B: Required  If you are thinking of attending a professional school after college, then you are probably trying to decide which school is best for you. If you aren’t thinking of going to a professional school, then pretend for a minute that you are, and chose a field that interests you: business, law, medicine, education, or engineering.  

(50 points)

1. To avoid anchoring, first write down three or four of the most important objectives you have in this problem. How might you choose scales to evaluate these objectives? What sort of scales would they be? If they are interval scales, then what units might you use?

I am not thinking of going to a professional school, so I will pretend for a minute that I am. Income is very important. For this exercise, I will pretend that I have enough cash to go to school and not work, but that the rest of my life remains unchanged. My main objectives will be different from those I might have had as single undergraduate considering professional school. Engineering is probably closest to my interest, but the field I choose is business. For the purposes of this problem, I am not going to worry about entrance exams and GPA – let’s assume I’ve either done very well or am just over-confident, so that all other things equal I will apply anywhere.

Most important objectives:

- Minimize cost of attending school, in dollars. This is important because we have a mortgage and are raising a family.
- Attend a school with a program of quality, to ensure satisfaction and a positive experience.
- Ensure the time and money spent on school results in better professional opportunities – we’ve assumed enough cash to attend school, but nonetheless, it would be best if time spent out of the workforce were offset by a better paying job upon graduation.
- Minimize the time spent traveling back and forth from my current residence, so I can spend as much time as possible at home.

Evaluating the cost of the school would use dollars, a ratio scale. It might take into account tuition, travel, and benefits like gym membership, or student discounts.

Measuring the quality of a program is difficult. The scale would almost certainly be ordinal, for example, a scale of 1-5 where 5 is the best. Factors to take into consideration would be noted classes or professors, conversations with recent graduates and current students, conversations with professionals about the caliber of graduates, and alumni materials. Also useful would be a look at the course catalog and course descriptions. The value assigned would have to be a judgment call.

There is a way to measure professional opportunities – look at the placement and recruiting of graduates. Different scales could be applied measure this factor. A ratio scale of starting salary for graduates would be instructive. A percentage of students placed in Fortune 500 companies might be useful. Placement in a Fortune 500 company
is categorical (“Placed” or “Not Placed”); the percentage allows for comparison, and in terms of translating one’s own chances for a successful placement, would be a ratio scale. An ordinal scale of student satisfaction with recruiting or placement services would also be helpful but maybe more difficult to attain.

Ideally, time spent traveling back and forth would be measured in minutes, which is a ratio scale. However, if we’re evaluating several alternatives, it might be hard to get a real sense of the commutes, even if we tried each one. They might change at different times of day or seasonally. One approach might be to measure the distance from my house in miles (ratio scale), and then add a second measure to account for the quality of the commute (ordinal scale). Generally, a commute headed towards Boston is going to have more variation and unpredictability and so will be less preferable to me than a commute headed away from Boston. An ordinal scale based on knowledge of the routes or a trial run, say 1-5 with 5 the best, could measure commute quality.

Now review the data from U.S. News Best Graduate Schools, which is available on the course website in an Excel file named “Assignment 3 Data.” Pick four such schools that you would like to compare and answer the following questions about what you see.

1. Harvard University
2. MIT Sloan School
3. Dartmouth College (Tuck)
4. Boston College (Carroll)

2. What general categories of objectives has U.S. News selected in preparing this report? Prepare a list of four or five categories or objectives. Don’t consider specific sub-objectives like “percent employed in manufacturing.” Instead, provide a more general grouping, more like your list of ends objectives.

- School Quality (peer/recruiter assessment)
- Entrance Competitiveness (undergrad GPA, GMAT, acceptance)
- Program Effectiveness (starting salary and employment rates)
- Cost (tuition and fees)
- Size (number enrolled)

3. For each objective of your own, select a proxy variable from the data listed that you think best represents that objective. If your objective is not reflected in the data from U.S. News, then you can add information from other sources and from your personal knowledge. Make a consequence table. Evaluate the four graduate programs by first doing a purely ordinal analysis, and then by imagining tradeoffs as necessary. Explain briefly your swaps. Come up with a ranking of the schools. Now review the U.S. News rankings for graduate schools in your field of interest.

