

Syllabus

Module	1. Introduction, Challenges, and Framework
Instructor(s)	Ryan Baker
Dates	Feb 5 ~ 9, 2024
AMA Sessions	<ol style="list-style-type: none">1. M1 Part 5: AMA Session 1 with Dr. Ryan Baker (Feb 7, 3pm ET)2. M1 Part 5: AMA Session 2 with Dr. Ryan Baker (Feb 9, 130pm ET)
Topics	<ul style="list-style-type: none">● Introduction to the course● Overall framework on learning analytics
Readings (if any)	<ul style="list-style-type: none">● Baker, R., Siemens, G. (2022) Educational data mining and learning analytics. Sawyer, K. (Ed.) Cambridge Handbook of the Learning Sciences: 3rd Edition.● Wise, A. F. (2019). Learning Analytics: Using Data-Informed Decision-Making to Improve Teaching and Learning. In Contemporary Technologies in Education (pp. 119-143). Palgrave Macmillan, Cham.
Assignments (if any)	<ul style="list-style-type: none">● Discussion Forum Questions● ASSISTments

Module	2. Prediction Modeling and Metrics
Instructor(s)	Anthony Botelho

Dates	Feb 12 ~ 16, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M2 Part 5: AMA Session 1 with Dr. Anthony Botelho (Feb 13, 11am ET) 2. M2 Part 5: AMA Session 2 with Dr. Anthony Botelho (Feb 14, 7pm ET)
Topics	
Readings (if any)	<ol style="list-style-type: none"> 1. Bosch, N., & Paquette, L. (2018). Metrics for discrete student models: Chance levels, comparisons, and use cases. Download Metrics for discrete student models: Chance levels, comparisons, and use cases. <i>Journal of Learning Analytics</i>, 5(2), 86-104. 2. Baker, R. S., Gowda, S. M., Wixon, M., Kalka, J., Wagner, A. Z., Salvi, A., ... & Rossi, L. (2012). Towards Sensor-Free Affect Detection in Cognitive Tutor Algebra Download Towards Sensor-Free Affect Detection in Cognitive Tutor Algebra . <i>International Educational Data Mining Society</i>.
Assignments (if any)	<ul style="list-style-type: none"> ● Discussion Forum Questions ● ASSISTments

Module	3. Feature Extraction and Feature Engineering
Instructor (s)	Haiying Li
Dates	Feb 19 ~ 23, 2024

AMA Sessions	<ol style="list-style-type: none"> External Url M3 Part 5: AMA Session 1 with Dr. Haiying Li (Feb 20, 5pm ET) M3 Part 5: AMA Session 2 with Dr. Haiying Li (Feb 22, 3pm ET)
Topics	<ul style="list-style-type: none"> What is Feature Extraction and Feature Engineering? Why are they important? Numeric Data Categorical Data
Readings (if any)	<ul style="list-style-type: none"> Romero, C., Romero, J.R., Ventura, S. (2014) A survey on pre-processing educational data. <i>Educational Data Mining: Applications and Trends</i>, 29-64. Seeniselvi, T., & Nirmala, M. (2019). A survey on data preparation and feature engineering in machine learning. <i>International Journal of Advanced Research in Computer Engineering & Technology</i>, 8(5).
Assignments (if any)	<ul style="list-style-type: none"> Discussion Forum Questions ASSISTments - Feature extraction and feature engineering project

Module	4. Neural Networks and Deep Learning
Instructor(s)	Anthony Botelho
Dates	Feb 26 ~ March 1, 2024
AMA Sessions	<ol style="list-style-type: none"> M4 Part 5: AMA Session 1 with Dr. Anthony Botelho (Feb 27, 11am ET) M4 Part 5: AMA Session 2 with Dr. Anthony Botelho (Feb 28, 7pm ET)

Topics	
Readings (if any)	<ol style="list-style-type: none"> 1. Dong, S., Wang, P., & Abbas, K. (2021). A survey on deep learning and its applications . Computer Science Review, 40, 100379. 2. Jiang, Y., Bosch, N., Baker, R. S., Paquette, L., Ocumpaugh, J., Andres, J. M. A. L., ... & Biswas, G. (2018). Expert feature-engineering vs. deep neural networks: which is better for sensor-free affect detection? . In <i>Artificial Intelligence in Education: 19th International Conference, AIED 2018, London, UK, June 27-30, 2018, Proceedings, Part I 19</i> (pp. 198-211). Springer International Publishing. 3. Botelho, A. F., Varatharaj, A., Patikorn, T., Doherty, D., Adjei, S. A., & Beck, J. E. (2019). Developing early detectors of student attrition and wheel spinning using deep learning . <i>IEEE Transactions on Learning Technologies</i>, 12(2), 158-170. 4. Aung, A. M., Ramakrishnan, A., & Whitehill, J. R. (2018). Who Are They Looking At? Automatic Eye Gaze Following for Classroom Observation Video Analysis . <i>International Educational Data Mining Society</i>.
Assignments (if any)	<ul style="list-style-type: none"> ● Discussion Forum Questions ● ASSISTments

