available across all of U of L's campuses, classrooms and buildings. The University of Louisville is connected to the Internet2 node via dedicated 10Gbps optical fiber backbone network. The Internet2 connection provides the University of Louisville direct, high bandwidth, access to national research and education networks such as XSEDE/Teragrid. The University of Louisville is also a member of the Kentucky Regional Optical Network (KyRON). This regional optical network is managed and operated through a consortium including the University of Louisville, the University of Kentucky and the Kentucky Council on Postsecondary Education. Participating universities are interconnected using 10Gbps optical links. The Kentucky RON extends the research data sharing capabilities of the University of Louisville with other participating universities throughout the state, and provides new opportunities for collaboration.

Multi-Disciplinary & Core Research Facilities - To support the training of students in state-of-the-art methodologies and techniques, Program students will have access to a number of multidisciplinary and core research facilities, as well as to individual faculty laboratories. Specifically, students will have access to the multi-disciplinary Bioinformatics Laboratory.

The Bioinformatics Laboratory is housed in the CECS department in room 238 of the Duthie Center. The facilities include a: visualization wall consisting of an assembly of 3x6 Dell monitors and used to visualize complex images; video conferencing system; powerful computers including Dell precision T7400 (8 processors, 20 gb RAM, 2 TB HDD, NVIDIA card) and Dell Alienware computers (8 processors, 12 GB RAM, 1 TB HDD, NVIDIA card); library with bioinformatics and related fields books; and, panaboard (Panasonic White board) that can take pictures of the discussion and can be saved and printed from computer.

2. Complete the SACS Faculty Roster Form found at the link below and submit it with this proposal.

Found at:

<http://louisville.edu/oapa/new-academic-program-approval-page/new-academic-program-approval>

Also submit a copy of the program director's CV.

3. Are new or additional faculty needed? Yes No

- a) If yes, please explain, indicating the number and role of each new faculty member and whether they will be part-time or full-time. Specify if graduate assistants are included in the additional faculty resources needed.
- b) If new faculty are needed, please provide a plan to ensure that appropriate faculty resources are available, either within the institution or externally, to support the program.
- c) What is the projected faculty/student ratio for the program?

N/A

4. Will this program impact existing programs and/or organizational units within UofL?
Yes No

If so, please describe the impact.
(examples: reallocation of resources, faculty or staff reassigned, changes to other programs and/or course offerings, reduction or increase in students served, any other possible impact) .

All the coursework for the Certificate Program will be from the BE and CECS department current course offerings, as listed in **Appendix A**. The modest increase in students taking any of the courses in the program is not expected to require additional resources over the next 5 years.

- **Complete the New Program Budget Spreadsheet.**

Found at:

<http://louisville.edu/oapa/new-academic-program-approval-page/new-academic-program-approval>

Notes for completing the Budget Spreadsheet:

- Provide an estimate of the level of new and existing resources that will be required to implement and sustain the program.
- Any existing resources reallocated to support this new offering should be estimated as an “internal reallocation” in both the Funding Sources and Expenses sections of the budget.
- Any new resources for which the unit/department plans to allocate funding should be listed as “allocation” in both the Funding Sources and Expenses sections of the budget.
- The program proposal is to be developed without the expectation of tuition-sharing or recovery agreements with the Provost. This approach ensures that the “cost” of operating the program is somewhat reflective of reality.
- For every place you add numbers (in both the Funding Sources and Expenses spreadsheet)

provide a written explanation for the numbers, including how they were calculated. The CPE system won't let us submit the proposal without explanations for the budget numbers.

- The budget for the proposed program is to be in alignment with the latest budget assumptions (provided below as of 10/7/19) from the Budget Model Workgroup.

Undergraduate*

70% (net of mandatory student fees) of resident per credit hour tuition rate (i.e., the listed rate on the bursar's website) charged to undergraduate students is allocated to the academic unit where the instruction takes place. Every credit hour is treated the same under the model.

Graduate/Professional*

Graduate: 75% (net of mandatory student fees) of tuition review revenue allocated according to a student's home academic program.

Professional: 85% of tuition revenues generated from professional degree (law, dentistry, medicine), doctoral, and DNP programs allocated to the student's home academic program. For purposes of the budget model, doctoral programs fall in the Professional category.

*These definitions of the Budget Model are as of 10/7/19 and are subject to change.

Note that there are three tabs to the Budget spreadsheet.

Funding Sources tab:

- Indicate funding to be supplied by the unit (include direct funding & In-kind support):
- Internal allocation and reallocation are those estimated dollars needed to fund the start-up and support the new academic program – typically defined as faculty, administrative/staff, and operational expenses.
- When calculating funding, consider the impact on current faculty workloads.
- Include the expected tuition revenue generated by anticipated student enrollment.
- If the program will use existing faculty or other existing resources, the amount of funding represented by those resources are to be listed in the Funding Sources table as reallocation of funds.
- If reallocation of “existing” funds are included in the Funding spreadsheet, the numbers should also be reflected in the Expenses spreadsheet.
- If the unit has allocated funds for any new expenses in the Funding Sources spreadsheet, the numbers should also be added to the Expenses spreadsheet.