Proxy variables:
For use only with Harvard Extension School Math E-126 course materials

<table>
<thead>
<tr>
<th>My objective</th>
<th>Proxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize Cost</td>
<td>Tuition</td>
</tr>
<tr>
<td>Minimize Travel</td>
<td>N/A (will add my own)</td>
</tr>
</tbody>
</table>
| Quality Program               | 1. Peer assessment  
|                               | 2. Recruiter Assessment  |
| Maximize Future Opportunities | 1. 2001 Avg. Sal  
|                               | 2. % Employed 3 mos. after graduation |

For the travel metric, I used driving minutes from Map Quest.

**Consequence Table:**

<table>
<thead>
<tr>
<th>Original Objective</th>
<th>Proxy Objective(s)</th>
<th>Harvard</th>
<th>MIT</th>
<th>Dartmouth</th>
<th>B.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>Tuition</td>
<td>$30,050</td>
<td>$31,200</td>
<td>$30,250</td>
<td>$25,892</td>
</tr>
<tr>
<td>Min Travel</td>
<td>Commute Time</td>
<td>25 Minutes</td>
<td>20 Minutes</td>
<td>135 Minutes</td>
<td>35 Minutes</td>
</tr>
<tr>
<td>Quality Program</td>
<td>1. Peer Rating</td>
<td>4.8</td>
<td>4.8</td>
<td>4.4</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>2. Recruiter Rating</td>
<td>4.6</td>
<td>4.4</td>
<td>4.2</td>
<td>3.1</td>
</tr>
<tr>
<td>Future Opportunity</td>
<td>1. Starting Salary</td>
<td>$121,979</td>
<td>$118,381</td>
<td>$121,692</td>
<td>$93,907</td>
</tr>
<tr>
<td></td>
<td>2. Emp. Rate</td>
<td>94.5%</td>
<td>90.1%</td>
<td>92.4%</td>
<td>91%</td>
</tr>
</tbody>
</table>

**Ordinal analysis:**

First, we replace the consequence table with a new table, with rankings 1-4 for each item, 1 is the best:
From this, we can see Harvard strongly dominates Dartmouth. Therefore, Dartmouth is a non-contender. The commute time for Harvard is really only slightly longer than the commute to MIT – on every other objective besides commute, Harvard is as good as or better than MIT. Therefore, we can make MIT a non-contender as well through “practical dominance.” That leaves Harvard and B.C. The tuition is significantly more for Harvard. On the other hand, the starting salary is much higher for Harvard graduates, which would pay for the difference in less than a year from graduation. It’s easy to see the first choice is Harvard.

To illustrate some even swaps, let’s pretend after removing Dartmouth, we want to select among the remaining choices using even swaps instead of “practical dominance.” Look back to the original consequence table, at the commute time for MIT and Harvard; there is a five-minute difference. We decide the 5-minute one-way = 10 minutes/day * 180 days/year = 30 hours of extra time per year. This time could be spent with the family – the equivalent of two weeks worth of evening activities each year. Let’s create an alternative MIT’ by adding 5 minutes to the commute to MIT. To compensate, as a heuristic we increase the starting salary by adding 30 times the approximate hourly rate of the graduate salary. 40 hours/wk is about $60/hr * 30 hours = $1800, which gives a salary of $120,181 for MIT’. (Granted few B-school candidates work only 40 hours, but just for argument’s sake) Now, Harvard weakly dominates MIT’. Since we are indifferent between MIT and MIT’, we can now say we prefer Harvard to MIT. If we did the swap the other way, creating Harvard’ by reducing Harvard’s commute 5 minutes, we could adjust the salary using a complimentary heuristic. The rate would be about $61/hr*30 hours = $1830, giving an adjusted salary of $120,149, in which case Harvard’ weakly dominates MIT, and Harvard is again preferred to MIT. However, let’s leave Harvard as is, and get rid of MIT and MIT’.

