UNIVERSITY SENATE | LEGISLATION APPROVAL | #18-19-27

Approved by the Senate on February 5, 2019

PCC Proposal to Establish a Master of Science in Geospatial Intelligence (Senate Document #18-19-27)

TO **Wallace D. Loh | President**

FROM **Christopher Walsh | Chair, University Senate**

I am pleased to forward the accompanying legislation for your consideration and approval. Janna Bianchini, Chair of the Programs, Curricula, & Courses Committee, presented the PCC Proposal to Establish a Master of Science in Geospatial Intelligence (Senate Document #18-19-27), which the University Senate approved at its meeting on February 5, 2019. Please inform the Senate of your decision and any administrative action related to your conclusion.

Approved: _____ **Date:** 02-12-2019

Wallace D. Loh
President

Copies of this approval and the accompanying legislation will be forwarded to:

Mary Ann Rankin, Senior Vice President and Provost
Reka Montfort, Executive Secretary and Director, University Senate
Michael Poterala, Vice President and General Counsel
Cynthia Hale, Associate Vice President for Finance and Personnel
John Bertot, Associate Provost for Faculty Affairs
Elizabeth Beise, Associate Provost for Academic Planning & Programs
Sylvia B. Andrews, Academic Affairs
Gregory Ball, Dean, College of Behavioral and Social Sciences
Ruibo Han, CGIS Director of Programs, College of Behavioral and Social Sciences
Janna Bianchini, Chair of the Programs, Curricula, & Courses Committee
Michael Colson, Senior Coordinator for Academic Programs

Establish a Master of Science in Geospatial Intelligence (PCC 18051)

PRESENTED BY	**Janna Bianchini, Chair, Senate Programs, Curricula, and Courses Committee**
REVIEW DATES	**SEC – January 28, 2019 | SENATE – February 5, 2019**
VOTING METHOD	**In a single vote**
RELEVANT POLICY/DOCUMENT	**N/A**
NECESSARY APPROVALS	**Senate, President, University System of Maryland Board of Regents, and Maryland Higher Education Commission**

ISSUE

The Department of Geographical Sciences within the College of Behavioral and Social Sciences (BSOS) proposes to establish a Master of Science degree program in Geospatial Intelligence. This program exists currently as an iteration of the Master of Professional Studies (MPS) program. The 30-credit program has been in operation since 2016. The Master of Professional Studies program was approved in 2005 by the University System of Maryland Board of Regents and Maryland Higher Education Commission to allow for the expedited approval of curricula that respond to changing market needs of working professionals. Once a new iteration of the MPS is approved through campus PCC review, it only needs approval by the USM Chancellor to become official.

A limitation of offering the program as an MPS iteration is that all Professional Studies programs must use the same generic Federal Classification of Instructional Programs (CIP) code rather than a CIP code that accurately describes the program content. Searches that use CIP codes to find program offerings will not find the discipline-specific iteration, which reduces market visibility. Moreover, some CIP codes are designated as “STEM” eligible by the Department of Homeland Security, and international students with F1 visas who graduate from STEM designated programs may continue to work in the United States for two years longer than students in non-STEM designated programs. The generic CIP code for Professional Studies programs does not qualify as STEM-designated, even if the academic content of the Professional Studies program is STEM-related.

Consequently, the Geographical Sciences Department proposes to transition the program from a Master of Professional Studies program to a stand-alone Master of Science program in order to be classified more accurately. No changes are proposed to the program curriculum or administration. In a separate proposal, Geographical Sciences is proposing to convert its Professional Studies program in Geospatial Information Sciences to a stand-alone program. The Economics Department is also proposing to convert its Master of Professional Studies program in Applied Economics to a stand-alone program in a separate proposal.

The Geospatial Intelligence program provides workforce-focused training in cutting-edge topics in geospatial intelligence, geographic information science, remote sensing, and data science in the big

data era, providing the skills and expertise to graduates to lead new initiatives in the rapidly shifting landscape of defense and security applications.

The curriculum consists of 15 credits of core courses and 15 credits from a list of eligible GEOG courses. The core courses are as follows:

- GEOG661 Fundamentals of Geospatial Intelligence (3 Credits)
- GEOG662 Advances in Geographic Information Science and Remote Sensing (3 Credits)
- GEOG664 Geospatial Intelligence Systems and Platforms (3 Credits)
- GEOG665 Algorithms for Geospatial Intelligence Analysis (3 Credits)
- GEOG697 Capstone Project (3 Credits)

Electives include courses such as GEOG660 Advanced Remote Sensing Using Lidar, GEOG680 Geospatial Intelligence Networks, GEPG682 Open Source Intelligence, and GEOG683 Hazards and Emergency Management, among others.

Through the program, students develop a well-rounded understanding of the nature of geospatial intelligence and analysis. Students learn the core theory, methods, and protocols for gathering and management of geospatial intelligence data. They learn geospatial intelligence data analysis and visualization, and use the resulting products in operational settings. Students also learn about the ethical treatment of data and analysis throughout these procedures.

Although the field of geospatial intelligence was initially associated with national security, graduates will find opportunities in a variety of areas, including machine intelligence, business intelligence, criminology, government, and emergency management.

This proposal was approved by the Senate Programs, Curricula, and Courses committee on December 7, 2018.

RECOMMENDATION(S)

The Senate Committee on Programs, Curricula, and Courses recommends that the Senate approve this new degree program.

COMMITTEE WORK

The committee considered this proposal at its meeting on December 7, 2018. Ruibo Han, Director of the Master of Professional Studies Program in Geospatial Intelligence, presented the proposal. The proposal was approved by the committee.

ALTERNATIVES

The Senate could decline to approve this new degree program.

RISKS

If the Senate declines to approve this degree program, the university will lose an opportunity to take an existing program and make it more attractive to international students by simply classifying the program more accurately.

FINANCIAL IMPLICATIONS

There are no significant financial implications with this proposal as the program already exists as a Master of Professional Studies program.

University of Maryland PCC
Program/Curriculum/Unit Proposal

PCC Log No: **18051**

Program: Master of Science in Geospatial Intelligence

Department/Unit: Department of Geographical Sciences

College/School: College of Behavioral and Social Sciences

Proposal Contact Person (with email): Dr. Ruibo Han, ruibo@umd.edu

Type of Action (check one):

- ☐ Curriculum change (includes modifying minors, concentrations/specializations and creating informal specializations)
  - ☐ Curriculum change is for an LEP Program
- ☐ *Rename a program or formal Area of Concentration*
- ☐ *Establish/Discontinue a formal Area of Concentration*
- ☐ Other:
- ☒ *Establish a new academic degree/certificate program*
- ☐ Create an online version of an existing program
- ☐ Establish a new minor
- ☐ *Suspend/Discontinue a degree/certificate program*
- ☐ Establish a new Master or Certificate of Professional Studies program
  - ☐ New Professional Studies program will be administered by Office of Extended Studies

Italics indicate that the proposal must be presented to the full University Senate for consideration.

Approval Signatures - *Please print name, sign, and date. For proposals requiring multiple unit approvals, please use additional cover sheet(s).*

1. Department Committee Chair JULIE SHORT 10/10/18
2. Department Chair Chris Justice 10/11/18
3. College/School PCC Chair Karl Kurtz (for Karol Salton) 11/9/18
4. Dean Wayne Meisel 11/9/18
5. Dean of the Graduate School (if required)
6. Chair, Senate PCC Janna Bianchini 12-7-18
7. University Senate Chair (if required)
8. Senior Vice President and Provost

Instructions:
When approved by the dean of the college or school, please send the proposal and signed form to the Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus-5031, **and** email the proposal document as an MSWord attachment to pcc-submissions@umd.edu.

Summary of Proposed Action (use additional sheet if necessary):

The proposal is to establish a **Master of Science in Geospatial Intelligence (MS GEOINT)** to train a workforce for the expanding GEOINT industry in Maryland and the greater Washington, D.C. metropolitan area. The proposed MS GEOINT program will replace the current Master of Professional Studies in GEOINT. The proposed MS GEOINT will have a STEM designation that allows international students a longer term (24 months) to work in the United States after graduation. The proposed MS GEOINT program encompasses a **30-credit** (10 units of 3-credit courses) course structure comprising **five core courses** and **five elective courses**, which is unchanged from the current MPS GEOINT program. The MS GEOINT will be offered in spring/summer/fall/winter quarter terms, and courses will be delivered on-site and online simultaneously in a hybrid format.

Unit Code(s) (to be entered by the Office of Academic Planning and Programs):

The Capstone is an independent research project that demonstrates competence in geospatial intelligence technologies. This project can originate from an internship, from relevant work at a current or past employer, or can be developed in conjunction with CGIS faculty. The student will prepare a project report and presentation which shall contain an executive summary, background information including a literature review and establishment of requirements, a detailed technical description of the project data and methods, a discussion of results obtained, and final conclusions and recommendations. The final project submission will include all data, computer code and/or workflow documentation required to replicate the project results. In completing this project, students develop a concrete example of how GEOINT technologies can be applied to solve real-world problems, and begin developing a portfolio that can be presented to potential employers.

Program: Master of Science in Geospatial Intelligence

Date of Proposal: Oct 2, 2018

Start Term for New Program: Fall, 2019

A new degree program proposal will need to be approved not just by campus but also by the University System of Maryland (USM) Board of Regents and the Maryland Higher Education Commission (MHEC). New certificate programs need to be approved by the USM Chancellor and MHEC. The following prompts are based on academic policies for programs and reflect campus requirements and MHEC requirements. The prompts also include questions frequently asked by review committees. See http://mhec.maryland.gov/institutions_training/Pages/acadaff/AcadProgInstitApprovals/NewAcademicProgramProposals.aspx for more information about MHEC requirements. Please feel free to add additional information at the end of this document or in a separate appendix.

Mission and Purpose

1. Describe the program and explain how it fits the institutional mission statement and planning priorities. The University Mission Statement and Strategic Plan can be found on this site: https://www.umd.edu/history-and-mission.

The Department of Geographical Sciences at the University of Maryland, College Park, proposes to establish a **Master of Science in Geospatial Intelligence (MS GEOINT)** to address the immediate and growing need to train a workforce for the rapidly expanding local geospatial intelligence industry in Maryland and the greater Washington, D.C. metropolitan area.

The need for a well-trained workforce in geospatial intelligence is growing markedly. Yet despite the large employment potential, the State of Maryland has been lacking graduate-level degree programs to train students in this field. There is a gap between the supply of graduate-level instruction and the steady demand for well-trained students in geospatial intelligence.

To respond to this gap in instructional offerings, the Department of Geographical Sciences established a **Master of Professional Studies in Geospatial Intelligence (MPS GEOINT)** in 2016. This is a dedicated Master's program to provide workforce-focused training at the graduate level in geospatial data handling for defense and security applications, emergency response, and humanitarian relief among other topics, involving applied problem-sets, analysis schemes, big geospatial datasets, and software platforms that characterize today's geospatial intelligence.

