

Adaptive Re-Ranking as an Information-Seeking Agent

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NICOLA TONELLOTO
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PASIR @ CIKM 2022



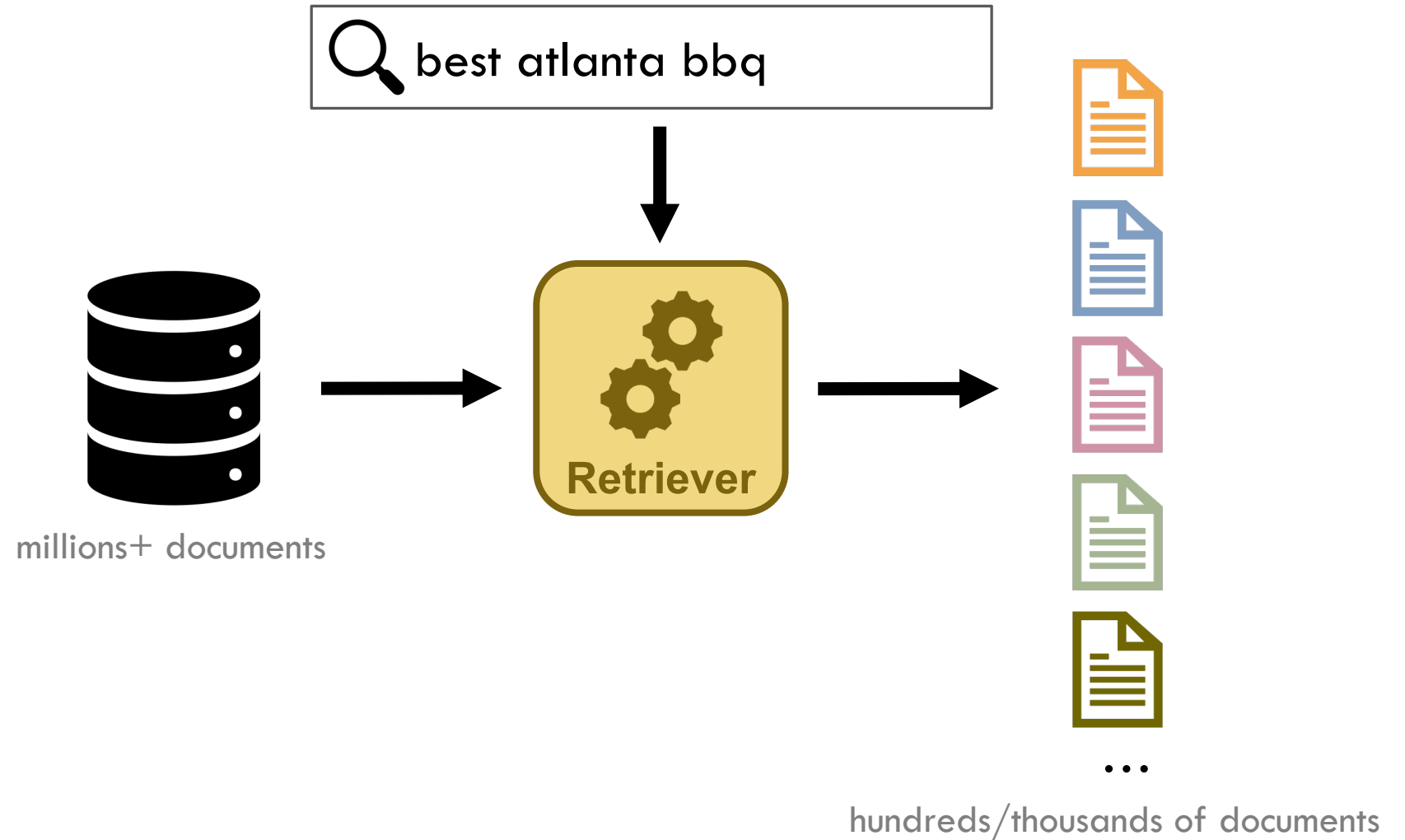
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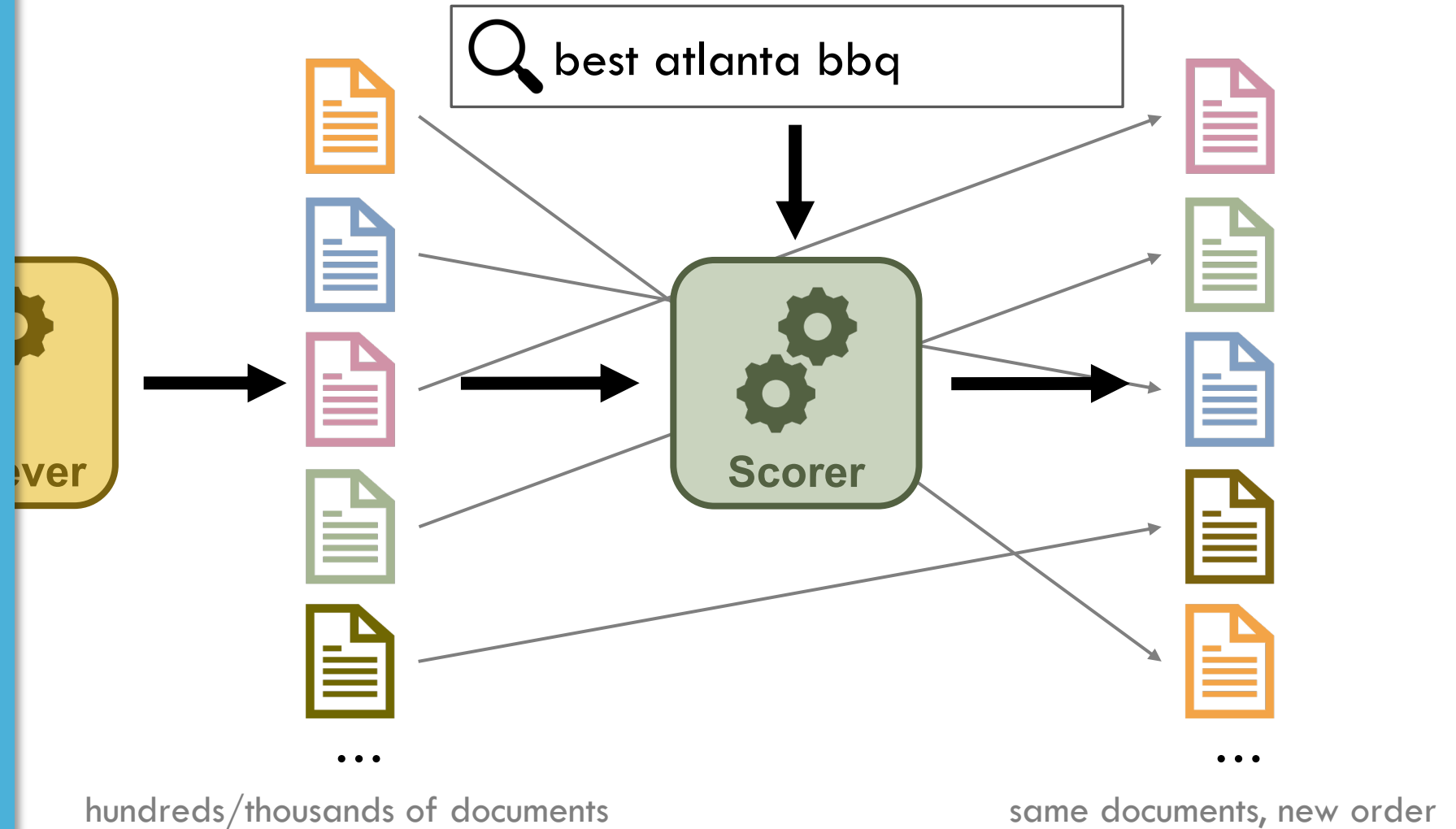
Re-Ranking

