LTR with multiple objectives

One of the key components for learning to rank is the definition of the relevance score. We have seen that it is difficult to achieve a ground truth when dealing with users and click data.

↳ For example, a company wants to optimise both sales and their premium products.

Why a single objective may not be enough?

- A possible scenario that we might face is how to optimise for multiple objectives. For example:
  - new sales vs short term retention
  - engagement vs post-order experience (returns)
  - engagement vs fashionability.

1) Optimizing with 1 objective.

EXAMPLE: NDCG OBJECTIVE

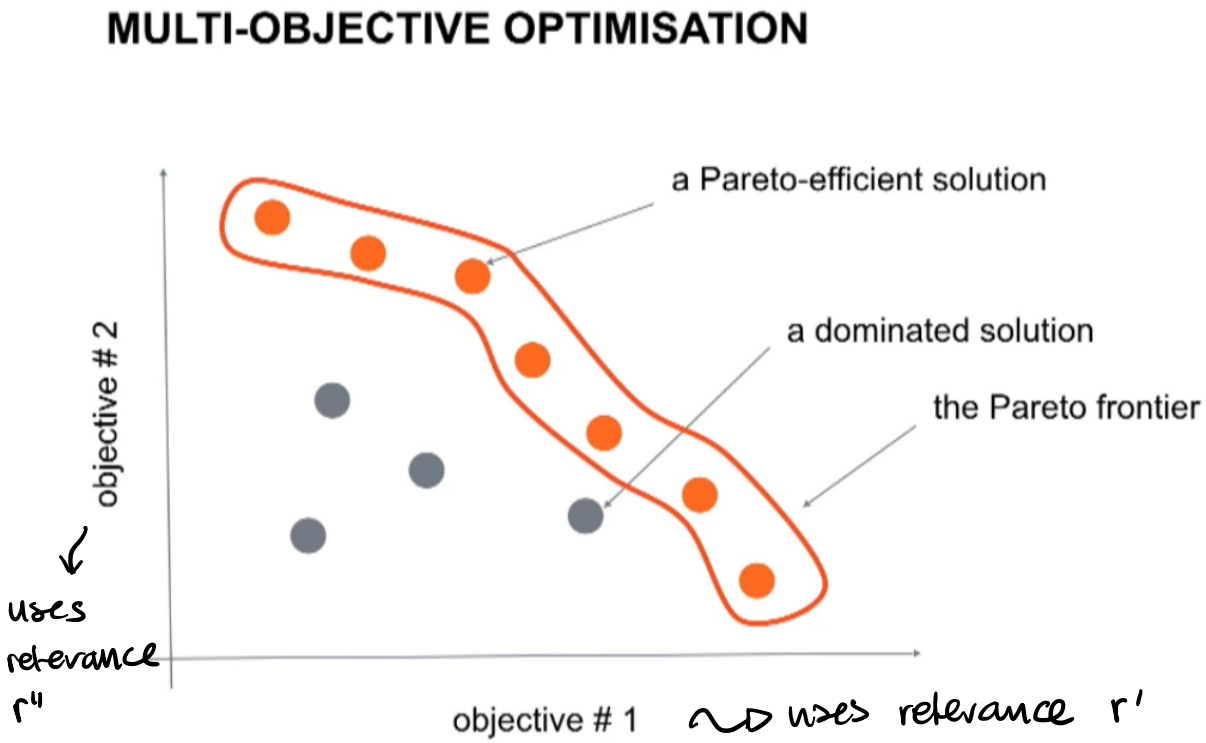
this is an example of how a company can score relevance

Interaction	r_{ij}
purchase	3
click	1
no interaction	0

$$i = 1, \ldots, N,$$
$$j = 1, \ldots, n_i.$$

$$DCG_i = \sum_{j=1}^{n_i} \frac{r_{ij}}{\log_2(j+1)} \qquad NDCG = \sum_{i=1}^{N} \frac{DCG_i}{\max DCG_i}$$

2) What would we ideally want to achieve?



option 1 → post-augmentation of the sorting rule

1) Optimise for one objective
2) tweak the solution to address certain areas that don't match what you want about the second objective.

option 2 → redefine relevance to include both objectives.