Module	5. Data Visualization
Instructor(s)	Jaclyn Ocumpaugh
Dates	March 4 ~ 8, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M5 Part 5: AMA Session 1 with Dr. Jaclyn Ocumpaugh (Mar 4, 2pm ET) 2. M5 Part 5: AMA Session 2 with Dr. Jaclyn Ocumpaugh (Mar 7, 10am ET)

Topics	<ul style="list-style-type: none"> • What data do we have?/What improves learning? • How do all people perceive data? The art and the science of data vis and visualization sciences. • How do we know if we're helping?
Readings (if any)	<ul style="list-style-type: none"> • Wise, A. F. (2014, March). Designing pedagogical interventions to support student use of learning analytics. In <i>Proceedings of the 4th International Conference on Learning Analytics and Knowledge</i> (pp. 203-211). • Rogers, T., Gašević, D., & Dawson, S. (2016). Learning analytics and the imperative for theory driven research. <i>The SAGE Handbook of E-Learning Research</i>, 232-250. • Franconeri, S. L., Padilla, L. M., Shah, P., Zacks, J. M., & Hullman, J. (2021). The science of visual data communication: What works. <i>Psychological Science in the Public Interest</i>, 22(3), 110-161. • Additional Resources available here: https://sites.google.com/view/discoverylearndashboards/home
Assignments (if any)	<ul style="list-style-type: none"> • Discussion Forum Questions • ASSISTments

Module	6. Ethics, Equity, and Algorithmic Bias
Instructors)	Shamya Karumbaiah
Dates	March 11 ~ 15, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M6 Part 5: AMA Session 1 with Dr. Shamya Karumbaiah (Mar 12, 3pm ET) 2. M6 Part 5: AMA Session 2 with Dr. Shamya Karumbaiah (Mar 14, 230pm ET)
Topics	<ul style="list-style-type: none"> • Algorithmic bias: approaches and limitations • Socio-technical systems in which AIED systems are embedded • Structural injustices that AIED systems reproduce

Readings (if any)	<ul style="list-style-type: none"> ● Baker, R. S., & Hawn, A. (2021). Algorithmic bias in education. <i>International Journal of Artificial Intelligence in Education</i>, 1-41. ● Holstein, K., & Doroudi, S. (2021). Equity and Artificial Intelligence in Education: Will "AIEd" Amplify or Alleviate Inequities in Education?. In <i>The Ethics of Artificial Intelligence in Education</i>. Routledge. ● Levinson, M., Geron, T., & Brighthouse, H. (2022). Conceptions of educational equity. <i>AERA Open</i>, 8, 23328584221121344.
Assignments (if any)	<ul style="list-style-type: none"> ● Discussion Forum Questions

Module	7. Data Management and Database Access
Instructor(s)	Michael Mogessie
Dates	March 18 ~ 22, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M7 Part 5: AMA Session 1 with Dr. Michael Mogessie (Mar 19, 6pm ET) 2. M7 Part 5: AMA Session 2 with Dr. Michael Mogessie (Mar 21, 6pm ET)
Topics	<ul style="list-style-type: none"> ● Understanding Databases ● Database servers and clients ● Accessing databases programmatically ● Getting the information you need from a database ● Observations, tips and tricks
Readings (Useful Links)	<ul style="list-style-type: none"> ● DBeaver: https://dbeaver.io/download/ ● Python: https://www.python.org/downloads/ ● Jupyter Notebook: https://jupyter.org/install

	<ul style="list-style-type: none"> • MySQL Connector/Python: https://dev.mysql.com/doc/connector-python/en/ • SQLAlchemy: https://www.sqlalchemy.org/
Assignments (if any)	<ul style="list-style-type: none"> • ASSISTments