The proposed **MS GEOINT** program will succeed the current **MPS GEOINT** program, and continue to provide workforce-focused technical training that gives graduates the skills and expertise to lead new initiatives

in the rapidly shifting landscape of GEOINT applications, data collection systems, analytic methods, and mission support. Domestic students include University of Maryland and Geographical Sciences alumni, students from other geospatial science programs in MD, VA, DE, and PA, individuals working in the Intelligence Community, and individuals from the GIS industry sector among others. The proposed MS GEOINT will have a STEM designation that allows international students a longer term (24 months) to work in the United States after graduation. Based on the number of inquiries from international students, we expect to attract a significant number of international students into the program, and a 24-month post-completion optional practical training (OPT) term will make our GEOINT program more competitive for international applicants.

Program Characteristics

2. Provide the catalog description of the proposed program. As part of the description, please indicate any areas of concentration or specializations that will be offered.

The Master of Science in Geospatial Intelligence (MS GEOINT) provides workforce-focused training in cutting-edge topics in geospatial intelligence, geographic information science, remote sensing, and data science in the big data era, providing the skills and expertise to graduates to lead new initiatives in the rapidly shifting landscape of defense and security applications.

3. What are the educational objectives of the program?

The MS GEOINT program will deliver fundamental and advanced courses in three main areas (labs and hands-on exercises in problem-solving will be integrated throughout the sequence):

1. Fundamentals of geospatial intelligence science and technology;
2. Geospatial data handling processes using advanced algorithms, models, and commercial and open source platforms;
3. Support systems for applying geospatial intelligence in behavioral and social science, emergency and security management, and computational science.

4. Describe any selective admissions policy or special criteria for students interested in this program.

The Graduate School of the University of Maryland admits applicants who have earned a four-year baccalaureate degree with a cumulative 3.0 GPA (on a 4.0 scale). Official transcripts of a post-secondary degree and a resumé are required along with the application. International applicants must meet all requirements for international admissions, which have specific standards for academic credentials, language proficiency, financial support, visa requirements, etc. Refer to http://www.gradschool.umd.edu/admissions/international-admissions for process and requirements for international applications.

In addition to the requirements from the Graduate School, the Department of Geographical Sciences also requires that applicants will have completed a sequence of course work equivalent to the Department of Geographical Sciences' 300-level offerings in statistics, remote sensing, and GIS. Students without this academic background may substitute with relevant professional experience. Applicants without academic or

professional backgrounds may be accepted with a conditional offer, given that applicants will take required prerequisite courses or workshops to address these core competencies.

As required by the Graduate School, all application materials are to be submitted electronically:

- Graduate Application
- College or University Transcripts
- Statement of Purpose
- Letters of Recommendation
- Program/Department Supporting Documents
- Non-refundable application fee ($75) for each program to which an applicant applies

Completed applications are reviewed by an admissions committee in each graduate degree program. The recommendations of the committees are submitted to the Dean of the Graduate School, who will make the final admission decision. Students seeking to complete graduate work at the University of Maryland for degree purposes must be formally admitted to the Graduate School by the Dean. To ensure the integrity of the application process, the University of Maryland authenticates submitted materials through **iThenticate for Admissions**.

5. Indicate the course requirements with course numbers, titles and credits. If applicable, indicate if any course will also count for a general education requirement. In an appendix, provide the course catalog information (credits, description, prerequisites, etc.) for all of the courses. Note that suffixed "selected" or "special" topics courses should be avoided. If suffixed-selected or special topics courses are offered regularly in the new program, you should make the courses permanent. Also, please review the basic requirements of degree programs or certificate programs to ensure that they meet the minimum policy requirements.

Please note: new courses or modifications to courses need to be submitted through the Testudo Curriculum Management system and will need to follow the normal VPAC course proposal review process. You may submit individual course changes to VPAC concurrently with the PCC proposal; however, the course changes may be held depending on the outcome of the PCC proposal.

The proposed MS GEOINT program encompasses a **30-credit** (10 units of 3-credit courses) course structure comprising **five core courses** and **five elective courses**, which is unchanged from the current MPS GEOINT program. These courses are currently being offered through the MPS GEOINT program.

Course Type	Course #	Course Title	Credit
Core	GEOG661	Fundamentals of Geospatial Intelligence	3
	GEOG662	Advances in Geographic Information Science and Remote Sensing	3
	GEOG664	Geospatial Intelligence Systems and Platforms	3
	GEOG665	Algorithms for Geospatial Intelligence Analysis	3
	GEOG697*	Capstone Project	3
Elective	GEOG651	Spatial Statistics	3
	GEOG656	Programming and Scripting for GIS	3
	GEOG657	Web Programing	3
	GEOG660	Advanced Remote Sensing Using Lidar	3

	GEOG663	Big Data Analytics	3
	GEOG680	Geospatial Intelligence Networks	3
	GEOG682	Open Source Intelligence	3
	GEOG683	Hazards and Emergency Management	3
	GEOG686	Mobile Computing and Geospatial Information Management	3
	GEOG684*	Image Analysis and Geovisualization	3
	GEOG685*	Machine Learning and Data Mining	3
	GEOG687*	Geospatial Intelligence for Security	3
	GEOG688*	Human and Activity-Based Intelligence	3
	GEOG690*	Data Visualization	3
	GEOG691*	Food Security	3

Note: * indicates courses that are being developed.

Course Catalog Information is provided in Appendix A.

6. Summarize the factors that were considered in developing the proposed curriculum (such as recommendations of advisory or other groups, articulated workforce needs, standards set by disciplinary associations or specialized-accrediting groups, etc.).

The few dedicated graduate programs for geospatial intelligence that exist in the United States are, in essence, programs for Geographic Information Systems (GIS) branded as "geospatial intelligence", often with very limited content (and sometimes none) that deals with intelligence. The UMD GEOINT program fills this gap.

Courses offered in the **MS GEOINT** will expose students to material that goes beyond the existing offerings in geospatial information sciences (GIS) at UMD, and provide education to a new population seeking employment and skills in the defense and security industry. The MS GEOINT program can train individuals for the higher end of the geospatial intelligence job market and will help UMD to distinguish itself from a growing cohort of university programs that are offering basic GIS courses aimed at more entry-level positions.

The MS GEOINT program will provide state-of-the-art training in the geospatial technologies (e.g., web mapping, mobile applications, geospatial programming), geographical knowledge (e.g., geostatistics, geospatial networks, spatial reasoning), and scientific methods to address issues of public administration and policy analysis; public safety; criminology; military intelligence; emergency response and preparedness; project and workflow management; environmental applications; urban studies and regional sciences; and transportation geography. Students are provided with knowledge and practical skills in geographic information science & technology (GIS&T), remote sensing, mapping and geo-visualization, computer programming to tackle geospatial intelligence problems such as pattern recognition and feature extraction, big geospatial computing, developing source-to-screen workflows, and communicating uncertainty to decision-makers. These skills range from project design, data collection and interoperation, software development, algorithm implementation, data-mining, analytic processing and management, visualizing results and reporting. Technical skills are closely intertwined with substantive topics in a range of applied geospatial intelligence contexts, from defense and homeland security to humanitarian response and emergency management.

7. Sample plan. Provide a term by term sample plan that shows how a hypothetical student would progress through the program to completion. It should be clear the length of time it will take for a typical student to graduate. For undergraduate programs, this should be the *four-year plan*.

The MS GEOINT will be offered in spring/summer/fall/winter quarter terms. This 12-week long quarter system allows working professionals or part-time students to concentrate on one or two courses in a short period, which contributes to better course performance. Students have the option to study full-time or part-time, and can skip a quarter term due to work or personal reasons. A full-time student will take two courses in a quarter term, and the degree of MS GEOINT will require at least five quarter terms (15 months) to complete.

The tables below provide information on which courses are offered in each quarter term and a sample plan of courses to take each term for a full-time student who plans to graduate in five quarter terms.

Quarter Term	Course Offered				Sample Plan	
Fall 2019	GEOG661 Fundamental of GEOINT	GEOG662 Advances in GIS and RS	GEOG686 Mobile Computing and Geospatial Information Management		GEOG661 Fundamental of GEOINT	GEOG662 Advances in GIS and RS
Winter 2019	GEOG664 GEOINT Systems and Platforms	GEOG665 Algorithms for GEOINT Analysis	GEOG682 Open Source Intelligence	GEOG651 Spatial Statistics	GEOG664 GEOINT Systems and Platforms	GEOG665 Algorithms for GEOINT Analysis
Spring 2020	GEOG661 Fundamental of GEOINT	GEOG697 Capstone Project	GEOG663 Big Data Analytics	GEOG683 Hazards and Emergency Management	GEOG663 Big Data Analytics	GEOG683 Hazards and Emergency Management
Summer 2020	GEOG680 GEOINT Networks	GEOG651 Spatial Statistics	GEOG656 Programming and Scripting for GIS		GEOG656 Programming and Scripting for GIS	GEOG680 GEOINT Networks
Fall 2020	GEOG661 Fundamental of GEOINT	GEOG662 Advances in GIS and RS	GEOG697 Capstone Project	GEOG682 Open Source Intelligence	GEOG697 Capstone Project	GEOG682 Open Source Intelligence

Note: Core courses are indicated by cell shading in the table above.

8. Indicate whether the program will be offered either online or off-campus. Please note that MHEC requires a separate proposal for off-campus delivery. If the program will be offered exclusively online or will have both a face-to-face and online version of the program, please complete this additional form and add as an appendix:
https://docs.google.com/document/d/1ojpUBt4mAWlNPCiQNzZ48UH68zGPYj31TPgEOfW3q1E/

Courses will be delivered in a hybrid format: instructors will present lectures and lead discussions in a regular classroom setting, while also streaming the lectures online. Students that can attend in person may do so, while those that require or prefer remote access can also participate (via WebEx). Similarly, laboratory sessions may be attended tangibly, or students may access instruction remotely using video conferencing and virtual machine access to our software and data in the Department of Geographical Sciences. Courses are scheduled in weekday evenings (e.g., 5:30 pm – 8:00 pm) to accommodate working professionals.

International students, however, are limited in the way they can take classes. According to F-1 Visa regulations by the United States Citizenship and Immigration Services (UCSIS), only one online or distance education course per semester can be counted toward the student's full course of study per academic period, and all other course work must be delivered in a "contact" classroom. Therefore, these students will need to attend lectures and lab sessions in person.

An Online Program Offering Supplemental Information form is attached in Appendix B.

9. If the program will be offered in a non-semester format, identify the term structure that will be used for the program:

- **Approved Campus 12-Week Term (see Academic Calendars)**
- ***Non-Standard Term**

***If you are using a non-standard term structure, indicate whether relevant offices, such as the Registrar's Office and International Scholar & Student Services, have been notified and support the program. Non-standard terms need to fit within the university's scheduling system calendar, and non-standard terms need to work with international student visa requirements.**

Term structure:

The proposed MS GEOINT will follow the approved campus 12-week Term Calendar. Each quarter is 12 weeks long, and an academic year is composed of four quarter terms (Fall, Winter, Spring, and Summer).

