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Statistics Department

Auctioning Experts in Credit Modeling

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Opportunities

- Anticipate default
  - Who are most likely to default in the near future?
- Detect fraudulent applications
  - Which loan applications are made up?
- Segment corporate bond market
  - Which companies are most risky?
- Other domains…
  - Employee evaluation: Who should we hire?
  - Disease prognosis: Who are most at risk?
  - Document classification: Can you find one like this?

Similarities

Different contexts, but common characteristics…

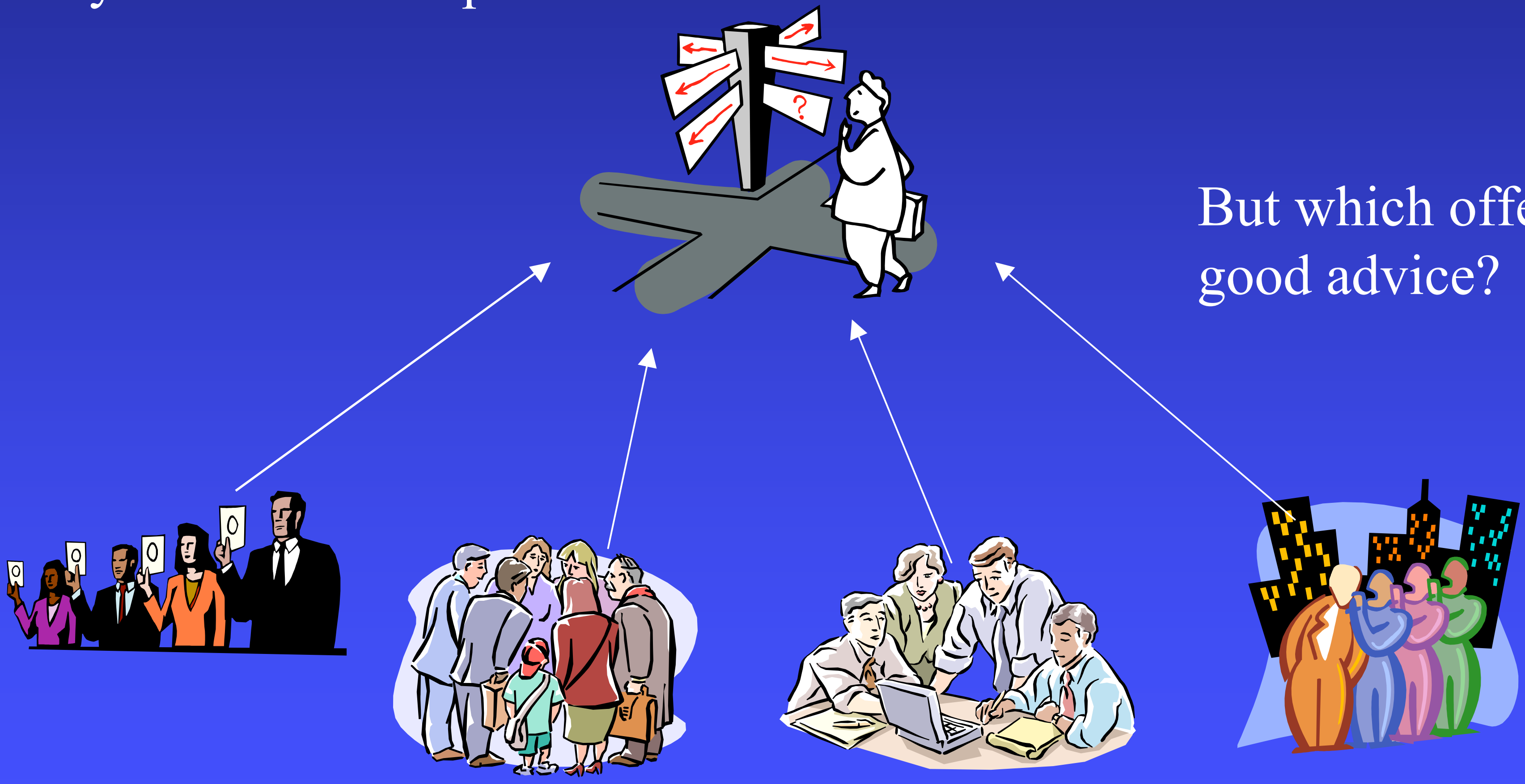
- Rare events
  - Few cases dominate costs.
  - Millions of accounts, thousands of defaults.
- Synergies
  - Linear models find little. Interactions work.
  - Many combinations seem plausible.
- Wide data: more features than cases
  - Interactions, transformations, categories, missing data…
  - Too many to find the best at each stage.

