

# Dynamic Regime Identification and Prediction Based on Observed Behavior in Electronic Marketplaces

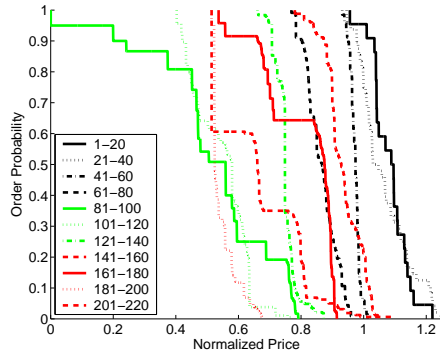
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<http://www.cs.umn.edu/tac>

In Proc. of the Twentieth National Conference on Artificial Intelligence, Pittsburgh, July 2005.

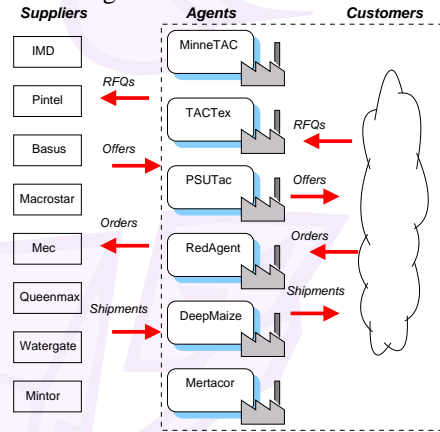
**Objective:** Design a method for an autonomous agent to identify dominant market conditions, such as oversupply or scarcity. The approach is validated with data from the Trading Agent Competition for Supply Chain Management.

**Economic Regime Identification:** We believe that market conditions can be characterized by statistical patterns, and that such patterns can be learned off-line from historical data. We call those distinguishable market conditions *regimes*.

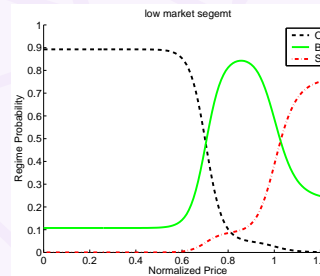
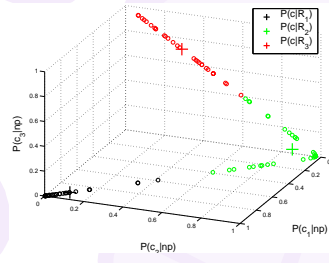
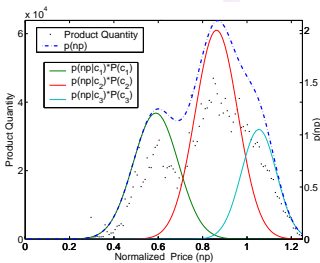


Reverse cumulative density function represents probability of order. The curves are shown for 20 day intervals, we see that the slope and the position of the curve is changing over time.

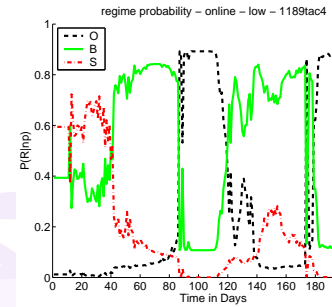
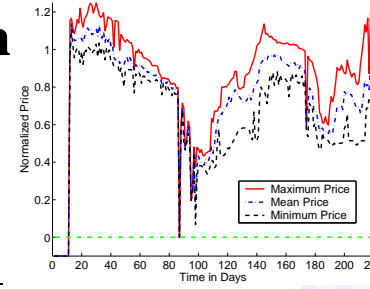
**TAC SCM:** Six autonomous agents compete to maximize profits in a computer-assembly scenario. Agents earn money by selling computers they assemble out of parts purchased by suppliers. The agent with the highest bank balance at the of the game wins.



Each computer type has a different nominal price, which is the sum of the nominal cost of each of the parts needed to build it. We normalize the prices across the different computer types in each market segment. We call np the normalized price.

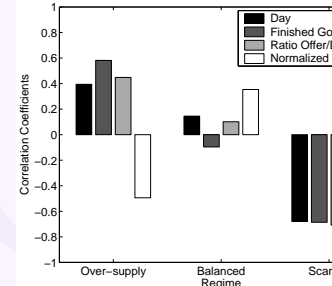
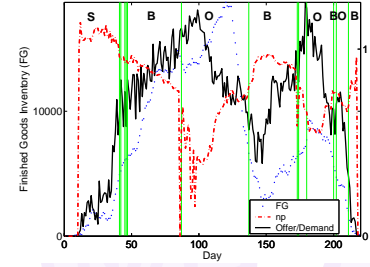


**Off-line Regime Identification:** Low market segment – Gaussian mixture model:  $p(np) = \sum_{i=1}^N p(np|c_i) P(c_i)$  where  $p(np|c_i)$  is the  $i$ -th Gaussian from the GMM (left). For our experiments we chose  $N = 3$ , because we found experimentally that this provides a good balance between quality of approximation and simplicity of processing. K-means clustering applied to the posterior probability  $P(c_i|np) = \frac{p(np|c_i) P(c_i)}{\sum_{i=1}^N p(np|c_i) P(c_i)} \quad \forall i = 1, \dots, N$  (middle). Regime probabilities over normalized price (right). Data are from 26 games from finals and semifinals of TAC SCM 2004.

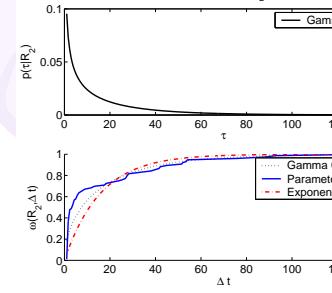
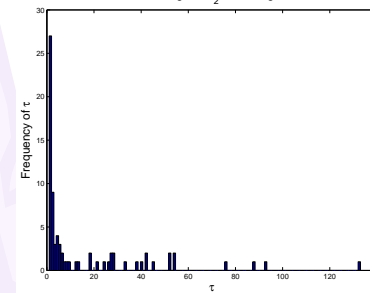


**Online Identification of Current Regime:** Game 1189@tac

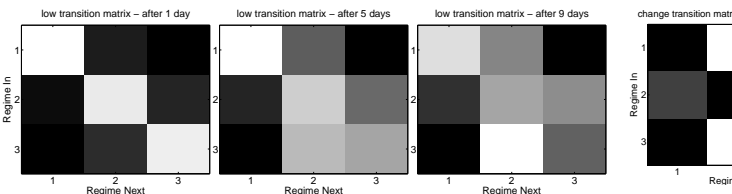
Minimum and maximum daily prices of computers sold, as reported during the game, and mean price (left). Regime probabilities of online computed online every day (right).



**Analysis:** Marketfactors with superimposed regimes over time (left). Correlation coefficients between regimes and time in the game, the ratio of offer to demand, normalized price (np), and quantity of finished goods inventory in the low market segment. (right).



**Economic Regime Prediction:**  $\tau$  (duration) values for the balance for the low market segment shown in ascending order. Fitted Gamma  $p(\tau|R_2)$  (right top); Cumulative distributions:  $\omega(\tau = R_2, \Delta t)$  (right bottom).



Rows are for the current regime and columns for the next regime. The transition matrix is evaluated for 1, 5, and 9 days from left to right. The matrix represents the change matrix without mixing.