Stage 1: Retrieve candidate results from a corpus



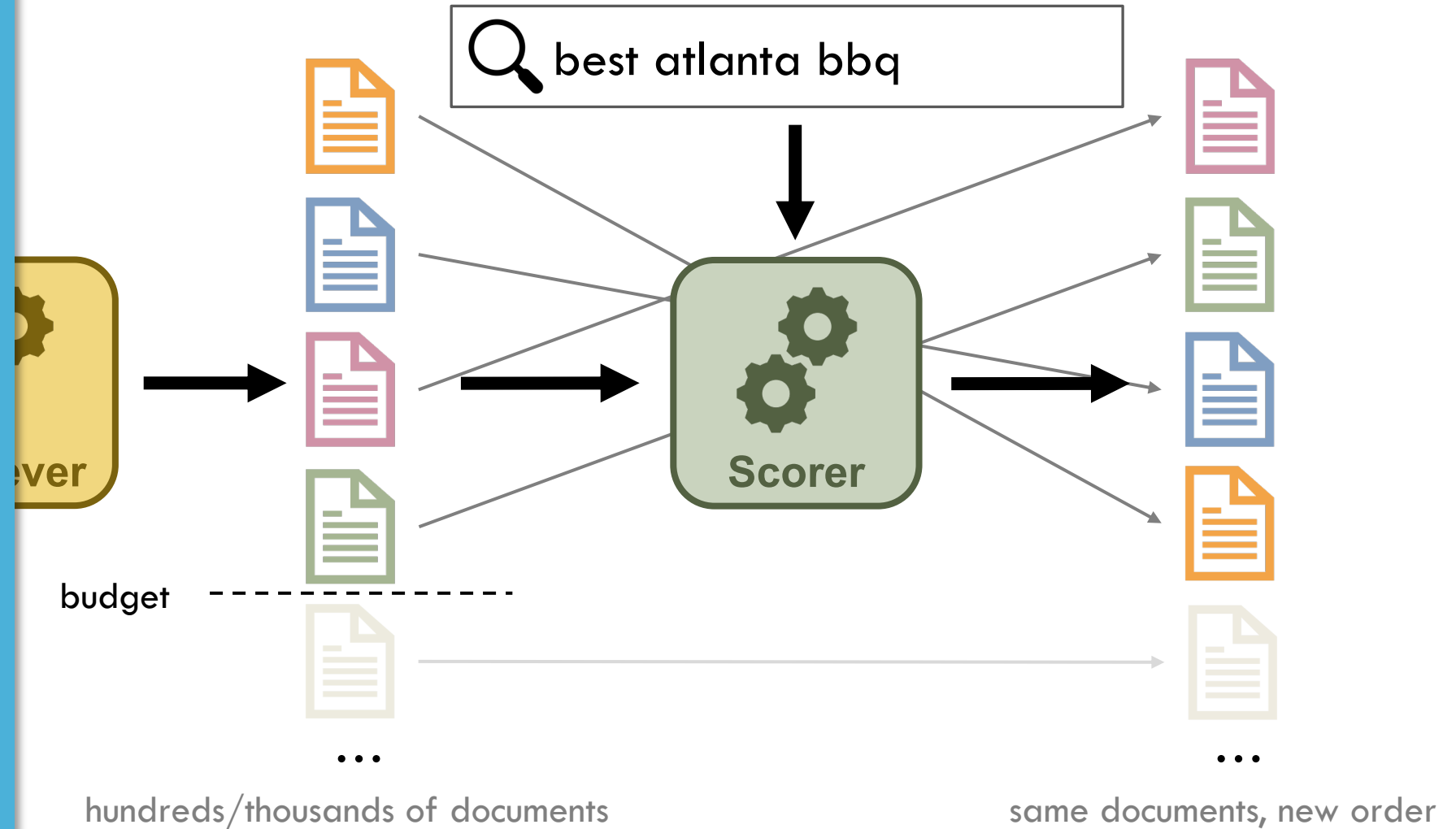
Re-Ranking

Stage 2: Re-order the candidates



Re-Ranking

Stage 2: Re-order the candidates



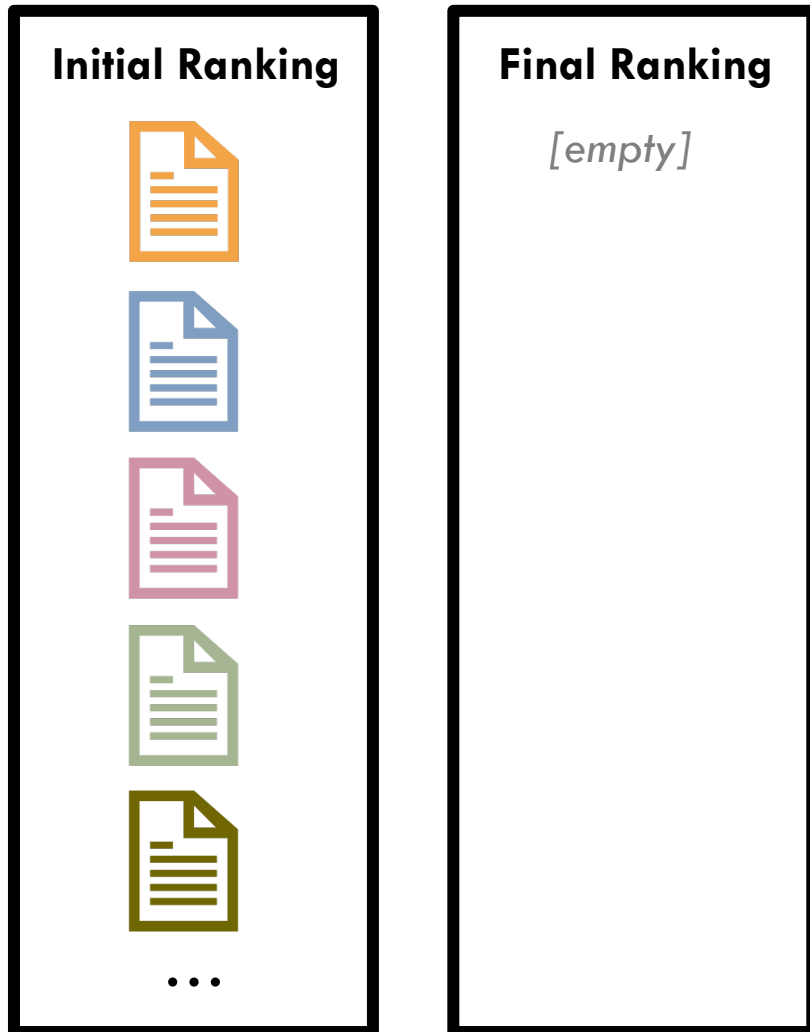
Stage 2: Re-order the candidates

Re-Ranking



What if we consider the re-ranking process as an **agent**?

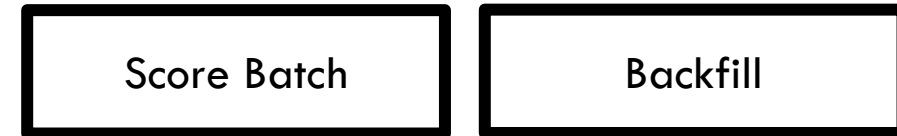
Environment:



Agent:



Actions:

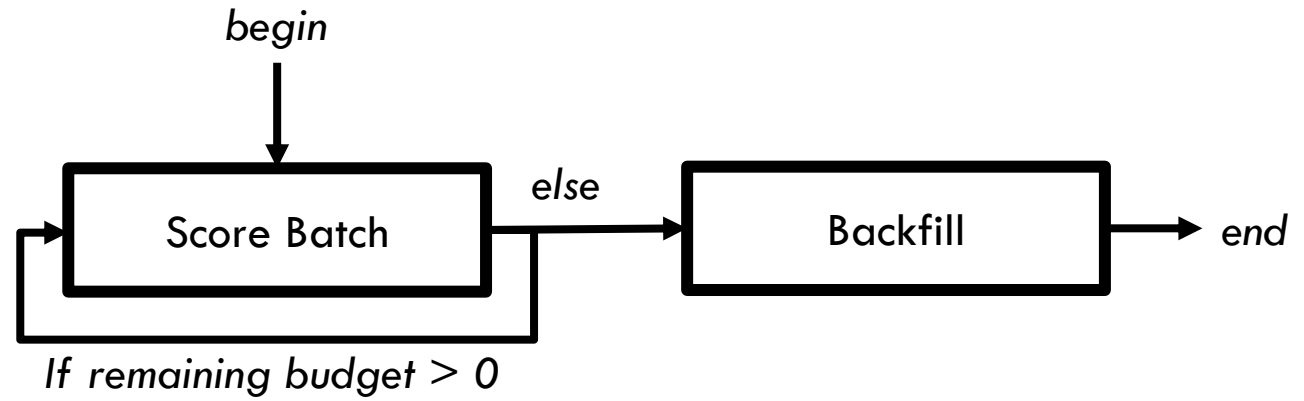


State:

Remaining budget

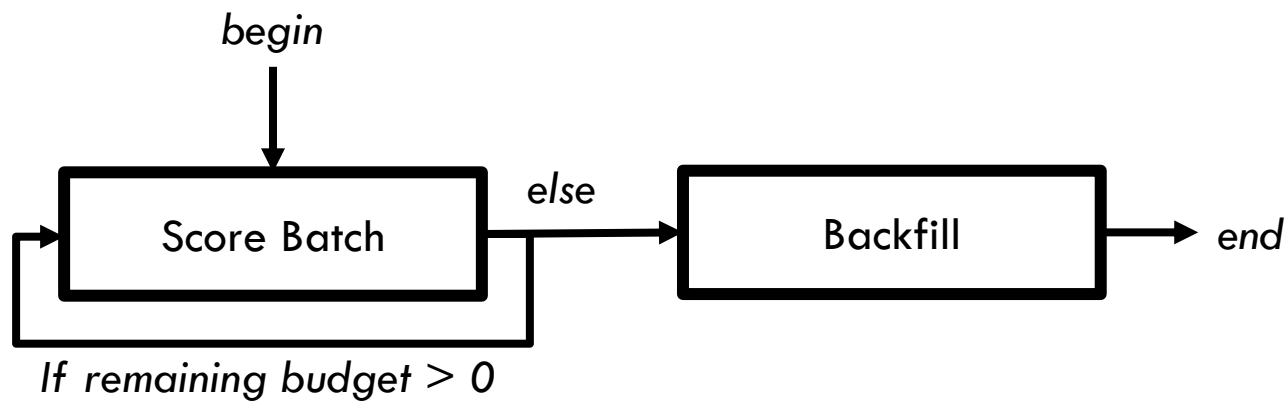


Traditional Re-Ranking

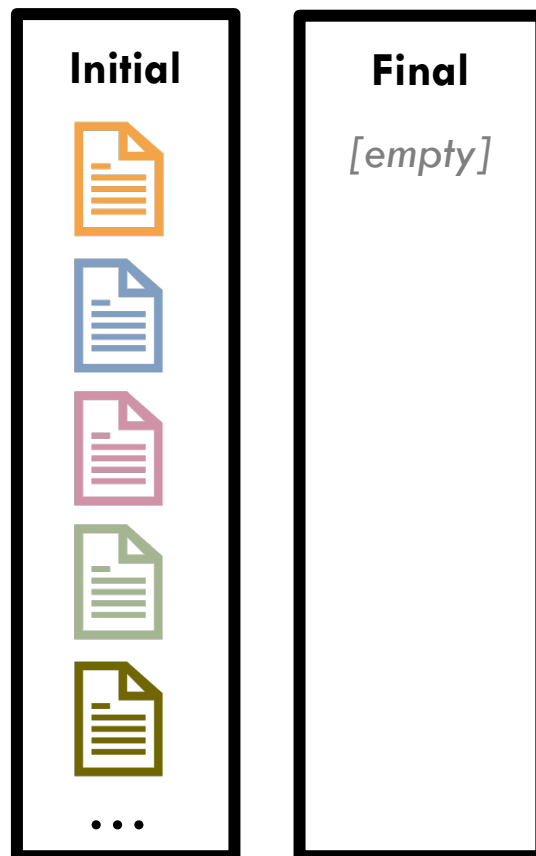




Traditional Re-Ranking



Environment:

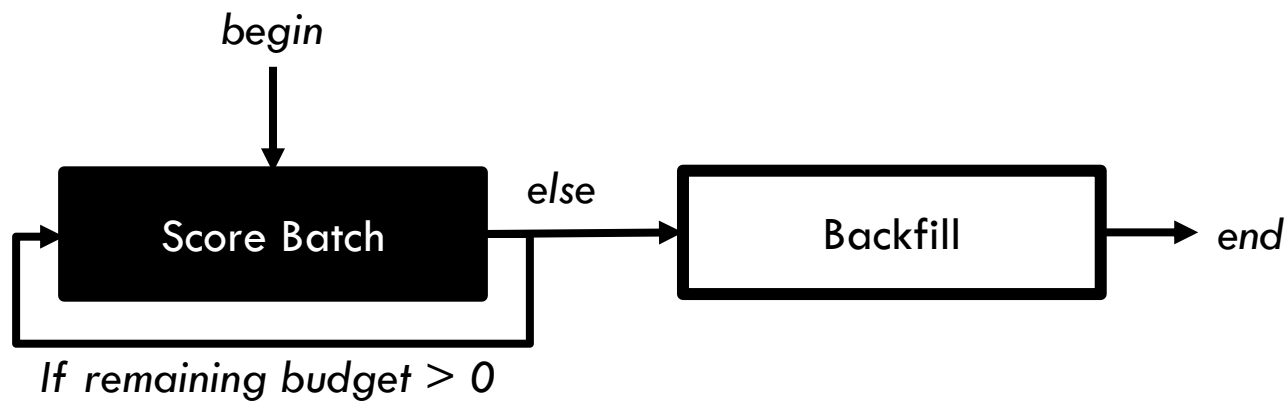


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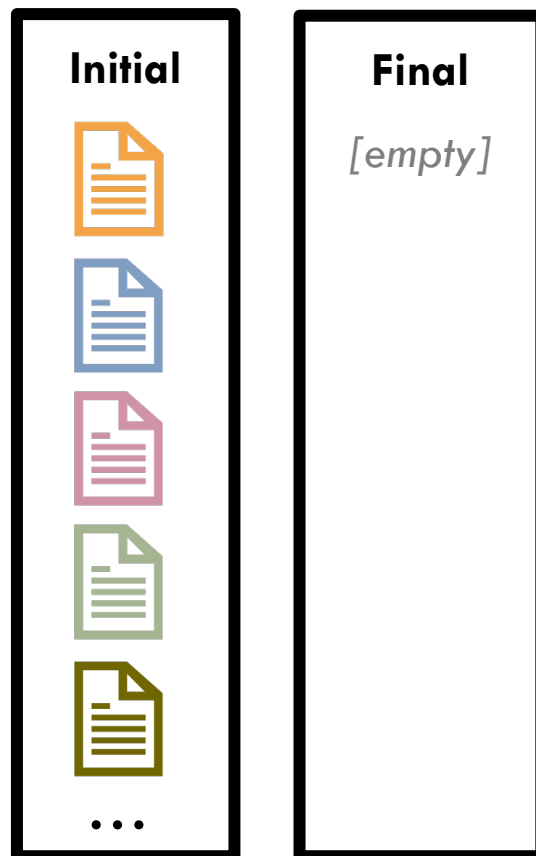
Remaining budget = 3



Traditional Re-Ranking



Environment:

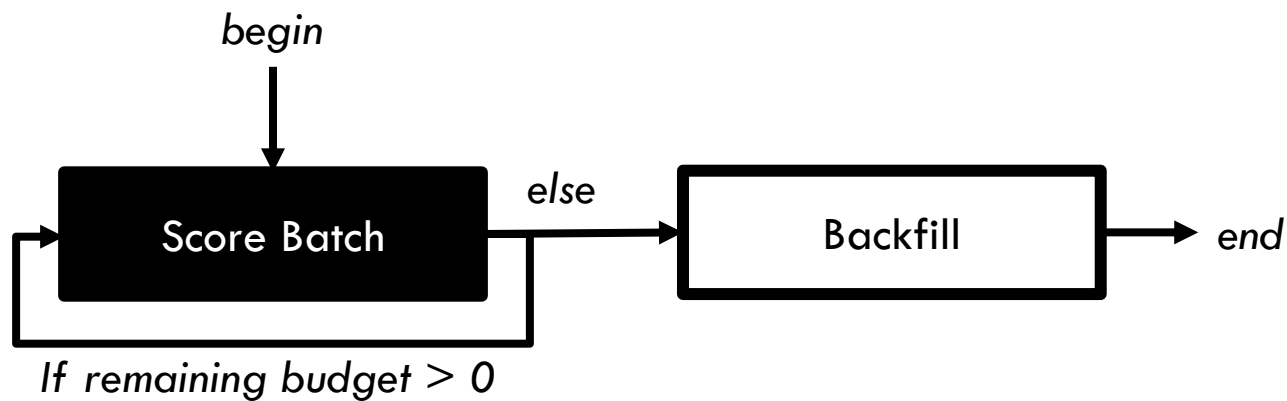


State:

Remaining budget = 3



Traditional Re-Ranking



Environment:

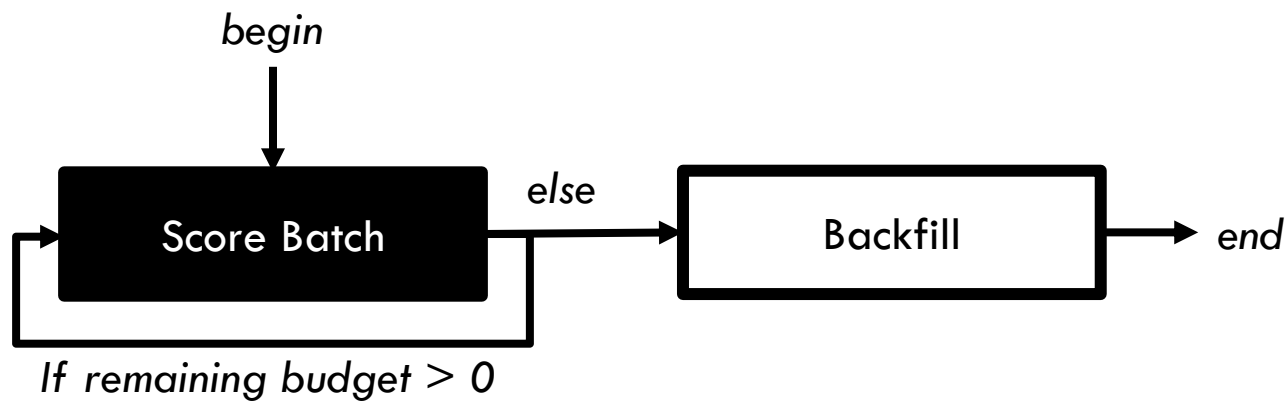


State:

Remaining budget = 2



Traditional Re-Ranking



Environment:

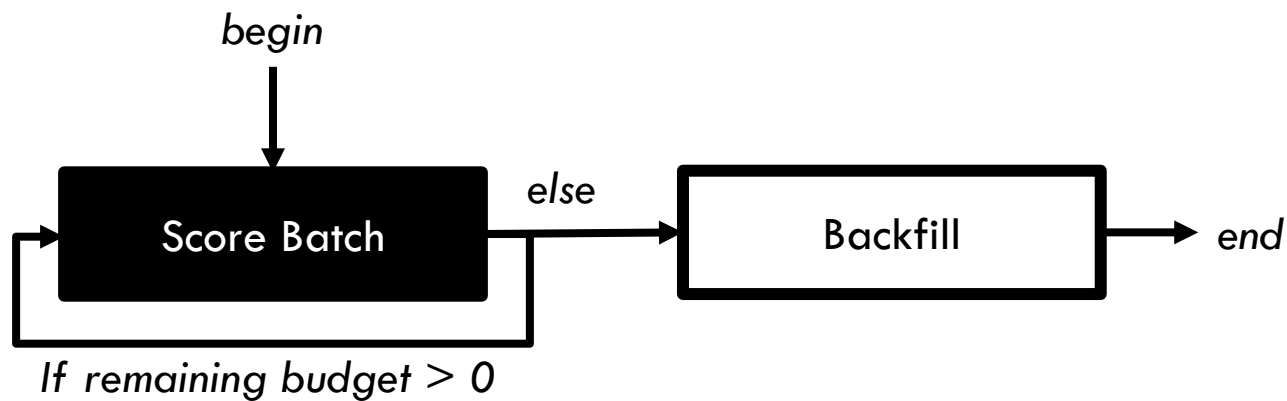


State:

Remaining budget = 1



Traditional Re-Ranking



Environment:

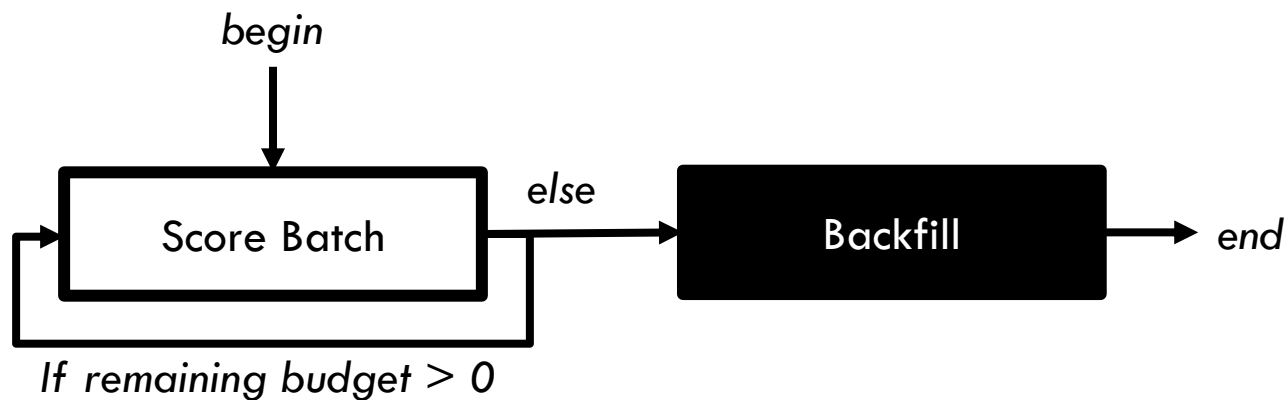


State:

Remaining budget = 0



Traditional Re-Ranking



Environment:





State:







Remaining budget = 0






This is similar to how a user might traverse search results.















 adaptive re-ranking 






About 2,210,000 results for "adaptive re-ranking"







Complementary Incremental Hashing With Query-Adaptive Re-Ranking for...
Xing Tian, Wing W. Y. Ng, Haibo Wang, S. Kwong ·
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




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But users may apply other strategies, too.



adaptive re-ranking

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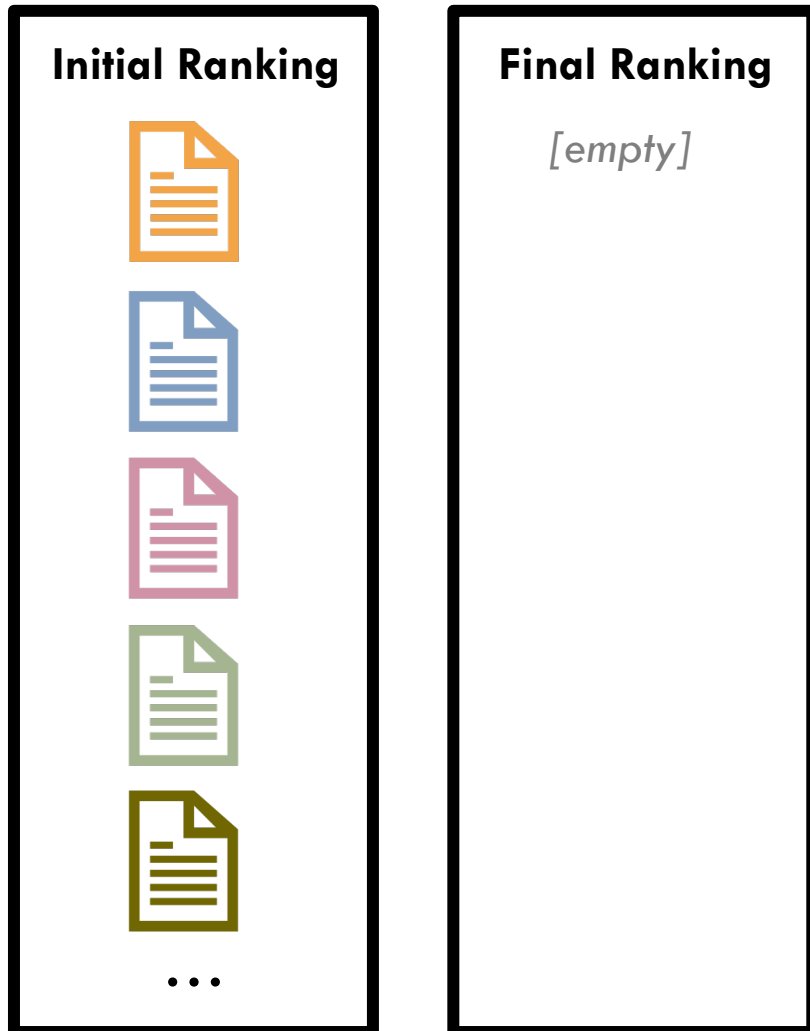
Semi-Supervised Boosting for Multi-Class Classification
Hamed Valizadegan, Rong Jin, Anil K. Jain
Computer Science · ECML/PKDD
2008
Most semi-supervised learning algorithms have been designed for binary classification, and are extended to multi-class c...
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Weighted multi-deep ranking supervised hashing for efficient image retrieval
Jiayong Li, Wing W. Y. Ng, Xing Tian, S. Kwong, Hui Wang
Computer Science · Int. J. Mach. Learn. Cybern.
2020
Deep hashing has proven to be efficient and effective for large-scale image retrieval due to the strong representation c...

Introducing the **find neighbours** action

Based on the Clustering Hypothesis: Relevant documents are often “close” to one another.

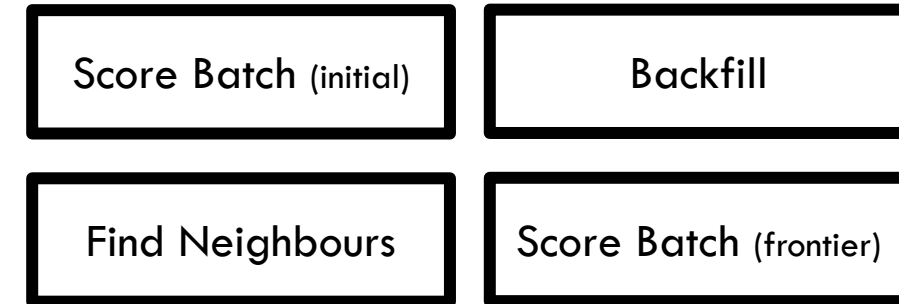
Environment:



Agent:

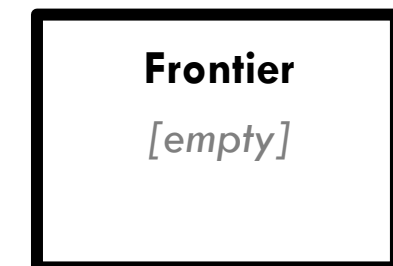


Actions:



State:

Remaining budget

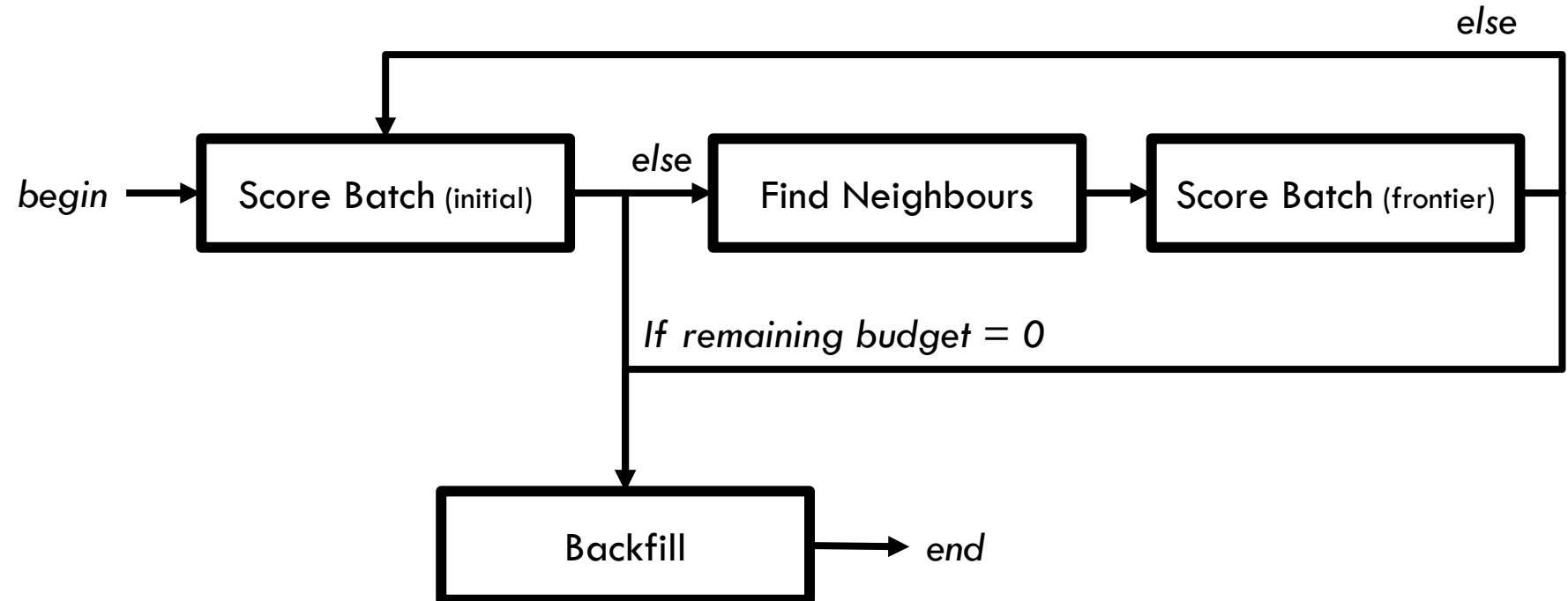




Adaptive Re-Ranking

ALTERNATE

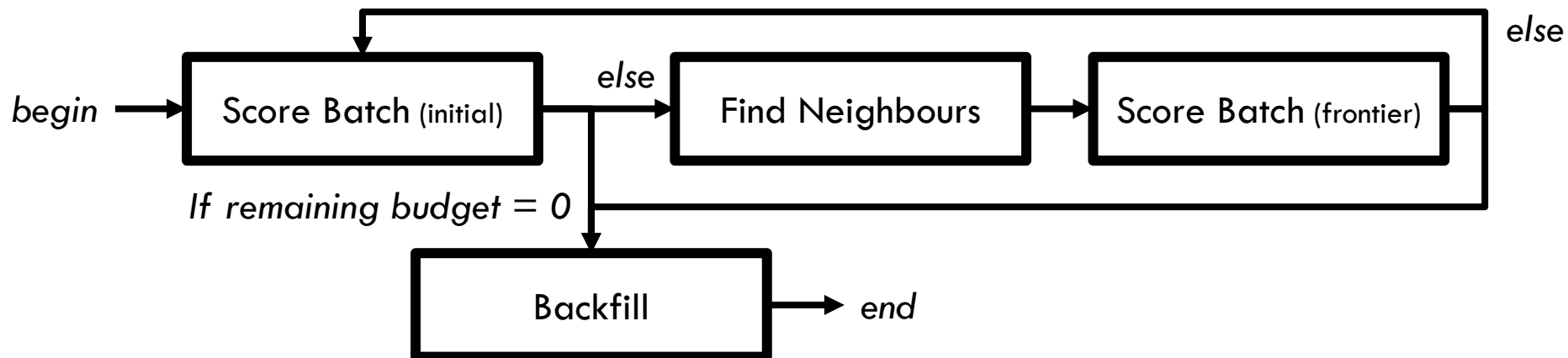
“Alternate” Strategy: Alternate between scoring from initial pool and neighbours. [cikm2022]