Expenses tab:

- You do not have to estimate classroom space unless you believe that existing space is not sufficient to support the academic program.
- Any expenses identified as “existing” funds in the expenses spreadsheet should also be added to the Funding Sources spreadsheet as either internal reallocation or internal allocation.

Funding Source/Expenses Combined tab:

- This spreadsheet will pre-populate based upon the numbers entered into the Funding Sources and Expenses spreadsheets. The goal is to have more funding than expenses.

Appendix A Program Curriculum

7. In the table below, provide the program curriculum and any options; indicate total number of credit hours required for degree completion.

- Include full course names and course descriptions.
- Where they exist you should report actual course numbers, titles, and descriptions in the course template. If the program has no specific course numbers required under a particular heading, provide a description of the type of course(s) required in the “course title” column and the number or range of credit hours required.
- Provide a copy of the course syllabus for any new courses developed.

Note 1. All of the courses required for the program already exist in the Department of Bioengineering (BE), the Department of Computer Science and Engineering (CSE), and the School of Public Health (SPH) (Departments of Bioinformatics & Biostatistics (PHST) and Department of Health Management Systems Sciences (PHMS)).

Note 2. A student may enroll in any of the available courses to satisfy the graduation requirements, with at least 9 credits originating from BE courses.

Note 3. Course currently not available online, but envisioned to be offered online in the future.

Prefix & Number	Course Title	Course Description	Credits	Required?	New	Existing	Revised	Offered Online?
BE 500	Computer Tools for medical image analysis		3	No (note 2 above)		X		Yes
BE 524	LabVIEW for Bioengineers		3	No (note 2 above)		X		Yes
BE 530	Machine learning in medicine using Python		3	No (note 2 above)		X		Yes
BE 540	Machine learning in medicine		3	No (note 2 above)		X		Yes
BE 542	Medical image computing		3	No (note 2 above)		X		Yes
BE 640	Medical image analysis		3	No (note 2 above)		X		Yes
BE 685	Modeling of biological phenomena		3	No (notes 2, 3 above)		X		No
CSE 545	Artificial Intelligence		3	No (note 2 above)		X		Yes
CSE 590	Big Data Analytics Tools & Tec		3	No (note 2 above)		X		Yes

CSE 590	Introduction to Machine Learning		3	No (note 2, 3 above)		X		No
CSE 590	Introduction to Deep Learning		3	No (note 2 above)		X		Yes
CSE 590	Python & Data Analytics		3	No (note 2 above)		X		Yes
CSE 632	Data Mining		3	No (note 2, 3 above)		X		No
CSE 641	Medical Image Systems		3	No (note 2, 3 above)		X		No
CSE 660	Introduction to bioinformatics		3	No (note 2, 3 above)		X		No
CSE 694	Current topics in bioinformatics		3	No (note 2, 3 above)		X		No
CSE 694	Topics in Advanced Machine Learning Theory & Methods		3	No (note 2, 3 above)		X		No
PHST 620	Introduction to Statistical Computing		3	No (note 2 above)		X		Yes
PHST 655	Statistical Methods for Bioinformatics		3	No (note 2, 3 above)		X		No
PHST 681	Biostatistical Methods		3	No (note 2, 3 above)		X		No
PHST 710	Advanced Statistical Computing		3	No (note 2, 3 above)		X		No
PHMS 641	Data Mining I		3	No (note 2 above)		X		Yes
PHMS 642	Data Mining II		3	No (note 2 above)		X		Yes
TOTAL CREDITS REQUIRED			15					

