IMSE 991 – Multi-Attribute Decision Making
HW1
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Problem 1

In class we discussed several rules pertaining to laying the ground work for a problem. The problem typically being led by a decision maker, even if that decision maker is ourselves. Each of the rules mentioned above spoke to several critical pillars of a study that could be overlooked if not known up front. Among these rules listed in our book and lecture, rules three, five, and six spoke out to me in a personal way.

Rule 3

"The model must fit the time frame available for development."

- Tillman, Cassone 2015, p.2

As an analyst at Ft. Leavenworth, I have had the opportunity to be introduced to some very interesting projects. One of these projects was the Extended Range Cannon Artillery (ERCA) study. In this study, the decision maker requested TRADOC Analysis Center (TRAC) to look into what adding range and rate of fire actually does to increase operational effectiveness of the M109A7. In the ongoing dialog back and forth between our team of analysts and the decision maker, it became clear that the decision maker's timeline was going to strongly inhibit our analysis methods, models, techniques, and tools of choice to solving their problem. We desired to run a full simulation, collect our own data on the operation with and without certain independent variables while noting the change in the depend variable of effectiveness. This was simply not possible with the time constraint. Rule three proved true in that the timeline will greatly influence the model you are able to choose for a study.

Rule 5

"The model must be linked to achieving the corporate objectives."

- Tillman, Cassone 2015, p.3

At the TRAC Analyst Development Program (TADP) this year, new analysts were assigned groups and old studies that were already completed and delivered from proceeding years. We were asked to look at the decision makers documents provided to the study team and develop our own problem statement, study questions, and methods models and tools we would use to attack the study. Four teams were divided into groups of two with the same problem. After concluding the study and briefing the results to leadership, my team and I noticed our problem statement was actually quite a bit different to the other team's problem statement, yet we had the exact same problem. So context is key, and I have found that without a true understanding of the corporate objectives, it is easy to be led astray down a path that might be very damaging in the long term of the study.

Rule 6

"Lack of data can be supplemented with expert opinion."

- Tillman, Cassone 2015, p.3

After working at the TRAC for about three months, I realized that expert opinion is critical. Many of the slides for studies had a lot of emphasis on the pedigree of the results and where the reliability hinged on. These demographics often came from expert war fighters who knew their

technical area better than anyone else in the world. Coming from academia, this was a bit of a shock, but I am now realizing that this is a critical part to analysis and forecasting if needed.

Problem 2

Background

- After looking into a request sent to our consulting agency, H-Tech Inc., has asked for us to look into providing a clearer strategic direction to the activities of the company.

Problem Statement:

- Address the needs of a technology manufacturer, High Tech Inc., to assess the overall direction of the company's interests to keep the company competitive in the technology industry.

Goal:

- High Tech Inc., must become competitive among the world's best in the technology industry by 2025. Based on current and projected trends in software and technology. The direction of High Tech Inc., must be forward in thinking, practical in application, and revolutionary in technology development.

Objectives, Attributes, and Measures:

- Cloud Computing Technology: Invest in cloud computing centers to allow accessible, readily available domain hosting, software services, and robust resources to our customers.
    - Features: Current quantity and rate of existing and future features that are made available through the cloud service.
        - Capabilities: What services or features do I have, and at what rate are they increasing? *Objective*: $\mathrm{y(x)} = \mathrm{x} + \frac{\mathrm{dy}}{\mathrm{dx}}$, $\mathrm{s.t} \frac{\mathrm{dy}}{\mathrm{dx}} \geq 0$, where x is the number of services or features, and $\frac{\mathrm{dy}}{dx}$ is the rate of increase in x. Monotonic increasing, as your value of y increases the value also increases.
    - Quality: Performance of the current specifications associated with the computing in the cloud service.
        - Hardware Performance: How much time it takes to Download/Find the Application/Site? *Objective*: Using public performance data on CPU speeds, RAM, disk space, graphics cards, and many others factors. Monotonic increasing, so as high valued specifications appear, more value is attributed.
    - Accessibility: Available online interfaces available to customers from the ease of a browser or mobile device application.
        - Time: How much time it takes to Download/Find the Application/Site? *Objective*: Monotonic decreasing, so as time increases value decreases.
    - Scalability: Long term storage needs will be satisfied as supply and demand fluctuate.
        - Flexibility: How dynamic can the growth or decay of the data center become? *Subjective:* Expert opinion from a scale of 0 to 10 based on the size of our data center's infrastructure, the amount of machines, the change in computing performance via unique specifications, and overall demands over time with their trends.