Now we have Harvard and BC. Again, looking back at the original consequence table, BC is $4,158 year less than Harvard is. Let’s say this is a two-year MBA program, that’s $8,316 overall, and that being able to pay for that difference within a year of graduation is satisfactory. If we create B.C' by increasing B.C. tuition to $30,050, and starting salary to $93,907 + $8,316 = $102,223, Harvard weakly dominates B.C’, so we prefer Harvard to B.C. The average starting salary difference is $28,072; it’s really no contest, but this formalizes a little what was easy to see above, that Harvard dominates B.C. for overall value.
School Ranking

Ranking the schools helps us represent information about the strength of our preferences. Using this process helps avoid the pitfalls of a Borda count, which for more than two alternative can violate transitivity and the independence of irrelevant alternatives.

First, we conditionally score our original table with desirability, using 0 for the worst alternative, and 100 for the best.

<table>
<thead>
<tr>
<th>Original Objective</th>
<th>Proxy Objective(s)</th>
<th>Harvard</th>
<th>MIT</th>
<th>Dartmouth</th>
<th>B.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>Tuition</td>
<td>22</td>
<td>0</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Min Travel</td>
<td>Commute Time</td>
<td>96</td>
<td>100</td>
<td>0</td>
<td>87</td>
</tr>
<tr>
<td>Quality Program</td>
<td>1. Peer Rating</td>
<td>100</td>
<td>100</td>
<td>73</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2. Recruiter Rating</td>
<td>100</td>
<td>87</td>
<td>73</td>
<td>0</td>
</tr>
<tr>
<td>Future Opportunity</td>
<td>1. Starting Salary</td>
<td>100</td>
<td>87</td>
<td>99</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2. Emp. Rate</td>
<td>100</td>
<td>0</td>
<td>52</td>
<td>20</td>
</tr>
</tbody>
</table>

Next, look at best and worst alternatives, and rank and rate the objectives.

<table>
<thead>
<tr>
<th>Original Objective</th>
<th>Proxy Objective(s)</th>
<th>Best</th>
<th>Worst</th>
<th>Rank</th>
<th>Rating</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>Tuition</td>
<td>$25,892</td>
<td>$31,200</td>
<td>2</td>
<td>90</td>
<td>0.22</td>
</tr>
<tr>
<td>Min Travel</td>
<td>Commute Time</td>
<td>2 Minutes</td>
<td>135 Minutes</td>
<td>5</td>
<td>40</td>
<td>0.10</td>
</tr>
<tr>
<td>Quality Program</td>
<td>1. Peer Rating</td>
<td>4.8</td>
<td>3.3</td>
<td>4</td>
<td>70</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>2. Recruiter Rating</td>
<td>4.6</td>
<td>3.1</td>
<td>3</td>
<td>80</td>
<td>0.19</td>
</tr>
<tr>
<td>Future Opportunity</td>
<td>1. Starting Salary</td>
<td>$121,979</td>
<td>$93,907</td>
<td>1</td>
<td>100</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>2. Emp. Rate</td>
<td>94.5%</td>
<td>90.1%</td>
<td>6</td>
<td>35</td>
<td>0.08</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>415</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Use the weights to compute the *Weighted Average Desirability Score*:

<table>
<thead>
<tr>
<th>Original Objective</th>
<th>Proxy Objective(s)</th>
<th>Harvard</th>
<th>MIT</th>
<th>Dartmouth</th>
<th>B.C.</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost</td>
<td>Tuition</td>
<td>22</td>
<td>0</td>
<td>18</td>
<td>100</td>
<td>0.22</td>
</tr>
<tr>
<td>Min Travel</td>
<td>Commute Time</td>
<td>96</td>
<td>100</td>
<td>0</td>
<td>87</td>
<td>0.10</td>
</tr>
<tr>
<td>Quality Program</td>
<td>1. Peer Rating</td>
<td>100</td>
<td>100</td>
<td>73</td>
<td>0</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>2. Recruiter Rating</td>
<td>100</td>
<td>87</td>
<td>73</td>
<td>0</td>
<td>0.19</td>
</tr>
<tr>
<td>Future Opportunity</td>
<td>1. Starting Salary</td>
<td>100</td>
<td>87</td>
<td>99</td>
<td>0</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>2. Emp. Rate</td>
<td>100</td>
<td>0</td>
<td>52</td>
<td>20</td>
<td>0.08</td>
</tr>
<tr>
<td>Weighted Average</td>
<td></td>
<td>82.44</td>
<td>64.41</td>
<td>58.16</td>
<td>32.30</td>
<td>1.00</td>
</tr>
</tbody>
</table>