Faculty Roster Form

Qualifications of Full-Time and Part-Time Faculty

Name of Institution: University of Louisville J. B. Speed School

Name of Primary Department, Academic Program, or Discipline: Bioengineering

Academic Term(s) Included: Spring, Summer, Fall

Date Form Completed: March 9, 2020-

<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
NAME (F, P)	COURSES TAUGHT Including Term, Course Number & Title, Credit Hours	ACADEMIC DEGREES & COURSEWORK Relevant to Courses Taught, Including Institution & Major List specific graduate coursework, if needed	OTHER QUALIFICATIONS & COMMENTS Related to Courses Taught
El-Baz, Ayman (F)	BE 500: Computer Tools for medical image analysis (3): Spring, Summer, Fall BE 530: Machine learning in medicine using Python (3): Spring, Summer, Fall BE 540: Machine learning in medicine (3): Spring, Summer, Fall BE 542: Medical Image Computing (3): Spring, Summer, Fall BE 640: Medical Image Analysis (3): Spring, Summer, Fall CSE 641: Medical Image Systems (3): Fall	Ph.D. in Electrical and Computer Engineering, University of Louisville, 2006 M.S. in Electrical Engineering, Mansoura University, 2000	
Roussel, Thomas (F)	BE 524: Labview for Bioengineers (3), Spring, Summer, Fall	Ph.D. in Mechanical Engineering, University of Louisville, 2014 Master of Science in Biomedical Engineering, Louisiana Tech University, 2001	
Frieboes, Hermann (F)	BE 685: Modeling of biological phenomena (3): Summer	Ph.D. in Biomedical Engineering, University of California - Irvine, 2006 M.S. in Computer Engineering, University of California - Irvine, 1993	
Rouchka, Erik (F)	CECS 660: Introduction to	D.Sc. in Computer Science, Washington	

	bioinformatics (3): Spring CECS 694: Current topics in bioinformatics (3): Fall	University - St. Louis, 2002 M.S. in Computer Science, Rensselaer Polytechnic Institute, 1996	
Nasraoui, Olfa (F)	CECS 694: Topics in Advanced Machine Learning Theory & Methods (3): Spring	Ph.D. in Computer Science & Computer Engineering, University of Missouri - Columbia, 1999 M.S. in Computer Engineering, University of Missouri - Columbia, 1992	
Kantardzic, Mehmed (F)	CECS 632: Data Mining (3): Fall	Ph.D. in Computer Science, University of Sarajevo, 1980 M.S. in Computer Science, University of Sarajevo, 1976	
Yampolski, R (F)	CSE 545: Artificial Intelligence (3): Fall	Ph.D. in Computer Science & Engineering, The State University of New York - Buffalo, 2008 M.S. in Computer Science, Rochester Institute of Technology, 2004 A.S. in Computer Science, Monroe Community College, 2000	
Kumar, A (F)	CSE 590: Big Data Analytics Tools & Tec (3): Fall	Ph.D. in Electrical Engineering, North Carolina State University, 1989 M.S. in Electrical Engineering, University of Manitoba, 1986 B.E. in Computer Science, University of Allahabad, 1983	
Sierrasosa, D (F)	CSE 590: Introduction to Deep Learning (3): Spring CSE 590: Python & Data Analytics (3): Spring	Ph.D, School of Physics at National University of La Plata (UNLP), La Plata, Argentina.	
Frigui, H (F)	CSE 590: Introduction to Machine Learning (3): Spring	Ph.D. in Computer Engineering, University of Missouri - Columbia, 1997 M.S. in Electrical Engineering, University of Missouri - Columbia, 1992 B.S. in Computer & Electrical Engineering, University of Missouri - Columbia, 1990	
Gunaratnam B	PHST 620: Introduction to Statistical Computing	Ph.D. Statistics (2013), Case Western Reserve University M.Phil. Statistics (2007), Cardiff University, United Kingdom M.Sc. Applied Statistics (2003), University of Peradeniya, Sri Lanka	

Mitra, R	PHST 655: Statistical Methods for Bioinformatics PHST 681: Biostatistical Methods PHST 750: Statistics for Bioinformatics	Ph.D in Biostatistics, University of North Carolina at Chapel Hill in 2010	
Zheng, Q	PHST 681: Biostatistical Methods	Ph.D. (2013) Mathematical Science, Clemson University.	
Kong, M	PHST 710: Advanced Statistical Computing	Ph.D., Statistics, 2004, Indiana University, Bloomington M.S., Computational Mathematics, Xian Jiaotong University, Shaanxi, China.	
Little B	PHMS 641: Data Mining I PHMS 642: Data Mining II	Ph.D. The University of Texas-Austin, Physical Anthropology (Human Genetics, Growth, Adaptability); Applied Mathematics (Statistics, Probability Theory) M.A. Ball State University, Primatology/Computer Science	

F, P: Full-time or Part-time;

HERMANN B. FRIEBOES

Associate Professor
Department of Bioengineering
J.B. Speed School of Engineering
University of Louisville

Lutz Hall 419
Louisville, KY 40202, USA
Phone 502-852-3345
Fax 502-852-7979
Email: hbfrie01 (at) louisville (dot) edu

EDUCATION

- Ph.D., Biomedical Engineering, University of California, Irvine, 2006. Area of research: *Mathematical and experimental modeling of cancer growth, vascularization, and drug treatment.*
- M.S., Computer Engineering, University of California, Irvine. Field of study: *Algorithms, real-time embedded systems, and microprocessor architecture.*