    - Convenience: Overall customer experience and interaction with the product and service made available through the cloud service.
        - Efficiency: When a user wants to perform a task, how many disruptions or interruptions occur between the end goal of the user and what actually happens with the interface? *Subjective*: Likely to be achieved with a NGT of different designs and gauging the responsiveness of different responses in the group.
- Distributed Computing/ High Performance Computing Technology: Invest in distributed computing centers to allow fast, reliable, and robust calculations for a myriad of software resources the user can select from.
    - Speed: Amount of time the user takes to execute a task on our system
        - Time: How much time it takes to complete a task? *Objective*: Monotonic decreasing, so as time increases value decreases.
    - Availability: Service accessibility to the user without disruption.
        - Delays: How often do crashes on this system occur? *Objective:* Monotonic decreasing, as crashes go up value goes down.
    - Understandability: Overall simplicity of the user's interaction with the power and increase in computational rigor.
        - Interface Usability: How difficult is it for the user to perform calculation on this computer cluster? *Subjective*: Likely to be achieved with a NGT of different designs and gauging the responsiveness of different responses in the group.

- Research & Development: Invest in the latest, cutting-edge Artificial Intelligence, Machine Learning, Recommender Systems, Data Mining, and Statistical Learning techniques and methods to pipe into the cloud data centers and distributed computing centers for a high performance, readily available, and revolutionary technology experience that is up and coming each year.
    - Discovery: Experimentation turning into new high quality products
        - Quality: How good is the new software/technology discovery? *Subjective*: Likely to be achieved with a NGT of different designs and gauging the responsiveness of different responses in the group.
        - Quantity: How much new software/technology is discovered annually? *Objective*: Monotonic increasing, as the number of discoveries increase value increases.
    - Implementation: Integration of newly discovered software algorithms, techniques, or technology into the existing cloud and distributed systems.
        - Success Rate: How successful is the integration of the new discoveries into the current system structure? *Objective:* Monotonic increasing, as the success rate is increased the value is increased.

Problem 3

Problem Statement:

- I desire to open a business on the side in a way that only utilizes 20% of my current time and efforts. Amongst this 20%-time commitment, I want to choose the best part time business, to make the most money I can, subject to a minimum worthwhile amount of $200 a week, while spending the least amount of initial investment costs within $1000.

High Level View:

a. Decision Criteria:

1. **Time invested**: How much raw time do I actually need to put into this business per week? By understanding that graduate school is very important to the investment in my future, I may need some of my 20%-time investment back to work on other things, so keeping my time investment as low as possible makes things better for the overall investment. The weighting scale for this is a subjective prediction, so **5** I need at most 5% of the allotted time, **4** is I need between 5% and 10% of my time, **3** is I need about 10%, **2** is I need between 10% to 15% of the allotted time, and **1** is I need at least 15% of the time allotted. This scale assumes that each value is the fractional percentage of it into the 20% of time allotted (e.g., 15% or more would translate to 15/20=75% or more of my time inside the 20% allotted domain of time would be required to be used for this time investment.)

2. **Effort invested**: How physically and mentally straining is the task, the learning curve, technicalities involved, and overall understanding of the industry or business I am seeking to invest into? By understanding what I am getting into, it may not be worth it for me to get into an industry I know very little about because of the strain it will put on me mentally to learn a whole new field. Rather, one that is closer to my area of expertise may be a bit less straining. The weighting scale for effort is a subjective prediction, so **5** I need at most 25% of my effort, **4** is I need between 25% and 50% of my effort, **3** is I need about 50%, **2** is I need between 50% to 75% of my effort, and **1** is I need at least 75% of my effort. This scale assumes I always have 100% effort wherever my time is being allocated (i.e., in my 80% school or 20% business).