A standard course will have a lecture on one day and a lab on another day. As all courses are scheduled in the evenings, a student can only take one course each day and a full-time student can only take two courses each term. This 12-week long quarter system allows working professionals or part-time students to concentrate on one or two courses in a short period, which contributes to a better course performance.

The following schedule outlines the quarter terms for the 2018-2019 12-Week Academic Calendar:

Fall Term 8/26/2019 - 11/15/2019
Winter Term 11/25/2019 - 2/19/2020
Spring Term 2/27/2020 - 5/20/2020
Summer Term 6/1/2020 - 8/21/2020

A detailed holiday schedule calendar is available at https://www.provost.umd.edu/calendar/index.html#.

10. For Master's degree programs, describe the thesis requirement and/or the non-thesis requirement.

The proposed MS GEOINT program does not have a thesis requirement. Students must complete five core courses (including a Capstone Project GEOG 697) and five elective courses in order to earn the degree. A Capstone Project, a faculty-advised independent research project, is the culmination of the students' entire body of work, and is essential to determine if the student has met a sufficient number of the required competencies. In addition to demonstrating problem-solving and critical thinking in one or more of the technical areas within the GEOINT domain, students must also take the initiative in planning and organizing this project and demonstrate that they can communicate effectively in writing and through the Capstone project presentation. Students are encouraged to work with department faculties, employers, or our connections in GEOINT industry for Capstone projects.

11. List the intended student learning outcomes. In an appendix, provide the plan for assessing these outcomes.

Graduating students from the MS GEOINT program are expected to complete courses with the following outcomes:

1. A well-rounded understanding of the fundamental nature of geospatial intelligence and analysis, including the core theory, methods, and protocols for gathering and management of geospatial intelligence data, analyses and visualization of those data, use of the resulting products in operational settings for applied geospatial intelligence, and the ethical treatment of data and analysis throughout those procedures.
2. Advanced expertise in either or both of the challenges and opportunities for geospatial intelligence in human, security, and engineering domains; and technologies for future geospatial intelligence and analysis in computing, machinery, and software.
3. Practical, hands-on project and lab-style training with data collection procedures, data analysis, algorithm development, using commercial and open source modeling and analysis software and platforms.
4. The ability to design and implement strategies to solve real-world intelligence problems as they present across a variety of domains, including intelligence activities, security and defense, hazards and emergency response and management, and transportation and urban applications.
5. Training in analytic thinking and real-world problem solving for future success in the workforce. Skills include but are not limited to interpersonal communications and teamwork, creative and critical thinking, occupational planning and organizing, problem-solving and decision making.

The plan for assessing these outcomes is provided in Appendix C.

12. Identify specific actions and strategies that will be utilized to recruit and retain a diverse student body.

The MS GEOINT program provides workforce-focused technical training that gives graduates the technical skills and domain expertise to qualify for mid-level career opportunities in industry and government. We are primarily recruiting from two pools of prospective students: Graduating/graduated students and working professionals. The Department of Geographical Sciences has a current cohort of around 300 students in the GIS concentration of the Geographical Sciences undergraduate major, the GIS minor, and the minor in remote sensing and environmental change. There are similar undergraduate GIS programs in Maryland from which we expect to draw undergraduate students: UM Baltimore County (http://goo.gl/Z9JvB9), Salisbury (https://goo.gl/F4zmCn), Washington College (https://goo.gl/2dVl7J), Towson (http://goo.gl/IUzlKi), Bowie State (https://goo.gl/vg3yWk), Coppin State (https://goo.gl/H8CiC9), Frostburg State (http://goo.gl/NghF3J), UM Eastern Shore (https://goo.gl/bbD7Ip), and the Naval Academy (https://goo.gl/LwGsYF). In-class presentations, flyers, on-campus info sessions, advertisements on UMD shuttle buses and visitor guides have been our major efforts to reach to students from UMD and other universities. We have also been actively attending local- and national-level conferences and setting up a booth to increase the publicity of our program to working professionals. On-line information sessions have also been an effective way of introducing the program and answering questions from both groups of prospective students.

Most of our current students in the MPS GEOINT program are working professionals from the Washington Metropolitan Area. They are employed in a wide range of sectors, including active-duty military, large contractors, and small businesses. Most of our students have completed their Bachelor's degree in Geography, GIS, or a related geospatial field. Some are from a non-geospatial background but are interested in working in

the field of GEOINT after completing our program. We plan on accepting a cohort of 25-30 new students each year in the proposed MS GEOINT program in order to maintain a high-quality learning environment through close and frequent interactions between our faculty and students. We expect that our enrollments will increase over time as we continue to attract new students and have the ability to add new classes and instructors.

Relationship to Other Units or Institutions

13. If a required or recommended course is offered by another department, discuss how the additional students will not unduly burden that department's faculty and resources. Discuss any other potential impacts on another department, such as academic content that may significantly overlap with existing programs. Use space below for any comments. Otherwise, add supporting correspondence as an appendix.

Not applicable.

14. Accreditation and Licensure. Will the program need to be accredited? If so, indicate the accrediting agency. Also, indicate if students will expect to be licensed or certified in order to engage in or be successful in the program's target occupation.

The MS GEOINT program plans to seek the accreditation from the United States Geospatial Intelligence Foundation (USGIF). The USGIF is the only organization dedicated to promoting the geospatial intelligence tradecraft in the USA, and recently our Graduate Certificate in Geospatial Intelligence program (GC GEOINT) was awarded accreditation by USGIF. This makes our GC GEOINT program one of the 15 accredited programs in the USA.

Accredited programs benefit our students, college, university, industry, government, and the GEOINT Community at large, by ensuring current hiring needs are reflected in cross-disciplinary classroom coursework. A USGIF GEOINT Certificate proves to hiring organizations that the holder is ready to work in the GEOINT Community. An accredited Master's program goes even further to demonstrate that students have the skills to work in the ever-expanding, global GEOINT Community.

15. Describe any cooperative arrangements with other institutions or organizations that will be important for the success of this program.

Not applicable.

Faculty and Organization

16. Faculty and organization. Who will provide academic direction and oversight for the program? As an appendix, please indicate the faculty involved in the program. Include their titles, credentials, and courses they may teach for the program.

The MS GEOINT will be housed in the department of Geographical Sciences. The "Program Oversight Committee" is responsible for directing the program, while the program will be administrated and managed by the University of Maryland Center for Geospatial Information Science (CGIS). The program will also form an "MS GEOINT Advisory Committee".

Members of the Program Oversight Committee include:

- CGIS Director— Kathleen Stewart, Professor, Department of Geographical Science, College of Behavioral and Social Sciences, University of Maryland
- Graduate Director— Laixiang Sun, Professor, Department of Geographical Sciences, College of Behavioral and Social Sciences, University of Maryland

The "MS GEOINT Advisory Committee" will be formed internally from faculty in the MS GEOINT program, with two elected student representatives. The role of the Advisory Committee will be to provide term-to-term guidance on the running of the program, as well as strategic advice regarding future opportunities for the program.

The administrative and teaching team will be led by the CGIS Program Director:

- Ruibo Han — Senior Lecturer Department of Geographical Sciences, College of Behavioral and Social Sciences, University of Maryland

Faculty list is provided in Appendix D.

Resource Needs and Sources

17. Each new program is required to have a library assessment prepared by the University Libraries in order to determine any new library resources that may be required. Please contact your departmental/programmatic library liaison or Daniel Mack at dmack@umd.edu, Associate Dean of Collections, to request a library assessment that will be added as an appendix.

Library Assessment Report is provided in Appendix E.

18. Discuss the adequacy of physical facilities, infrastructure and instructional equipment.

The proposed MS GEOINT program will use existing resources and no additional library resources or support are required.

MS GEOINT students have access to two 25-seat GIS labs equipped with dual-monitor high-end workstations and connected to remote storage facilities. Students are also able to work from virtual desktops and servers supported by a VMware environment. The labs run a wide variety of commercial and open source software for GIS, remote sensing, statistical analysis, data access, image processing, mathematical analyses, graphics and 3D modeling, and software development. The Department of Geographical Sciences is also an ESRI Development Center.

The CGIS maintains a set of location-aware devices for teaching mobile GIS. These include (1) tablets equipped with positioning and motion sensors that students can learn how to program and extract data from, (2)

virtual reality media for immersive exploration of models and data, and (3) sensing devices for desktop and console computing that can generate real-time positioning, motion, and gesture captures.

The CGIS has two high-performance Hadoop-based computing clusters that have been purchased for research and student teaching. In each instance, the clusters are networked to other HPC resources in the Geographical Sciences department. The Department also maintains a Linux-based HPC cluster. Two IT professionals oversee, maintain, and guide the development of these computing resources. The CGIS and Department of Geographical Sciences also link to high-performance computing in the College of Behavioral and Social Sciences (the "BSWIFT" cluster), as well as to the University of Maryland Institute for Advanced Computer Studies (UMIACS), which operates several clusters. In partnership with the Mid-Atlantic Crossroads (MAX), we also have high-performance networking access to other high-performance computing sites around the country, as well as nimble access to commercial computing resources (Amazon AWS).

The University of Maryland maintains an Enterprise Learning Management System (ELMS) for coursework. ELMS is a Web-based platform for sharing course content, tracking assignments and grades, and enabling virtual collaboration and interaction. The MS GEOINT program will use ELMS for all its courses. The Department of Geographical Sciences also maintains a Cisco WebEx Online course delivery platform, by which lectures and discussions can be streamed virtually. The Department maintains two dedicated servers and shared storage for server-side delivery of GIS software.

19. Discuss the instructional resources (faculty, staff, and teaching assistants) that will be needed to cover new courses or needed additional sections of existing courses to be taught. Indicate the source of resources for covering these costs.

No additional instructional resources are required for the proposed MS GEOINT program.

The CGIS has two full-time Lecturers for the current MPS GEOINT program. These two dedicated lecturers will serve as instructors for most of the courses in the proposed MS GEOINT program, and some of the elective courses will be taught by other lecturers from the department. Initially, lecturers also provide lab instruction, but these responsibilities will be shifted to graduate teaching assistants as the program grows large enough to warrant the support of graduate TAs for supporting lab assignments.

In the following years, we anticipate to hire one new lecturer and request two to three TA lines. In each case, resources for these hires will come from program revenues directly unless other sources can be identified.

20. Discuss the administrative and advising resources that will be needed for the program. Indicate the source of resources for covering these costs.

The program director and a Senior Faculty Specialist will play the major management roles for the program. The director and lecturers in the program will serve as academic advisors for students. Tuition revenue will cover the cost of these resources.

21. Use the Maryland Higher Education Commission (MHEC) commission financial tables to describe the program's financial plan for the next five years: https://docs.google.com/spreadsheets/d/1V6iSZG05edMitWP6CAOXjCoGO58Gf6VXxPaacKfrhZ4/edit#gid=0. Add these tables as attachments. Use the space below for any additional comments on program funding.

The program's five-year financial plan is provided in Appendix F.

Implications for the State (Additional Information Required by MHEC and the Board of Regents)
If the proposed program is for a Post-Baccalaureate Certificate that is derived entirely from existing courses within an existing Master's degree program, then you **only** need to respond to prompts 22 (on market demand) and 25 (curriculum of current master's degree program).

