

**Final Examination - Answer All Questions**

1) (20 points) The year is 1994. The repair shop of a typical Ford dealership has three kinds of technicians:

- “A” level technicians who are superstar diagnosticians.
- “B” level technicians who are competent diagnosticians but not superstars.
- “Lube Boys” who work largely on oil changes, replacing mufflers, changing tires and so on.

The facility has virtually no computers.

The year is 2004. The repair shop now has computerized diagnostic tools and receives daily updates to its repair manuals over the internet. The shop still has three kinds of technicians but their relative proportions may have changed.

a) (8 points). Carefully explain carefully how and why you would expect the computerized diagnostic tools and the Internet repair updates to change the mix of the three kinds of technicians in the shop.

Ans: The best guess is that tools and bulletins codify – express in rules – solutions that used to be out of the reach of mid-level technicians. So we would expect that a repair facility could handle a given problem mix with fewer “A” s and more “B”s We would expect the number of Lube Boys to be unchanged since computer provide no improvement in their ability to do their work.

b) (8 points) Throughout the semester, we have returned to a general story about the skill levels for which computers might be substituting. Explain why the pattern in this auto repair shop differ from the story we have been telling in class.

Ans: The general story in class is that computers substitute for workers in the lower middle of the skill distribution – which would correspond to “B” level workers in this case. In that case, we are talking about assembly line and clerical workers where most of what they do can be expressed in software. In the auto repair case, the “B” level workers’ jobs involve a mix of application of knowledge and non-routine physical movements, optical recognition, etc. that can’t be automated. The non-routine physical movements mean they can’t be replaced by machines but if machines can complement those

movements by giving them a broader range of knowledge, they can take on a wider range of problems.

c) (4 points) Is the technology in this scenario designed to substitute for human perception, human cognition or both? Explain.

Ans: Some of both. The computerized testing tools expand perception – i.e. unearth problems that a tech might not see on their own – and providing step-by-step problem investigation and solutions certainly substitutes for human cognition.

2) (20 points) If you are like most people, you have probably eaten cakes prepared in many different ways: cakes baked by your mother, cakes baked by a friend, cakes baked by a commercial bakery, and so on.

a) (10 points) Explain to what extent you agree and/or disagree with the following statement: “I have seen assembly lines in Entenmann’s Bakery that turn out hundreds of cakes a day with very little human intervention. The existence of this assembly line means that baking a cake is an inherently rules based task that does not require pattern recognition.”

Ans: Certainly, when your mother bakes a cake, it involves a lot of pattern recognition including knowing what a mixing bowl looks like, tasting the batter for the correct amount of sugar, etc. The fact that a bakery assembly line can bake a cake means that it has been reduced to mostly rules through Simon’s notion of routinizing the environment – focusing on a single mix of ingredients, keeping all the flour in a single bin that always occupies the same position so that fixed amounts can be released into mixing tubs, etc.

b) (10 points) Assuming the statement above is at least partially correct, explain why the technique of baking a cake can be described in rules while the techniques of a successful automobile salesman captured on videotape cannot be described in pattern recognition software (e.g. neural nets), much less rules.

Ans: The answer here involves problem representation. In the case of a cake, we can move toward writing rules because we have a natural problem representation to which the rules apply – teaspoons of this, cups of that, baking should proceed at a measurable temperature for a measurable amount of time, etc. In the case of the sales person, we are much less far along in figuring out which variables are important (facial expression?, tone of voice) and how those variables can be measured. Without good problem representation – i.e. input variables, even machine learning is at a loss (recall, for example, that to set up the dog/cat neural net example for class, the investigator first had to decide they were going to try to express the problem on the basis of a set of physical dimensions – nose length, etc. – each of which had to be measured and written down as input.

3) (20 points) In an article published two years ago, an MIT economist and his co-author examined an Israeli data set in which a number of schools had applied for grants to purchase classroom computers. Because funds were insufficient to provide grants to all who applied, the grants were awarded to schools by a lottery like procedure. The authors analyzed scores from tests given a year after the computers had been purchased and they found that there was no test score difference between schools that did and did not have the computers.

a) (7 points) Why was the sample construction – e.g. a lottery among applicants - important? Why couldn't the authors have just assembled a sample of schools some of which had computers and some of which did not?

