Subject Description Form

Subject Code	LSGI1001
Subject Title	**Big Earth Data and Geospatial AI**
Credit Value	2
Level	1
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives and Development Opportunities	Artificial Intelligence and Data Analytics (AIDA) are crucial tools in the world today, revolutionizing the paradigm of various fields, such as business, public health, environment, science, technology, social science, etc. They provide beneficial methodologies to automatically process the huge volume and variety of data, access the essential information, and facilitate decision-making in different aspects of life. Big Earth Data, big data collected from space for Earth observations, provides new opportunities for Earth and environmental sciences, revolutionizing the methods and techniques for understanding of the Earth's systems and dynamics, human-environment interactions, and sustainability of nature and human systems. Geospatial analytics uses data from all kinds of technology — satellite imagery, GPS, location sensors, social media, mobile devices — to analyse and visualize the geo-referenced data for understanding phenomena and finding patterns and trends in complex relationships between people and places. Geospatial analytics adds location and timing to traditional types of data, and this additional context allows for a more complete picture of phenomena and events, a more accurate prediction of patterns and trends, and real-time visualization. This course provides a general education on various issues in Earth Observations and Geospatial Artificial Intelligence (EO-GeoAI). Identification and evaluation of Earth features from images/data acquired from space are explored. Aerial photos, Earth resources satellite images, weather satellite images, LiDAR, drone images, social media, mobile devices etc. are used to give insight into important physical, economic, and cultural features on the Earth surface. Rudimentary knowledge on machine learning in remote sensing, geospatial AI and geospatial big data analytics, will further be introduced.
Intended Learning Outcomes	**Upon completion of the subject, students will be able to:** (i) Demonstrate an understanding of the foundational concepts of Artificial Intelligence and Data Analytics (AIDA); (ii) Acquire basic skills in using AIDA technologies and applications; (iii) Articulate examples of how the adoption AIDA could enhance their chosen disciplines; (iv) Demonstrate an awareness of global contemporary ethical issues and impact from AIDA applications in daily life; (v) Appreciate different types of Earth observation images/data; (vi) Acquire basic principles of Earth observations; (vii) Show basic understanding of machine learning for remote sensing, geospatial AI and big data analytics.

Subject Synopsis/ Indicative Syllabus

Topics:

1. *Earth Observations, Big Earth Data, and Geospatial Analytics*
   The definition of remote sensing, Earth observations, remote sensors, big Earth data, and digital image processing; geospatial analytics and geospatial imagery analytics; benefits and examples of using big Earth data in analytics.

2. *Types and Characteristics of Big Earth Data*
   Aerial photographs; satellite images; drone images; space shuttles; ground-based sensing; geo-referenced information over the web (e.g., Google Earth and Virtual Globe); volunteered geographic information; characteristics of big Earth data (image; pixel; image bands or channels; spatial resolution; and temporal resolution).

3. *Introduction to Machine Learning in Remote Sensing* Introduction to machine learning for remote sensing image analysis. Application examples of machine learning to Big Earth Data. Geospatial AI methods in machine learning (e.g., deep learning), image semantic segmentation, object detection, change monitoring, and scene recognition.

4. *Geospatial Artificial Intelligence*
   Introduction to frameworks for deep learning, classic network architectures, and applications in image classification, and high-performance/cloud computing to extract knowledge from Big Earth Data.

5. *Geospatial Data Analytics*
   Basics of spatial data science, social sensing, people sensing, spatial data mining, pattern recognition & matching, time series image analysis, rule learning for spatial data mining.

Teaching/Learning Methodology

Teaching and Learning Methods	**Intended Subject Learning Outcome**	**Remarks**
Lectures	(i), (ii), (iii), (iv), (v), (vi), (vii)	AIDA big Earth data, and geospatial analytics concepts, principles, and skills will be given through lectures. There will be in-class activities (e.g., discussions, debates, videos) to better engage students in active learning.
Lab exercises	(ii), (v), (vi), (vii)	Lab exercises will be given to train the student skills through hands-on practices in solving real-world problems with geospatial analytics tasks.
Quizzes	(i), (ii), (iii), (iv), (v), (vi), (vii)	Quizzes will be given to help students better understand the points discussed in lectures and labs, and to gain more related knowledge via after-class reading and reviewing and learn how to employ the knowledge to solve geospatial big data problems in real world.

