Neural Collaborative Filtering & Multi-Armed Bandits

Advanced Techniques for Recommendation Systems

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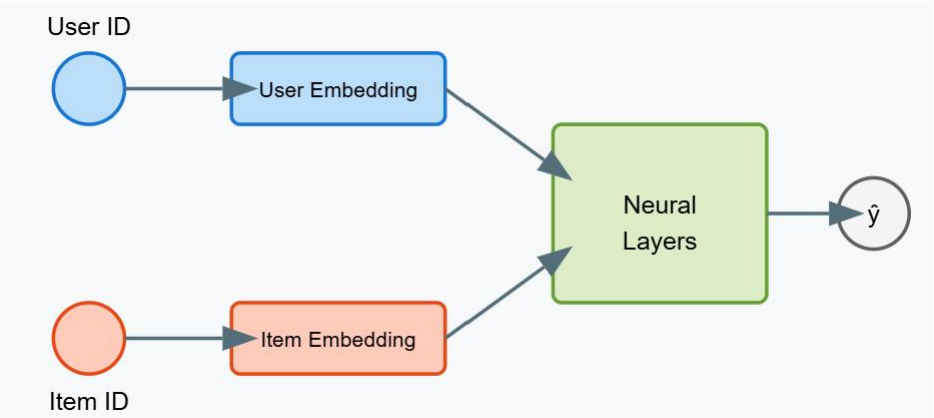
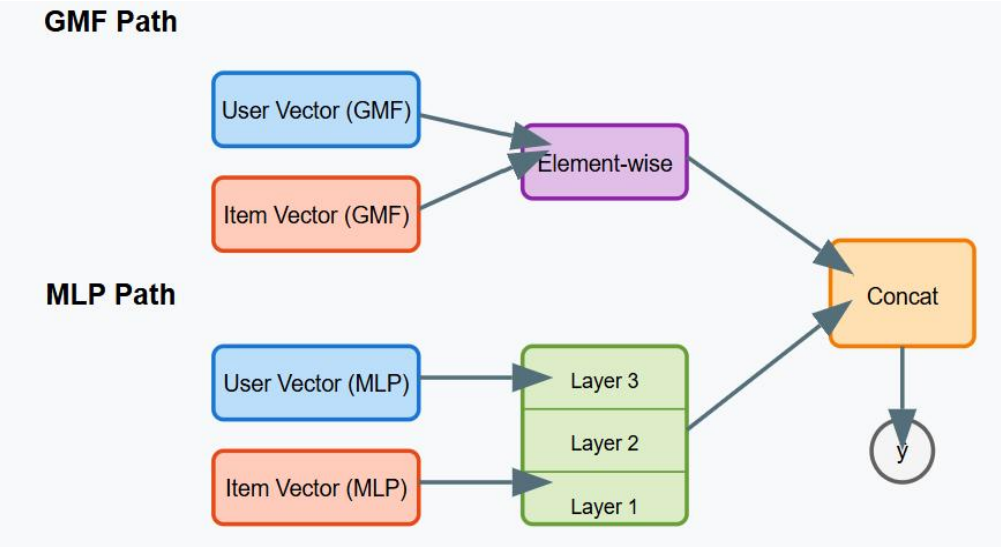
Neural Collaborative Filtering (NCF)

- Extends Matrix Factorization with neural networks
- Replaces inner product with neural architecture
- Captures complex non-linear interaction patterns



He, X., Liao, L., Zhang, H., Nie, L., Hu, X., & Chua, T. S. (2017). Neural collaborative filtering. In Proceedings of the 26th international conference on world wide web (pp. 173-182).