22. Explain how there is a compelling regional or statewide need for the program. Argument for need may be based on the need for the advancement of knowledge and/or societal needs, including the need for "expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education." Also, explain how need is consistent with the Maryland State Plan for Postsecondary Education.

The growing field of *geospatial intelligence* was originally associated with *national security*—the National Geospatial-Intelligence Agency (NGA) is tasked with visualizing, analyzing, and assessing national security through collection and interpretation of geospatial data. These data now come from an ever-growing array of sources, including other intelligence agencies; grounded, airborne, and orbital sensor platforms; evolving silos of big data generated by Internet and Communications Technologies (ICTs); and actively and passively volunteered geographic information that populations and devices cast during their everyday actions and interactions. Geospatial intelligence has, however, begun to grow beyond its original security focus, and the field now encompasses a variety of arenas in which geospatial intelligence plays a role. In *machine intelligence*, geospatial intelligence is a core component of navigation systems for vehicles and robots, as well as computer vision schemes. In *business intelligence*, it forms the basis for geodemographics, customer management systems, marketing analytics, location-allocation and site selection support systems, and logistics. In *criminology*, geospatial intelligence is widely employed in managing public security and investigating crime. In *government and public policy*, geospatial intelligence is significant in resource allocation and assessment of service delivery. In *natural hazards and emergency response*, it provides key data management and analysis tools for monitoring, assessing, and mitigating capabilities in decision making, method preparedness, and early warning system. In *engineering and computing industries*, it forms an important component of systems engineering, particularly in the emerging area of cyber-physical systems and cyberspace systems using commercial and open-source platforms. In the *earth sciences*, geospatial intelligence is used to provide base mapping, geo-referencing, and data fusion for a variety of data products and sensor systems.

Our local surroundings play host to the center of influence for the geospatial intelligence industry in the United States. The National Geospatial-Intelligence Agency employs 8,500 people at the third largest federal building in the D.C. region at nearby Springfield, VA. The NASA Goddard Space Flight Center in nearby Greenbelt, and the United State Geological Survey in nearby Reston, VA serve as the nexus for the nation's earth science geospatial intelligence. The U.S. Census Bureau in nearby Suitland, MD is tasked with a decennial nationwide data collection exercise that mobilizes a huge workforce to perform geospatial intelligence gathering year-round.

The few dedicated graduate programs for geospatial intelligence that exist in the United States are, in essence, programs for Geographic Information Systems (GIS) branded as "geospatial intelligence", but which have very little (sometimes none) content that deals with intelligence. This has become an issue for the intelligence community, who are having to scramble to train GIS graduates on the job. As a result, there is a move to establish certification programs for geospatial intelligence (see a new initiative by the U.S. Navy at http://goo.gl/WPEB5H; and the US Geospatial Intelligence Foundation, who have accredited our graduate certificate program; https://usgif.org/education/accreditation). There is a gap in the supply of graduate-level instruction in this area, and a large demand for well-trained students.

23. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program. Possible sources of information include industry or disciplinary studies on job market, the USBLS Occupational Outlook Handbook, or Maryland state Occupational and Industry Projections over the next five years. Also, provide information on the existing supply of graduates in similar programs in the state (use MHEC's Office of Research and Policy Analysis webpage for Annual Reports on Enrollment by Program) and discuss how future demand for graduates will exceed the existing supply. As part of this analysis, indicate the anticipated number of students your program will graduate per year at steady state.

The field of geospatial intelligence has recently and suddenly ballooned and major technology companies (Google, Apple, Facebook, Über, for example) have been scrambling to put together teams to get up to speed. These technology-based companies join already well-established geospatial intelligence divisions in major government contract companies in and around the Beltway, such as BAE Systems (http://goo.gl/9viLPl), Lockheed Martin (http://goo.gl/FEgEjl), Harris (http://goo.gl/Ww4UQJ), Northrup-Grumman (http://goo.gl/3MQz47); IDS (http://goo.gl/b2lWzs), and Leidos (https://goo.gl/8ekubo), as well as most banks and insurance companies, all of which have geospatial intelligence divisions. Entirely new companies are beginning to form around the topic of geospatial intelligence (see Palantir, which has offices locally in Tyson's Corner, VA; https://goo.gl/Wi1JQE). In early August 2015, Audi, BMW, and Daimler purchased the geospatial intelligence division of Nokia (known as "Here") for $3.1 *billion*.

The need for a well-trained and nimble workforce in geospatial intelligence is growing, markedly. The Bureau of Labor Statistics "Job outlook" statistics place graduates in geospatial intelligence in the "Much faster than average" category for employment prospects across each classification of relevance to the field (20% to 29% change in employment over the next ten years; see http://goo.gl/j8f1F1 and http://goo.gl/cnBXnT). Again, Maryland is enjoying some of the strongest increases in future job prospects for geospatial intelligence. We rank as the number one state for the highest employment level in the occupation, as well as the top state for highest concentration of jobs. The D.C. metropolitan area ranks the highest (by a factor of between four and seven!) in urban areas with the highest employment level in this category, job concentration, and mean wage. Maryland is ranked second (behind Virginia) for top paying states for the occupation. (Details are at http://goo.gl/Jw9M9G.)

We plan to graduate a cohort of 25-30 students each year in the proposed MS GEOINT program. We expect that our enrollments will increase over time as we continue to attract new students and graduate a highly-equipped labor force to the job market.

24. Identify similar programs in the state. Discuss any differences between the proposed program and existing programs. Explain how your program will not result in an unreasonable duplication of an existing program (you can base this argument on program differences or market demand for

graduates). The MHEC website can be used to find academic programs operating in the state: http://mhec.maryland.gov/institutions_training/pages/HEPrograms.aspx.

There is only one similar existing programs to the proposed MS GEOINT program in the State of Maryland: the Master of Science in Geospatial Intelligence at Johns Hopkins University (https://goo.gl/9kGpXT). Johns Hopkins University's MS GEOINT program is fairly recent (starting in Summer 2018), and it is a fully online program composed of courses compiled from two established programs at the university: GIS and Government.

Our MS GEOINT program will not result in an unreasonable duplication of this program based on the following aspects:

Our curriculum is dedicated to courses designed for Geospatial Intelligence with offerings including Open Source Intelligence, Mobile and Social Computing, Big Data Analytics, Hazards and Emergency Management. It is significantly different from Johns Hopkins' GEOINT program. It is also distinctive from current GIS, geoinformatics, remote sensing or government courses as it offers a specific intelligence focus. Course contents are based on the cutting-edge technologies and platforms used in the GEOINT industry including open source tools and methods and big data computing, instead of the more typical GIS focus on spatial data handling of other programs.

Our course delivery format is different from Johns Hopkins' GEOINT program as well. We adopt a hybrid format (on-site + online) to integrate the benefits of traditional classroom teaching style and modern remote education. Students who live near to campus can attend lectures or lab sessions in person if they so choose or select remote participation if that is a better fit for them. This facilitates a more dynamic learning environment for our students.

Our special quarter term system will allow our students to graduate sooner than traditional semester-based programs listed above. Students may finish 10 courses in as fast as 15 months (two courses every 3-month term) in our MS GEOINT program.

25. Discuss the possible impact on Historically Black Institutions (HBIs) in the state. Will the program affect any existing programs at Maryland HBIs? Will the program impact the uniqueness or identity of a Maryland HBI?

None of the Maryland HBIs currently offers a GEOINT program. We hope that graduates from HBI programs interested in a career in the geospatial intelligence field will consider our Master's program to extends their skills and background.

26. For new Post-Baccalaureate Certificates derived from existing master's programs only, include the complete curriculum of the existing master's program.

Not applicable.

Appendix A: Course Catalog

All the courses listed below are 3-credit courses.

GEOG 661:Fundamentals of GEOINT
Geospatial Intelligence (GEOINT) is the collection, analysis, visualization and dissemination of geospatial information to support decision-making. This course introduces the fundamental knowledge required to become a successful GEOINT practitioner, including the history of the GEOINT discipline, the intelligence applications of remote sensing and Geographic Information Systems (GIS) technologies, and how GEOINT products are used to support national security and humanitarian missions. Upon completion of this course you will understand the roles that technology, policy, doctrine, government, and industry play in shaping the Geospatial Intelligence discipline, and develop the technical knowledge and domain expertise to create basic GEOINT products that provide context for decision makers.

GEOG 662: Advances in GIS and Remote Sensing
Assuming a basic understanding of geographic information systems and services, and remote sensing techniques, this course focuses on state-of-the-art advances in geographic information science and remote sensing as they support geospatial intelligence. The course will focus on synergies between GIS and remote sensing in informatics, computer science, and spatial engineering, and their application to problem domains in human systems, physical systems, and cyberspace. Advances in GIS presents recent advances regarding fundamental issues of geo-spatial information science (space and time, spatial analysis, uncertainty modeling and geo-visualization), and new scientific and technological research initiatives for geo-spatial information science (such as spatial data mining, mobile data modeling, and location-based services). Advances in remote sensing will provide opportunity to understand and work with latest developments in the Remote Sensing datasets. The curriculum covers wide range of remote sensing data interpretation and their processing techniques.

GEOG 664: GEOINT Systems and Platforms
There are numerous systems and platforms that support the collection, visualization and dissemination of Geospatial Intelligence (GEOINT). Platforms such as satellites and aircraft carry sensors systems that can detect both physical and man-made objects on the earth. Ground-based processing systems are used to analyze and visualize sensor data, and also to create and disseminate GEOINT products that guide decision-making. In this course you will learn how to develop and implement source-to-screen GEOINT workflows, and will understand how to use a system of systems approach to describe the programmatic and technical strengths and weaknesses of many different GEOINT systems and platforms.

GEOG 665: Algorithms for GEOINT Analysis
With increasing sources and platforms of geospatial and imagery data, GEOINT analysts face new challenges in data exploitation and analytics. This course focuses on communicate the knowledge and capabilities that allow GEOINT analysts to be more efficient in analyzing and understanding the activities, relationships, and patterns discovered from these GEOINT sources. The purpose of this course is to expose students to fundamental algorithms in geospatial intelligence and their application in methodological and substantive domains, and their implementation in computer programs and software systems. This course provides an introduction to theoretical and applied aspects of GEOINT systems and quantitative methods with a focus on spatial analysis. Emphasis will be placed on the analysis of continuous and discrete geographical data for spatial problem solving in both the human and physical spatial sciences. We will explore algorithms, data structures, and advanced computational topics. Implementation of algorithms will be explored through pseudo-code and a variety of scripting, data access, and programming languages.

GEOG 697: Capstone Project

The Capstone is an independent research project that demonstrates competence in geospatial intelligence technologies. This project can originate from an internship, from relevant work at a current or past employer, or can be developed in conjunction with CGIS faculty. The student will prepare a project report and presentation which shall contain an executive summary, background information including a literature review and establishment of requirements, a detailed technical description of the project data and methods, a discussion of results obtained, and final conclusions and recommendations. The final project submission will include all data, computer code and/or workflow documentation required to replicate the project results. In completing this project, students develop a concrete example of how GEOINT technologies can be applied to solve real-world problems, and begin developing a portfolio that can be presented to potential employers.