Common Objective

- Regardless of the context
  - Credit default
  - Detecting fraudulent loan applications
  - Segmenting corporate bond market
- Pragmatic goal remains *prediction*.
- Best model generates highest revenue
  - Asymmetry of costs, presence of rare events
- Many schemes for building a predictive model
  - Algorithms, features, criteria…

Which model to use?

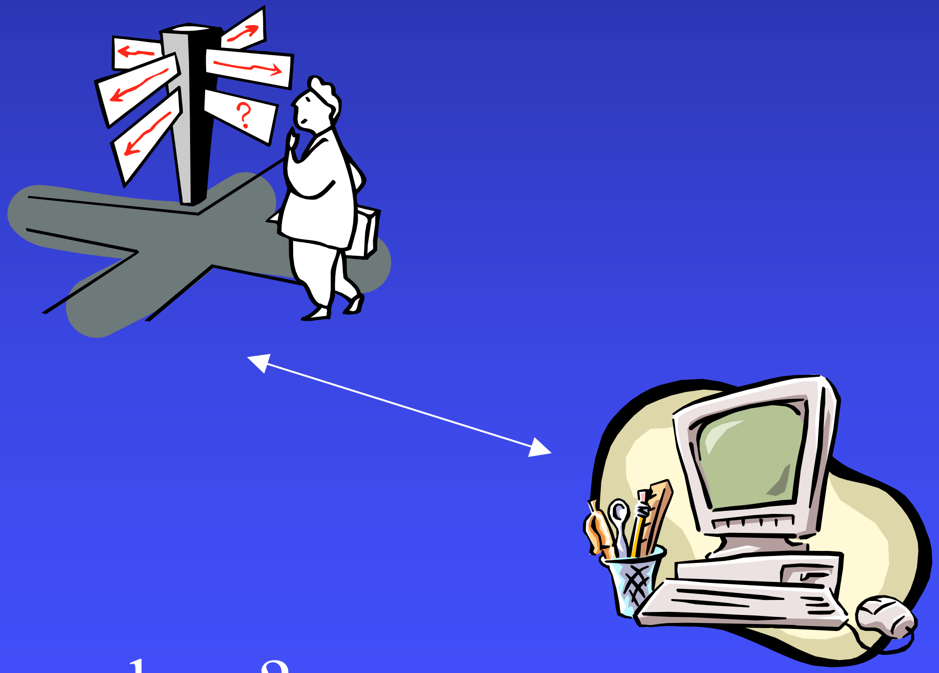
Every domain has experts…



But which offer good advice?

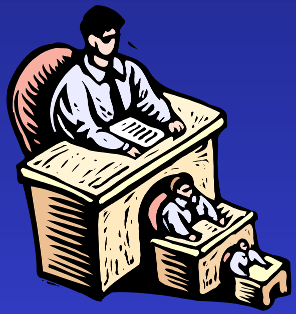
Automated Methods

- Expense of custom modeling hard to justify
- Automate process
  - Higher productivity
  - “Objective”
  - “Rigorous”
  - Convenient



- But what about expert know-how?
  - Is the loss of their insight worthwhile?

Comparison



Substantive

Pick model "by hand"

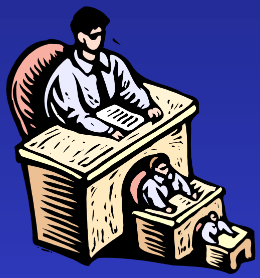
- Advantages
  - Leverage domain knowledge
  - Can "interpret" for regulator
- Disadvantages
  - Did we miss something?
  - Time consuming to
    - Construct
    - Maintain

Automatic

Computer search

- Advantages
  - Scans entire data warehouse
  - Hands-off, fast
    - Construction
    - Maintenance
- Disadvantages
  - Lost domain expertise
  - Hard to explain or interpret

