

IRT for NLP: Structured Reading List

EACL 2024 Tutorial

1 Introductory

- Frank B Baker. *The basics of item response theory*. ERIC, 2001
- James E Carlson and Matthias von Davier. Item response theory. *ETS Research Report Series*, 2013(2):i-69, 2013
- Prathiba Natesan, Ratna Nandakumar, Tom Minka, and Jonathan D Rubright. Bayesian prior choice in irt estimation using mcmc and variational bayes. *Frontiers in psychology*, 7:1422, 2016
- R Darrell Bock and Robert D Gibbons. *Item response theory*. John Wiley & Sons, 2021

2 IRT in NLP

- Naoki Otani, Toshiaki Nakazawa, Daisuke Kawahara, and Sadao Kurohashi. IRT-based aggregation model of crowdsourced pairwise comparison for evaluating machine translations. In *Proceedings of the 2016 Conference on Empirical Methods in Natural Language Processing*, pages 511–520, Austin, Texas, November 2016. Association for Computational Linguistics
- John P. Lalor, Hao Wu, and Hong Yu. Building an evaluation scale using item response theory. In *Proceedings of the 2016 Conference on Empirical Methods in Natural Language Processing*, pages 648–657, Austin, Texas, November 2016. Association for Computational Linguistics
- John P. Lalor, Hao Wu, Tsendsuren Munkhdalai, and Hong Yu. Understanding deep learning performance through an examination of test set difficulty: A psychometric case study. In *Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing*, pages 4711–4716, Brussels, Belgium, October-November 2018. Association for Computational Linguistics
- João Sedoc and Lyle Ungar. Item response theory for efficient human evaluation of chatbots. In *Proceedings of the First Workshop on Evaluation and Comparison of NLP Systems*, pages 21–33, Online, November 2020. Association for Computational Linguistics

- Clara Vania, Phu Mon Htut, William Huang, Dhara Mungra, Richard Yuanzhe Pang, Jason Phang, Haokun Liu, Kyunghyun Cho, and Samuel R. Bowman. Comparing test sets with item response theory. In Chengqing Zong, Fei Xia, Wenjie Li, and Roberto Navigli, editors, *Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)*, pages 1141–1158, Online, August 2021. Association for Computational Linguistics
- Pedro Rodriguez, Joe Barrow, Alexander Miserlis Hoyle, John P. Lalor, Robin Jia, and Jordan Boyd-Graber. Evaluation examples are not equally informative: How should that change NLP leaderboards? In *Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)*, pages 4486–4503, Online, August 2021. Association for Computational Linguistics
- John P. Lalor and Pedro Rodriguez. py-irt: A scalable item response theory library for python. *INFORMS Journal on Computing*, 2022
- Pedro Rodriguez, Phu Mon Htut, John Lalor, and João Sedoc. Clustering examples in multi-dataset benchmarks with item response theory. In *Proceedings of the Third Workshop on Insights from Negative Results in NLP*, pages 100–112, Dublin, Ireland, May 2022. Association for Computational Linguistics
- Vasudha Varadarajan, Sverker Sikström, Oscar NE Kjell, and H Andrew Schwartz. Adaptive language-based mental health assessment with item-response theory. *arXiv preprint arXiv:2311.06467*, 2023

3 IRT in ML

- Fernando Martinez-Plumed and Jose Hernandez-Orallo. Dual indicators to analyze ai benchmarks: Difficulty, discrimination, ability, and generality. *IEEE Transactions on Games*, 12(2):121–131, 2018
- Fernando Martínez-Plumed, Ricardo BC Prudêncio, Adolfo Martínez-Usó, and José Hernández-Orallo. Item response theory in ai: Analysing machine learning classifiers at the instance level. *Artificial intelligence*, 271:18–42, 2019
- M Wu, R Davis, B Domingue, C Piech, and Noah D Goodman. Variational item response theory: Fast, accurate, and expressive. 2020
- Ana C Lorena, Pedro YA Paiva, and Ricardo BC Prudêncio. Trusting my predictions: on the value of instance-level analysis. *ACM Computing Surveys*, 2023

- Qi Liu, Zheng Gong, Zhenya Huang, Chuanren Liu, Hengshu Zhu, Zhi Li, Enhong Chen, and Hui Xiong. Multi-dimensional ability diagnosis for machine learning algorithms. *arXiv preprint arXiv:2307.07134*, 2023