GEOG651: Spatial Statistics
This course is about quantitative analysis of spatial data. It is intended to provide a broad survey of various spatial statistic methods. The course is geared towards helping students: (1) develop an understanding of the important theoretical concepts in spatial data analysis; and (2) gain practical experience in the application of spatial statistics to a variety of social and environmental problems using the advanced statistical software. This course covers five broad topical areas: (1) point pattern analysis; (2) area data analysis; (3) continuous data analysis; (4) spatial sampling; and (5) multivariate spatial and temporal analysis.

GEOG656: Programming and Scripting for GIS
This course teaches programming and scripting for GIS users. The concepts of scripting and object-oriented programming using the Python programming language are reviewed. This course teaches students to design clearly structured programs and introduces ArcPy, a library providing access to ArcGIS geoprocessing tools. ArcPy includes a series of modules such as data access, mapping, spatial analysis, and network analysis. Students will develop geoprocessing programs to edit, query, manipulate, and analyze spatial data (both vector and raster data) with Python, ArcPy, and other modules like NumPy.

GEOG657: Web Programming
Component-based web server design and efficient session and secure access management have become challenges to provide fast, robust, and flexible GIS services on the Internet. This course is designed to teach fundamental techniques required in developing both client-side and server-side web application for not only GIS but also non-GIS applications. This course covers web design and static web generation using HTML5 and CSS, client-side programming with JavaScript, and dynamic web development using PHP and MySQL. Basic web design using HTML, XHTML, CSS, etc. is helpful, but not required.

GEOG660: Advanced Remote Sensing using Lidar
This course will expand on remote sensing concepts with a focus on light detection and ranging (lidar) technology. Lidar, also known as laser scanning, is an active remote sensing tool that can produce high-resolution point clouds. This course will cover the fundamentals of lidar, explore current developments in lidar technology, and discuss different applications where it is being used. Students will get hands-on learning about lidar data management, processing, and analysis. It is recommended that students have some background in spatial modeling and computer programming.

GEOG 663: Big Data Analytics
This course is designed to introduce statistical analysis over big data sets (and tackling big data problems), primarily in geography and spatial sciences, but with broader appeal throughout the socio-behavioral sciences. Students will be introduced to a range of methods that can be applied to the exploration, modeling, and visualization of big quantitative data. This course explores data fusion, statistical analysis, and data-mining for geospatial and non-geospatial data in structured and unstructured form, with an emphasis on large silos of data across diverse sources and assumptions.

GEOG 680: Geospatial Intelligence Networks
Networks are an important part of the Geospatial Intelligence (GEOINT) cycle, from the sensor networks that are used to collect raw geospatial information to the telecommunication networks that are used to disseminate finished GEOINT products. Transportation networks, computer networks, social networks, and many other man-made and natural features can also be characterized by a link-node network topology, and can be studied using network science methods. Upon completion of this course you will be able characterize and classify real-world GEOINT networks and their components, understand network dynamics including routing, scalability, and robustness, and be able to apply engineering methods for network design and network analysis.

GEOG 682: Open Source Intelligence
Open Source Intelligence (OSINT) is information that is publicly available which is collected and analyzed to support decision-making. The collection and analysis of OSINT is often considered to be the first step in developing an "all-source" intelligence product, where OSINT is fused with Geospatial Intelligence (GEOINT), Signals Intelligence (SIGINT), and Measurement and Signature Intelligence (MASINT), and Human Intelligence (HUMINT). In this course you will learn about the sources, ethics, and methods that are associated with OSINT, and will also develop knowledge and skills related to open-source geospatial technologies and organizations such as the Open Geospatial Consortium (OGC).

GEOG 683: Hazards and Emergency Management
Timely and accurate Geospatial Intelligence (GEOINT) is essential for protecting people from hazardous events such as floods, wildfires, tsunamis, hurricanes, industrial accidents, and terrorist attacks. GEOINT plays a critical role in all four stages of emergency management: preparedness, mitigation, response, and recovery. The use of remote sensing and Geographic Information Systems (GIS) before, during, and after Hurricane Katrina and the 9/11 terror attacks are two of the case studies that are discussed during this course. You will develop a deeper understanding of the emergency management successes and failures that occurred during these historic and deadly events, and learn the technical skills to develop and disseminate GEOINT products that support decision-making at all four stages of emergency management.

GEOG 686: Mobile Computing and Geospatial Information Management
This course is designed as an introduction to mobile GIS, to the programming concepts underlying mobile GIS development, and more importantly, to the design and implementation of a mobile GIS application. The course covers how to develop, test, and publish mobile GIS native apps working across two mobile platforms: Android and iOS. It also leverages the capabilities of JavaScript, Swift, Google maps, ArcGIS Server and runtime SDK to developing and publishing mobile GIS apps.

GEOG684: Image Analysis and Geovisualization
This course explores image processing routines atop remotely-sensed data from a variety of multispectral, hyperspectral, radar, and microwave platforms, including data preparation and enhancement, feature transformation, classification, pattern detection, and feature extraction. It explore next-generation platforms for machine vision, including commercial sensors in location-aware devices and gaming devices, car sensor systems, and security cameras, and methods for object detection and tracking, structure from motion, and gait and expression analysis. It will also cover computer cartography, scientific visualization, handling high-dimensional data, and animation.

GEOG685: Machine Learning and Data Mining
This course provides a basic introduction to Machine learning and Data mining, a dynamic and fast evolving subfield of artificial intelligence that learn from past experience and find useful patterns in data. Topics include the three basic branches in this field: (1) Supervised learning to predict problems; (2) Unsupervised learning for clustering data and discovering patterns from data; and (3) Reinforcement learning for decision making. The

course will not only learn various machine learning and data mining techniques, but also learn how to apply them to real problems in practice including character recognition, speech recognition, text mining, document classification, pattern recognition, social media analysis, and information extraction from web pages.

GEOG687: Geospatial Intelligence for Security
This course focuses on security problem-sets, opportunities, methods, and applications of geospatial intelligence in security four main domains. First, in defense and homeland security, the course will examine how geospatial intelligence supports military operations (including operations other than war) and national security initiatives. Second, in the domain of crime, the course will explore how geospatial intelligence is used in law enforcement, crime prevention, and forensic analysis. Third, the course examines the role of geospatial intelligence in cyber-security, including topics such as cyber-crime, location spoofing, and space-time dynamics of computer virus and service attacks, fraud, and SPAM. Fourth, the course treats geospatial intelligence as it relates to the identification, analysis, evaluation, management, and response to hazards, crises, and critical scenarios. Here, we focus on both natural and on man-made phenomena and systems, as well as interactions between them.

GEOG688: Human and Activity-Based Intelligence
This course focuses on the applied human domain of geospatial intelligence and its relationship to social and behavioral science. It begins with a review of human geography, behavioral geography, political geography, and cultural geography and their relationships to human intelligence gathering. It then focuses on fundamental and emerging techniques for activity-based intelligence. Current topics include migration and flow, movement analytics, transportation analytics, time geography and event conceptualization, transactions and interactions, and social and cyber-physical networks.

GEOG690: Data Visualization
Data visualization techniques provide people with enhanced perceptual and cognitive abilities to understand and extract information from increasing amounts of data. This course will introduce a number of common data domains and corresponding analysis tasks, including multivariate data, networks, text, and spatial data. Students will learn offline data visualization tools as well as interactive web techniques to create visualizations that allow viewers from all backgrounds to interact with data, and gain insight into data through the data's presentation. This course will also cover computer cartography, handling high-dimensional data, and dynamic visualization.

GEOG691: Food Security
Measuring human food security is an important application of geospatial intelligence. Remote sensing resources can be used to identify regions where food insecurity may occur, and geospatial data fusion can help analysts understand and predict broader national security implications. Course topics include monitoring crop conditions using multispectral imagery, developing products to manage agricultural areas, analyzing the complexity and diversity of food production systems, and integrating socioeconomic and demographic data into geospatial analysis processes and decision support products.

Appendix B: Online Program Offering Supplemental Information

According to the Maryland Higher Education Commission, a new offering of "more than 50 percent" of an existing program in an online format requires MHEC approval. The following prompts are based on academic policies for online programs as well as questions frequently asked by review committees.

Discuss the role of faculty in the development, oversight, and teaching of this online program. Note that MHEC 13B.02.03.11(F) requires that "at least 50 percent of the total semester credit hours within the proposed program shall be taught by full-time faculty." Indicate any other unit or vendor that will be used to administer or deliver the program.

The MS GEOINT will be housed in the Graduate School. The "Program Oversight Committee" is responsible for directing the program, while the program will be administrated and managed by the University of Maryland Center for Geospatial Information Science (CGIS). The program will also form an "MS GEOINT Advisory Committee".

Members of the Program Oversight Committee include:

- CGIS Director— Kathleen Stewart, Professor, Department of Geographical Science, College of Behavioral and Social Sciences, University of Maryland
- Graduate Director— Laixiang Sun, Professor, Department of Geographical Sciences, College of Behavioral and Social Sciences, University of Maryland
- Graduate School Representative— Steve Fetter, Dean, Graduate School, University of Maryland

The "MS GEOINT Advisory Committee" will be formed internally from faculty in the MS GEOINT program, with two elected student representatives. The role of the Advisory Committee will be to provide term-to-term guidance on the running of the program, as well as strategic advice regarding future opportunities for the program.

The administrative and teaching team will be led by the CGIS Program Director:

- Ruibo Han — Senior Lecturer Department of Geographical Sciences, College of Behavioral and Social Sciences, University of Maryland

100 percent of the total credit hours in the proposed MS GEOINT program will be taught by full-time faculty from the Department of Geographical Sciences at the University of Maryland.

Discuss the resources available for training and supporting faculty in regard to course development and instructional technology.

All the courses in the proposed MS GEOINT program are fully developed and currently taught in the MPS GEOINT program.

Courses are subject to constant updates with the development of the technologies in the GEOINT industry. The Teaching and Learning Transformation Center at the University of Maryland inspires and supports effective,

engaging, efficient, and equitable teaching innovations among the University's instructors and assistants. This team provides faculty with training, resources, professional development activities, and individualized consultation to transform their classrooms and careers.

Discuss how courses will be taught using online technologies. Will courses be synchronous, asynchronous, or a combination of both? What technologies will be used to present material and evaluate the quality and authenticity of student work? How will these technologies be assessed?

The proposed MS GEOINT program will be delivered in a **hybrid** format: Instructors present lectures and lead discussions tangibly in a regular classroom setting, while also streaming the lectures online. Students that can attend in person may do so, while those who require or prefer remote access can also participate (via *WebEx*). Similarly, laboratory sessions may be attended tangibly, or students may access instruction remotely using video conferencing and virtual machine access to our software and data in the Department of Geographical Sciences.