We should check to see how the weights based on the proxy objectives line up with our original objectives. Because we’ve assumed additivity, this is easy:

- Minimize Cost = 0.22
- Quality = (peer + recruiter) = 0.36
- Future Opportunity = (salary + employment rate) = 0.32
- Travel = 0.10

This seems right – quality and future opportunity are more important the minimizing cost and time spent traveling now. The idea is that overall, focusing on the benefits (quality and future opportunity) is more important than considering those things we want to minimize (travel and cost). Notice that breaking the objectives into sub-objectives allows flexibility in our rating scheme. We can rate one part of future opportunities highly, and one lower. In future opportunities, the differences between the best and worst employment rates was less than 5%, so this doesn’t have to be so important. On the other hand, the difference between the best and worst salaries was very high – so this was very important, we want to be on the high side for that. Having the proxies mapped to more than one objective allows this to be assigned directly. If instead we had rated “future opportunities,” and then within that objective divided the weights between the two proxies, the overall impact would have been obscured. Therefore, for me the natural way to do this was to consider everything independently, and then check the results with our original objectives to make sure it makes sense.

This gives our ranking:

1. Harvard
2. MIT Sloan
3. Dartmouth (Tuck)
4. Boston College (Carroll)
4. In what order does U.S. News rank your schools? Is this different from your own rankings? How do you think U.S. News weights its objectives, and how does this compare to your analysis? Do you think they’ve left out anything?

U.S. News ranks my schools in the same order I did. In my weighted average, MIT Sloan and Dartmouth Tuck were closer together, and in the U.S. News, Harvard and MIT were closer. I don’t know (yet) how U.S. News weights its objectives, however, given the differences in distribution, I’d guess that they don’t rate starting salary or employment rate as highly as I do, since these pull MIT away from Harvard and towards Dartmouth in the ratings. The same goes for tuition. It looks like they weight the peer and recruiting ratings highly, and probably the entrance qualifications, which I didn’t look at. All of this would make sense to an audience of undergraduates, as opposed to someone who is already a professional: my focus is on the result and professional relevance; their focus is on the beginning of the process and quality of experience, as well as perceived quality by recruiters. I would like to have seen a student satisfaction rating as well. Other than that, the data seemed complete enough to give students a rough guideline.

5. Now review the “methodology” for the professional school of your choice. What sort of weighting does U.S. News use (linear or nonlinear)? List examples of all the different types of scales employed (nominal, ordinal, interval, and ratio). Provide a brief critique of how they are used. For example, does the “quality assessment” component of the ranking make use of a meaningful statistic?

For the Business School rankings, the weights described are linear: (0.40 Quality Assessment + 0.35 Placement Success + 0.25 Student selectivity.) I was wrong about their weights – they weighted overall placement success higher than I did. What accounted for the most of the difference was that I thought cost was important, and U.S. News rated selectivity important. I did not rate selectivity as important because I was simply choosing the best school I could find; there is no penalty for not getting in, aside from application fees and for this problem, I am not worrying about test scores. Having ranked schools, I can apply to all of them, and if more than one accepts me, I have a way to choose which school to attend.