EXPERIENCE

2016-present Associate Professor, Dept. of Bioengineering, University of Louisville, KY
2011-present Assistant Scientist, Brown Cancer Center, University of Louisville
2010-2016 Assistant Professor, Dept. of Bioengineering, University of Louisville, KY
2007-2010 Postdoctoral Fellow, Univ. of Texas Health Science Center – SHIS, Houston, TX
2003-2006 Doctoral Student, Dept. of Biomedical Engineering, Univ. of California, Irvine

RESEARCH STATEMENT

Dr. Hermann Frieboes received the Ph.D. degree in Biomedical Engineering from the University of California, Irvine, in 2006. He is currently an Associate Professor in the Department of Bioengineering at the University of Louisville. Dr. Frieboes' research focuses on the interdisciplinary development and implementation of mathematical modeling, computational simulation, and experimental biology techniques that can be quantitatively integrated to characterize disease progression and treatment response. This work includes the development of quantitative techniques for multiscale linking of the molecular- to cell- to-tissue-scale interactions and associated biophysical processes during disease progression. He is the author of numerous peer-reviewed journal articles and book chapters, and his work has been supported by grant funding from the National Institutes of Health.

Dr. Frieboes pursues an improved understanding of disease progression and response to treatment by applying principles from engineering and the physical sciences. His expertise is

focused on the development and integration of mathematical modeling, computational simulation, and experimental biology techniques to study cancer. This work is part of the burgeoning field of “Physical Oncology,” in which cancer is studied not only from a biological standpoint but also as a physical system using mathematics and physics. This interdisciplinary study of cancer requires that experimental and clinical data drive the computational and modeling work. The aim of Dr. Frieboes’ research is to predict tumor behavior from the molecular and cellular scale events, with the ultimate goal to help guide the treatment of individual patients. This novel research intersects the fields of cancer biology, scientific computing, data visualization, mathematical biology, and physical oncology.

The ultimate goal of this integrated physical sciences/biology work is to dramatically improve cancer treatment outcomes. To this end, the work can be divided into the following scientific contributions:

- Mathematical modeling and computational simulation to characterize tumor growth
- Multiscale linking of molecular- to cell- to-tissue-scale events during tumor progression
- Integration of modeling and experimentation to characterize cancer treatment response
- Modeling and simulation of cancer nanotherapy
- Modeling and simulation of cancer immunotherapy

Complete list of publications:

<http://www.ncbi.nlm.nih.gov/pubmed/?term=frieboes+h>

Cost/Funding Explanation

Complete the following table for the first five years of the proposed program and provide an explanation of how the institution will sustain funding needs. For any existing dollar amounts and department allocation for new dollar amounts reported in the Expenses spreadsheet, also add the dollar amounts to the Funding Sources spreadsheet under Internal allocation or reallocation.

You must add an explanation/justification for any dollar amount reported in this table.

*The FundingSource Expenses-Combined spreadsheet will pre-populate from the numbers entered into the Funding Sources and Expenses spreadsheets. The total funding and expenses shown in the Combined spreadsheet should be the same (i.e., there should be enough funding to cover the proposed expenses).

Provide an explanation for any excess funding beyond those needed to cover expenses.

A. Funding Sources, by year of program:	1st Year	2nd Year	3rd Year	4th Year	5th Year
Total Resources Available from Federal Sources					
~ New	\$ -	\$ -	\$ -	\$ -	\$ -
~ Existing	\$ -	\$ -	\$ -	\$ -	\$ -
Narrative Explanation/Justification:					
Funding Sources, by year of program (continued)	1st Year	2nd Year	3rd Year	4th Year	5th Year
Total Resources Available from Other Non-State Sources					
~ New					
~ Existing					
Narrative Explanation/Justification:					

Cost/Funding Explanation

Funding Sources

Funding Sources, by year of program (continued)					
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
State Resources					
~ New	\$ -	\$ -	\$ -	\$ -	\$ -
~ Existing	\$ -	\$ -	\$ -	\$ -	\$ -
Narrative Explanation/Justification:					
Funding Sources, by year of program (continued)					
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
Internal					
Internal Allocation	\$ -	\$ -	\$ -	\$ -	\$ -
Internal Reallocation	\$ -	\$ -	\$ -	\$ -	\$ -

Cost/Funding Explanation

Narrative Explanation/Justification: *The sources and process of allocation and reallocation should be detailed, including an analysis of the impact of the reduction on existing programs and/or organization units. Internal reallocation are those estimated dollars that will be dedicated to fund the start-up and support of the new academic program – typically defined as faculty, administrative/staff and operational expenses.*