4 Advanced

- Jacopo Amidei, Paul Piwek, and Alistair Willis. Identifying annotator bias: A new IRT-based method for bias identification. In *Proceedings of the 28th International Conference on Computational Linguistics*, pages 4787–4797, Barcelona, Spain (Online), December 2020. International Committee on Computational Linguistics
- José Hernández-Orallo, Bao Sheng Loe, Lucy Cheke, Fernando Martínez-Plumed, and Seán Ó hÉigeartaigh. General intelligence disentangled via a generality metric for natural and artificial intelligence. *Scientific reports*, 11(1):22822, 2021
- Antonio Laverghetta Jr., Animesh Nighojkar, Jamshidbek Mirzakhlov, and John Licato. Can transformer language models predict psychometric properties? In *Proceedings of *SEM 2021: The Tenth Joint Conference on Lexical and Computational Semantics*, pages 12–25, Online, August 2021. Association for Computational Linguistics
- Fernando Martínez-Plumed, David Castellano, Carlos Monserrat-Aranda, and José Hernández-Orallo. When ai difficulty is easy: The explanatory power of predicting irt difficulty. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 36, pages 7719–7727, 2022
- Yu Chen, Telmo Silva Filho, Ricardo B Prudencio, Tom Diethe, and Peter Flach. β^3 -irt: A new item response model and its applications. In *The 22nd International Conference on Artificial Intelligence and Statistics*, pages 1013–1021. PMLR, 2019
- Manuel Ferreira-Junior, Jessica TS Reinaldo, Eufrasio A Lima Neto, Ricardo BC Prudencio, et al. β^4 -irt: A new β^3 -irt with enhanced discrimination estimation. *arXiv preprint arXiv:2303.17731*, 2023
- João VC Moraes, Jessica TS Reinaldo, Ricardo BC Prudencio, and Telmo M Silva Filho. Item response theory for evaluating regression algorithms. In *2020 International Joint Conference on Neural Networks (IJCNN)*, pages 1–8. IEEE, 2020
- Mark D Reckase. 18 multidimensional item response theory. *Handbook of statistics*, 26:607–642, 2006
- Wes Bonifay. *Multidimensional item response theory*. Sage Publications, 2019

- G. H. Fischer. Linear logistic test models. *Encyclopedia of Social Measurement*, 2:505–514, 2005
- Purya Baghaei and Klaus D Kubinger. Linear logistic test modeling with r. *Practical Assessment, Research, and Evaluation*, 20(1):1, 2019
- Hamdollah Ravand. Item response theory using hierarchical generalized linear models. *Practical Assessment, Research, and Evaluation*, 20(1):7, 2019
- Isabella Sulis and Michael D Toland. Introduction to multilevel item response theory analysis: Descriptive and explanatory models. *The Journal of Early Adolescence*, 37(1):85–128, 2017

References

- [1] Frank B Baker. *The basics of item response theory*. ERIC, 2001.
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- [4] R Darrell Bock and Robert D Gibbons. *Item response theory*. John Wiley & Sons, 2021.
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- [6] John P. Lalor, Hao Wu, and Hong Yu. Building an evaluation scale using item response theory. In *Proceedings of the 2016 Conference on Empirical Methods in Natural Language Processing*, pages 648–657, Austin, Texas, November 2016. Association for Computational Linguistics.
- [7] John P. Lalor, Hao Wu, Tsendsuren Munkhdalai, and Hong Yu. Understanding deep learning performance through an examination of test set difficulty: A psychometric case study. In *Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing*, pages 4711–4716, Brussels, Belgium, October–November 2018. Association for Computational Linguistics.
- [8] João Sedoc and Lyle Ungar. Item response theory for efficient human evaluation of chatbots. In *Proceedings of the First Workshop on Evaluation and Comparison of NLP Systems*, pages 21–33, Online, November 2020. Association for Computational Linguistics.