There are examples of different scales mentioned. In quality assessment:

“Business school deans and directors of accredited programs were asked to rate programs on a scale from "marginal" (1) to "outstanding" (5)"

This is clearly an ordinal scale. This accounts for 5/8 of the QA portion (the peer rating I would guess). Then, they mention another survey that I have to assume is the same scale that accounts for the other 3/8 of the QA portion (the recruiter rating). As a basis for comparison, I think it’s a fair enough use of the information, and it’s a useful to be able to have access to this information. However, though the percentage of responders is provided, we don’t know what the real size of the survey was. Small samples can be meaningful, but just the same, without knowing what the coverage of the survey was, it is impossible to get a feel for the bias of the results. Overall, if the coverage of the survey
was sufficient, this seems as if it would be useful. If the coverage wasn’t sufficient, the ratings could be misleading and biased. We don’t have enough information to determine one way or the other – although personally I didn’t see any surprises in the ratings.

The next measure is placement success. There are three components to this. First is salary and signing bonus, measured in dollars, which is a ratio scale. Second and third are employment rates at and three months after graduation. The notion of “employed” or “unemployed” is a categorical (or nominal) scale. The percentage employed is a normalized count of the members of the category; the normalization gives us a basis for comparison among the schools. Therefore, a 90% employment rate is better than an 80% employment rate, even though in absolute terms the 80% may represent a larger number. The important thing is that the prospective student, all things equal, will fare better at the school with the higher rate. This seems like a practical heuristic for representing the data in the model. Relative to the student chance’s at employment, this is a ratio scale, since a 50% chance means the student is twice as likely to be employed than a 25% chance, and a 0% chance means, naturally, the student has no chance at all.

The third item in the business rating methodology is student selectivity, which I called competitiveness. The first component is the mean GMAT. The GMAT certainly uses a scale of data, and I don’t know enough about it to say what type of scale it is. My guess would be its ordinal. The second component is the mean undergraduate GPA. GPA is an ordinal scale in my opinion, since the value establishes rank, but meaningful arithmetic transformations of GPAs aren’t possible. The third component is proportion of applicants selected for admission. “Selected” and “Not selected” are categorical data, and the proportion again gives us a basis for comparison among the schools, as well as giving the prospective student a sense of his or her chances for admission. In that sense, percent of applicants selected can be thought of as a ratio scale. (All things equal, a given student is twice as likely to get into a school with 10% acceptance rate as a school with 5% acceptance rate, and has no chance of getting into a school with 0% acceptance.) Again, I think this is a fair use of the data, and provides useful information to the careful consumer.

Overall, I’d say the model could be quite useful, as long as it is understood for what it is, and where bias can’t be fairly evaluated (e.g., not knowing the coverage of the surveys.) The most useful exercise a student could perform is perhaps to try to understand the model, and then use the PrOACT approach, ordinal analysis, even swaps, etc, to reach his or her own conclusions.

C: Choices Think of a real decision problem you face and analyze it using the PrOACT approach. Try incorporating the method of even swaps as well, explaining explicitly about what trade offs you would make and why. Does this exercise make you feel closer to making a good decision? What about your PrOACT analysis might you now want to refine or adjust? (35 points)
Problem

Define the Decision Problem

1. My assumption of the problem is that I must choose a topic for my thesis.
2. The triggering occasion is time – it is a requirement for completing my current course of study, and I’m completing my class work.
3. The connection between the trigger and the problem: simply that choosing a topic is the first step in completing the thesis project.

It is important to question the constraints of the problem statement. In this case, the statement seems straightforward. However, the truly essential element is that a topic must be chosen. It isn’t necessary that I invent the choice. For example, instead of generating my own topic, I could solicit work in an area of ongoing research. Many researchers welcome the graduate student contributions. This has some possible advantages over generating a topic: the work is often well directed and the scope is well understood. (Though it is important to choose carefully; if this isn’t the case, you may not have the control to fix it!) In addition, building on existing work might yield something more interesting than a project done in isolation.

Objectives

Step 1: Concerns I hope to address through my decision
There are several concerns I hope to address by choosing thesis topic. These concerns come from the thesis requirements and from my own desires about the project.

From the requirements, the topic should be in an area of intrinsic interest. The project should be a significant work, synthesizing knowledge and skills developed over the entire program. The work should provide the writer with new insight into the problem, and the result should be of interest to others. It should apply interesting and up-to-date technology. Finally, the topic should be sufficiently focused to prevent the work from being superficial.