The University of Maryland maintains an Enterprise Learning Management System (ELMS) for coursework. ELMS is a Web-based platform for sharing course content, tracking assignments and grades, and enabling virtual collaboration and interaction. The MS GEOINT program will use ELMS for all its courses.

The Department of Geographical Sciences also maintains a Cisco WebEx Online course delivery platform, by which lectures and discussions can be streamed virtually. WebEx is a Web conferencing application that can be used to host classes, office hours, and other meetings, in an online environment. Faculty, staff, and students can communicate in real-time using chat, voice (microphone and speakers), and video (webcam) with WebEx. WebEx allows for the ability to display presentations, annotate overtop slides, perform live editing of documents and even conduct a poll within the software.

Additionally, the Department maintains two dedicated servers and shared storage for server-side delivery of GIS software.

Discuss how the online program will be comparable to the existing program in terms of academic rigor. What are the learning outcomes for the online offering? Do they differ from the existing on-site program? How will the program be evaluated?

The proposed MS GEOINT program will be delivered in a **hybrid** format: Instructors present lectures and lead discussions tangibly in a classroom setting, while also streaming the lectures Online. Academic rigor can be challenging for online teaching and learning, especially when assessing a student's course work. We try to enhance the academic integrity by decreasing the amount/weight of exams which is difficult to control for online students, and increasing the amount/weight of personal projects or customized assignments.

We don't distinguish the students who study online from those whole who study on-site, as students may choose to mix the learning style during a term. The leaning outcomes stay the same as online and on-site students.

We will use various methods of assessments to evaluate the program, including In-class observation, Student participation, Student feedback, course evaluation, etc. Details are provided in Appendix C.

Describe the admissions criteria and procedures for the online program.

The proposed MS GEOINT program will be delivered in a **hybrid** format, so we don't distinguish the students who study online from those whole who study on-site. The admission criteria are the same for all applicants, which are listed in section 4 of this proposal.

Discuss how students will have reasonable and adequate access to the range of student support services (library materials, teacher interaction, advising, counseling, accessibility, disability support, and financial aid) needed to support their learning activities.

The proposed MS GEOINT program will be delivered in a hybrid format, thus all students have equal access to on-campus resources as regular graduate students. All available resources for our current MPS GEOINT program are listed on our program website (https://geospatial.umd.edu/education/resources), and the proposed MS GEOINT program will have the same access to these resources and services.

Discuss how the program will provide students with clear, complete, and timely information on the curriculum, technological competence and equipment needed for the program, admissions criteria, financial aid resources, complaint procedures, and cost and payment policies.

Program website http://geoint.umd.edu will serve as the portal to provide clear, complete, and prompt information on curriculum, requirement, course plan, admission procedure, resources, etc.

In addition to the broader program learning outcomes and student competencies, all courses in the GCPS GEOINT program have unique learning outcomes that are designed to ensure that one or more student competencies are met. Student assessment strategies vary by course as well, but typically include regular technical laboratories and a final project that emphasizes problem-solving and critical thinking in Geographic Information Systems (GIS), Remote Sensing, Spatial Analysis, Computer Programming, and Geospatial Intelligence. Students are encouraged to partner with faculty in the CGIS, the Department of Geographical Sciences, or other UMD departments to conduct their Capstone Project research. Students may also choose to integrate their current workplace duties into their research project. By encouraging research collaborations with both the academic and industry partners, we help ensure that student projects are relevant and applicable to current problems within the GEOINT domain.

Broader oversight of student competencies, learning outcomes, course development, and research is provided through several mechanisms. As the Director of the Center for Geospatial Information (CGIS), Dr. Kathleen Stewart ensures that the GCPS GEOINT program is aligned with the broader mission of the center, including scholarship and teaching of future-forward geospatial information science technologies and advanced computational approaches. In addition, a CGIS Advisory Committee meets quarterly to discuss and plan the future directions of the center and coordinate goals and activities across all of the Graduate Certificate and Master of Professional Studies Programs administered by the center. Finally, CGIS and GCPS GEOINT goals and program progress are discussed and defined at the quarterly Department of Geographical Sciences Committee Meetings, which are chaired by Dr. Chris Justice (Chair, Geographical Sciences).

Intellectual Property Policy. Units developing online programs should be familiar with the university's intellectual property policy. See https://www.president.umd.edu/iv-320a. Please indicate that the unit will comply with the university's intellectual property policy.

The department will comply with the university's intellectual property policy to deliver the proposed MS GEOINT program.

Discuss the instructional and administrative resources (faculty, staff, and teaching assistants) that will be needed to cover the cost of the program. Indicate the source of resources for covering these costs. These formatted tables can be used to indicate the resources and expenditures for the program: https://docs.google.com/spreadsheets/d/1V6iSZG05edMitWP6CAOXjCoGO58Gf6VXxPaacKfrhZ4/edit#gid=0.

The proposed MS GEOINT program has two full-time Lecturers to serve as instructors for most of the courses in the proposed MS GEOINT program, and some of the elective courses will be taught by other lecturers from the department.

In the following years, we anticipate to hire one new lecturer and request three to four TA lines. In each case, resources for these hires will come from program revenues directly unless other sources can be identified.

The program director and a Senior Faculty Specialist will play the major management roles for the program. The director and lecturers in the program will serve as academic advisors for students.

Tuition revenue will cover the cost of these resources.

A budget form is provided in Appendix F.

Describe the market demand for the program. Evidence may be research from industry or the discipline, and should also consider state and federal employment projections. Indicate the job opportunities available to those who would graduate from this program.

The need for a well-trained and nimble workforce in geospatial intelligence is growing, markedly. The Bureau of Labor Statistics "Job outlook" statistics place graduates in geospatial intelligence in the "Much faster than average" category for employment prospects across each classification of relevance to the field (20% to 29% change in employment over the next ten years; see http://goo.gl/j8f1F1 and http://goo.gl/cnBXnT). Again, Maryland is enjoying some of the strongest increases in future job prospects for geospatial intelligence. We rank as the number one state for the highest employment level in the occupation, as well as the top state for highest concentration of jobs. The D.C. metropolitan area ranks the highest (by a factor of between four and seven!) in urban areas with the highest employment level in this category, job concentration, and mean wage. Maryland is ranked second (behind Virginia) for top paying states for the occupation. (Details are at http://goo.gl/Jw9M9G.)

The field of geospatial intelligence has recently and suddenly ballooned and major technology companies (Google, Apple, Facebook, Über, for example) have been scrambling to put together teams to get up to speed. These technology-based companies join already well-established geospatial intelligence divisions in major government contract companies in and around the Beltway, such as BAE Systems (http://goo.gl/9viLPl), Lockheed Martin (http://goo.gl/FEgEjl), Harris (http://goo.gl/Ww4UQJ), Northrup-Grumman (http://goo.gl/3MQz47); IDS (http://goo.gl/b2lWzs), and Leidos (https://goo.gl/8ekubo), as well as most banks and insurance companies, all of which have geospatial intelligence divisions. Entirely new companies are beginning to form around the topic of geospatial intelligence (see Palantir, which has offices locally in Tyson's Corner, VA; https://goo.gl/Wi1JQE). These create abundant job opportunities for graduates from our proposed MS GEOINT program.

Appendix C: Assessment Of Learning Outcomes

To ensure that these outcomes are met, the MS GEOINT program will focus on coursework and course modules that emphasize:

1. *Well-rounded understanding*—Impose a core set of coursework to ensure that students develop a well-rounded education in the fundamentals of geospatial intelligence and analysis, with courses that cover basics of the profession and science, technical offerings, and ethics.
2. *Advanced expertise*—Offer a series of balanced electives that build on that core with advanced coverage of topics of a substantive nature and/or a technical nature.
3. *Practical training*—A capstone project will be required of all students, affording them the opportunity to develop hands-on problem-solving skills on operational intelligence tasks.
4. *Lab skills*—In each course, a set of projects or lab exercises will ensure that students apply their theoretical knowledge to actionable topics in geospatial intelligence and analysis.
5. *Workforce success*—A dedicated course will be offered to train students in the art and practice of thinking and acting entrepreneurially, so that they are well-prepared for success in the workplace.

Our success in guiding students through the outcomes will be evaluated using a set of varied metrics and instruments:

1. *In-class observation*–Assessments will be carried out throughout the program to gauge (1) student involvement, (2) student interest and engagement, (3) student performance, (4) faculty performance, and (5) the nature of the learning environment. This assessment will be carried out by informal observation by other faculties in the MS GEOINT program, as well as by faculty in the Department of Geographical Sciences. Unstructured (quick chats and check-ins) and structured (survey questions) data will be collected to support these observations.
2. *Student participation*—Will be gauged through checks on attendance and progression through course milestones (submitting assignments and projects in a timely manner). Where content is provided digitally (through Adobe Connect or via ELMS, for example), empirical metrics for students' access to course resources can also be evaluated.
3. *Student feedback*—Will be collected through open sessions (office hours or question-and-answer sessions) and formal evaluation events (end-of-course evaluation). Upon graduating from the course, we will also hold student exit interviews to gather feedback on their success in the course and in meeting our learning outcomes objectives.
4. *Capstone project*—The capstone project is one of the main culminating course experiences for the MS GEOINT program. Each capstone project will be evaluated in a dedicated review session and evidence of learning outcomes as they present in the projects will be assessed.

Appendix D: Program Faculty

CGIS faculty are actively pursuing research opportunities with DoD organizations (both government agencies and industry partners). This includes research on urban dynamics, mobility, event modeling, and cybersecurity topics. We are also working with collaborators at START, The National Consortium for the Study of Terrorism and the Responses to Terrorism, at the University of Maryland to pursue research in the field of geospatial intelligence. Dr. Stewart is currently the primary advisor for a PhD student who works at START and whose dissertation research relates to terrorism and geospatial modeling. Dr. Stewart has had research support from IARPA and NGA, particularly in the area of geospatial semantic data modeling. As the CGIS develops its research program in geospatial intelligence, we will work to provide opportunities for students in the MS GEOINT program to learn about these projects and even work with us through, for example, their capstone course projects.

Dr. Micah Brachman

Micah Brachman is a Lecturer in the Center for Geospatial Information Science at the University of Maryland, College Park. He holds a PhD (2012) and MA (2009) in Geography from the University of California, Santa Barbara and a BS (2000) in Geography from the University of Minnesota. Micah has extensive professional experience in GIS and Remote Sensing in the commercial, government, and non-profit sectors, and recently transitioned from a Geospatial Scientist position supporting the Army Geospatial Center to teach in the new Geospatial Intelligence (GEOINT) program. In addition to GEOINT, Micah is also actively engaged in teaching and scholarship in Hazards and Emergency Management, Network Science, and Active Transportation.

Courses to teach in the MS GEOINT program:

GEOG661, GEOG664, GEOG680, GEOG682, GEOG683

Dr. Junchuan Fan

Dr. Junchuan Fan is a postdoctoral research associate with the Center for Geospatial Information Science at the University of Maryland. His research is focused on spatiotemporal modeling and analysis of naturalistic driving behaviors, big geospatial data mining on human activity and movement dynamics, geospatial semantics, and smart cities. Dr. Fan has been involved in research projects funded by FDOT, MSHA, National Advanced Driving Simulator (NADS), and IARPA. He teaches courses on open source GIS, spatial databases, web mapping, and geospatial semantic data handling.