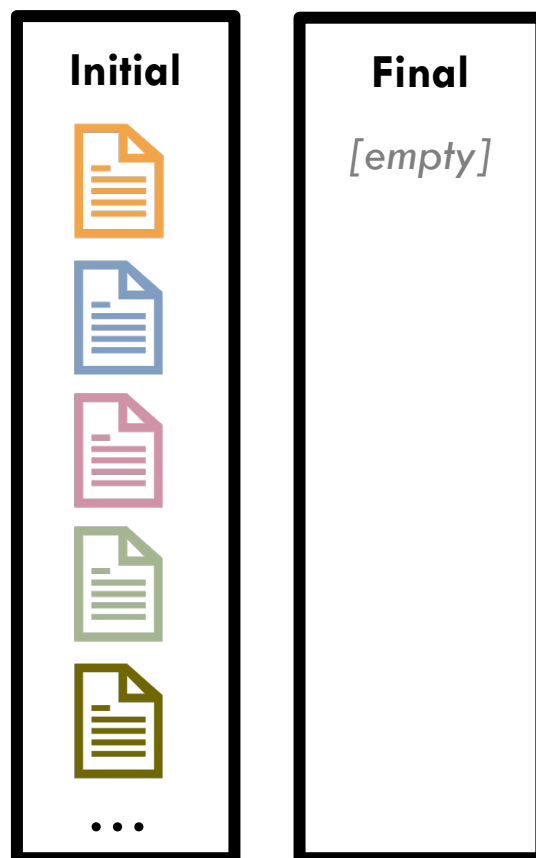


Adaptive Re-Ranking

ALTERNATE

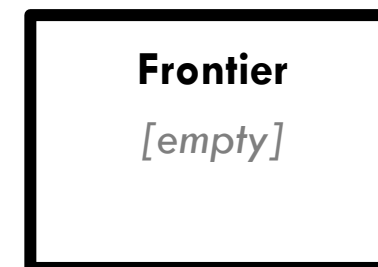


Environment:



State:

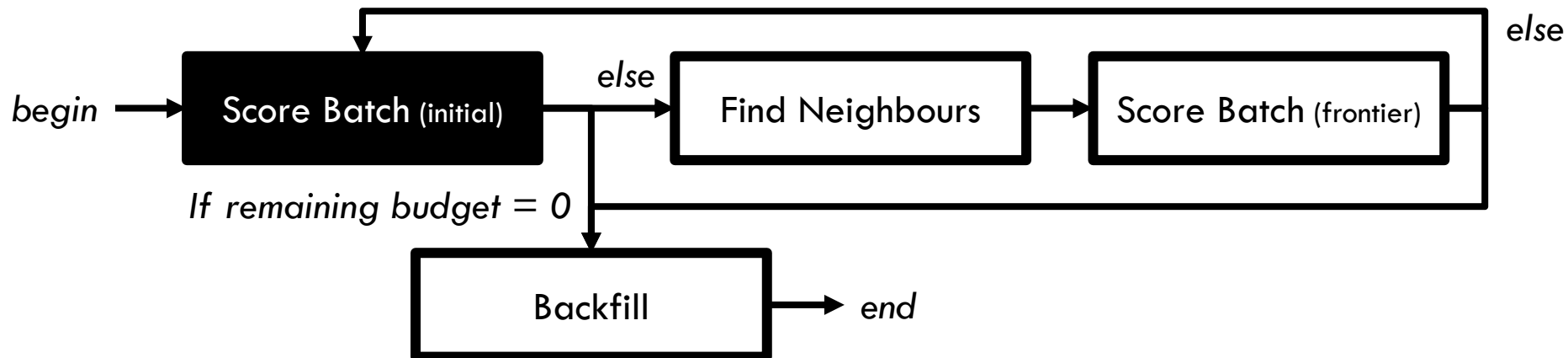
Remaining budget = 3





Adaptive Re-Ranking

ALTERNATE

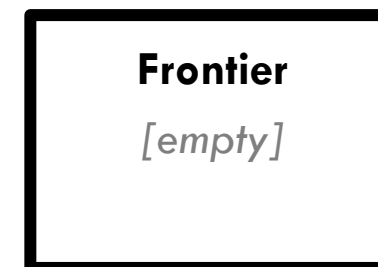


Environment:



State:

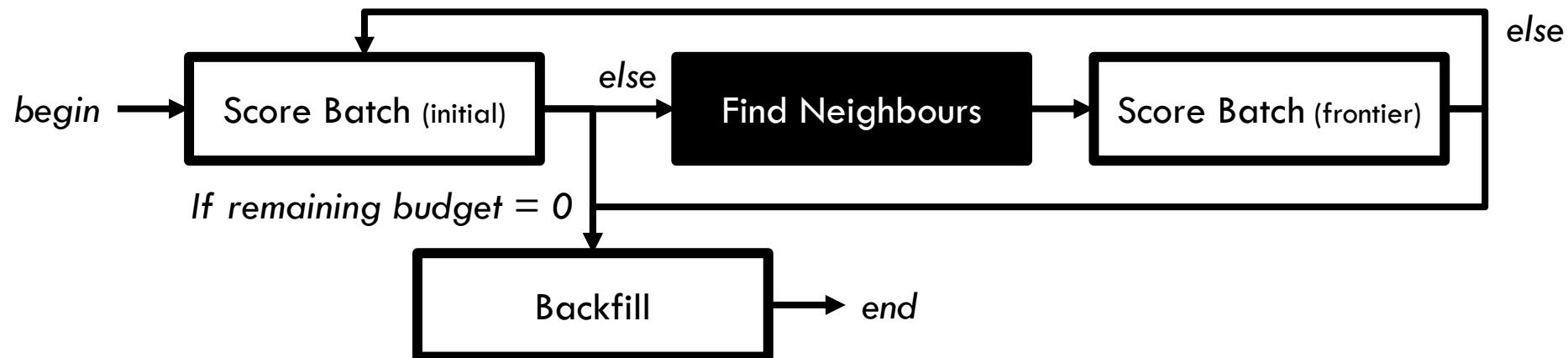
Remaining budget = 2





Adaptive Re-Ranking

ALTERNATE



Environment:



State:

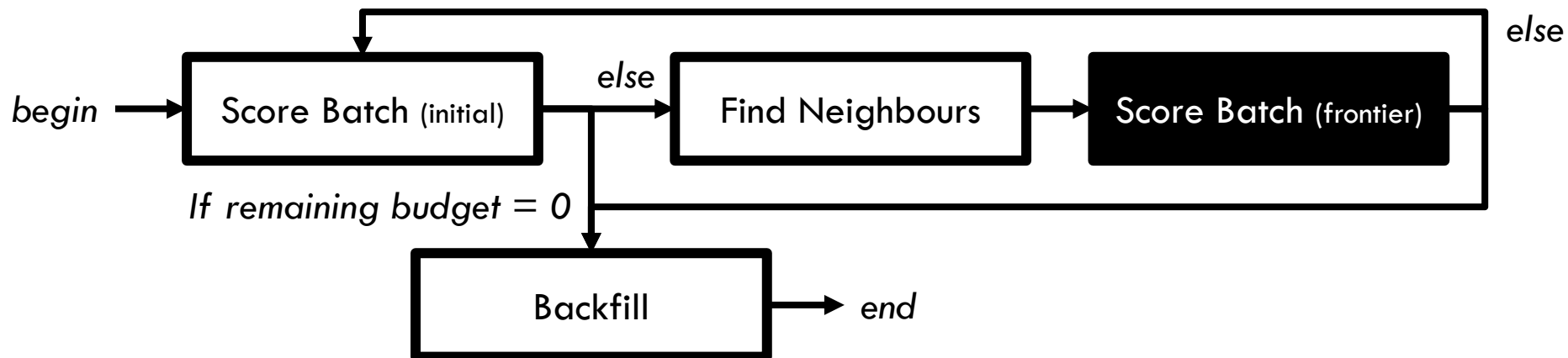
Remaining budget = 2





Adaptive Re-Ranking

ALTERNATE

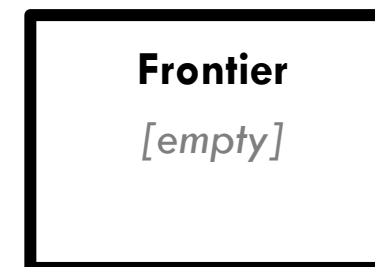


Environment:



State:

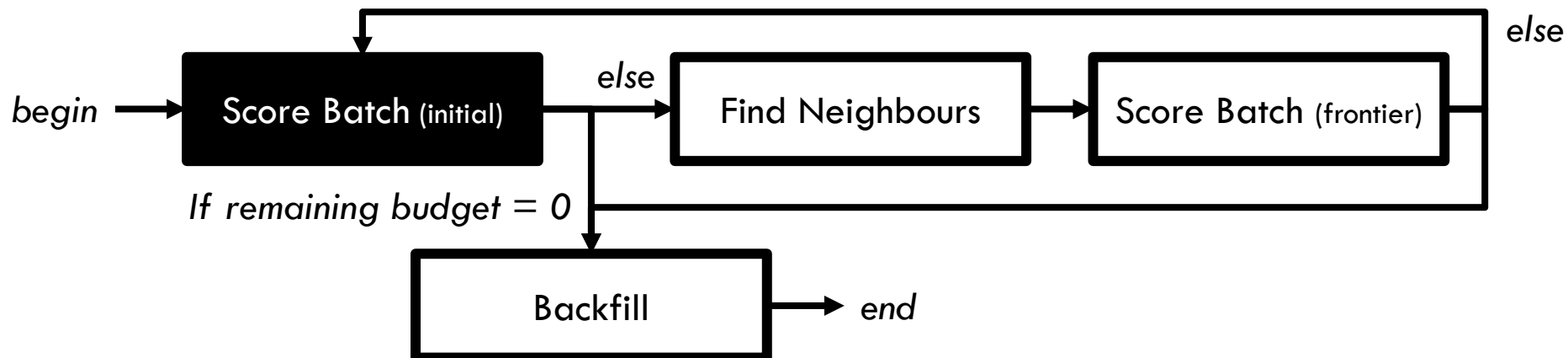
Remaining budget = 1





Adaptive Re-Ranking

ALTERNATE

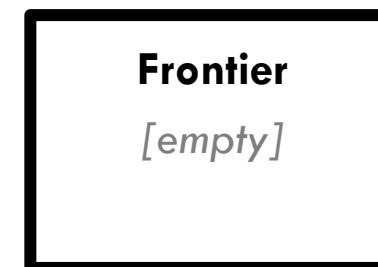


Environment:



State:

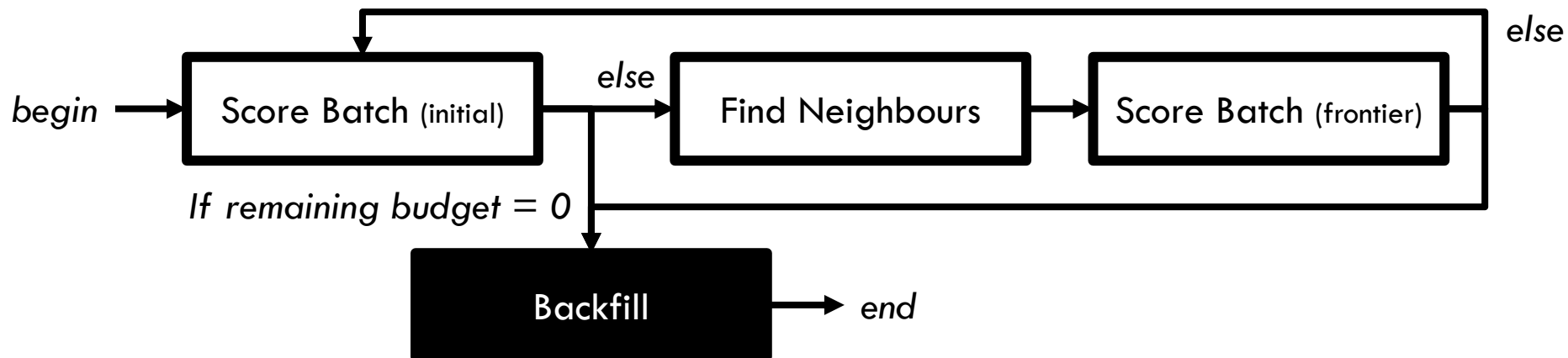
Remaining budget = 0



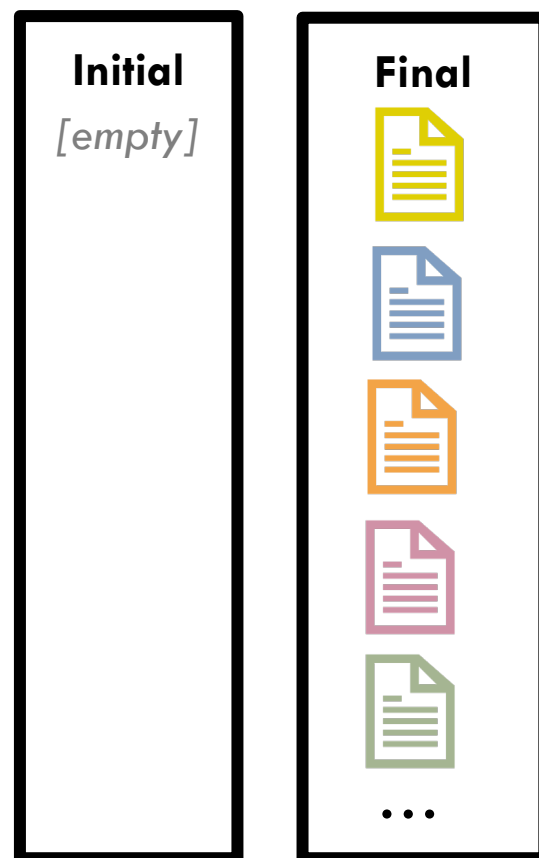


Adaptive Re-Ranking

ALTERNATE

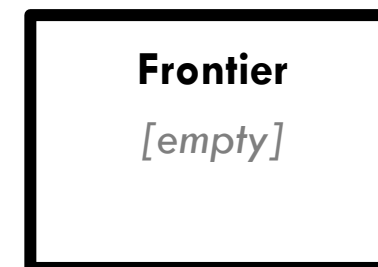


Environment:



State:

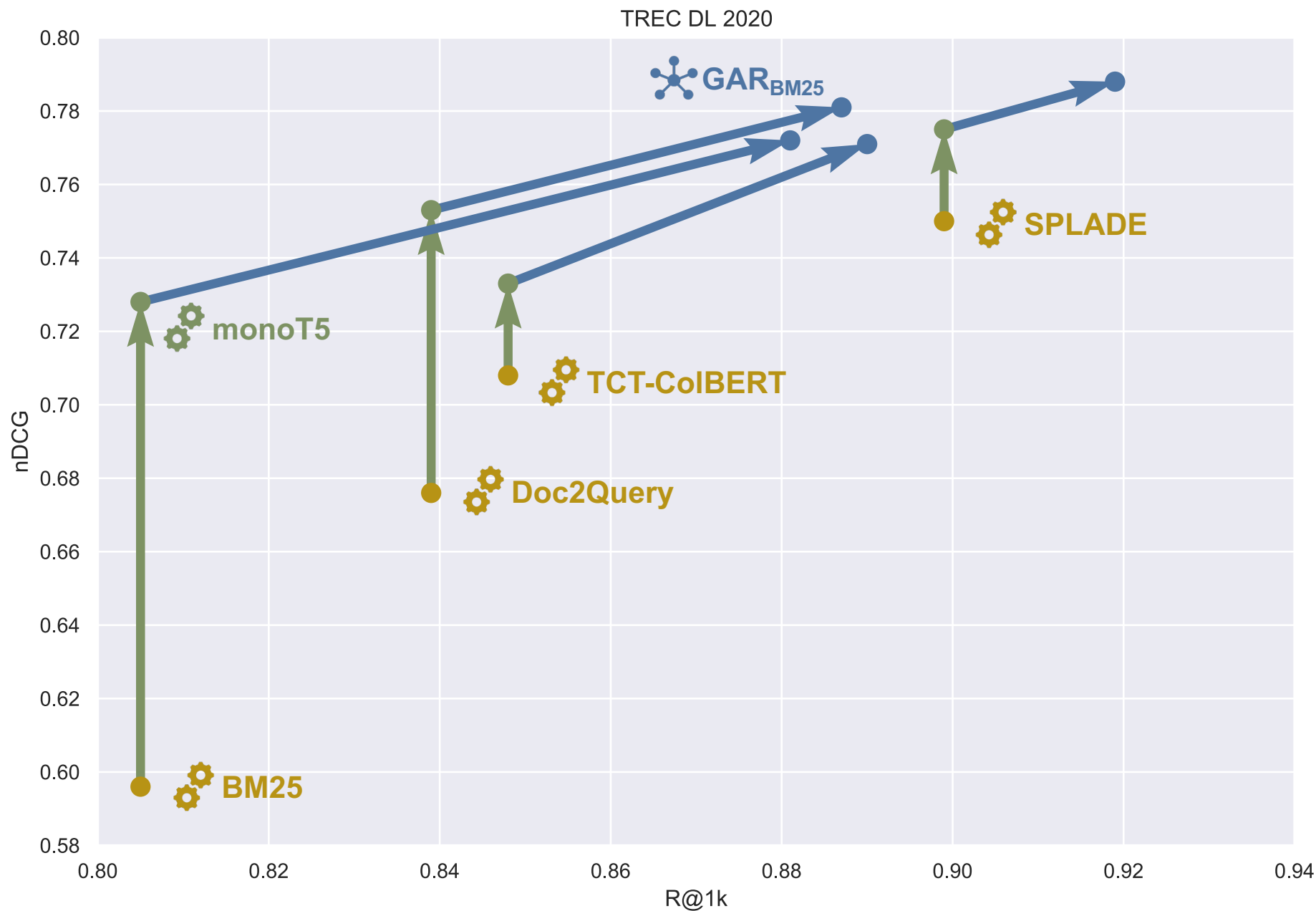
Remaining budget = 0





Adaptive Re-Ranking

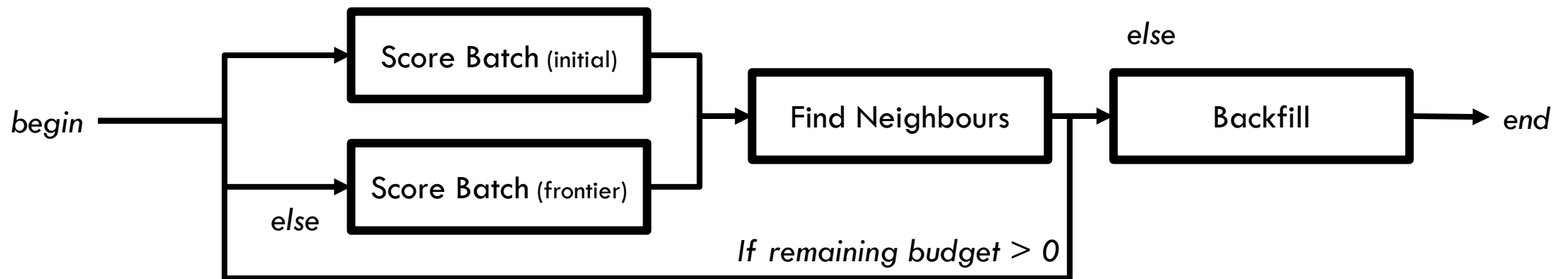
ALTERNATE



“Alternate” works, but there must be a smarter strategy, right?



If batch from initial will give more relevant documents than frontier



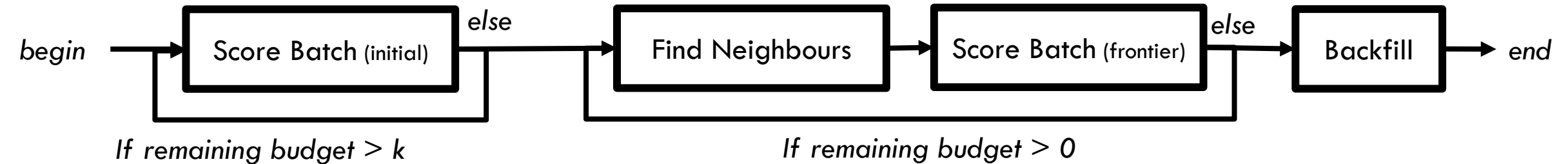
There's considerable room to improve upon Alternate.