Funding Sources, by year of program (continued)	1 st Year	2 nd Year	3 rd Year	4 th Year	5 th Year
Student Tuition					
~ New	\$ 50,000.00	\$ 100,000.00	\$160,000.00	\$ 220,000.00	\$280,000.00
~ Existing					
<p>Narrative Explanation/Justification: <i>Describe the impact of this program on enrollment, tuition, and fees.</i></p> <p>The increase in student enrollment is expected to be spread among the courses for this program. These courses already exist. In the case of online students, courses with online versions are expected to have higher enrollment. The program requires students to complete 15 credit hours, with each credit hour generating revenue of \$705/credit hour (resident) and \$1405/credit hour (non-resident). We anticipate approximately half of the students will be from international universities taking the program online as visiting students, leveraging existing partnerships established by the Department of Bioengineering. Online courses are assumed to be charged the same as in-class. The projected tuition revenue is conservatively estimated by calculating it at the resident student rate and assuming a 3% yearly inflation-adjusted increase in tuition.</p>					
Total					
~ New	\$ 50,000.00	\$ 100,000.00	\$160,000.00	\$ 220,000.00	\$280,000.00

Cost/Funding Explanation

Funding Sources

~ Existing	\$ -	\$ -	\$ -	\$ -	\$ -	
A.	TOTAL - Funding Sources (REVENUES)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
		\$ 50,000.00	\$ 100,000.00	\$160,000.00	\$ 220,000.00	\$280,000.00

Calculation Details (annual amounts are conservatively rounded down):

Tuition Revenue 1st year: $\$705/\text{credit} \times 5 \text{ resident students} \times 15 \text{ credits/student} = \$52,875$ (rounded to \$50,000)
 Tuition Revenue 2nd year: $\$726/\text{cr} \times 12 \text{ resident students} \times 12 \text{ cr/student} = \$104,544$ (rounded to \$100,000)
 Tuition Revenue 3rd year: $\$748/\text{cr} \times 19 \text{ resident students} \times 12 \text{ cr/student} = \$170,544$ (rounded to \$160,000)
 Tuition Revenue 4th year: $\$770/\text{cr} \times 25 \text{ resident students} \times 12 \text{ cr/student} = \$231,000$ (rounded to \$220,000)
 Tuition Revenue 5th year: $\$793/\text{cr} \times 31 \text{ resident students} \times 12 \text{ cr/student} = \$294,996$ (rounded to \$280,000)

\$ 810,000.00	Funding Total over 5 Years (will pre-populate)
----------------------	-------------------------------------------------------

Cost/Funding Explanation

Complete the following expense spreadsheet for the first five years of the proposed program

Provide a detailed explanation wherever dollar amounts are reported, including how the numbers were calculated.

You should also add any existing dollar amounts and department allocation for new dollar amounts reported in this Expenses spreadsheet to the Funding Sources spreadsheet (under Internal allocation or reallocation).

*The FundingSource Expenses-Combined spreadsheet will pre-populate from the numbers entered into the Funding Sources and Expenses spreadsheets. The total funding and expenses shown in the Combined spreadsheet should be the same or show an excess in funding (provide an explanation for any excess funding).

B. Breakdown of Budget Expenses/Requirements	1 st Year	2 nd Year	3 rd Year	4 th Year	5 th Year
Staff					
<i>Executive, Administrative, Managerial</i>					
~ New					
~ Existing	\$ -	\$ -	\$ -	\$ -	\$ -
<i>Other Professional</i>					
~ New					
~ Existing					
<i>Faculty</i>					
~ New					
~ Existing	\$ 6,956.00	\$ 7,095.00	\$ 7,237.00	\$ 7,382.00	\$ 7,530.00
<i>Graduate Assistants</i>					
~ New					
~ Existing					
<i>Student Employees</i>					
~ New					
~ Existing					
Narrative Explanation/Justification: <i>Includes salaries for all listed above and explain how they were calculated. Identify the number of new faculty required and whether the new hires will be part-time or full-time. Identify the number of assistantships/stipends that will be provided. Include the level of support for each assistantship/stipend.</i>					

Cost/Funding Explanation

Budget Expenses/Requirements

Estimate 5% FTE of Program Director's time (current salary: \$108,255 + 28.5% fringe) to direct the program, advise students, and evaluate progress. Assume a yearly 2% COL increase. The BE administrative office has excessive capacity to handle paperwork related to any new students.

