



Dynamic Bidding for Sponsored Products

Value-Based Bid Scaling with Per-SKU Normalization

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Static CPC Inefficiencies

Context Blindness

Many e-commerce auctions typically rely on **static, campaign-level default bids** configured by suppliers.

These flat bids completely ignore real-time context: user intent, time of day, device, and placement quality variations across sessions.

Value Misalignment

Fixed CPC bids treat all clicks as having equal value, but actual conversion rates differ widely.

This structure misallocates spending. Advertisers cannot bid directly for actual **sales value**, only for clicks, lowering their overall ROAS.

Optimization Objective

$$\begin{aligned} \max_b \quad & \sum_{j \in \mathcal{J}_i} \sum_{a \in W} x_{i,j,a}(b) v_{i,j,a} \\ \text{s.t.} \quad & \frac{\sum_{a \in W} x_{i,j,a}(b) c_{i,j,a}(b)}{\sum_{a \in W} x_{i,j,a}(b)} = b_{ij}^0, \quad \forall j \in \mathcal{J}_i \end{aligned}$$

where x represents a binary click outcome, v represents the value of a product to the supplier, c , the cost per click, and b^0 , the default supplier bid.

Supplier-Preserving Optimization

We formulate dynamic bidding as a constrained optimization problem.

The goal is to maximize conversions while ensuring expected actual CPC matches the advertiser's intent.

$$V_{i,j,a} = \pi_j \cdot \hat{p}_{i,j,a}$$

Where π represents estimated supplier product value and $\hat{p}$ is the post-click conversion probability.

The Scaling Rule & Bid Multiplier

-  **Lagrangian Approximations:** Structured dynamically based on primal-dual updates. Yields scaling factor λ .
-  **Value Terms Cancel out:** Because supplier intent π is fixed, it cancels out of numerator and denominator.
-  **Clipped Constraints:** Safety bounds restrict excessive bid modifications while preserving supplier trust regions.

pCVR Ratio

DRIVING THE MULTIPLIER

$$b_{i,j,a} = b_{i,j}^0 \cdot \text{clip}\left(\frac{\hat{p}_{i,j,a}}{\bar{p}_{i,j}^{(w)}}, \alpha_{\min}, \alpha_{\max}\right)$$

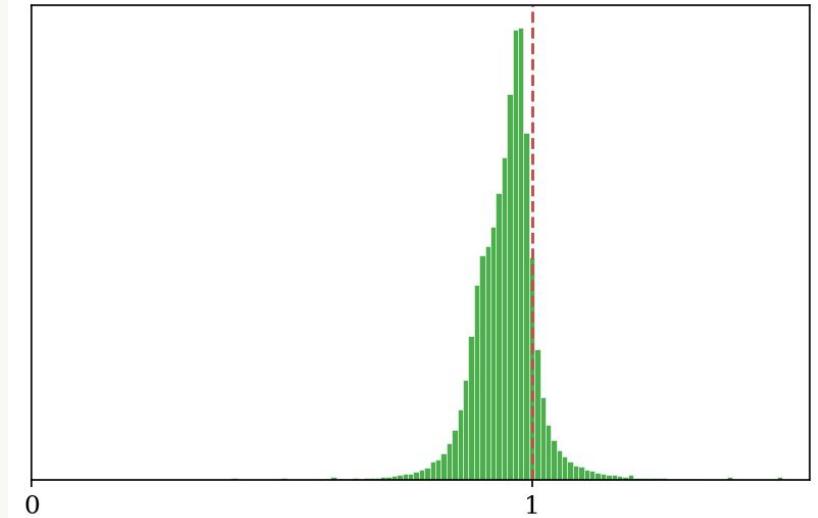
Granular Campaign-SKU Anchor

Preventing Cross-SKU Leakage

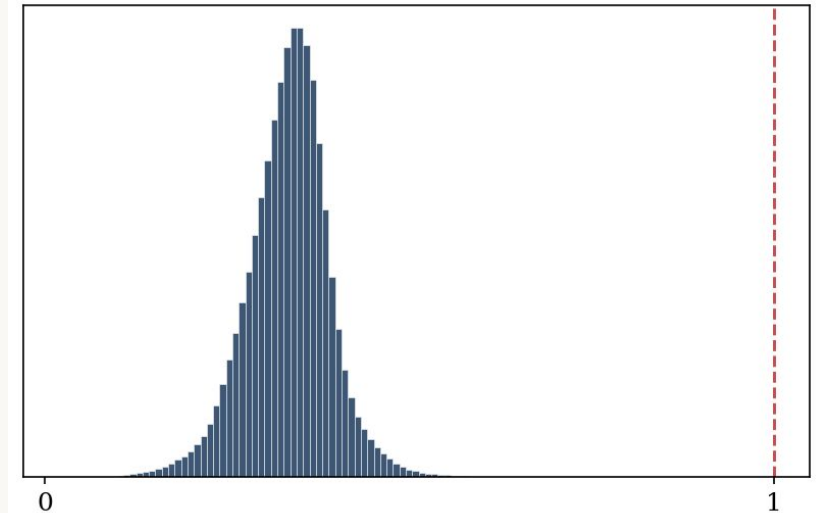
Normalization **must match the granularity** of the advertiser's default bid expression (the SKU-level).