Ans: Without that front end, it might look a lot like the Krueger paper. I.E. you could come up with the fact that schools with computers look good on tests but you wouldn't know if that just reflected the fact that these were very revved up schools and had nothing to do with computers.

b) (8 points) Draw on relevant readings you have done for class to explain why you are or are not surprised by the authors' findings.

Ans: The most relevant readings here are the productivity readings – particularly, the McKinsey study of productivity: Figuring out how to use this technology takes time so some schools may have figured it out while other schools haven't and so there will be no significant statistical effects. Similarly, in McKinsey, they showed that most firms that had made big productivity gains had relied on computers but many firms that invested in computer made no productivity gains.

c) (5 points). Assume you are in Israel with complete access to the authors' data, the schools from which the data came etc. If you wanted to further pursue the question of whether computers could improve education, how would you proceed?

Ans: I would look at schools that had big test score gains – both those that did and did not use computers. I would then start doing case studies to see if computers had a role in ways that might be generalized to other places – i.e. techniques tested in some kind of controlled environment.

4 (20 points) Some economists argue the web offers easy access to price information which pushes firms toward Bertrand competition. Conversely, other economists argue that even on the web, getting price information takes time and fear of Bertrand competition is overblown.

In practice, a number of travel related products e.g. airline tickets, rental cars, hotel rooms, etc. can be purchased through any of four channels:

- Face-to-face (i.e. walking up to the counter)
- Over the telephone talking to an operator
- Through a travel agent
- From a web site like Orbitz.com or Avis.com

a.) (12 points) Describe an analysis based data from these four channels that would allow you to test whether the web does push firms toward Bertrand Competition. If your analysis does not utilize information from all four channels, explain why. Also explain any potential problems you see that might complicate your ability to draw conclusions.

Ans: Of the four methods, the two that are closest are web and telephone operator. It is a reasonable assumption that if you rely on phone, the costs involved in getting comparative pricing information is higher than the costs of getting comparative pricing information on the web. Therefore, if something like Bertrand competition workers on the web, we would expect higher prices by phone operator than on the web. The complication here is that the operator might coax you into buying more, etc. (Actually, this happened to me last week in a car rental – the Avis web price was about 18% less than the price the operator gave me and there was no hint that that might be the case)

In this experiment, face to face introduces a lot of other factors (even greater possibility for influence) as does a travel agent (who might get a commissions or get a special discount) and if so I don't see using data from either source though I am certainly willing to listen to alternatives.

b) (8 points) Suppose you were focusing on men's dress shirts rather than airline tickets. You could still collect data from face-to-face purchases, telephone purchases (e.g. to Land's End or LL Bean, etc.) and web site purchases. What kind of analysis would you construct here and what potential problems might complicate your ability to draw conclusions?

Ans: Again, I would compare phone with web but this is a trickier situation. If you compare different providers, you risk being unable to control for quality differences. If you compare the same provider, here, unlike auto rental or plane tickets, the phone channel is probably backed up by a catalog which makes it easier for a customer to compare catalog and web prices and get ticked off if there is a difference.

5. (20 points) Consider the production technology  $Y_t = BK_t^\alpha [(A_{L_t}L_t)^\rho + (A_{H_t}H_t)^\rho]^{1/\rho}$  where t indexes time, where the inputs  $K_t$  (physical capital),  $L_t$  (workers with no college education), and  $H_t$  (workers with college education) are available, and where B,  $A_{L_t}$  and

$A_{Ht}$  are parameters of the production function.. Assume all inputs are paid their marginal product.

a) (6 points) Find the wage ratio between high and low skilled workers.

Ans: Check with TA on this one.

b) (7 points) In light of class discussions, which parameters in the production function should computers have affected over time?

Ans: I would have expected it to work through the  $A$ 's, increasing the college labor  $A$  through complementarity.

c) (7 points) Drawing on class discussion and the readings, what evidence can you cite to show that the parameter  $\rho$  does not assume the value of negative infinity.

Ans: Negative infinity suggests, as you said, that the two kinds of labor are strict complements but we know that computers can substitute for less skilled labor which means such strict complementarity cannot exist.

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