Module	8. Knowledge Graphs
Instructor(s)	Seth Adjei
Dates	March 25 ~ 29, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M8 Part 5: AMA Session 1 with Dr. Seth Adjei (Mar 25, 2pm ET) 2. M8 Part 5: AMA Session 2 with Dr. Seth Adjei (Mar 29, 2pm ET)
Topics	<ul style="list-style-type: none"> • What are knowledge graphs? How do they apply to student learning? • Techniques for Building Knowledge graphs from students performance data <ul style="list-style-type: none"> ◦ LFA, POKS, Q-Matrix, etc.
Readings (if any)	<ul style="list-style-type: none"> • Aidan Hogan, Eva Blomqvist, Michael Cochez, Claudia D'amato, Gerard De Melo, Claudio Gutierrez, Sabrina Kirrane, José Emilio Labra Gayo, Roberto Navigli, Sebastian Neumaier, Axel-Cyrille Ngonga Ngomo, Axel Polleres, Sabbir M. Rashid, Anisa Rula, Lukas Schmelzeisen, Juan Sequeda, Steffen Staab, and Antoine Zimmermann. 2021. Knowledge Graphs. ACM Comput. Surv. 54, 4, Article 71 (May 2022), 37 pages. https://doi.org/10.1145/3447772 • Cen, H., Koedinger, K., Junker, B. (2006). Learning Factors Analysis – A General Method for Cognitive Model Evaluation and Improvement. In: Ikeda, M., Ashley, K.D., Chan, T.W. (eds) Intelligent Tutoring Systems. ITS 2006. Lecture Notes in Computer Science, vol 4053. Springer, Berlin, Heidelberg.

	<p>https://doi.org/10.1007/11774303_17</p> <ul style="list-style-type: none"> • Desmarais, Michel C., Xiaoming Pu, and Jean-Guy Blais. "Partial Order Knowledge Structures for CAT Applications." Proceedings of the 2007 GMAC Conference on Computerized Adaptive Testing. Retrieved [12/21/2023] from www.psych.umn.edu/psylabs/CATCentral . 2007. • Barnes, Tiffany. "The q-matrix method: Mining student response data for knowledge." American association for artificial intelligence 2005 educational data mining workshop. AAAI Press, Pittsburgh, PA, USA, 2005. <p>Videos</p> <ul style="list-style-type: none"> • Introduction to Knowledge Graphs • Q-Matrices [YouTube] [pptx] • Other Approaches [YouTube] [pptx] • Learning Curves [YouTube] [pptx]
Assignments (if any)	<ul style="list-style-type: none"> • Discussion Forum Questions • ASSISTments

Module	9. Knowledge Tracing
Instructor (s)	Ryan Baker
Dates	April 1 ~ 5, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M9 Part 5: AMA Session 2 with Dr. Ryan Baker (Apr 5, 1130am ET) 2. M9 Part 5: AMA Session 1 with Dr. Ryan Baker (Apr 2, 1230pm ET)
Topics	<ul style="list-style-type: none"> • What is Knowledge Tracing? Why is it used? What is it used for? • Bayesian Knowledge Tracing

	<ul style="list-style-type: none"> • Logistic Knowledge Tracing/Performance Factor Analysis • Item Response Theory and Elo • Deep Knowledge Tracing • Memory Algorithms
Readings (if any)	<ul style="list-style-type: none"> • Pelánek, R. (2017). Bayesian knowledge tracing, logistic models, and beyond: an overview of learner modeling techniques. <i>User Modeling and User-Adapted Interaction</i>, 27, 313-350.
Assignments (if any)	<ul style="list-style-type: none"> • Bayesian Knowledge Tracing exploratory activity • Performance Factors Analysis assignment in ASSISTments • Discussion Forum Questions

Module	10. Data and Measurement Validity
Instructor(s)	Wendy Chan
Dates	April 8 ~ 12, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M10 Part 5: AMA Session 1 with Dr. Wendy Chan (Apr 8, 11am ET) 2. M10 Part 5: AMA Session 2 with Dr. Wendy Chan (Apr 9, 230pm ET)
Topics	<ul style="list-style-type: none"> • Construct validity • Statistical conclusion and other types of validity • Internal validity and causality • External validity and generalizability
Readings (if any)	<ul style="list-style-type: none"> • Cook, T.D. & Campbell, D.T. (1978). <i>Quasi-experimentation</i>. New York: Houghton Mifflin. • Shadish, W.R., Cook, T.D., & Campbell, D.T. (2002). <i>Experimental and Quasi-Experimental Designs for</i>