- ✗ **Coarser baselines (Campaign/Global):** Blends high-CVR & low-CVR items together. Distorts bid structures causing severe budget leaks across items.
- ✓ **Campaign-SKU base:** Restricts average baseline directly to each SKU. Restores a pure contextual correction without shifting organic class-level spending. Accommodates inter-surface CVR differences implicitly.

Normalized Bid Multiplier Distribution



$p(\text{CVR} \mid \text{click})$ Bid Multiplier Distribution



Production System Architecture

1. Upstream Alignment

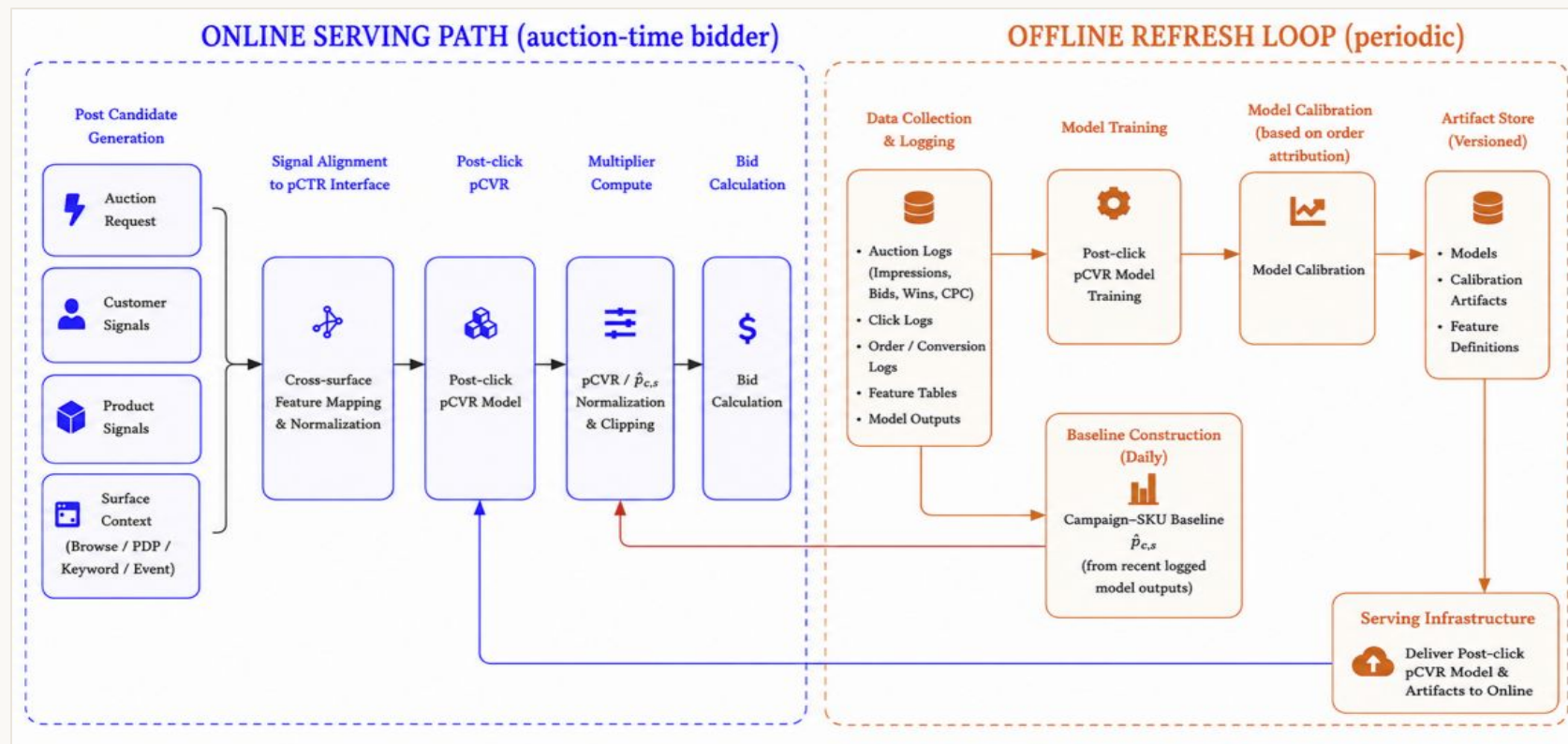
Calibrates page-specific and surface-specific raw model click scores onto a unified probabilistically shared pCTR scale.

