Annex to the “visiting lecturers” programme

Proponent from WUT	
Title and degree	Dr hab. inż., Associate Professor
Name and surname	DARIUSZ GOTLIB
Faculty	Geodesy and Cartography Faculty
E-mail address in the WUT domain	dariusz.gotlib@pw.edu.pl
Phone number	501048277

The person proposed as a visiting professor	
Title and degree	PhD., Associate Professor
Name and surname	**ZHENLONG LI**
Exact affiliation	Department of Geography Director, Geoinformation and Big Data Research Laboratory The Pennsylvania State University
E-mail address	zhenlong@psu.edu
Description of achievements (1/2-1 page)	Dr. Zhenlong Li is an Associate Professor in the Department of Geography at the Pennsylvania State University, where he leads the Geoinformation and Big Data Research Laboratory (GIBD). He is also a Faculty Associate of the Penn State Institute for Computational and Data Sciences (ICDS). Dr. Li is a broadly trained GIScientist with research focusing on geospatial big data analytics, spatial computing, and geospatial AI. By developing and synthesizing advanced geospatial methods and computing technologies, his research aims to advance knowledge discovery and decision making to address a broad range of geographic questions about hazards, public health, population mobility, environment and climate change. Through his teaching and advising, Dr. Li seeks to equip the next generation of GIScientists and geographers with strong problem-solving skills through the integration of spatial thinking and computational thinking. Dr. Li has published more than 120 peer-reviewed journal articles, the majority of which were published with his students and postdoctoral researchers in top tier international journals in GIScience. His research is supported by over $2.3 million in funding directly allocated to him from grants awarded by NIH, NSF, NASA, the Taylor Geospatial Institute, among others. His recent NIH R21 award focuses on developing and testing a nationwide obesogenic environment measurement tool at multiple geographic levels using cellphone-based place visitation data (geospatial big data) and individual level body mass index (electronic health record or EHR data). Dr. Li currently serves as an Associate Editor of the International Journal of Digital Earth (Taylor & Francis) and International Journal of Applied Earth Observation and Geoinformation (Elsevier). He also sits on the editorial board of three international journals including the Cartography and Geographic Information Science. Previously, he served as the Chair of the AAG Cyberinfrastructure Specialty Group, co-Chair of ESIP Cloud Computing Group, and the Board of Director of the International Association of Chinese Professionals in GIScience (CPGIS). Prior to joining Penn State, Dr. Li was an Associate Professor of Geography at the University of South Carolina, where he was the founding director of

	the Center for GIScience and Geospatial Big Data (CeGIS) and GIBD lab. He received B.S. in GIScience from Wuhan University in 2006, and Ph.D. (with Distinction) in Geography and Geoinformation Sciences from George Mason University in 2015. Dr. Li was recognized as a Breakthrough Star by USC in 2020 and was named one of the Geospatial World 50 Rising Stars by Geospatial Media and Communications in 2021. He is also the recipient of the prestigious inaugural Raskin Scholarship from Earth Science Information Partners (ESIP). Full resume: https://www.geog.psu.edu/sites/geog/files/ZhenlongLI_CV_0.pdf

Code of the course	4606-VL-ES-00025	Name of the course	Polish	**Zastosowanie sztucznej inteligencji w analizach geoprzestrzennych na zbiorach danych big data**
			English	**Application of artificial intelligence in geospatial analysis on big data**
Type of the course	Specialty subject			
Course coordinator	Zhenlong Li	Course teacher	Zhenlong Li	
Implementing unit	Geodesy and Cartography Faculty	Scientific discipline / disciplines*	Civil engineering, geodesy and transport; Information and communication technology	

Level of education	Doctoral studies	Semester	summer		
Language of the course	English				
Type of assessment	pass	Number of hours in a semester	16	ECTS credits	1
Minimum number of participants	10	Maximum number of participants	30	Available for students (BSc, MSc)	Yes

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	3		3		
	in a semester	8		8		

* does not apply to the Researcher's Workshop

1. Prerequisites
Knowledge of GIS basics, ability to use QGIS software, Python language basics

2. Course objectives
Recent advancements in generative artificial intelligence (AI) and particularly Large Language Models (LLMs), offer promising capabilities for spatial analysis. Despite their potential, the integration of generative AI with established GIS platforms remains underexplored. In this lecture it will be explained a framework for integrating LLMs directly into existing GIS platforms. This approach leverages the reasoning and programming capabilities of LLMs to autonomously generate spatial analysis workflows and code through an informed agent that has comprehensive documentation of key GIS tools and parameters. The framework also incorporates external tools such as GeoPandas to enhance the system's geoprocessing capabilities. The implementation of this framework can resulte in the development of a new GIS tools" that allows GIS users to conduct using natural language for spatial analysis. Thanks to it, it is possible to advance knowledge discovery and decision-making to address a broad range of geographic questions related to hazards, public health, population, the environment, and climate change.