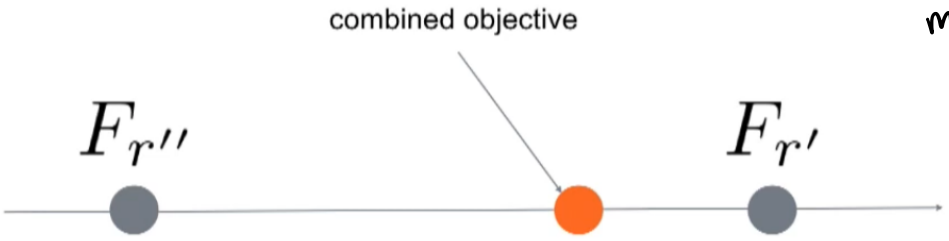
second dimension

Interaction	r_{ij}
purchase, fashionable	7
purchase, non-fashionable	3
click	1
no interaction	0

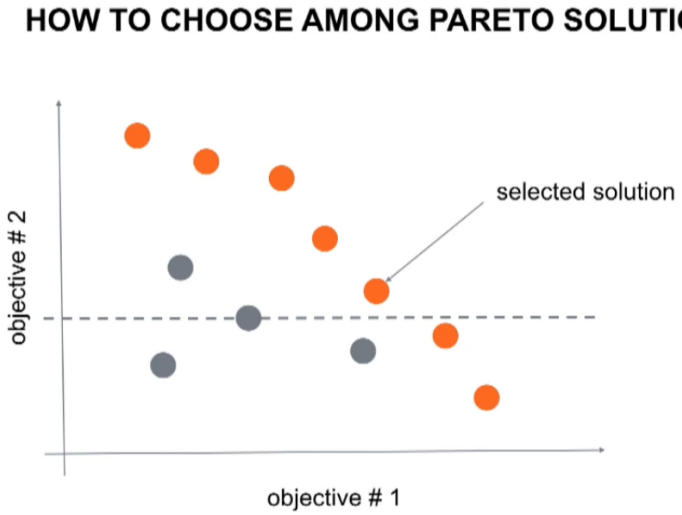
3) option 3 → scalarization

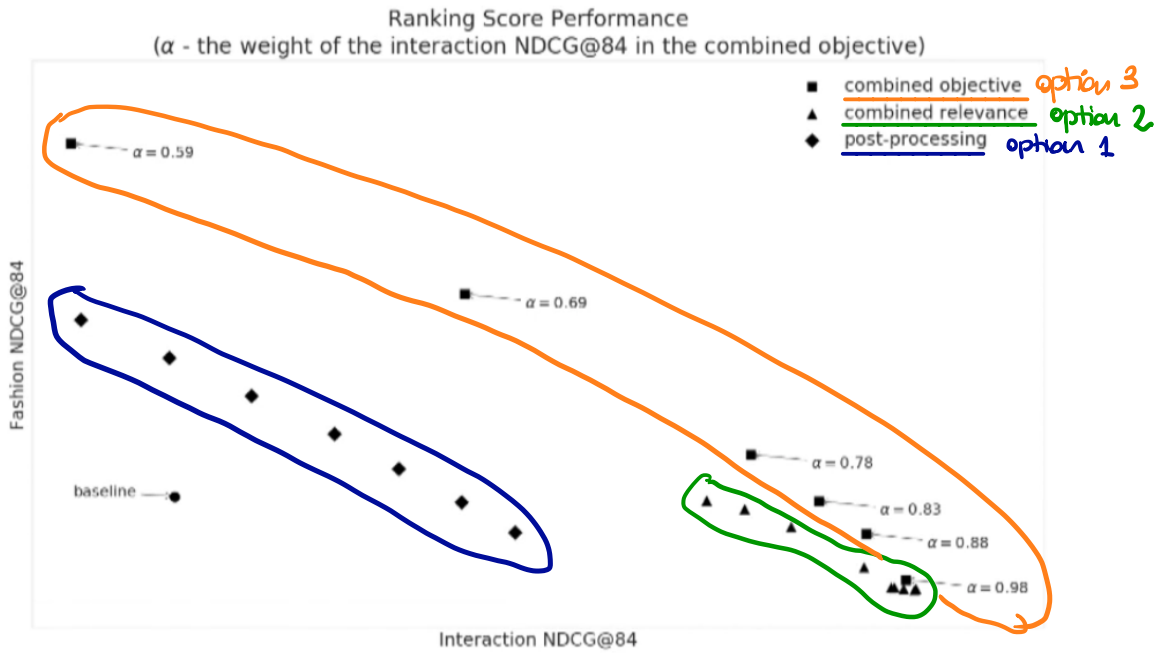
$$\alpha F_{r'} + (1-\alpha) F_{r''} \rightarrow \max$$
$$\alpha \in (0, 1)$$

- optimise both objectives separately and combine them using weighting.
- this could be applied to multiple objectives.



out of the possible α combinations you could define a minimum threshold to achieve in obj2 and allow α to decide best possible value to maximise obj 1.





Other possible secondary objectives

Lack of diversity

- Aside from results being relevant a user might want to have some choices to explore:
  - ↳ For example, if a user searches for "best phones", you don't want to return all iphone models!
  - ↳ For skyscanner, you might not want to show flights that are incredibly similar in departure time, duration and prices all crammed in the same spot.

- Options:

  1 → Regularise based on pairwise similarity scores

  2 → Re-ranking → 2 step optimization
  - ↳ rank for relevancy
    - ↳ then rank for diversity