	<p><i>Generalized Causal Inference</i>. New York: Houghton Mifflin.</p> <ul style="list-style-type: none"> ● Coe, R., Waring, M., Hedges, L.V., & Ashley, L.D. <i>Research Methods & Methodologies in Education</i>. Los Angeles: SAGE.
Assignments (if any)	<ul style="list-style-type: none"> ● Basic assignment: conceptual questions about the different types of validity ● Discussion Forum Questions

Module	11. Cluster Analysis
Instructor(s)	Alex Bowers
Dates	April 15 ~ 19, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M11 AMA Session 1 with Dr. Alex Bowers (Apr 15, 3pm ET) 2. M11 AMA Session 2 with Dr. Alex Bowers (Apr 17, 4pm ET)
Topics	<ul style="list-style-type: none"> ● Cluster analysis combined with heatmaps ● Hierarchical cluster analysis(HCA) and k-means ● HCA Heatmaps in R using ComplexHeatmap
Readings (if any)	<ul style="list-style-type: none"> ● Bowers, A.J., Zhao, Y., & Ho, E. (2022). Towards Hierarchical Cluster Analysis Heatmaps as Visual Data Analysis of Entire Student Cohort Longitudinal Trajectories and Outcomes from Grade 9 through College. <i>The High School Journal</i>, 106(1), 5-36. https://doi.org/10.1353/hsj.2022.a906700 HCA Heatmap open access R code tutorial: https://doi.org/10.7916/r1mg-yn37 ● Gu, Z. (2021) <i>ComplexHeatmap Complete Reference</i>. Chapters 1-3. https://jokergoo.github.io/ComplexHeatmap-reference/book/ ● Zhe, A.Y. (2022) K-Means Clustering An Explorable Explainer. https://k-means-explorable.vercel.app/

	<ul style="list-style-type: none"> • Xu, R., & Wunsch, D. (2005). Survey of Clustering Algorithms. IEEE Trans On Neural Networks, 16. https://doi.org/10.1109/tnn.2005.845141
Assignments (if any)	<ul style="list-style-type: none"> • Replicate Bowers et al. (2022) HCA heatmap R markdown tutorial https://doi.org/10.7916/r1mg-yn37 • Discussion Forum Questions • ASSISTments

Module	12. Network Analysis
Instructor(s)	Bodong Chen
Dates	April 22 ~ 26, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M12 Part 5: AMA Session 1 with Dr. Bodong Chen (Apr 23, 11am ET) 2. M12 Part 5: AMA Session 2 with Dr. Bodong Chen (Apr 25, 330pm ET)
Topics	<ul style="list-style-type: none"> • Foundations of social network analysis • Techniques for collecting, organizing, and visualizing network data • Basic network measures • Practical guidelines on conducting network analysis in education
Readings (if any)	<ul style="list-style-type: none"> • Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences. <i>Science</i>, 323(5916), 892-895. https://doi.org/10.1126/science.1165821 • Poquet, O., & Joksimović, S. (2022). Cacophony of networks in learning analytics. In C. Lang, G. Siemens, A. F. Wise, D. Gašević, & A. Merceron (Eds.), <i>The handbook of learning analytics</i> (2nd ed., pp. 38-45). SoLAR. https://www.solaresearch.org/publications/hla-22/hla22-chapter4/ • [Optional] Scott, J. (2017). <i>Social network analysis</i> (4th edition). SAGE Publications.

Assignments (if any)	<ul style="list-style-type: none"> • Discussion Forum Questions • ASSISTments
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Module	13. Sequential Pattern Mining and Temporal Analysis
Instructor(s)	Bodong Chen
Dates	April 29 ~ May 3, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M13 Part 5: AMA Session 1 with Dr. Bodong Chen (Apr 30, 11am ET) 2. M13 Part 5: AMA Session 2 with Dr. Bodong Chen (May 2, 330pm ET)
Topics	<p>Data in digital learning systems are often rich in temporal information that enables us to explore the dynamic changes in learning behavior at different time granularities. This module will engage participants to explore:</p> <ul style="list-style-type: none"> • Basic concepts in temporal analysis and why temporality matters • Data manipulation with sequences • Exploratory sequence analysis • Association rules and frequent sequence mining • Critical issues in applying temporal analysis to digital learning data
Readings (if any)	<ul style="list-style-type: none"> • Chen, B., Knight, S., & Wise, A. F. (2018). Critical Issues in Designing and Implementing Temporal Analytics. <i>Journal of Learning Analytics</i>, 5(1), 1-9. https://doi.org/10.18608/jla.2018.53.1 • Gabadinho, A., Ritschard, G., Müller, N. S., & Studer, M. (2011). Analyzing and Visualizing State Sequences in R with TraMineR. <i>Journal of Statistical Software</i>, 40(1), Article 1. https://doi.org/10.18637/jss.v040.i04 <p>Technical manuals (no need to read sequentially)</p> <ul style="list-style-type: none"> • Mining sequence data in R with the TraMineR package (Chapters 1-8)