Pipeline	Agent	TREC DL 2019 (dev)		TREC DL 2020 (test)	
		GAR_{bm25}	GAR_{tct}	GAR_{bm25}	GAR_{tct}
BM25»MonoT5	Non-Adaptive	0.699	0.699	0.711	0.711
	Alternate	0.726	0.743	0.743	0.749
	Oracle	0.747	0.786	0.748	0.768
TCT»MonoT5	Non-Adaptive	0.704	0.704	0.693	0.693
	Alternate	0.733	0.724	0.719	0.710
	Oracle	0.793	0.766	0.762	0.754
D2Q»MonoT5	Non-Adaptive	0.747	0.747	0.731	0.731
	Alternate	0.757	0.766	0.748	0.748
	Oracle	0.797	0.798	0.791	0.793
SPLADE»MonoT5	Non-Adaptive	0.737	0.737	0.731	0.731
	Alternate	0.745	0.737	0.737	0.734
	Oracle	0.807	0.783	0.777	0.781

nDCG

Two-Phase:

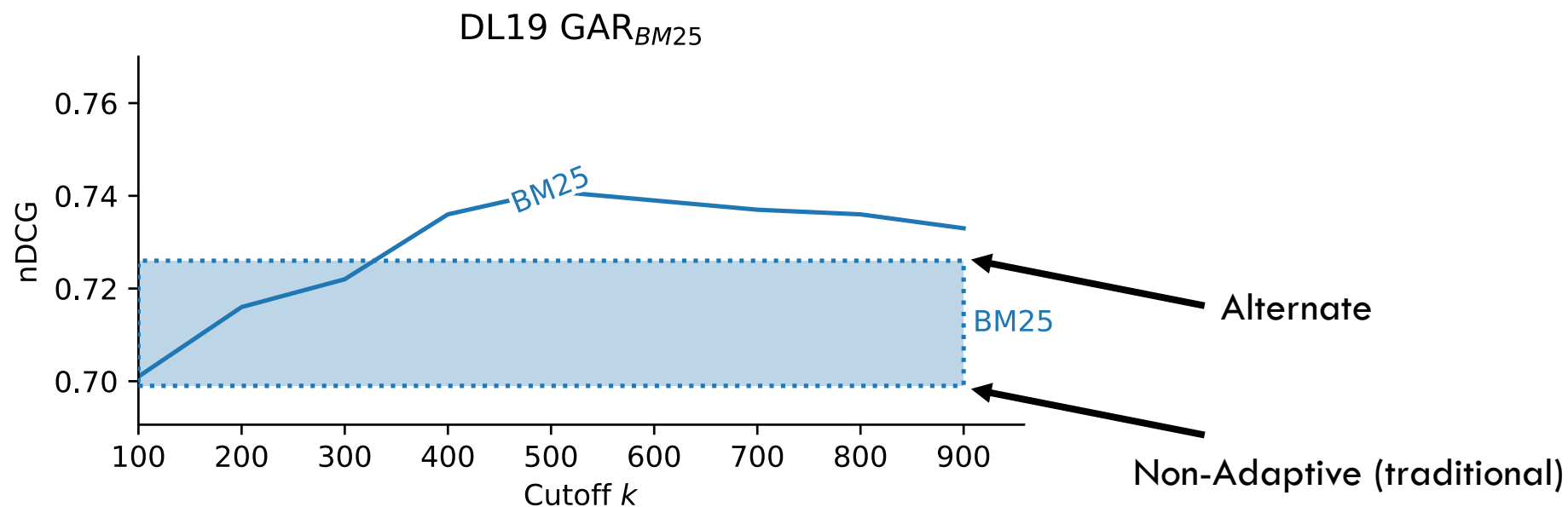
Spend k of your budget on the initial re-ranking upfront, then move to neighbours.





Adaptive Re-Ranking TWO-PHASE

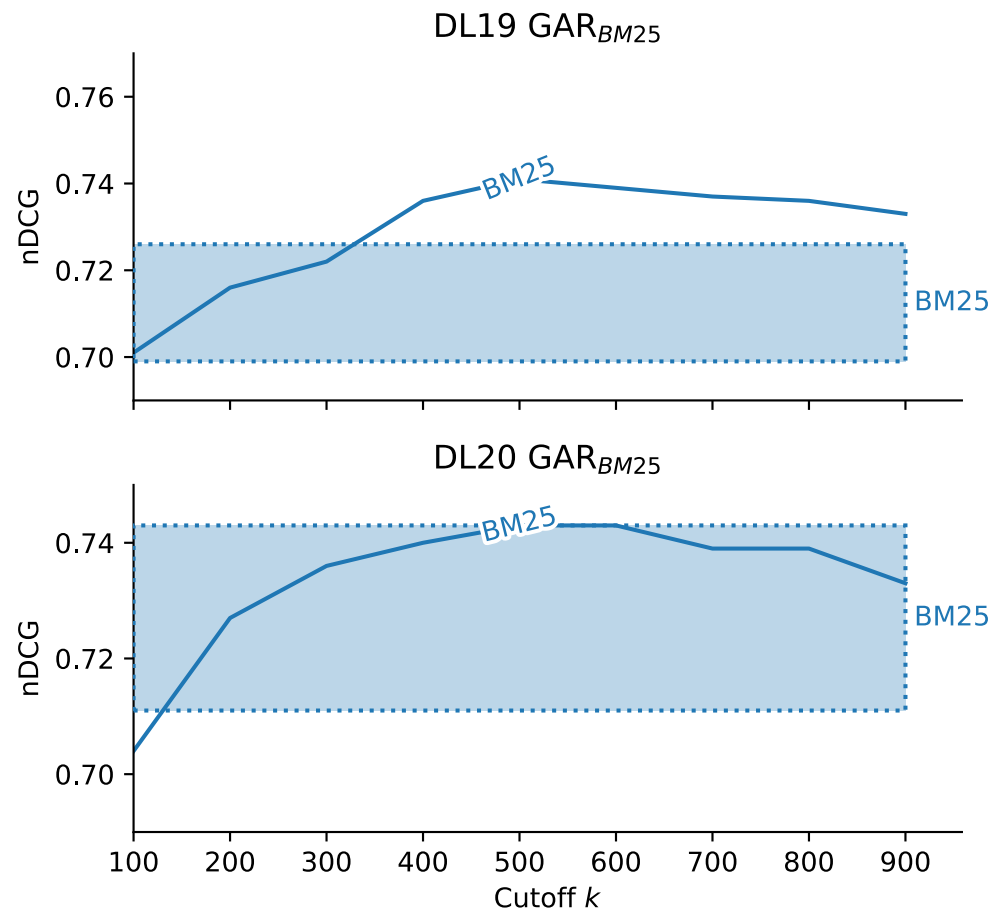
Can outperform Alternate... But not always.





Adaptive Re-Ranking TWO-PHASE

Can outperform Alternate... But not always.