Courses to teach in the MS GEOINT program:

GEOG684, GEOG687, GEOG688

Dr. Ruibo Han

Dr. Ruibo Han is the Director and Senior Lecturer of the Master and Graduate Certificate programs of GEOINT in the Center for Geospatial Information Science at the University of Maryland, College Park. He also teaches courses in both of the program, as well as the graduate and undergraduate programs in the Department of Geographical Sciences. Ruibo earned his PhD in Geography from the University of Ottawa and formerly worked at the University of Ottawa and the University of Toronto teaching courses in GIS and Statistics. Ruibo's research and teaching interests include urban dynamics, web and mobile GIS, big data analytics, and public participatory geospatial systems, and he has received research funded and produced publications in these fields.

Courses to teach in the MS GEOINT program:

GEOG662, GEOG663, GEOG665, GEOG685, GEOG686, GEOG697

Dr. Eunjung Elle Lim

Dr. Lim earned a Ph.D degree in Geography (GIS specialty) from the State University of New York at Buffalo. Her dissertation is about methodology detecting a sequence of changes in dynamic spatiotemporal data and investigating patterns of detected changes. In her dissertation she dealt emergency vehicle location and allocation strategies coping with time-varying emergency 911 calls. Her specialty is geographic information sciences. In the realm of GIS, she has developed special interest and knowledge in GIS modeling, programming, network analysis, and spatial statistics. She has about 12 years of experience developing software using Java, C, C++, Visual Basic and relational databases. She is very interested in designing and developing new functionalities in GIS that provide abilities to make users perform tasks that they even haven't thought they can do with geographical knowledge.

Courses to teach in the MS GEOINT program:

GEOG651, GEOG657,

Dr. Jonathan Resop

Dr. Jonathan Resop earned his Ph.D. at Virginia Tech in Biological Systems Engineering. During his time at Virginia Tech, he worked on multiple projects related to spatial modeling and remote sensing, in particular problems that involve agricultural and environmental systems. His dissertation involved applying ground-based lidar to various ecological applications. After completing his Ph.D. he worked as a post-doc for the USDA-ARS in Beltsville in the Crop Systems and Global Change Lab, doing research related to simulating the potential production capacity of crops within regional food systems using a geospatial crop model. Jonathan received his undergraduate degrees at the University of Maryland, College Park in Biological Resources Engineering and Computer Science.

Courses to teach in the MS GEOINT program:

GEOG656, GEOG660

Dr. Kathleen Stewart

Kathleen Stewart is Director of the Center for Geospatial Information Science and works in the area of geographic information science with a particular focus on geospatial dynamics. This includes topics such as moving objects research (e.g., space-time trajectories, space-time scheduling) and event modeling for dynamic GIS. She is interested in mobility, spatial accessibility, big geospatial data, and currently investigates movement and mobility for a number of different application domains, for example, health and transportation. She is also interested in modeling geospatial semantics including geospatial ontologies and their role for geographic information system design, and spatiotemporal information retrieval. At the University of Maryland, Dr. Stewart is a member of the Program in Oncology at the University of Maryland Marlene and Stewart Greenebaum Comprehensive Cancer Center and also collaborates with researchers at the Institute for Global Health, the Center for Substance Abuse Research, the National Transportation Center, the School of Public Health, and among others. Her research is currently supported in part by grants from the National Institutes of Health, NASA, and the Federal Highway Administration, among other organizations, and she has also received support from IARPA, NGA and NSA. Dr. Stewart serves as a member of the Mapping Science Committee of

the National Academies of Sciences, Engineering and Medicine and the Board of Directors for the University Consortium of Geographic Information Science. She is a member of the steering committee for the Maryland Transportation Institute. She also serves as a member of the editorial boards for The International Journal of Geographical Information Science (IJGIS), Computers, Environment, and Urban Systems, Transactions in GIS, Geographical Analysis, and the open-access Journal of Spatial Information Science (JOSIS).

APPENDIX E: LIBRARY ASSESSMENT

DATE: September 18, 2018

TO: Dr. Kathleen Stewart
Director of the Center for Geospatial Information Sciences
Department of Geographical Sciences

Dr. Ruibo Han
Director of Programs, Center for Geospatial Information Sciences
Department of Geographical Sciences

CC: Daniel Mack, Associate Dean of Collections, UMD Libraries
Maggie Saponaro, Head, Collection Development, UMD Libraries
FROM: Kelley O'Neal, GIS and Spatial Data Librarian, UMD Libraries
RE: Library Resources to Support New Program – a Master of Science in Geospatial Intelligence (MS GEOINT)

We are providing this assessment in response to a proposal by the Department of Geographical Sciences in the college of Behavioral and Social Sciences to create a Master of Science in Geospatial Intelligence (MS GEOINT). The MS GEOINT program requested a collections resources assessment from the University of Maryland Libraries to determine how well the Libraries support the curriculum of this proposed program.

Serial Publications

The University of Maryland Libraries subscribe to a large number of scholarly journals, almost all in online format, focusing on Geospatial Intelligence and related topics including:

Geospatial Intelligence

International Journal of Intelligence and CounterIntelligence

Remote Sensing and Image Processing

Remote Sensing of Environment
ISPRS Journal of Photogrammetry and Remote Sensing
IEEE Transactions on Geoscience and Remote Sensing
International Journal of Applied Earth Observation and Geoinformation
IEEE Applied Earth Observations and Remote Sensing
IEEE Geoscience and Remote Sensing Letters
International Journal of Remote Sensing

Geographic Information Science (GISc)

International Journal of Geographical Information Science
Journal of Geographical Sciences
Transactions in GIS
Computers & Geosciences
Journal of Spatial Science

International Journal of Digital Earth
GeoInformatica
Computers, Environment and Urban Systems
The Cartographic Journal
Geographical Analysis
Cartographica: The International Journal for Geographic Information and Geovisualization

Big Data Analytics and Computation

Big Data and Society
Computational Intelligence: An International Journal
Advances in Artificial Intelligence
Data Mining and Knowledge Discovery
Neural Networks
IEEE Transactions on Neural Networks

In cases in which the Libraries do not subscribe to a particular journal of interest, articles within that journal likely will be available through Interlibrary Loan.

In addition to subscriptions, the following open access journals are another valuable resource to the Master of Science in Geospatial Intelligence program:

Remote Sensing
Public Library of Science One (PLOS One)
Journal of Spatial Information Science
International Journal of Spatial Data Infrastructures Research
Applied Computational Intelligence and Soft Computing

Databases

The Libraries' *Database Finder* (http://www.lib.umd.edu/dbfinder) resource offers online access to databases that provide indexing and access to scholarly journal articles, geospatial datasets, and other information sources. Databases relevant to the Master of Science in Geospatial Intelligence program include:

Policy Map - Policy Map is a cloud-based GIS and geospatial data tool that provides access to over 15,000 indicators related to housing, crime mortgages, health, jobs, demographics, and education from more than 150 authoritative public and proprietary sources. Data is cleaned and standardized and updated regularly. The database includes basic GIS tools to create reports and maps.

Social Explorer - Social Explorer is a cloud-based GIS and geospatial data tool that provides access to demographic information about the United States from 1790 to present. Available data includes Census, Public Use Microdata Sample (PUMS), and American Community Survey (ACS). The database includes basic GIS tools to create reports, maps, and slide shows.

SimplyAnalytics – SimplyAnalytics is a cloud-based GIS and geospatial data tool that contains extensive data including demographic, historic census, business, health, real estate, housing, employment, consumer spending, and marketing (over 70,000 variables total). Users can create customized maps and reports. Data is available at the State, County, City, ZIP Code, Census Tract, and Block Group levels for custom trade areas and the entire United States.

LandScan Global Population Dataset - LandScan is a global population database that shows geographical distribution of population at one-kilometer resolution over an average 24 hour period. LandScan datasets are compiled annually using different information sources and analytical techniques and should ideally not be compared across years.

EIU ViewsWire - Full-text country news daily that provides analysis and forecast information on worldwide politics, economics, business strategies & conditions and market trends in almost 200 countries.

Passport – Provides global statistics for 205 countries on economic indicators, health, foreign trade, environment, lifestyle, industrial and agriculture output, communications and more. It also includes market size data for over 300 consumer products and services, including reports covering analysis of drivers of the industry, industry risk, market data and segments, competitors and industry performance. It provides demographic trends, economic indicators, finance, foreign trade, health, labor force, industrial and agricultural production, environmental data, consumer expenditure patterns, retail sales, advertising and media patterns, consumer prices, household patterns, literacy rates, telecommunications, automotive and transport figures, travel and tourism, income and earnings potential.

IEEE Xplore - Provides full-text access to IEEE transactions, journals, magazines and conference proceedings published since 1988 and all current IEEE Standards. Includes access to Bell Labs Technical journal Archive (BLTJA) 1922-2015.

Communication & Mass Media - Communication & Mass Media Complete originated with the acquisition and subsequent merging of two popular databases in the fields of communication and mass media studies -- CommSearch (formerly produced by the National Communication Association (NCA)), and Mass Media Articles Index (formerly produced by Pennsylvania State University).

Encyclopedia of Statistical Sciences (Wiley) - Covers topics in statistics, biostatistics, quality control, economics, sociology, engineering, probability theory, computer science, biomedicine, psychology, survey methodology, and many other areas. Includes the full text of the first and second print editions, plus the supplemental volumes. The entries are self-contained and easily understood by readers with a limited statistical background.

Global Terrorism Database - Developed by the National Consortium for the Study of Terrorism and Responses to Terrorism and START: A Center of Excellence of the U.S. Department of Homeland Security, University of Maryland. The Global Terrorism Database is an open-source database including information on terrorist events around the world from 1970 through 2016 (with annual updates). Unlike many other event databases, the GTD includes systematic data on domestic as well as international terrorist incidents that have occurred during this time period and now includes more than170,000 cases.

Military & Government Collection- Designed to offer current news pertaining to all branches of the military, this database offers full text for nearly 300 journals, periodicals, and U.S. government documents. The database also includes full text for 245 pamphlets and offers indexing and abstracts for nearly 400 titles. Many full text titles are available in native (searchable) PDF, or scanned-in-color.

Also four multi-disciplinary databases, *Academic Search Ultimate, Nexis Uni, ScienceDirect,* and *Web of Science,* are good sources of articles relevant to this topic.

In most cases, these indexes offer full text copies of the relevant journal articles. In those instances in which the journal articles are available only in print format, the Libraries can make copies available to graduate students through either the Libraries' Scan & Deliver Program or via Interlibrary Loan.

Monographs

The Libraries acquire scholarly monographs regularly in geographical sciences and geospatial science and technology along with allied subject disciplines. Monographs not already part of the collection can usually be added upon request.

Even though most library research for this course/program likely will rely upon online journal articles, students may wish to supplement this research with monographs. Fortunately, more and more monographs are available as e-books. Even in instances when the books are only available in print, graduate students will be able to request specific chapters for online delivery through the Libraries' Scan & Deliver program (Note: see below).