- [9] Clara Vania, Phu Mon Htut, William Huang, Dhara Mungra, Richard Yuanzhe Pang, Jason Phang, Haokun Liu, Kyunghyun Cho, and Samuel R. Bowman. Comparing test sets with item response theory. In Chengqing Zong, Fei Xia, Wenjie Li, and Roberto Navigli, editors, *Proceedings of the 59th Annual Meeting of the Association for Computational Linguistics and the 11th International Joint Conference on Natural Language Processing (Volume 1: Long Papers)*, pages 1141–1158, Online, August 2021. Association for Computational Linguistics.
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- [12] Pedro Rodriguez, Phu Mon Htut, John Lalor, and João Sedoc. Clustering examples in multi-dataset benchmarks with item response theory. In *Proceedings of the Third Workshop on Insights from Negative Results in NLP*, pages 100–112, Dublin, Ireland, May 2022. Association for Computational Linguistics.
- [13] Vasudha Varadarajan, Sverker Sikström, Oscar NE Kjell, and H Andrew Schwartz. Adaptive language-based mental health assessment with item-response theory. *arXiv preprint arXiv:2311.06467*, 2023.
- [14] Fernando Martinez-Plumed and Jose Hernandez-Orallo. Dual indicators to analyze ai benchmarks: Difficulty, discrimination, ability, and generality. *IEEE Transactions on Games*, 12(2):121–131, 2018.
- [15] Fernando Martínez-Plumed, Ricardo BC Prudêncio, Adolfo Martínez-Usó, and José Hernández-Orallo. Item response theory in ai: Analysing machine learning classifiers at the instance level. *Artificial intelligence*, 271:18–42, 2019.
- [16] M Wu, R Davis, B Domingue, C Piech, and Noah D Goodman. Variational item response theory: Fast, accurate, and expressive. 2020.
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- [20] José Hernández-Orallo, Bao Sheng Loe, Lucy Cheke, Fernando Martínez-Plumed, and Seán Ó hÉigeartaigh. General intelligence disentangled via a generality metric for natural and artificial intelligence. *Scientific reports*, 11(1):22822, 2021.
- [21] Antonio Laverghetta Jr., Animesh Nigohjkar, Jamshidbek Mirzakhlov, and John Licato. Can transformer language models predict psychometric properties? In *Proceedings of *SEM 2021: The Tenth Joint Conference on Lexical and Computational Semantics*, pages 12–25, Online, August 2021. Association for Computational Linguistics.
- [22] Fernando Martínez-Plumed, David Castellano, Carlos Monserrat-Aranda, and José Hernández-Orallo. When ai difficulty is easy: The explanatory power of predicting irt difficulty. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 36, pages 7719–7727, 2022.
- [23] Yu Chen, Telmo Silva Filho, Ricardo B Prudencio, Tom Diethe, and Peter Flach. β^3 -irt: A new item response model and its applications. In *The 22nd International Conference on Artificial Intelligence and Statistics*, pages 1013–1021. PMLR, 2019.
- [24] Manuel Ferreira-Junior, Jessica TS Reinaldo, Eufrasio A Lima Neto, Ricardo BC Prudencio, et al. β^4 -irt: A new β^3 -irt with enhanced discrimination estimation. *arXiv preprint arXiv:2303.17731*, 2023.
- [25] João VC Moraes, Jessica TS Reinaldo, Ricardo BC Prudencio, and Telmo M Silva Filho. Item response theory for evaluating regression algorithms. In *2020 International Joint Conference on Neural Networks (IJCNN)*, pages 1–8. IEEE, 2020.
- [26] Mark D Reckase. 18 multidimensional item response theory. *Handbook of statistics*, 26:607–642, 2006.
- [27] Wes Bonifay. *Multidimensional item response theory*. Sage Publications, 2019.
- [28] G. H. Fischer. Linear logistic test models. *Encyclopedia of Social Measurement*, 2:505–514, 2005.
- [29] Purya Baghaei and Klaus D Kubinger. Linear logistic test modeling with r. *Practical Assessment, Research, and Evaluation*, 20(1):1, 2019.

- [30] Hamdollah Ravand. Item response theory using hierarchical generalized linear models. *Practical Assessment, Research, and Evaluation*, 20(1):7, 2019.
- [31] Isabella Sulis and Michael D Toland. Introduction to multilevel item response theory analysis: Descriptive and explanatory models. *The Journal of Early Adolescence*, 37(1):85–128, 2017.