	<ul style="list-style-type: none"> • Introduction to arules
Assignments (if any)	<ul style="list-style-type: none"> • Discussion Forum Questions • Self-paced sequential analysis lab

Module	14. Causal Reasoning
Instructor(s)	Walter Leite
Dates	May 6 ~ 10, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M14 Part 5: AMA Session 1 with Dr. Walter Leite (May 8, 4pm ET) 2. M14 Part 5: AMA Session 2 with Dr. Walter Leite (May 10, 4pm ET)
Topics	<ul style="list-style-type: none"> • Potential outcomes framework • Propensity score methods • Regression discontinuity designs • Heterogeneity of treatment effects
Readings (if any)	<ul style="list-style-type: none"> • Chapter 1 of Leite, W. L. (2017). Practical propensity score methods using R. Sage Publishing. • Chapter 5 of Leite, W. L. (2017). Practical propensity score methods using R. Sage Publishing. • Bloom, H. S. (2012). Modern Regression Discontinuity Analysis. Journal of Research on Educational Effectiveness, 5(1), 43-82. https://doi.org/10.1080/19345747.2011.578707 • Jacob, D. (2021). CATE meets ML. Digital Finance, 3(2), 99-148. https://doi.org/10.1007/s42521-021-00033-7
Assignments	<ul style="list-style-type: none"> • Discussion Forum Questions • ASSISTments:

(if any)	<ul style="list-style-type: none"> ○ Assignment 1 in Assistments: Causal Reasoning ○ Assignment 2 in Assistments: Propensity Score Analysis ○ Assignment 3 in Assistments: Regression Discontinuity Designs ○ Assignment 4 in Assistments: Heterogeneity of Treatment Effects
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Module	15. Natural Language Processing
Instructor (s)	Scott Crossley
Dates	May 13 ~ 17, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M15 Part 5: AMA Session 1 with Dr. Scott Crossley (May 13, 2pm ET) 2. M15 Part 5: AMA Session 2 with Dr. Scott Crossley (May 15, 430pm ET)
Topics	<ul style="list-style-type: none"> · Tidytext: Videos 1_tt to 3_tt · Tokenization: Video 4_tt · Word frequency: Videos 5_tt to 6_tt · Sentiment Analysis: Videos 1_sent to 5_sent
Readings (if any)	<ul style="list-style-type: none"> ● Crossley, S. A., Kyle, K., & McNamara, D. S. (2017). Sentiment Analysis and Social Cognition Engine (SEANCE): An Automatic Tool for Sentiment, Social Cognition, and Social Order Analysis. <i>Behavior Research Methods</i>, 49 (3), 803-821. ● Crossley, S. A., Paquette, L., Dascalu, M., McNamara, D., & Baker, R. (2016). Combining Click-Stream Data with NLP Tools to Better Understand MOOC Completion. In Gasevic, D., & Lynch, G. (eds.). <i>Proceedings of the 6th International Learning Analytics and Knowledge (LAK) Conference</i>. (pp. 6-14). New York, NY: ACM. doi: 10.1145/2883851.2883931

	<ul style="list-style-type: none"> • Silge, J., & Robinson, D. (2017). Text Mining with R: A Tidy Approach. O'Reilly Media, Sebastopol, CA
Assignments (if any)	<ul style="list-style-type: none"> • Discussion Forum Questions • Sentiment analysis project (Kaggle)

Module	16. Transformer and Foundation Models
Instructor(s)	Jinnie Shin and Anthony Botelho
Dates	May 20 ~ 204, 2024
AMA Sessions	<ol style="list-style-type: none"> 1. M16 Part 5: AMA Session 1 with Dr. Jinnie Shin (May 20, 130pm ET) 2. M16 Part 5: AMA Session 2 with Dr. Jinnie Shin (May 22, 1pm ET)
Topics	<ul style="list-style-type: none"> - Language Models in NLP - Properties and Characteristics of Transformer models - Example Transformer Models
Readings (if any)	<ul style="list-style-type: none"> • Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. <i>Advances in neural information processing systems</i>, 30. • Devlin, Chang, Lee, & Toutanova (2018). BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding
Assignments (if any)	<ul style="list-style-type: none"> • Discussion Forum Questions • Text classification model project