Breakdown of Budget Expenses/Requirements (continued)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
Equipment and Instructional Materials					
~ New					
~ Existing					
Narrative Explanation/Justification:					
Breakdown of Budget Expenses/Requirements (continued)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
Library					
~ New					
~ Existing					
Narrative Explanation/Justification:					

Cost/Funding Explanation

Budget Expenses/Requirements

<div style="border: 1px dashed black; min-height: 100px;"></div>					
Breakdown of Budget Expenses/Requirements (continued)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
Contractual Services					
~ New					
~ Existing					
Narrative Explanation/Justification:					
Breakdown of Budget Expenses/Requirements (continued)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
Academic and/or Student Support Services					
~ New					
~ Existing					
Narrative Explanation/Justification:					

Cost/Funding Explanation

Budget Expenses/Requirements

Breakdown of Budget Expenses/Requirements (continued)						
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>	
Other Support Services						
~ New						
~ Existing						
Narrative Explanation/Justification:						
Breakdown of Budget Expenses/Requirements (continued)						
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>	
Faculty Development						
~ New						
~ Existing						
Narrative Explanation/Justification:						

Cost/Funding Explanation

Budget Expenses/Requirements

Breakdown of Budget Expenses/Requirements (continued)						
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>	
Assessment						
~ New						
~ Existing						
Narrative Explanation/Justification:						
Program assessment is included in costs under Facult6 (existing)						
Breakdown of Budget Expenses/Requirements (continued)						
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>	
Student Space and Equipment (if doctorate)						
~ New						
~ Existing						
Narrative Explanation/Justification:						

Cost/Funding Explanation

Budget Expenses/Requirements

Breakdown of Budget Expenses/Requirements (continued)					
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
Faculty Space and Equipment (if doctorate)					
~ New					
~ Existing					
Narrative Explanation/Justification:					
Breakdown of Budget Expenses/Requirements (continued)					
	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
Other					
~ New					
~ Existing					

Cost/Funding Explanation

Budget Expenses/Requirements

Narrative Explanation/Justification:						
Total						
~ New		\$ -	\$ -	\$ -	\$ -	\$ -
~ Existing		\$ 6,956.00	\$ 7,095.00	\$ 7,237.00	\$ 7,382.00	\$ 7,530.00
B.	TOTAL - Expenses/Requirements (EXPENDITURES)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
		\$ 6,956.00	\$ 7,095.00	\$ 7,237.00	\$ 7,382.00	\$ 7,530.00

\$	36,200.00	Expenses Total over 5 Years (will pre-populate)
----	------------------	--------------------------------------------------------

A.	TOTAL - Funding Sources (REVENUES)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
		\$ 50,000.00	\$ 100,000.00	\$ 160,000.00	\$ 220,000.00	\$ 280,000.00
B.	TOTAL - Expenses/Requirements (EXPENDITURES)	<i>1st Year</i>	<i>2nd Year</i>	<i>3rd Year</i>	<i>4th Year</i>	<i>5th Year</i>
		(6,956.00)	(7,095.00)	(7,237.00)	(7,382.00)	(7,530.00)
BALANCE - (SURPLUS/DEFICIT)		\$43,044.00	\$92,905.00	\$152,763.00	\$212,618.00	\$272,470.00

January 27, 2020

Ayman El-Baz, PhD.
Professor and Chair of Bioengineering
Speed School of Engineering
University of Louisville
Louisville, KY 40292

RE: Certificate of Artificial Intelligence in Medicine

Dear Dr. El-Baz:

It is with great enthusiasm that I am writing in full support of the Certificate of Artificial Intelligence in Medicine. Key constituents within the JB Speed School of Engineering and I have reviewed the proposal for the certificate program and are supportive of certificate program students enrolling in our engineering courses. Additionally, the School of Medicine has been consulted in the development of this program. This program will create excellent opportunities for collaborations within the current academic and research programs in the schools of engineering, medicine, dentistry, business and more. I especially look for certificate program students to work closely with our engineering faculty to apply their expertise and talents to further enhance our level of innovation and find creative new ways to better engineer human health using artificial intelligence.

The overall outcomes of the program will yield tremendous benefits to the students and faculty, and also to the university as a whole. I look forward to working with the Department of Bioengineering to assist in any way I can to make sure the certificate program is successful. Best of luck as this moves forward!

Sincerely,



Emmanuel Collins, PhD.
Dean,
Speed School of Engineering
University of Louisville
Louisville, KY 40292

March 17, 2020

Connie Shumake
Office of the Provost
University of Louisville
Louisville, KY 40292

Connie,

We have been asked to provide a letter of support for the proposed Certificate in Artificial Intelligence in Medicine in the Speed School. As this certificate is composed entirely of courses currently supported by the Libraries, we do not anticipate needing to add any additional resources in support of it.

Please contact us if you have any questions or need additional information.

Sincerely,



Robert E. Fox, Jr.
Dean, University Libraries

CC: Emmanuel Collins
Sarah Drerup
Ayman El-Baz

**EVALUATION OF LIBRARY RESOURCES
ESSENTIAL TO THE SUPPORT OF:**

**CERTIFICATE IN
ARTIFICIAL INTELLIGENCE IN MEDICINE**

Sarah Drerup
STEM Librarian

Dean Robert E. Fox, Jr.
University Libraries
March, 2020

BACKGROUND

The University of Louisville (UofL) Libraries are comprised of five separate libraries: Ekstrom Library serving humanities, social sciences, life sciences, business, engineering, physical sciences, and technology; Kornhauser Health Sciences Library; Anderson Music Library; Bridwell Art Library; and the Law Library. University Archives and Special Collections center is also part of the UofL library system. Resources relevant to artificial intelligence in medicine are found in both Ekstrom Library and Kornhauser Health Sciences Library.