	E-learning Modules	(iii), (vii)	Each student should watch at least five Webinars in the IEEE Learning Network (ILN) with certificates. * (https://www.ieee.org//education/iln.html) , which requires them to answer questions in order to get certificates. Each Webinar covers a specific technological topic with real world example. Through the E- learning modules, students can learn how geospatial AI and data analytics will help to solve practical issues in daily life and in their career.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	**% weighting**	**Intended subject learning outcomes to be assessed (Please tick as appropriate)**						
		(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
• Lab exercises	40%		✓			✓	✓	✓
• E-learning modules	20%			✓				✓
• Quiz	15%	✓	✓	✓	✓	✓	✓	✓
• Final test	25%	✓	✓	✓	✓	✓	✓	✓
Total	100 %							

For the continuous assessments, four lab exercises are first used to assess learning outcomes (ii) (v), (vi) and (vii); then each student should watch five Webinars and submit certificates to show their understandings of AIDA, especially the EO-GeoAI applications, in their specific disciplines (i.e., learning outcome (iii) and (vii)) and their skills to solve real-world problems. In addition, students will be assessed by one quiz and one final test for learning outcomes (i) – (vii).

Student Study Effort Expected

Class contact (time-tabled):	
• Lectures 2 hours in weeks 1-3, 5, 9, 11-12; and 1 hour in week 7.	15 Hrs.
• Labs 2 hours x 4 lab exercises in weeks 4, 6, 8, and 10.	8 Hrs.
• Quiz and test Quiz: 1 hour in week 7. Final test: 2 hours in week 13.	3 Hrs.
Other student study effort:	
• E-Learning modules 2 hours x 5 learning modules in weeks 3, 5, 9, 11 and 12.	10 Hrs.
• Self-study and review	40 Hrs.
Total student study effort	76 Hrs.

Reading List and References	**Reference Books:** 1. Beecher, K., *Computational Thinking*, BCS, 2017. 2. Teetor, P., *R Cookbook*, O'Reilly Media, 2011. 3. Wickham, H. and Grolemund, G., *R for Data Science*, O'Reilly Media, 2017. 4. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly Media, Inc., 2016. 5. Peter Bruce and Andrew Bruce, *Practical Statistics for Data Scientists*, O'Reilly Media, 2017. 6. Boyd, S. and Vandenberghe, L., *Introduction to Applied Linear Algebra*, Cambridge University Press, 2018. 7. Stewart, J., *Calculus: Early Transcendentals*, 8th Edition, Cengage Learning, 2015. 8. Hastiem, T., Tibshirani, R., and Friedman, J., *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, 2nd Edition, Springer, 2009 9. Russell, S. and Norvig, P., *Artificial Intelligence: A Modern Approach*, 3rd Edition, Pearson, 2009. 10. Bishop, Christopher M., *Pattern Recognition and Machine Learning*. Springer, 2016. 11. Weng, Q., *An Introduction to Contemporary Remote Sensing*. McGraw-Hill Professional, 2012. 12. Avery, T. E. and Berlin, G. L., *Fundamentals of Remote Sensing and Airphoto Interpretation (fifth edition)*. Saddle River, N.J.: Prentice Hall, 1992. 13. Stefan Hinz (Editor), Martin Weinmann (Editor), Andreas Braun (Editor), *Object and Pattern Recognition in Remote Sensing*, Whittles Publishing, 2021. 14. Martin Werner and Yao-Yi Chiang, *Handbook of Big Geospatial Data*, Springer, 2021.

- Note: Prof. Weng is the Co-Lead of the IEEE GRSS Educational Webinar Series, who will arrange for students to watch five Webinars for free.