To these concerns, I can add some of my own. I’d prefer to apply and stretch existing skills and knowledge, rather than develop new skills. For example, I don’t want to learn a new programming language just to build the application for my thesis. Ideally, I’d like the topic to be relevant to my current professional interests. Even if the work were not directly applicable to my work environment, I would prefer a topic that generalized well to my professional work.

Step 2: Convert my concerns into succinct objectives
Here is an initial list of objectives to be used for this exercise from the information we have so far:

- Maximize intrinsic interest
- Build on existing knowledge and skills
Step 3: Separate ends from means to establish fundamental objectives

It is important to ask “why” to get to the ends for each objective:

- Why maximize intrinsic interest? Because I will be working on this topic for months. The more interested I am, the better my chance of success. Maximizing intrinsic interest feels like a fundamental objective to me; I’d reject out of hand alternatives that did not interest me.

- Why build on existing knowledge and skills? Because learning a new language or technology takes time. Getting past a learning curve could mean compromising the depth of work. Therefore, building on existing knowledge and skill is a means to producing a work of sufficient depth, which will be added into the list of fundamental objectives.

- Why produce a significant work? This is a fundamental requirement for the project. We’ll need to clarify later what is meant by significant in this context.

- Why maximize interest to others? This is a way of measuring the quality of the work. Producing an application that is useful and interesting is a meaningful contribution; it maximizes utility. Perhaps this is a means objective then – a means to maximizing utility. (Not utility in the sense we use it in this course, but in the sense of being useful, helpful, and beneficial)

- Why use up-to-date technology? Because it ensures the application produced is relevant, and builds on work others have done to patch, correct, and refine the technology over time. Using up-to-date technology seems like a means to maximizing utility, again.

- Why propose a clear, focused topic? This is a means to producing a work of sufficient depth, a fundamental objective we just uncovered!

- Why maximize relevance to professional work? This is a personal and fundamental objective – I want to pursue interests that will help develop my career.

Let’s review our refined list of “ends” objectives:

- Maximize intrinsic interest
- Produce a significant work
- Produce a work of depth
- Maximize application utility
- Maximize relevance to professional work

Step 4: Clarify what is meant by each objective
• “Maximize intrinsic interest” is very clear to me, although it is subjective. It means I want to choose a topic that is as interesting as possible to me.

• “Produce a significant work” is unclear. The thesis requirements discuss the notion of significance at some length. For the purposes of this exercise, let’s equate significant with a semester’s worth of work, since anything less is not going qualify. To clarify the objective, I’ll restate it as, “Produce a semester’s worth of work.” The implication of significant work in the context of the thesis as a whole is greater than this, but it is at least a semester of work, and so for clarity and as basis of comparison, we will use this idea for evaluating the alternatives. This is in line with the idea of an LP – we’ll build a simple model and see if it gives us insight into the alternatives.

• “Produce a work of depth” is not as clear as it could be either. We don’t want a superficial work. But what does that mean? For this exercise, let’s say a work of depth solves a specific problem. To clarify, the objective becomes, “Solve a specific problem.” This is not synonymous, but again, if an alternative doesn’t solve a specific problem, it clearly lacks depth. This will help us find a clear alternative that is not superficial.

• “Maximize application utility” means the work should be relevant, interesting, and useful to others. For my purposes, this is succinct and clear.

• “Maximize relevance to professional work” means the work should be applicable to my professional life, current or desired. Again, for my purposes, this is clear to me.

Again, we have a revised list:

• Maximize intrinsic interest
• Produce a semester’s worth of work
• Solve a specific problem
• Maximize application utility
• Maximize relevance to professional work

Step 5: Test objectives to see if they capture interests

We can look at several alternatives to see how they fare. We’ll do this more in depth next section, but just as a benchmark, we can look at a few.

SQL speech-recognition front end: an application that interprets a user’s speech to execute SQL (structured query language) commands. Speech recognition is an interesting topic. It may not be feasible to do this in one semester. It solves a specific problem – I have a friend who is a database administrator with crippling hand problems.
It would be very useful. It is not directly relevant to my work, but is somewhat related. The objectives work well for this example.

