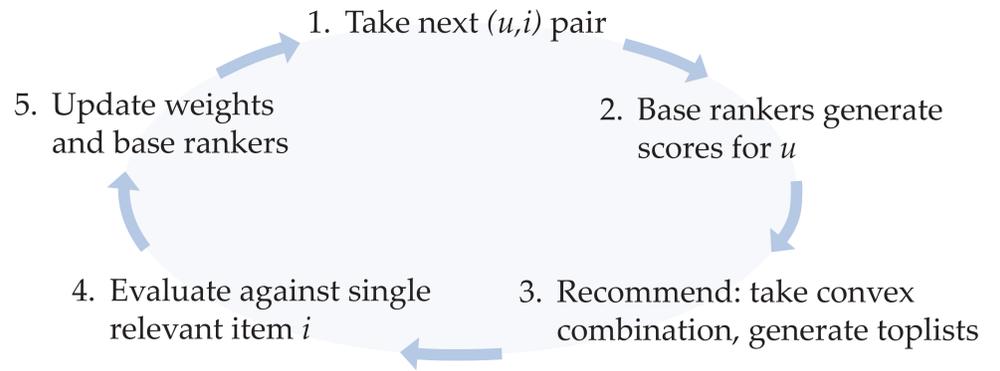
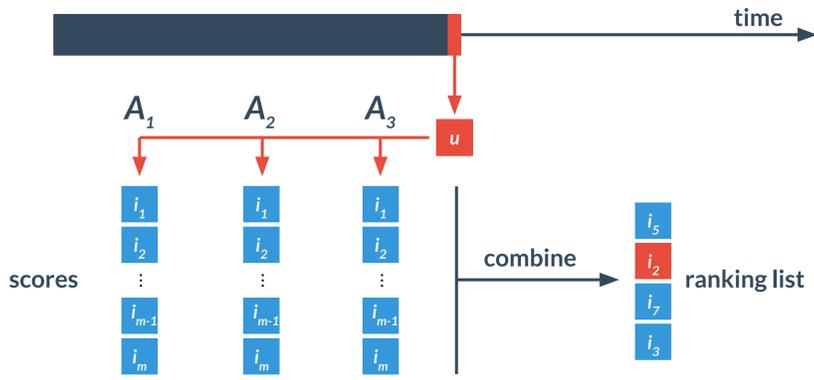


Online Ranking Combination

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PROBLEM: ONLINE RANKING COMBINATION WITH PREQUENTIAL EVALUATION



Objective: find combination weights

Idea: optimize the ranking evaluation function directly

Difficulty: function is not continuous

ALGORITHMS

ExpW

- Lay a grid Q over the weight space and apply exponentially weighted forecaster:

$$P(\text{select } \mathbf{q} \in Q \text{ in round } t) = \frac{e^{-\eta t \sum_{\tau=1}^{t-1} (1-r_{\tau}(\mathbf{q}))}}{\sum_{\mathbf{s} \in Q} e^{-\eta t \sum_{\tau=1}^{t-1} (1-r_{\tau}(\mathbf{s}))}}$$

- Theoretical guarantee for finding optimum with error $O(\sqrt{T})$
- Difficulty: $|Q|$ is exponential in the number of base rankers

SPSA

- Gradient approximation: $g_{ti} = \frac{r_t(\theta_t + c_t \Delta_t) - r_t(\theta_t - c_t \Delta_t)}{2c_t \Delta_{ti}}$
- Difficulty: hard to find appropriate perturbation step size

RSPSA

- Grad. of SPSA with fixed per-coordinate step sizes (RProp)
- Decrease step size if sign of gradient changes, increase otherwise (RProp)
- Difficulty: if the function is constant in one coordinate w.r.t. current step size, the step size keeps decreasing and the optimization process never escapes

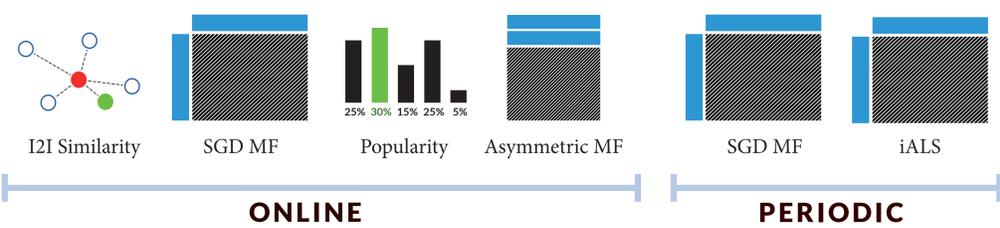
OUR SOLUTION: RFDSA+

- Finite differences instead of simultaneous perturbation (i.e. per-coordinate perturbation)
- Escape constant sections by detecting them and increasing step size

	item2item	OMF	Pop	OAMF	MF	IALS	ExpA	ExpAW	SGD	SPSA	RSPSA	RFDSA+
Amazon												
CD	0.03	0.04	0.06	0.03	0.01	0.00	0.06	0.06	0.06	0.07	0.06	0.09
Movies	0.04	0.04	0.07	0.03	0.01	0.01	0.07	0.07	0.07	0.07	0.07	0.09
Electro	0.02	0.02	0.03	0.02	0.01	0.01	0.03	0.03	0.04	0.03	0.04	0.05
MovieLens	0.14	0.14	0.09	0.17	0.01	0.01	0.17	0.17	0.16	0.17	0.14	0.19
Twitter	0.02	0.35	0.35	0.31	0.01	0.01	0.35	0.35	0.36	0.37	0.45	0.46

EXPERIMENTS

BASE RANKERS



BASELINES

SGD

- Optimize for MSE
- For positive item, target = 1
- Generate negative samples with target = 0

ExpA

- Exponentially weighted forecaster on the base rankers

ExpAW

- Use probabilities of the exponentially weighted forecaster as weights

RESULTS

- ExpW finds global optimum for two base rankers, but it scales exponentially in the number of base rankers
- RFDSA+ keeps up in case of more base rankers