Best of Both Approaches



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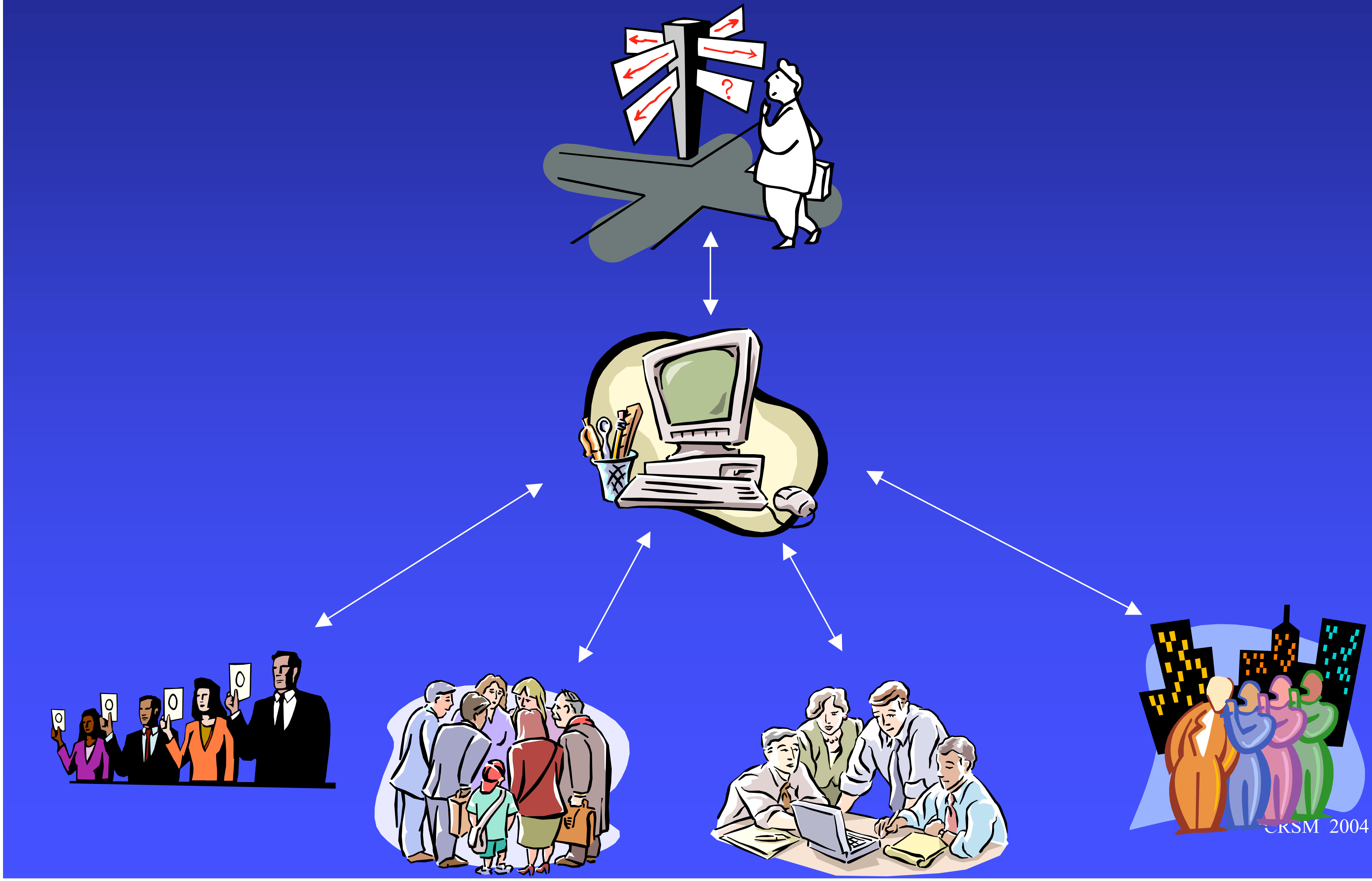
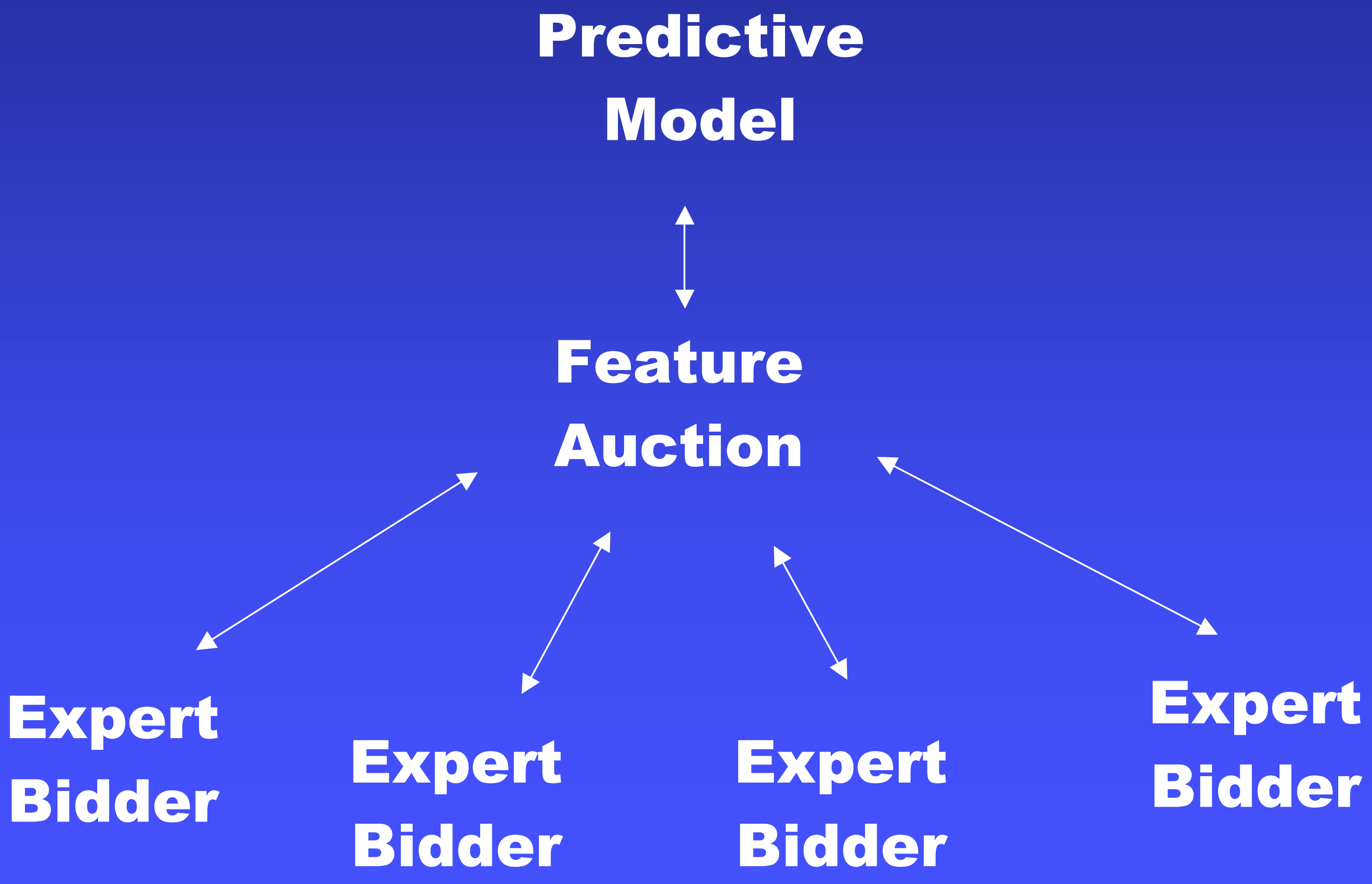