Neural Matrix Factorization (NeuMF)

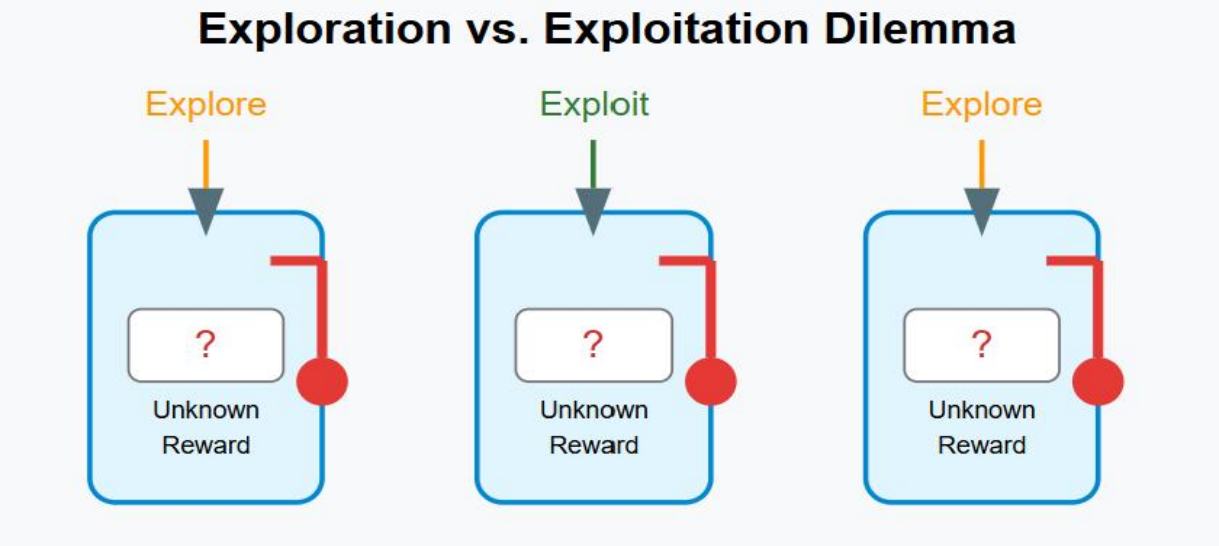


NeuMF combines:

GMF: Captures linear patterns
MLP: Models non-linear relationships

Wang, Q., Zeng, C., Zhou, W., Li, T., Iyengar, S. S., Shwartz, L., & Grabarnik, G. (2018). Neural collaborative filtering based personalized recommendation system for medical diagnosis. In 2018 IEEE International Conference on Bioinformatics and Biomedicine (BIBM) (pp. 1619-1624).

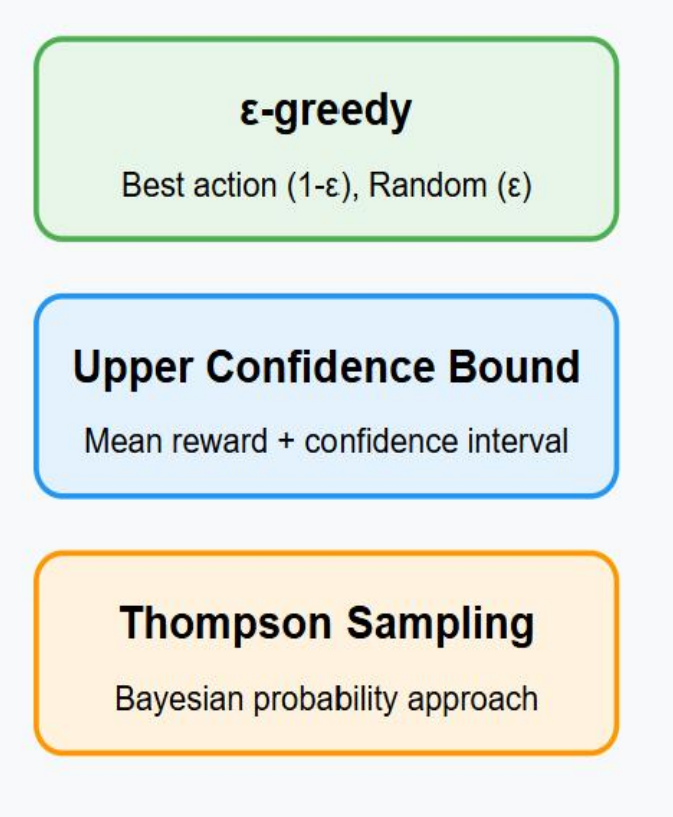
Multi-Armed Bandits



- Balancing exploration (trying new options) and exploitation (using best known options)
- Learning optimal choices with incomplete information
- Continuous learning from feedback

Li, L., Chu, W., Langford, J., & Schapire, R. E. (2010). A contextual-bandit approach to personalized news article recommendation. In Proceedings of the 19th international conference on World wide web (pp. 661-670).