UofL's library system supports the instructional and research needs of over 22,000 full and part-time students and more than 7,000 faculty and staff. UofL belongs to the Association of Research Libraries (ARL), an organization of North American libraries affiliated with 124 large, comprehensive research institutions, as well as the State-Assisted Academic Library Council of Kentucky (SAALCK), and Kentuckiana Metroversity, a consortium of Louisville area libraries.

The Speed School of Engineering at the University of Louisville offers multiple ABET accredited degree programs. Currently, the Speed School of Engineering offers a 5-Year Masters (MEng) and Masters of Engineering Degree. The certificate in artificial intelligence in medicine would be targeted towards students obtaining masters degrees who want to apply engineering techniques to medicine.

COLLECTIONS

Books

According to WorldCat, UofL only has around a hundred eBooks and print books specifically related to artificial intelligence and medicine. However, UofL has over a million books published in the last five years on both medicine and machine learning. Artificial intelligence and medicine are fields that are constantly innovating and having more current resources is imperative to the advancement of research and maintaining support for the certificate program.

Journals

UofL has online full-text access to all journals which are listed in the top ten most frequently used and cited journals on the subject of artificial intelligence in medicine according to Web of Science:

Full Journal Title	Journal Impact Factor	Online Full Text
IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE	17.73	1979-Present
Journal of Statistical Software	11.655	Open Access
IEEE WIRELESS COMMUNICATIONS	11	2002-Present
Information Fusion	10.716	2000-Present
IEEE Transactions on Cybernetics	10.387	2013-Present

IEEE Internet of Things Journal	9.515	2014-Present
MEDICAL IMAGE ANALYSIS	8.88	1996-Present
IEEE TRANSACTIONS ON FUZZY SYSTEMS	8.759	1993-Present
IEEE TRANSACTIONS ON EVOLUTIONARY COMPUTATION	8.508	1997-Present
IEEE TRANSACTIONS ON MEDICAL IMAGING	7.816	1982-Present

Databases

UofL has subscriptions to the following databases related to artificial intelligence in medicine:

- Access Medicine
- ACM Digital Library
- IEEE Explore
- INSPEC
- MathSciNet
- MEDLINE
- PubMed
- ScienceDirect
- Web of Science
- Wiley Online Library

These databases offer abstracts and full-text access to the periodicals listed above in addition to thousands of conference proceedings, book chapters, and patents.

The following databases are not available at UofL but could be beneficial to support the certificate program:

- Computers and Applied Sciences Complete – Ebsco – Title list of this database includes multiple journals we receive through other vendors. If we would like to purchase this database in the future, an in-depth comparison would need to be made to verify we are purchasing the titles through the vendor that can give us the best price.
- American Institute of Mathematical Sciences Database – AIMS does offer five open access journals which are currently listed on multiple engineering library subject guides.

SERVICES

Inter-Library Loan

Books and periodicals not held by the UofL Libraries are identified through online databases and WorldCat, an online catalog with more than 32 million records describing materials owned by libraries around the world. Requested materials are obtained through UofL's traditional Interlibrary Loan (ILL) service, and supplemented by the University Libraries participation in KUDZU, a consortium of major university libraries in the southeastern United States. Articles and chapters are transferred to requestors via email.

Research Assistance

Each library within the University of Louisville Libraries offers instruction programs designed to meet the needs of its researchers. Ekstrom Library provides research assistance via email, telephone, in-person research appointments, and online chat.

STAFFING

Ekstrom Library has a dedicated STEM librarian who will be the primary point of contact for students and faculty associated with the proposed Certificate in Artificial Intelligence in Medicine.

CONCLUSION

The Libraries at the University of Louisville already supports a 5-year Master's degree in Engineering and a MS in Engineering. No new courses will be developed for the Certificate in Artificial Intelligence in Medicine. The University of Louisville Speed School does not anticipate a need for any new library books, journals, databases, or other services to support the new program. However, this review does show that the libraries can strengthen its support of the proposed program by increasing the number of online resources available to include the purchase of new databases.



COMPUTER SCIENCE & ENGINEERING
DEPARTMENT

J. B. Speed School of Engineering
University of Louisville
Louisville, Kentucky 40292

Office: 502-852-0715
Fax: 502-852-4713

louisville.edu/speed/computer

May 7, 2020

Dr. Ayman El-Baz
Chair and Professor
Department of Bioengineering
University of Louisville

Dear Ayman,

I am pleased to collaborate with you on the new Certificate Program in Artificial Intelligence in Medicine. As the progress of AI technology has advanced, it has been increasingly used in many different fields. This program, designed to apply computational and mathematical techniques to study medical and biological information, addresses a specific need for training in this field, and overall for the analysis of health sciences information.