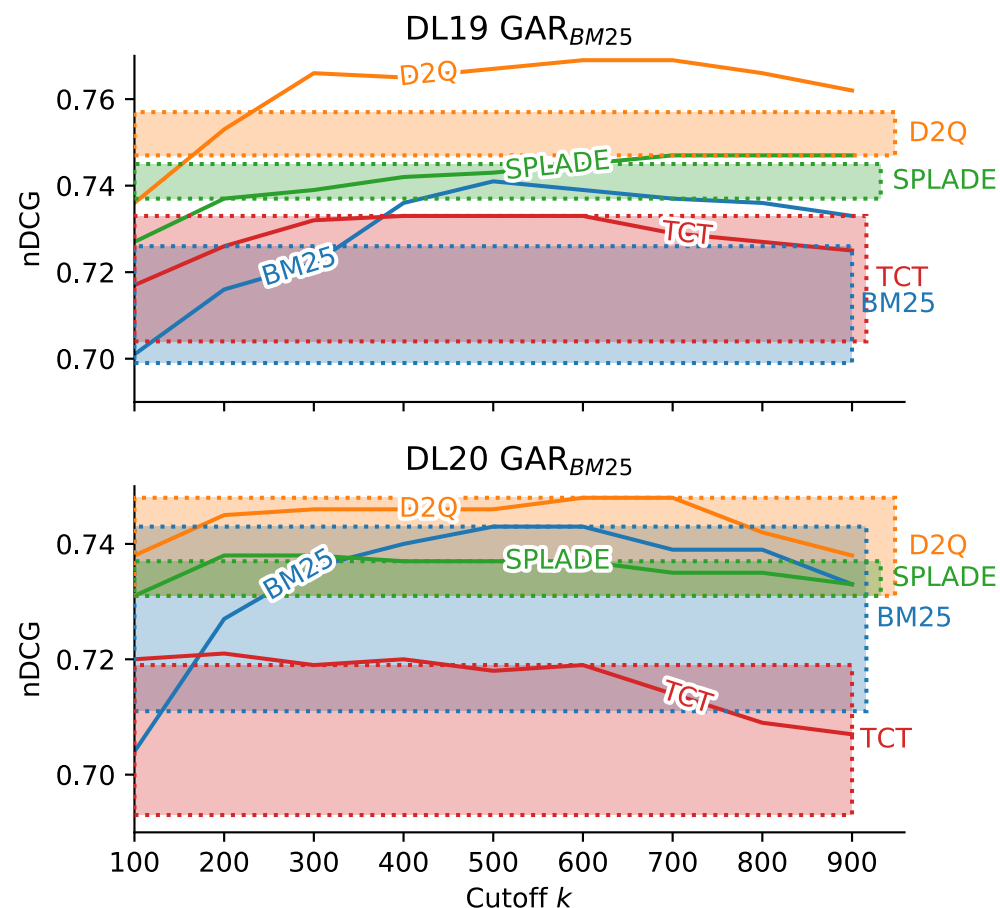




Adaptive Re-Ranking

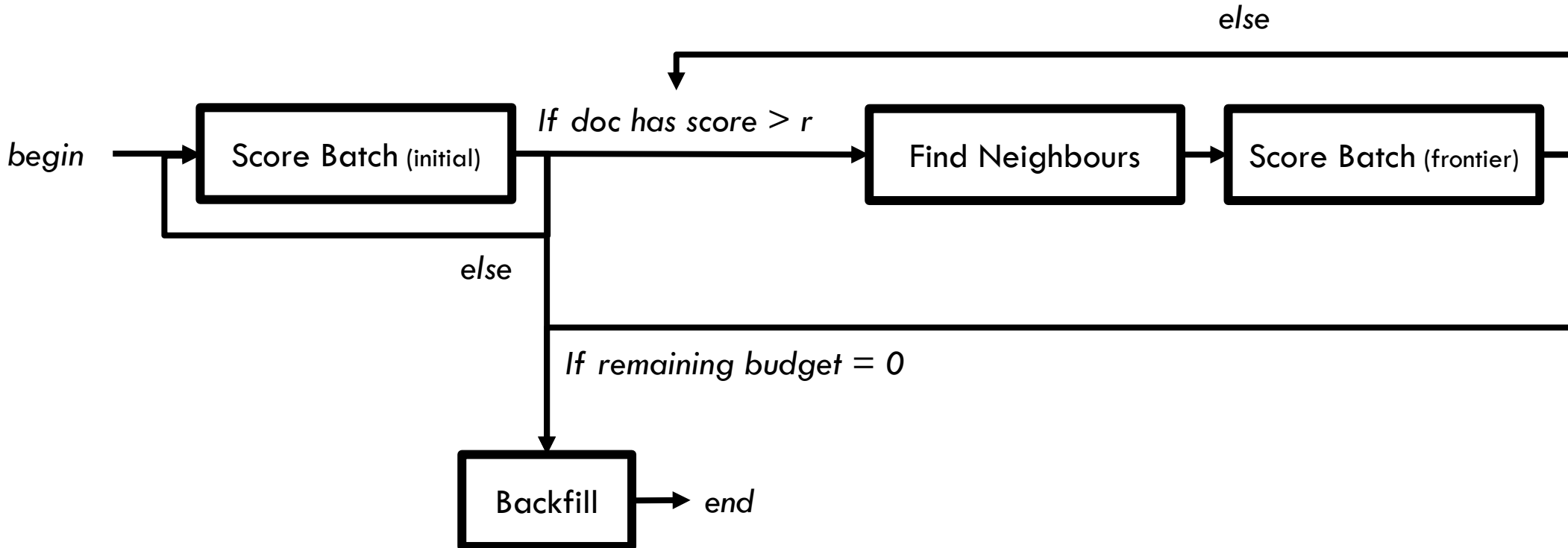
TWO-PHASE

Can outperform Alternate... But not always...
And is sensitive to k



Threshold:

Only explore neighbours of documents that meet relevance score threshold r .



But users may apply other strategies, too.



adaptive re-ranking

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Xing Tian, Wing W. Y. Ng, Haibo Wang, S. Kwong · Computer Science · IEEE Transactions on Multimedia · 8 May 2020
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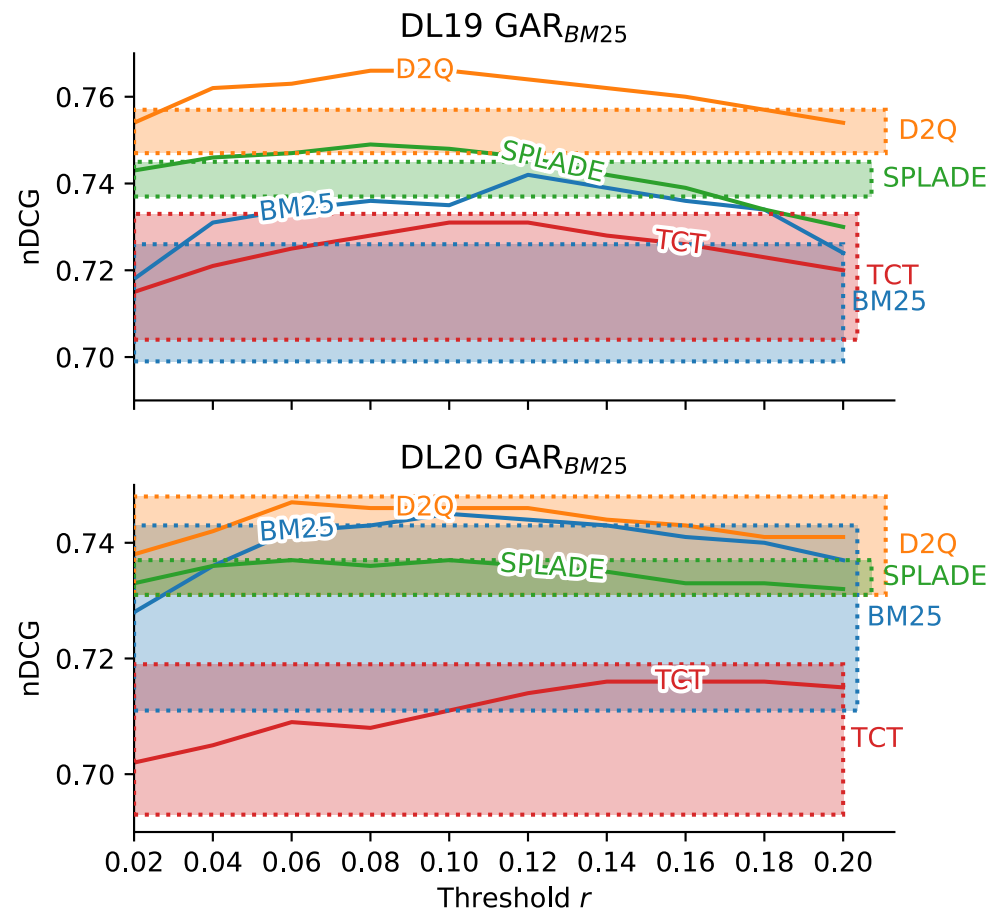
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Deep hashing has proven to be efficient and effective for large-scale image retrieval due to the strong representation c...





Adaptive Re-Ranking THRESHOLD

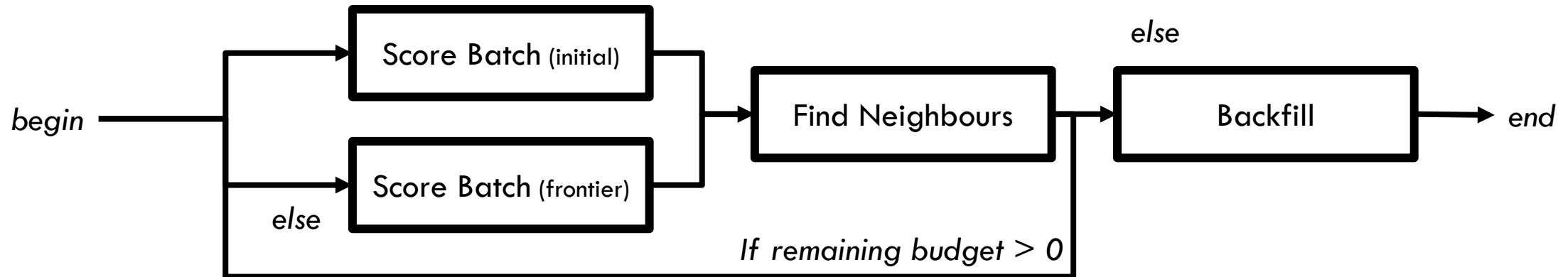
Can outperform Alternate... But not always...
And is sensitive to r



Greedy:

Score from initial ranking or frontier based on what gave the highest score recently.

If batch from initial gave higher score on most recent batch than frontier





Adaptive Re-Ranking GREEDY

Also no better than Alternate

Pipeline	Agent	TREC DL 2019 (dev)		TREC DL 2020 (test)	
		GAR_{bm25}	GAR_{tct}	GAR_{bm25}	GAR_{tct}
BM25»MonoT5	Non-Adaptive Oracle	0.699	0.699	0.711	0.711
		0.747	0.786	0.748	0.768
	Alternate	0.726	0.743	0.743	0.749
	TwoPhase	0.741	0.743	0.743	0.744
	Threshold	0.742	0.751	0.744	0.744
	Greedy	0.723	0.737	0.743	0.744
TCT»MonoT5	Non-Adaptive Oracle	0.704	0.704	0.693	0.693
		0.793	0.766	0.762	0.754
	Alternate	0.733	0.724	0.719	0.710
	TwoPhase	0.733	0.722	0.719	0.707
	Threshold	0.731	0.720	0.711	0.705
	Greedy	0.731	0.725	0.713	0.708
D2Q»MonoT5	Non-Adaptive Oracle	0.747	0.747	0.731	0.731
		0.797	0.798	0.791	0.793
	Alternate	0.757	0.766	0.748	0.748
	TwoPhase	0.769	0.767	0.748	0.747
	Threshold	0.766	0.767	0.746	0.745
	Greedy	0.754	0.757	0.744	0.748
SPLADE»MonoT5	Non-Adaptive Oracle	0.737	0.737	0.731	0.731
		0.807	0.783	0.777	0.781
	Alternate	0.745	0.737	0.737	0.734
	TwoPhase	0.769	0.764	0.748	0.736
	Threshold	0.766	0.759	0.746	0.744
	Greedy	0.747	0.740	0.734	0.734

Outlook



Let's make re-rankers smarter!



Moving beyond simply re-scoring an initial set of documents
Allowing re-rankers to pull in new relevant documents.



Simple heuristics are strong, but there's room to improve
Oracle results show considerable headroom.



Fertile ground: more actions, multiple initial rankings, etc.
Learning-to-re-rank? Learning to stop? Multi-armed bandits? Etc.

Code: https://github.com/terrierteam/pyterrier_adaptive

Adaptive Re-Ranking as an Information-Seeking Agent

- Building off CIKM 2022 proposal for “adaptive re-ranking”
- There is considerable room for improvement in pipelines by employing smarter agents
- The “Alternate” adaptive strategy is a remarkably strong baseline
- Sets the stage for work that learns a good strategy for re-ranking

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EPSRC grant EP/R018634/1: Closed-Loop Data Science
for Complex, Computationally- & Data-Intensive Analytics.