

RISK-AWARE REVENUE MAXIMIZATION IN DISPLAY ADVERTISING

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Display advertising is the graphical advertising on the World Wide Web (WWW) that appears next to content on web pages, instant messaging (IM) applications, email, etc. Over the past decade, display ads have evolved from simple banner and pop-up ads to include various combinations of text, images, audio, video, and animations. As a market segment, display continues to show substantial growth potential, as evidenced by companies such as Microsoft, Yahoo, and Google actively vying for market share. As a sales process, display ads are typically sold in packages, the result of negotiations between sales and advertising agents.

A key component to any successful business model in display advertising is sound pricing. Main objectives for on-line publishers (e.g. Amazon, YouTube, CNN) are maximizing revenue while managing their available inventory appropriately, and pricing must reflect these considerations.

This paper addresses the problem of maximizing revenue by adjusting prices of display inventory. We cast this as an inventory allocation problem. Our formal objective (a) maximizes expected revenue using (b) iterative price adjustments in the direction of the gradient of an appropriately constructed Lagrangian relaxation. We show that our optimization approach drives the revenue towards local maximum under *mild* conditions on the properties of the (unknown) demand curve.

The major unknown for optimizing revenue in display environment is how the demand for display ads changes to prices, the classical demand curve. This we address directly, by way of a factorial pricing experiment. This enables us to estimate the gradient of the revenue function with respect to inventory prices. Overall, the result is a principled, risk-aware, and empirically efficient methodology.