2. Post-Click CVR

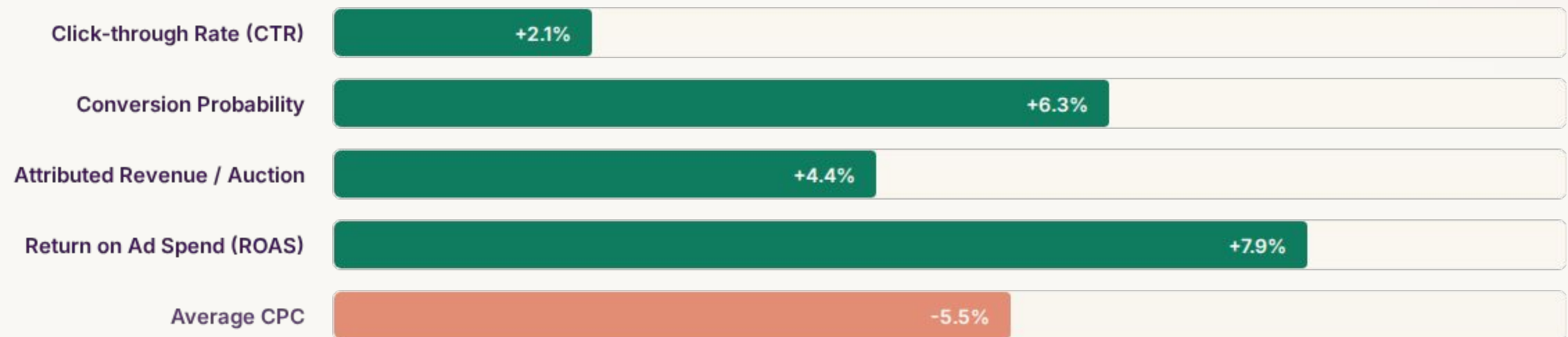
Leverages gradient-boosted decision trees over logged clicks, orders, and context to predict accurate conditional probabilities.

3. Real-Time Bidder

Thin and highly latency-optimized online execution layer. Keeps end-to-end P99 serving times below 40 ms.



Shadow Test Evaluation



Relative performance lift compared against the static-bid control over a 2-week mirrored production traffic evaluation.

Online A/B Test (Browse Grid)

Primary Metric	Relative Performance Lift	Statistical Significance
Ads-Attributed Orders / Click	+3.84%	Significant (p < 0.05)
Click-Through Rate (CTR)	+0.87%	Significant (p < 0.05)
Cost Per Click (CPC)	+2.34%	Significant (p < 0.05)
Return on Ad Spend (ROAS)	+1.28%	Neutral / n.s.
Customer Conversion Rate (Guardrail)	-0.07%	Neutral / n.s. (Goal Met)

Placement Expansion Performance

Ad Placement Type	Lift in Attributed Orders/Click	Statistical Significance
Overall (All Placements)	+1.16%	Significant (p < 0.05)
Product Carousel	+3.77%	Significant (p < 0.05)
Browse Grid	+1.32%	Significant (p < 0.05)
Keyword Search	+1.48%	Directional / n.s.
Customer CVR (Guardrail)	+0.02%	Neutral / n.s. (Goal Met)



Questions & Answers

Dynamic Bidding for Sponsored Products

Backup Slides Available for Technical Reference

Mitigating Sparse History (Q&A)

Global Fallback Anchor

New or low-frequency campaign-SKU pairings naturally lack robust historic baseline counts over typical 7-day windows.

We apply a **fallback to global historical averages** calculated dynamically across same-window pairs, preventing denominator instability.

Future: Hierarchical Backoff

Rather than jumping directly from SKU to global average, we are building a hierarchical backoff structure.

The pipeline will fallback gracefully from **SKU** → **Campaign-category** → **Supplier-category** → **Global** to retain structured priors.

| Multi-Surface Calibration (Q&A)

-  **Heterogeneous Inputs:** Different pages and formats (browse vs product detail carousels) use completely distinct upstream features and formats.
-  **Decoupled CTR Interface:** Page-specific scores are mapped locally using isotonic regression into actual calibrated click probabilities (pCTR) before bidding consumption.
-  **Reusable Bidder:** Isolating raw page scoring models from the downstream bidder keeps core bidding logic independent of upstream surface model choices.

Ranker & GSP Integration (Q&A)

Decoupling Bidder and Ranker

The calculated dynamic bid is processed downstream by the existing valuation-aware marketplace ranker.

The ranker evaluates the bid alongside organic Relevance Constraints and Platform Profit metrics to determine layout slots.

PAE Metric

PROFIT-AWARE VALUATION

$$PAE_j = b_{i,j,a} \times pClick_{j,a} + A \times pCVR \times Value^k + B \times pCVR$$