3. Course content (separate for each type of classes)
Lecture
Integrating generative artificial intelligence with existing GIS platforms Autonomous GIS: Next-generation GIS based on artificial intelligence Building a Large Spatial Model for AI in the way LLMs are trained on large text corpora. Examples of cloud-based GIS infrastructures and tools using AI
Project classes
Tests of the GIS tool Copilot Defining the research task. Case Studies e.g., performing a detailed terrain analysis using DEM, extracting land cover data from a larger dataset covering whole country. calculation of an obesity risk behavior index, Analyzing and visualizing the fast-food accessibility score, analyses of party voter behavior

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
	Knowledge		
K01	Has general knowledge of automating geospatial analysis using AI	SD_W2	project evaluation
K02	A student knows the trends in the development of geo-information systems in conjunction with AI	P8S_W3	project evaluation
K03	A student understands the principles of building new IT system architectures for geoinformation analysis using AI	P8S_WG2	project evaluation
	Skills		
S01	A student knows how to outsource tasks for AI in geospatial analysis using verbal description	SD_U1	active participation during classes
S02	A student is familiarized with the Co-Pilot software architecture and knows how to plan	SD_U7	active participation during classes

	research teamwork to exploit the possibilities of this technology		
Social competences			
SC01	The student is familiar with the developmental trends of GIS in the use of AI and understands the advantages and risks of this technology	SD_K1	active participation during classes

*Allowed learning outcomes verification methods: exam; oral exam; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

The basis for passing the class is the evaluation of the completed project. The detailed evaluation criteria will be provided during the first introductory lecture. The following aspects will be assessed: the correctness of the research task definition, the approach to solving it, and the description of the project implementation. To receive a passing grade, a minimum of 60% of the points must be achieved. More than 1 unjustified absences during laboratory project classes time means student's failing the project. The additional element of the assessment of the exercises is the substantive activity of the student.

6. Literature

Primary references:

[1] Akinboyewa, T., Li, Z., Ning, H., & Lessani, M. N. (2024). GIS Copilot: Towards an Autonomous GIS Agent for Spatial Analysis. arXiv preprint arXiv:2411.03205

[2] Jiang Y., Li Z., Kim J., NIng H., Han S. (2024). Comparative Analysis of Human Mobility Patterns: Utilizing Taxi and Mobile (SafeGraph) Data to Investigate Neighborhood-Scale Mobility in New York City. arXiv. http://dx.doi.org/10.48550/arXiv.2410.16462

[3] Ning, H., Li, Z., Akinboyewa, T., & Lessani, M. N. (2024). An Autonomous GIS Agent Framework for Geospatial Data Retrieval. arXiv. https://doi.org/10.48550/arXiv.2407.21024

[4] Wang S., Hu T., Huang X., Li Y., Zhang C., Ning H., Zhu R., Li Z., Ye X. (2024). GPT, large language models (LLMs) and generative artificial intelligence (GAI) models in geospatial science: a systematic review. *International Journal of Digital Earth.* https://doi.org/10.1080/17538947.2024.2353122

[5] The source code for the GIS Copilot is available on GitHub at https://shorturl.at/vRcm6

[6] The data used for testing alongside with the case studies can be accessed through https://shorturl.at/bI4Ep

Secondary references:

[1] Li Z., (2020) Geospatial Big Data Handling with High Performance Computing: Current Approaches and Future Directions, In Tang, W., Wang, S., (eds.), High Performance Computing for Geospatial Applications, Springer

[2] Lessani, M. N., Li, Z., Qiao, S., Ning, H., Aggarwal, A., Yuan, G. F., … & Scott-Sheldon, L. A. (2024). Leveraging large language models for systematic reviewing: A case study using HIV medication adherence research. medRxiv, 2024-09. https://doi.org/10.1101/2024.09.18.24313828

[3] Ying, S., Li, Z., & Yu, M. (2024). Beyond Words: Evaluating Large Language Models in Transportation Planning. arXiv preprint arXiv:2409.14516. https://doi.org/10.48550/arXiv.2409.14516

[4] Hohl, A., Wen, M., Wu, G., Zhang, Y., Li, Z., & Su, D. Developing and validating an anti-Asian area racism index at the county level in the contiguous United States 2020-2021. https://doi.org/10.31235/osf.io/n5tpw

7. PhD student's workload necessary to achieve the learning outcomes**

No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	15
2	Hours of consultations with the academic teacher, exams, tests, etc.	5
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	10
4	Amount of time devoted to the preparation for exams, test, assessments	
	Total number of hours	**30**
	ECTS credits	**1**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

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8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	0,5
Number of ECTS credits earned by a student in a practical course	1