DSP Processing/Effects in Java: an application that models in software the function of digital signal processors commonly found in a sound studio. This is definitely an interesting topic. It’s probably a semester’s worth of work. This isn’t too specific, so maybe it would have to be refined. The use isn’t clear, and this isn’t relevant professionally.

Polynomial Texture Mapping: extending work done by Hewlett-Packard to refine this method of creating dynamic textures for graphical applications. This is very interesting to me. It may be more than a semester’s work. It solves a very specific problem, and is useful within the context of HP’s ongoing research. Not relevant to my current career, but could be if I made a change in direction to data visualization.

Overall, the objectives feel good – they are reinforcing thoughts I’ve had already about these topics, although in a more straightforward and complete way. I don’t get the sense that anything is missing.

**Alternatives**

Not quite in line with PrOACT, I have generated alternatives in the form of proposed topics already. They were not created from the objectives above, but instead are just ideas I’ve had along the way that would be of interest. Here are the top ideas I have now:

1. Java Data Visualization/3D Graphing Tool
2. Java speech recognition for SQL
3. Java DSP component library
4. Polynomial texture mapping extensions
5. Collaborative filtering/Associative analysis software

The advice on pages 50-56 of Smart Choices tells us how to generate a list of good alternatives. In this case, I already have some ideas that I’d like to evaluate. Nonetheless, it is useful to ask “How?” for each objective. Here is how the questions look in a table:
The alternatives do fulfill the objectives in different ways. New alternatives can now be generated from the current objectives if desired. The rest of the material – challenging constraints, etc. – is not so relevant to the decision problem I’ve chosen, since the constraints come from the project requirements and from me.

**Consequences**

(Step 1: Mentally put yourself into the future: no output)

Step 2: Create a free form text description of the consequences of each alternative

(From a future point of view:)

1. **Java Data Visualization/3D Graphing Tool**

   This was a good choice, and a fair amount of work. It was a topic of interest to me. It allowed me to expand on skills I have. Students, people at my workplace, or anyone interested in data visualization can use the tool.

2. **Java speech recognition for SQL**

   Though this was an interesting topic, the end result has limited application. It solves a small problem because anything larger would have been too ambitious for one semester. It is useful for a small set of people. It is indirectly related to my work.

3. **Java DSP component library**

   Though a fair amount of work, this was more of an exercise than an application. It helped me understand and gain insight about the way DSP algorithms work. The library will be of use to people integrating audio into their software applications. It wasn’t professionally relevant.
4. Polynomial texture mapping extensions

This was a good deal of work, some of it outside my core skill set. The project had a clear direction and objective dictated by the goals of the researchers. The work has several possible applications. It is an interesting topic. It doesn’t relate to my work, but could if my career changed direction.

5. Collaborative filtering/Associative analysis software

This project is directly applicable to my current work. It’s of interest to me, and to the internet community. It solves a specific problem – how to recommend items to a website audience. It is in a topic area that interests me. It was a good deal of work but I was able to work within existing skills, pushing them to new limits.

Step 3: Eliminate any clearly inferior alternatives.

The speech recognition idea is dominated by collaborative filtering (CF). Both are of interest to me, however, speech recognition may be too ambitious, and so specific as to be of limited use. In addition, it really isn’t relevant to current or future professional interests.

Similarly, the Java DSP library is dominated by CF because of limited usefulness.

This leaves three:

1. Java Data Visualization/3D Graphing Tool
2. Polynomial texture mapping extensions
3. Collaborative filtering/Associative analysis software

Step 4: Organize descriptions of remaining alternatives into a consequences table.