As Chairperson of the Computer Science and Engineering (CSE) Department at the J. B. Speed School of Engineering, I am happy to support this program by having enrolled students take relevant courses from the CSE Department, including but not limited to CSE 545: Artificial Intelligence, CSE 590 (02): Introduction to Machine Learning; CSE 590 (03): Introduction to Deep Learning; CSE 590 (04): Python & Data Analytics; CSE 632: Data Mining; CSE 641: Medical Image Systems; CSE 660: Introduction to Bioinformatics; CSE 694: Current Topics in Bioinformatics; CSE 694: Topics in Advanced Machine Learning Theory & Methods.

I will continue to assist and collaborate with more specific needs that may arise with this program. We are very familiar with a wide range of the computational tools and approaches that students in this program will use. Of particular interest for this program is our knowledge of tools, models, and algorithms designed to examine large volumes of data in order to arrive at predictive capabilities.

Sincerely,

Wei Zhang
Chair and Professor
Department of Computer Science and Engineering
J. B. Speed School of Engineering
University of Louisville

March 9, 2020

Dr. Ayman El-Baz
Chair and Professor
Department of Bioengineering
University of Louisville

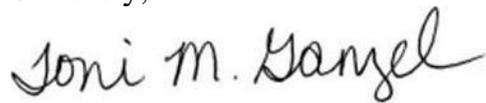
Dear Dr. El-Baz,

It is a great pleasure for the School of Medicine to support the new Certificate Program in *Artificial Intelligence in Medicine* from your department.

We greatly value the collaborations that the faculty in the Department of Bioengineering has built over the years with researchers at the School of Medicine, including with the Cardiovascular Innovation Institute, the Kentucky Spinal Cord Injury Research Center, the Brown Cancer Center, the Center for Predictive Medicine, and the Departments of Oncology and Radiology. This new program builds upon these collaborations to further extend the interactions between your department and the School of Medicine.

We are especially excited that students participating in the program will be able to participate in projects that relate and leverage these extensive collaborations.

Sincerely,



Toni M. Ganzel, MD, MBA

May 25, 2020

Dear Dr. Frieboes,

I may support the use of PHMS 641 and 642 as electives in the proposed certificate in Artificial Intelligence if data mining using quantitative tools is useful. Please note that prerequisite requirements may have to be satisfied in these courses because they are advanced statistical analysis courses designed for public health and medicine. My instruction does not support black box approaches.

Regards,



Bert Little, MA, PhD, FAAAS, FRAI, FRSM
Professor
Director, MS in Health Data Analytics
Department of Health Management and Systems Sciences
School of Public Health and Information Sciences
University of Louisville
Louisville, KY 40202
502-852-5933
Bert.Little@Louisville.edu

Senior Research Scientist
Medical Service, Division of Cardiology
Dallas VA Medical Center
4500 Lancaster Rd.
Dallas, Texas 75216
BertisB.Little@VA.gov

May 25, 2020

Dear Hermann,

I support the use of PHST 620, 650, 681, and 710 as electives in the proposed certificate in Artificial Intelligence. Please note that prerequisite requirements may have to be satisfied in some of these courses. Please let me know if there are questions or concerns.

Thank you.

Sincerely,

A handwritten signature in black ink, appearing to read "K.B. Kulasekera", is written over a horizontal line. The signature is cursive and somewhat stylized.

K.B. Kulasekera, Ph.D.
Professor and Chair
Assistant Dean for Academic Affairs



Susan Harkema, PhD

Professor
Owsley B. Frazier Chair in
Neurological Rehabilitation
Department of Neurological Surgery

Associate Director
Kentucky Spinal Cord Injury Research Center

Director of Research
Frazier Rehab Institute

220 Abraham Flexner Way
Louisville, Kentucky 40202

P: (502) 581-8747

F: (502) 582-7605

susanharkema@kentuckyonehealth.org

May 8, 2020

Dr. Ayman El-Baz
Chair and Professor
Department of Bioengineering
University of Louisville

Dear Ayman,

The Kentucky Spinal Cord Injury Research Center enthusiastically supports the proposal for a new Certificate Program in *Artificial Intelligence in Medicine* from the Department of Bioengineering. This program will strengthen our existing collaborations with your department and offers the possibility to expand these interdisciplinary venues in a way that is beneficial to both students and faculty. Please let me know if there is anything we can do to help support the rollout and implementation of this initiative.

Sincerely,

Susan Harkema, Ph.D.