Data Science and Strategic Pricing

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Course Assignments & Reading

Course assignments should be printed and turned in at the start of class unless otherwise noted. Feel free to work in groups but everyone is required to turn in their own work with answers written in your own words. In both calculations and complex ideas, write down each step of logic used in reaching your conclusion. Keep in mind that in most cases a good answer is one precise sentence; quality is heavily favored over quantity. This will be graded on a full credit, half credit and no credit basis. All work must be typed

Week 7, due Nov 16

Assignment to be turned in. Please turn in typed out answers for the non-R portions (math with pen/pencil OK) and Rmd for the code portion.

1) Define what a player or firm's "Best Response" (BR) is to another player's action.
    a. How is this different from a BR function?
    "Best Response" is specific actions that maximize the payoff, and BR function take other player's behavior as input and generates best response.
    b. If a player or firm has a complete BR function defined for all states of the world and actions, will anything surprise the firm? Why or why not?
    No, they will not be surprised as the complete BR function can always generate a best response no matter what other players do.
    c. If a player or firm has a complete BR function, will they have preferences about what the other player does? Why or why not?
    Yes, I think they will have preferences, as even though BR function can generate best responses according to inputs, but these best responses might be different, thus, they still want to find the maximum payoff among these best responses.
    d. How is a BR function different from Nash Equilibrium (NE)?
    BR function generates best response for one player, and the NE is the intersection of best responses for all players in the game.
2) What is the BR of a firm competing Cournot if all other firms produce zero quantity? What are their profits? Is this a NE? Why or why not?
    Then this is same as monopolist, and I can produce as much as I can, and set price to MR = MC. This is not a NE as zero quantity is not a BR for other companies.
3) A dominant strategy in game theory is that no matter what the other player does, its always optimal to take the same action.
    a. Is there a dominant strategy in Cournot competition? Why or why not?
    No, there is no dominant strategy, as players always change their best responses when other players change their behavior.

b. What about for a monopolist? Why or why not?
No, as there is not other players, though the strategy is stable as MR = MC.

4) Estimate a random forest model and compare the MSE with the same LASSO model when predicting sales. Try to make a complicated model. Remember that you have to install the randomForest package.
   a. Here is some code:

```
# Install and use the randomForest package. Using price in
levels as well, just to change it up.
mydata$price <- log(mydata$price)
oj.rf <- randomForest(logmove ~ ., data = mydata, ntree =
      100, keep.forest = TRUE)
mydata$pred_logmove_rf = predict(oj.rf)
mydata$resid2 <-  (mydata$logmove -
mydata$pred_logmove_rf)^2
```

   b. Try to plot observed versus predicted using ggplot.
   c. Compare a complicated LASSO model for the MSE.

5) Show that if there is a low and high quality good with utility specified as in lecture that if $\frac{s2}{p2} > \frac{s1}{p1}$ then all consumers purchase high quality good if they purchase.

Start with

$$\theta s_1 - p_1 > 0 \text{ if willing to purchase good 1.}$$
$$\therefore \frac{\theta s_1}{p_1} - 1 > 0$$

Now see if you can get to here, which will give you the result (with another two lines of algebra:

$$(\theta s_2 - p_2) - (\theta s_1 - p_1) > 0$$

Now adjust to this: $p_2\left(\frac{\theta s_2}{p_2} - 1\right) - p_1\left(\frac{\theta s_1}{p_1} - 1\right)$.

How can you change $\frac{\theta s_2}{p_2}$ so that $p_2\left(\frac{\theta s_2}{p_2} - 1\right) - p_1\left(\frac{\theta s_1}{p_1} - 1\right)$ is bigger than another expression?

by assumption, $s_2 > s_1$, $P_2 > P_1$, $\frac{s_2}{P_2} > \frac{s_1}{P_1}$

then $P_2(\theta\frac{s_2}{P_2} - 1) - P_1(\theta\frac{s_1}{P_1} - 1) > P_2(\theta\frac{s_2}{P_2} - 1) - P_1(\theta\frac{s_2}{P_2} - 1) = (P_2 - P_1)\cdot(\theta\frac{s_2}{P_2} - 1)$

as $P_2 > P_1$, $P_2 - P_1 > 0$.

as $\theta \cdot s_1 - P_1 > 0$, $\theta\frac{s_2}{P_2} - 1 > 0$.

thus, $(P_2 - P_1)\cdot(\theta\frac{s_2}{P_2} - 1) > 0$.

Therefore, $(\theta s_2 - P_2) - (\theta s_1 - P_1) > 0$ and consumers always purchase high quality good if $\frac{s_2}{P_2} > \frac{s_1}{P_1}$.