Auction = Experts + Model



Predictive Model

Feature Auction

Expert Bidder

Expert Bidder

Expert Bidder

Expert Bidder

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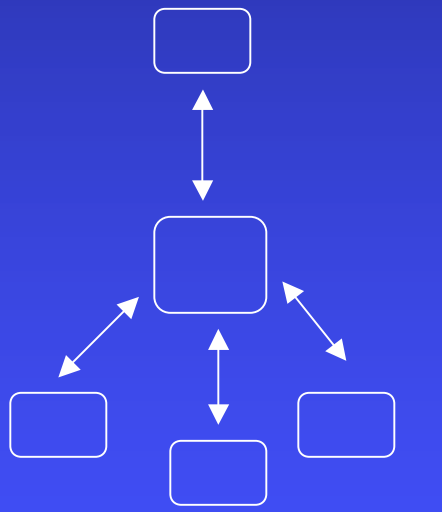
- *Experts* recommend features.
  - Bid reflects strength of "conviction" (Bayes prior)
- *Auction* identifies feature with highest bid.
- *Statistical model* tests feature.
  - Bid determines p-value threshold
  - Accepts significant predictors, rejects others
- *Auction* passes results back to experts.
  - Winning bids earn wealth for expert.
  - Losing bids reduce wealth.
- *Information* flows both ways.



