

## New Online Algorithms for Story Scheduling in Web Advertising

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We study storyboarding where advertisers wish to present sequences of ads (stories) uninterruptedly on a major ad position of a web page. These jobs/stories arrive online and are triggered by the browsing history of a user who at any time continues surfing with probability  $\beta$ . The goal of an ad server is to construct a schedule maximizing the expected reward. The problem was introduced by Dasgupta, Ghosh, Nazerzadeh and Raghavan (SODA'09) who presented a 7-competitive online algorithm. They also showed that no deterministic online strategy can achieve a competitiveness smaller than 2, for general  $\beta$ .

We present improved algorithms for storyboarding. First we give a simple online strategy that achieves a competitive ratio of  $4/(2-\beta)$ , which is upper bounded by 4 for any  $\beta$ . The algorithm is also  $1/(1-\beta)$ -competitive, which gives better bounds for small  $\beta$ . As the main result of this paper we devise a refined algorithm that attains a competitive ratio of  $c=1+\phi$ , where  $\phi=(1+\sqrt{5})/2$  is the Golden Ratio. This performance guarantee of  $c\approx 2.618$  is close to the lower bound of

2. Additionally, we study for the first time a problem extension where stories may be presented simultaneously on several ad positions of a web page. For this parallel setting we provide an algorithm whose competitive ratio is upper bounded by  $1/(3-2\sqrt{2})\approx 5.828$ , for any  $\beta$ .

All our algorithms work in phases and have to make scheduling decisions only every once in a while.