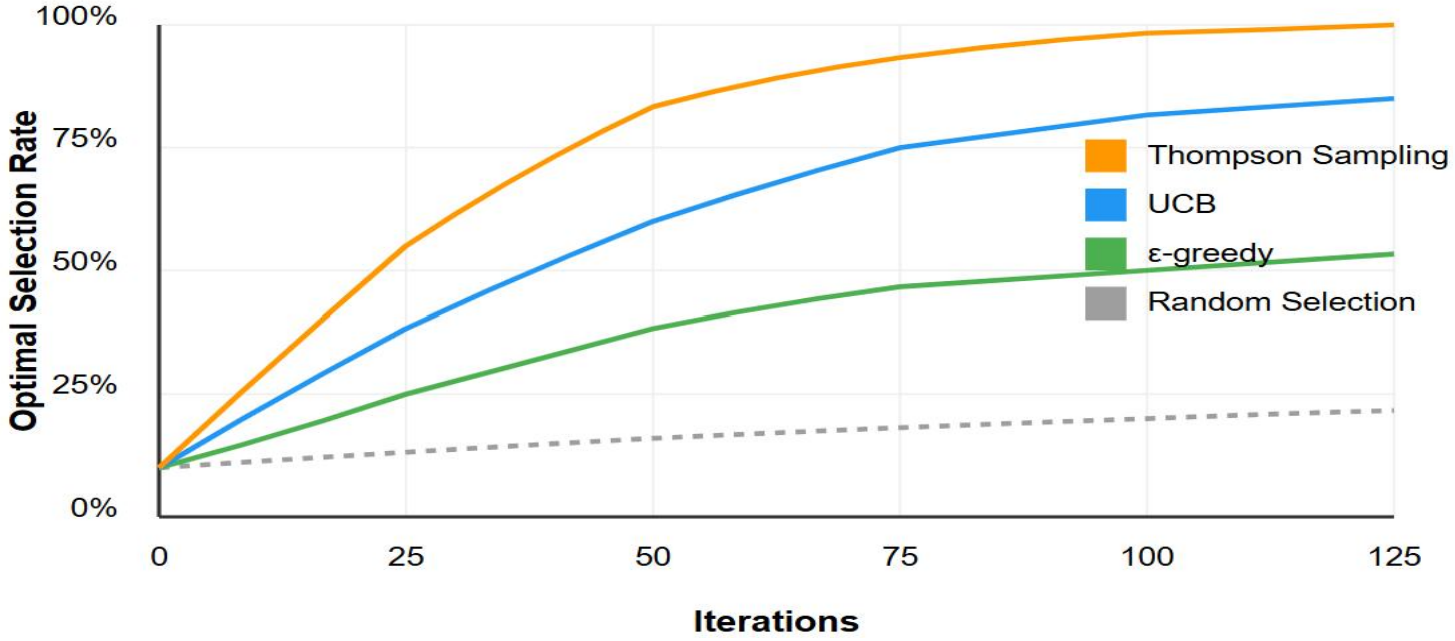
Common MAB Algorithms



- ε-greedy: Usually selects best option, occasionally explores randomly
- UCB: Favors options with high potential based on statistical confidence
- Thompson Sampling: Uses Bayesian probability to select based on optimality likelihood

Lattimore, T., & Szepesvári, C. (2020). Bandit algorithms. Cambridge University Press.

How MAB Algorithms Learn



- Continuously update understanding of each option's value
- Converge toward optimal selections over time
- No need for complete information upfront

Chapelle, O., & Li, L. (2011). An empirical evaluation of thompson sampling. Advances in neural information processing systems, 24.

Applications & Conclusion

Key Takeaways

- NCF captures complex patterns traditional methods miss
- MAB optimizes with limited initial data
- Combined approaches offer powerful recommendation capabilities

Thank you