Ordinal Ratings were used for each objective – 1-5, 5 is the most. Ties across alternatives are struck-through. (It is hard to see the strike on the “4”)

<table>
<thead>
<tr>
<th>Objective</th>
<th>Java Data Vis.</th>
<th>Poly. Texture Map.</th>
<th>CF/Assoc Anal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>4</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Semester of work</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Specific</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Utility</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Prof. Relevance</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

The Collaborative Filtering software idea dominates the other choices. Therefore, we don’t need to make any tradeoffs – we have a clear choice! This is interesting to me because frankly, this wasn’t in the front of my mind as an alternative. I was giving much more thought to the data visualization idea. Honestly though, I have to agree with my consequences table. A surprising result for me – this was a worthwhile exercise!
Tradeoffs

Nevertheless, we can pretend for a minute that we got a slightly different result, and that there was no dominant choice. For example:

<table>
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</table>

The rating of 5 for the polynomial texture mapping solving a specific problem is actually quite reasonable. The rating of 5 for the data visualization utility could be based on, say, gathering requirements from a professional team that will become users of the finished application, ensuring an audience for the application.

Now things are not so clear. We can try to find the dominant alternative using even swaps. First, let’s look at polynomial texture mapping (PTM). What is it worth to us to reduce the specificity of that problem? If we reduce it to 4, perhaps this allows introducing some interesting work that we had not been able to include in limited research, increasing interest to 4. We create PTM', with a specific problem rating of 4, and interest rating of 4. We are indifferent between PTM and PTM'. Now collaborative filtering (CF) weakly dominates PTM' on professional relevance, so CF is preferred to PTM. We have Java data visualization (JDV) and CF remaining. For JDV, let’s say we’re willing to do a project that is less useful and relevant if it really compliments our work. The imaginary alternative JDV' has utility of 4, and professional relevance of 5. We are indifferent between JDV and JDV'. CF weakly dominates JDV' on solving a specific problem, our “depth” proxy, so CF is preferred to JDV'. This feels right to me knowing what I know about each topic.

Even changing the ratings a little bit, the even swaps method chooses our original winner, the collaborative filtering proposal. This demonstration strikes me as similar to a sensitivity analysis – we perturb the data a little bit within a reasonable range to see if the model produces the same results. Because the results are the same and the ratings so close, I can be more confident having done this little even-swap demonstration.

This exercise made me feel much closer to making a good decision. If I did it again (which I might), I might include ratings for specific interest areas, like graphics, audio, and data mining, since some of them combine interests. I think intrinsic interest in the topic is the most critical objective for success, and so maybe should be weighted higher. Another thing I might do is re-read the thesis requirements again in light of this exercise, to make sure I included all the critical items. In addition, I made some simplifications that helped make comparisons: “significant” became a fixed quantity of work, and “depth” became the notion of solving a specific problem. Some might argue this isn’t even valid, but within the context of this exercise, I felt these simplifications served well as a basis for comparison. However, there may be other qualities within these broad
terms that could be succinctly represented as objectives. These could be added to the existing list. Overall, though, I do feel this was productive, and feel closer to a good decision.

**D: Writing**  Write a paragraph explaining something that you understand better this week than you did last week. Include a specific example, such as an item on a previous problem set that you now know how to do better.  (15 points)

This week, I definitely understand sensitivity analysis better than I did last week. The last problem set really helped me to get a firm grasp on the concepts of shadow prices and the effect of perturbing objective coefficients and right-hand-side constraints. The “writing” problem last week was especially helpful in this regard. In contrast to the other problems, that problem required us to recount or invent a real-life example. I made up an example based on experience, and used common sense to make up the numbers and constraints. I was very surprised to find that the sensitivity analysis immediately yielded some information I had not “planned.” The shadow price for one of the constraints was very high, higher than anyone would pay, signaling that a little bit of investment could make a significant difference in profits. This for me was proof of what the question asked us to assert – to describe why sensitivity analysis is a powerful tool. The experience of insight is very different from the idea that sensitivity analysis can provide insight, and by working through that problem last week, I had that experience. Insight into the problems in Denardo feels a little artificial, because the problems are carefully contrived to allow students to uncover information. In contrast, being able to uncover information about a problem of my own invention – information I did not plan to find - showed me that indeed sensitivity analysis is a powerful and practical tool. In that sense, I understand sensitivity analysis better – I “believe” it, if you will. In addition, working through the other problems in the assignment made the useful aspects of the analysis more familiar. I hope we’ll return to further exploring LP and other modeling techniques in future assignments.