Experts

- Experts recommend predictive features
- *Substantive* experts order features
  - Domain knowledge of specific area
  - Prior models in similar problems
- *Automatic* experts
  - Interactions based on other experts
  - Transformations
    - Segments, nearest-neighbor, principal components
    - Nonlinearity
  - Feedback adjustments for calibration

Underlying Theory

- Streaming feature selection
  - Sequential, not all at once
    - “Depth-first” rather than “breadth-first”
  - Overcomes width constraints
  - Ordering captures prior information
- Universal bidding strategies
- Multiple testing without overfitting
  - False discovery rate (FDR) for infinite sequence of tests.
- Calibration
  - Ensures predictions track reality.
  - Adaptive link function

Sequential vs. Batch Selection

Sequential	Batch
Search features in order identified by domain expert	Search “all possible” features to find the best one.
Allows an infinite stream of features.	Needs all possible features before starts.
Adapts search to successful domains.	Constrains search to those available at start.
Reduces calculations to a sequence of simple fits.	Requires onerous array manipulations.

Sequential works…

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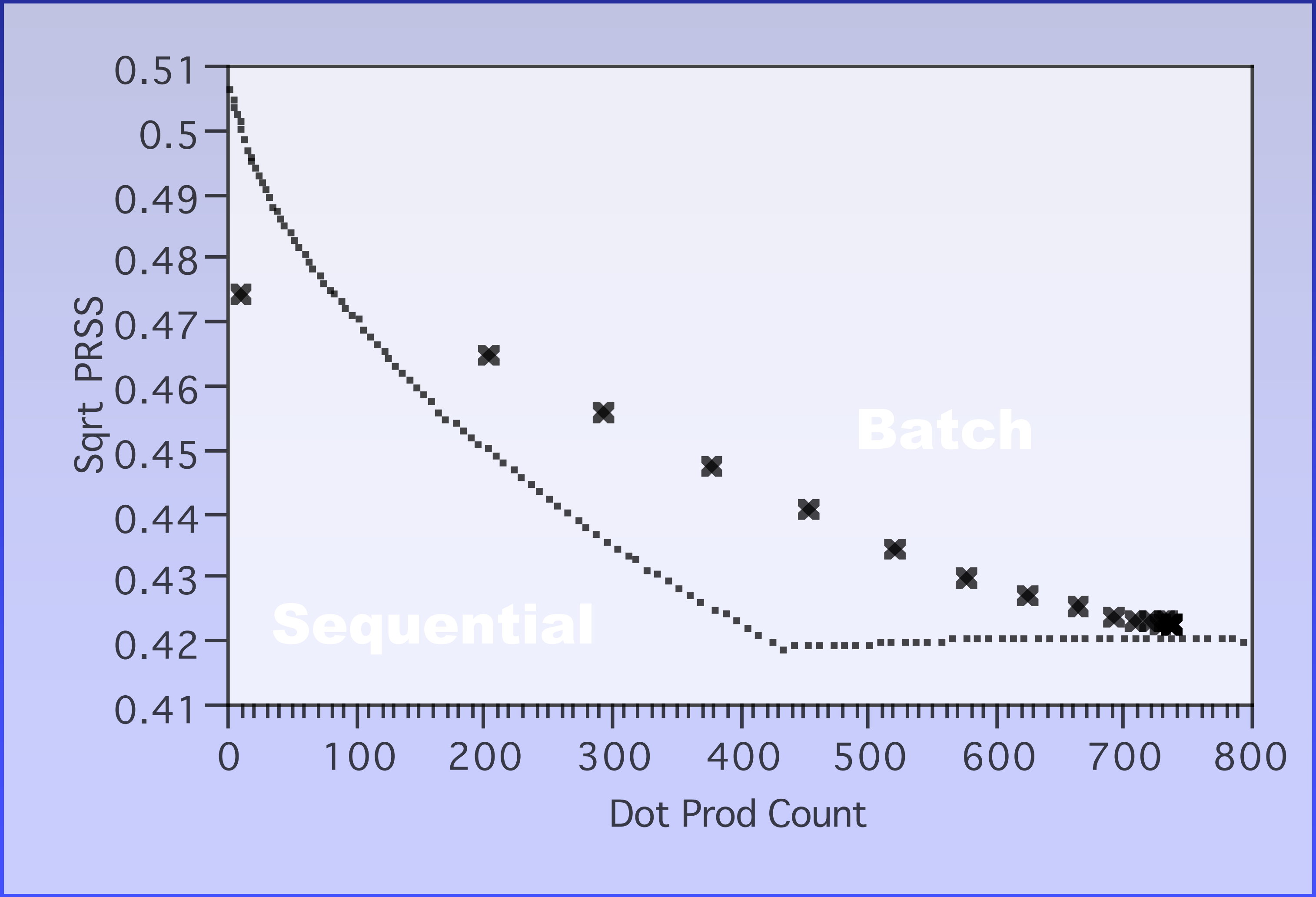
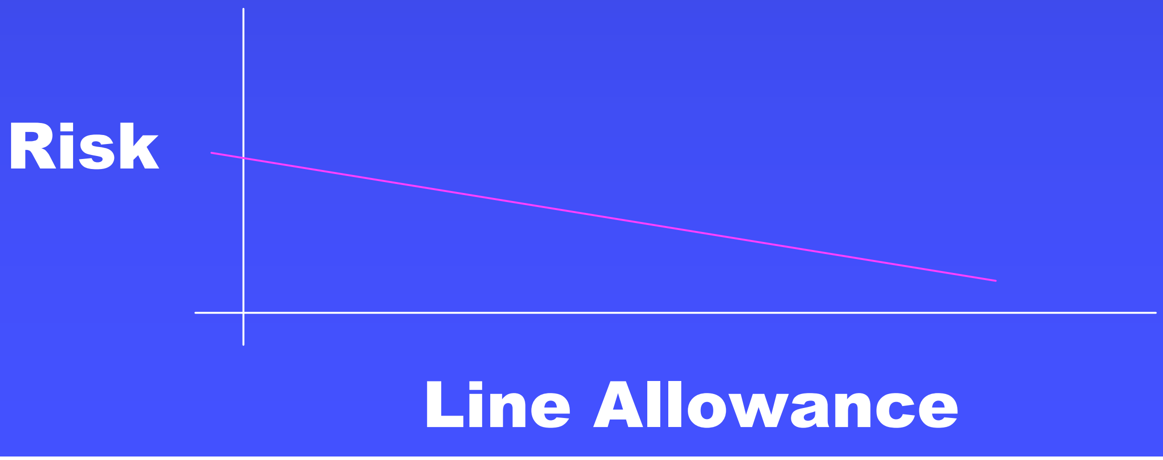