A search of the University of Maryland Libraries' WorldCat UMD catalog (http://www.lib.umd.edu) was conducted, using a variety of relevant subject terms. This investigation yielded sizable lists of citations of books that we own. I provide here some example subjects within the field of geospatial intelligence, title counts for those subjects, and some example monographs available within our holdings.

Geospatial Intelligence = 89

From maps to models: augmenting the nation's geospatial intelligence capabilities (e-book) 2016
The five disciplines of intelligence collection (print) 2015
Future U.S. workforce for geospatial intelligence (e-book) 2013
Geospatial intelligence support in joint operations (e-book) 2012
U.S. national intelligence an overview (e-book) 2011

Open Source Intelligence = 37

Open source intelligence in the twenty-first century: new approaches and opportunities (print) 2014
Hacking web intelligence: open source intelligence and web reconnaissance concepts and techniques (e-book) 2015
Practical Cyber Intelligence: How action-based intelligence can be an effective response to incidents (e-book) 2018
Social engineering: the science of human hacking (e-book) 2018

Geographic Information Systems (GIS) = 1,666

Imagery and GIS: best practices for extracting information from imagery (e-book) 2017
Geographic information science & systems (print) 2015
Geographic information systems in action (e-book) 2017
Geographic information systems (GIS): techniques, applications and technologies (e-book) 2014
Geographic information systems (GIS) for disaster management (e-book) 2015

Mobile GIS = 22

Information fusion and geographic information systems (IF & GIS' 2015): deep virtualization for mobile GIS (e-book) 2015
Building web and mobile ArcGIS Server applications with JavaScript: master the ArcGIS API for Java Script, and build exciting, custom web and mobile GIS applications with the ArcGIS Server (e-book) 2014
Geospatial computing in mobile devices (print) 2014

Web GIS = 26

Mastering ArcGIS Enterprise Administration (e-book) 2017
Getting to know web GIS (print) 2016
ArcGIS for JavaScript Developers by Example (e-book) 2016
Tile-based geospatial information systems: principles and practices (e-book) 2010

Remote Sensing = 4,590

Earth observation open science and innovation (e-book) 2018
Urban remote sensing (e-book) 2018
Satellite Earth observations and their impact on society and policy (e-book) 2017
Remote Sensing of Aerosols, Clouds, and Precipitation (e-book) 2017
Remote sensing image fusion: a practical guide (e-book) 2017

Image Processing = 4,851

Digital image processing (print) 2018
Automatic Target Recognition (e-book) 2018
Digital Image Processing and Analysis with MATLAB and CVIPtools, Third Edition (e-book) 2017
Multisensor Image Fusion and Data Mining for Environmental Remote Sensing (e-book) 2017

Spatial Statistics = 112

Spatial Analytics with ArcGIS (e-book) 2017
Spatial econometrics (e-book) 2017
Computational and statistical methods for analysing big data with applications (e-book) 2016
Stochastic geometry, spatial statistics and random fields: models and algorithms (print) 2015

Network Analysis = 1,113

Environment, Politics and Society (e-book) 2018
Networks of international trade and investment: understanding globalization through the lens of network analysis (print) 2018
GIS and the social sciences: theory and applications (e-book) 2018
Sociometrics and human relationships: analyzing social networks to manage brands, predict trends, and improve organizational performance (e-book) 2017

Big Data Analytics = 121

Practical big data analytics: hands-on techniques to implement enterprise analytics and machine learning using Hadoop, Spark, NoSQL and R (e-book) 2018
Big data analytics: tools and technology for effective planning (print) 2018
Earth observation open science and innovation (e-book) 2018
Big Data Analytics with Hadoop 3 Build highly effective analytics solutions to gain valuable insight into your big data (e-book) 2018

Python = 812

Beginning Data Analysis with Python And Jupyter Use powerful industry-standard tools to unlock new, actionable insight from your existing data (e-book) 2018
Hands-On Data Analysis with NumPy and Pandas Implement Python Packages from Data Manipulation to Processing (e-book) 2018
Hands-On Automated Machine Learning A beginner's guide to building automated machine learning systems using AutoML and Python (e-book) 2018
Mastering Geospatial Analysis with Python Explore GIS processing and learn to work with GeoDjango, CARTOframes and MapboxGL-Jupyter (e-book) 2018

ArcPy = 10

ArcPy and ArcGIS - Second Edition (e-book) 2017
Introduction to GIS programming and fundamentals with Python and ArcGIS (print) 2017
ArcPy and ArcGIS, geospatial analysis with python: use the ArcPy module to automate the analysis and mapping of geospatial data in ArcGIS (e-book) 2015
Python for ArcGIS (print) 2015
Programming ArcGIS with Python cookbook: over 85 hands-on recipes to teach you how to automate your ArcGIS for Desktop geoprocessing tasks using Python (e-book) 2015

Hazards and Emergency Management = 659

Essentials of Public Health Preparedness and Emergency Management (e-book) 2018
Transforming Disaster Response Federalism and Leadership (e-book) 2018
Urban Emergency Management (e-book) 2017
GIS for critical infrastructure protection (e-book) 2016
Hazard mitigation in emergency management (e-book) 2015

A further search revealed that the Libraries' membership in the Big Ten Academic Alliance (BTAA) dramatically increases these holdings and citations. As with our own materials, graduate students can request that chapters be copied from these BTAA books if the books are not available electronically.

Geospatial Intelligence = 178

Open Source Intelligence = 86

Geographic Information Systems (GIS) = 4,954

Mobile GIS = 44

Web GIS = 60

Remote Sensing = 12,287

Image Processing = 10,767

Spatial Statistics = 4,181

Network Analysis = 3,239

Big Data Analytics = 1,427

Python = 2,127

ArcPy = 11

Hazards and Emergency Management = 1,465

Access Services: Scan & Deliver and Interlibrary Loan

These services offer online delivery of bibliographic materials that otherwise would not be available online. As a result, remote users who take online courses may find these services to be helpful. Scan & Deliver and Interlibrary Loan are available free of charge.

A special amenity for graduate students and faculty, the Scan & Deliver service scans and delivers journal articles and book chapters within three business days of the request--provided that the items are available in print on the UM Libraries' shelves or in microform. In the event that the requested article or chapter is not available on campus, Scan & Deliver will automatically refer the request to Interlibrary Loan (ILL). Interlibrary Loan is a service that enables borrowers to obtain online articles and book chapters from materials not held in the University System of Maryland.

Please note that one limitation of these services that might create some challenges for the online student is that the Libraries are not allowed to make online copies of entire books. The only way that a student can get access to a print copy of an entire book is to physically come to the Libraries and check out that book.

Additional Materials and Resources

In addition to serials, monographs and databases available through the University Libraries, students in the Master of Science in Geospatial Intelligence will have access to a wide range of media, datasets, software, and technology. Library Media Services (http://www.lib.umd.edu/lms) houses media in a variety of formats that can be utilized both on-site and via ELMS course media. GIS datasets are available through the GIS and Spatial Data Center website (http://www.lib.umd.edu/gis) which includes the BTAA Geoportal (https://geo.btaa.org/). Statistical consulting and additional research support is available through the Research Commons (http://www.lib.umd.edu/rc) while technology support and services are available through the Terrapin Learning Commons (http://www.lib.umd.edu/tlc).

The subject specialist librarian for geographic information systems (GIS) and spatial data, Dr. Kelley O'Neal (kelleyo@umd.edu), also serves as an important resource to Geographical Sciences and the upcoming Master of Science in Geospatial Intelligence program.

Other Research Collections

Because of the University's unique physical location near Washington D.C., Baltimore and Annapolis, University of Maryland students and faculty have access to some of the finest libraries, archives and research centers in the country vitally important for researchers in geospatial intelligence. These include the Library of Congress, the National Archives, National Agricultural Library, and the Smithsonian, to name just few.

Conclusion

With our substantial journals holdings and index databases, as well as additional support services and resources, the University of Maryland Libraries have resources to support teaching and learning in Geospatial Intelligence. These materials are supplemented by a strong monograph collection. Additionally, the Libraries' Scan & Deliver and Interlibrary Loan services make materials that otherwise would not be available online, accessible to remote users in online courses. As a result, our assessment is that the University of Maryland Libraries are able to meet the curricular and research needs of the proposed Master of Science in Geospatial Intelligence program.

APPENDIX F: FIVE-YEAR BUDGET

MS GEOINT Resources	Year 1	Year 2	Year 3	Year 4	Year 5
Resources					
Tuition Revenue	**$289,080**	**$540,580**	**$751,897**	**$971,451**	**$990,880**
Tuition per Credit Hour (assuming a 2% increase)*	$803	$819	$835	$852	$869
Number Full time students 1st year:	10	16	22	25	25
Full time load 10 credits term **	24	24	24	24	24
Number Fulltime students second year	0	10	20	30	30
Full time load 10 credits term **	0	6	6	6	6
Annual Full-time tuition revenue	$192,720	$363,663	$541,366	$664,677	$677,971
Number Part-time students	10	10	15	20	20
Part time load 6 credits term	12	12	12	12	12
Annual Part time tuition revenue	$96,360	$98,287	$100,253	$102,258	$104,303
Full-time = 2 course/term for 4 quarter terms					
Part-time = 1 course/term for 4 quarter terms					
* Tuition is subject to increase at the same rate as the university graduate school tuition/fees.					
** Fulltime Cohort graduate in 5 quarter terms so calculated at half load their second year					
Expenses					
Number of Courses	11	11	11	11	11
Lecturers (teaching)	2.0	2.0	2.0	2.0	2.0
Program Director (review applicants, recruit)			0.5	0.5	0.5
Total Lecturers including Program Director	2.0	2.0	2.5	2.5	2.5
Total Salary (Lecturers/Dir @85K, assuming a 3% increase)	$170,000	$175,100	$180,353	$185,764	$191,336
Program Coordinator Assistant ***			1	1	1
*** Existing Coordinator for GEOG MPS programs will be used. Additional may need to be hired as cohorts increase (60K)					
Total Salary Coordinators			$60,000	$60,000	$60,000
TAs					
Number		2.0	2.0	2.0	2.0
TA Salary ($20,603 step II)		$41,206	$41,206	$41,206	$41,206
Total TA Cost (including tuition remission)		$69,886	$69,886	$69,886	$69,886
Total Salary	**$170,000**	**$244,986**	**$310,239**	**$315,650**	**$321,222**
Total Benefits	$51,000	$73,496	$93,072	$94,695	$96,367
Campus 15% of Tuition for on campus programs	$43,362	$69,292	$96,243	$115,040	$117,341
Advertising including travel to conferences	$15,000	$15,000	$15,000	$15,000	$15,000
Supplies	$50,000	$50,000	$50,000	$50,000	$50,000
Total Expense	**$329,362**	**$452,774**	**$564,554**	**$590,385**	**$599,930**
Balance	**($40,282)**	**$9,176**	**$77,065**	**$176,550**	**$182,343**