3. **Profit**: How much money am I going to actually make after all the revenue and costs are accounted for? As the saying goes, money talks. If the profit is high enough, I would consider the sacrifice of other criteria to be lower because of the tangible stream of money that is coming in. The weighting scale for initial investment is a subjective prediction, from **1** being the smallest expected profit to **5** being the least expected profit.

4. **Initial investment**: How much of the initial $1000 do I actually need to invest? For example, by knowing up front that my initial investment is only $500, I know that I can flip the coin twice instead of just once because it will only deplete my initial funds in half. So by seeing the cost of the investment, I am enabled with a reasonable amount of comfort to choose whether it is more or less important to me and use the remaining upstart funds elsewhere. The weighting scale for initial investment is a subjective prediction, from **1** being the smallest expected cost to **5** being the least expected cost

5. **Potential**: How much potential does this business have looking out one, five, and ten years into the future? By knowing this, the temporary sacrifice and pain might be worth it overall after college tuition is paid for. The weighting scale for potential is a subjective prediction, so **5** I see significant potential, **4** I see potential, **3** it could go either way, **2** I don't see potential, and **1** I see significant lack of potential.

b. Alternative Selection:

1. **Website Building Business**: Design and build dynamic user friendly personal, commerce, and social media pages for a myriad of interests. A website building business wouldn't take too much time, but would still be tasking with the effort would be about the same. The profit for a website building business can sometimes be substantial. I know it costs almost nothing to start up the business, and the internet is the future, so I also see significant potential for it. So my row vector for the website building alternative would be: $3 \quad 3 \quad 4 \quad 1 \quad 5$

2. **Pizza Shop**: Start up a small pizza shop in the northland of KC offering Italian pizza, calzones, breadsticks, and much more. A pizza shop would be something totally new to me, so I know that would max out my time and effort. The profits are pretty good I've heard, but uncertain, plus I am new to the industry. The initial investment to rent out a building would be very high as well, but the long term potential would be pretty good because I know I would enjoy it. So my row vector for the pizza shop alternative would be: $5 \quad 5 \quad 3 \quad 5 \quad 4$

3. **Math Tutoring Business**: Streamline the tutoring process for students in math classes K-12 and in undergraduate math courses. A math tutoring business wouldn't require too much time or effort, but also wouldn't yield as much profit. The upstart costs are also very little, but the potential is very small also. So my row vector for the math tutoring alternative would be: $3 \quad 2 \quad 2 \quad 1 \quad 2$

4. **Small Software Solutions Company**: Build unique software solutions to solve logistics, optimization, inventory, point of sale, data warehousing, and many other custom applications companies need nationally. A software solutions business would no doubt require all of my time and effort, with a high profit opportunity. I know software mostly requires labor, not infrastructure, so the upfront costs aren't much. However, the future for

this would be exponential. So my row vector for the software solutions alternative would be: 5 5 5 3 5

c. Original Decision Matrix

	Attributes	Time	Effort	Profit	Investment	Potential
	Weights	0.20	0.30	0.25	0.05	0.20
Alternatives						
Website Building		3	3	4	1	5
Pizza Shop		5	5	3	5	4
Math Tutoring		3	2	2	1	2
Software Solutions		5	5	5	3	5

d. Normalized Decision Matrix

	Attributes	Time	Effort	Profit	Investment	Potential
	Weights	0.30	0.30	0.25	0.05	0.20
Alternatives						
Website Building		0.363803438	0.377964473	0.544331054	0.166666667	0.597614305
Pizza Shop		0.606339063	0.629940788	0.40824829	0.833333333	0.478091444
Math Tutoring		0.363803438	0.251976315	0.272165527	0.166666667	0.239045722
Software Solutions		0.606339063	0.629940788	0.680413817	0.5	0.597614305

Conclusion

After applying the *Lexographic Method,* I was able to consider the weights of the normalized decision matrix. This took a look at time first, so since the least amount of time for the website building and math tutoring was the same, it then looked at the next highest weighted attribute which was effort. After locating that the least effort came from math tutoring, the *Lexographic Method* decided to choose the Math Tutoring Business alternative as my best choice. This was a pretty interesting conclusion, but makes sense.

Works Cited

Tillman, F., A, Cassone, D., T. (2015). *The Science of Common Sense: Best Practical Decision Science Methods*. HTX, Incorporated.