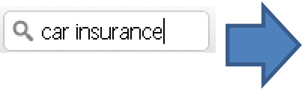
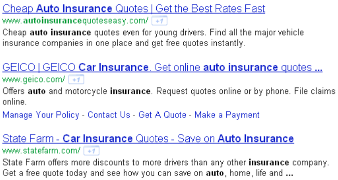
Online Submodular Set Cover, Ranking, and Repeated Active Learning

Online Ranking: At each round, the learner produces an ordered list of items, then suffers loss or receives reward. *Example: search result ranking*

Get search query



Display ranked results



In this paper, loss is:

the number of items needed to achieve some coverage objective

Example: The cost at each round is the number of pages the user needs to view to deduce the complete information they desire.

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Repeated Active Learning is an interesting special case where the list consists of questions to ask or tests to perform. *Example: diagnosis*

Visited by patient

Perform series of tests

Here a reasonable loss is the number of the tests we need to perform before we can make a accurate diagnosis.

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For these applications we propose a new online learning problem we call **online submodular set cover**.

- At round t we pick a sequence $S^t = v_1, v_2, \ldots v_n$.
- A monotone, submodular objective F^t is then revealed.
- We pay cost equal to the cover time of F^t: the minimum value $c \in \{1, 2, \ldots n\}$ such that $F^t(\bigcup_{i=1}^{c}\{v_i\}) \geq 1$.

Example: $F^t(S)$ is proportional to the number of candidate diseases eliminated by the set of tests S.

Related but not equivalent to online submodular maximization and online min-sum submodular set cover (Streeter and Golovin, 2008)

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Our results:

- A low-regret algorithm for online submodular set cover, building on a recent offline algorithm of Azar and Gamzu.
- Extensions to handle multiple objectives, partial information, context.
- Experimental results on synthetic data and a movie recommendation repeated active learning problem.