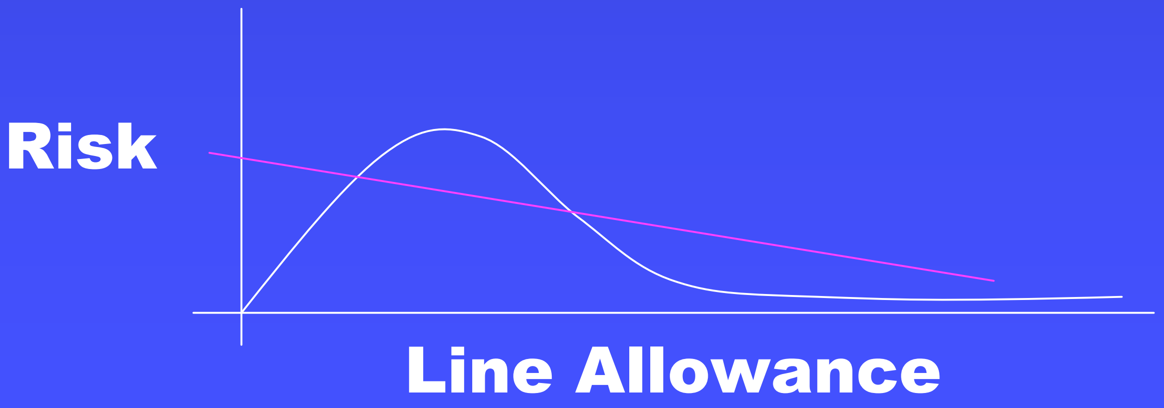
Example

- Predicting default
  - Logistic regression model
  - 15,000 cases, 67,000 possible features (most interactions).
- Standard model finds linear predictor
  - Higher risk with lower line allowance.
  - Statistically significant



Example: Nonlinear pattern

- Auction model
  - Experts recommendations based on state of model.
  - Look for combinations of extant predictors.
- Discovers nonlinear effect
  - Nonlinear effect for size of credit line
  - Statistically significant "bump" in risk



Example: Synergies

- Feedback expert
  - Builds interactions among predictors in current model.
  - Limited search does not obscure simple predictors.

Feature	Found in Model
Behavioral score	Marginally linear
Missing data	Behavior score affects these differently
Non-linear	Larger for high scores
Synergies	Changes with payment

Summary

- Auction modeling combines
  - Domain knowledge
  - Automatic search procedures
- Offers
  - Fast, guided search over complex domains
  - Strategies for constructing features in parallel.
  - Flexible statistical models
- More information…

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