Math 160 - Projects

This course has some projects that require you to go beyond the level of material covered in the book or use outside sources to acquire data.

Although you may work the problems individually, the projects are designed to be group projects. They require extra work and you can benefit from the group. The exams will often see questions similar to those on the projects and so having other people verify the correctness of the problems before you take the exam can be beneficial.

Groups may have up to 3 people in them (except for the first project, which is an individual project). You will be able to select your own groups for the projects and you may change groups at midterm.

Some of these projects are very similar to problems that will appear on your exams. For that reason, it is important that you complete and understand them before taking your exam.

On the following pages, questions that need an answer begin with _____. In some cases, that might provide sufficient room to write the answers, but in other cases you will need to use your own paper, or better yet, go electronic.

Project 1: Planning for Retirement (Chapter 3)

This project is to designed to help you get a sense of what is needed to retire. When estimating costs, remember that inflation will occur and things will be more expensive than they are now, but that by the that time , you are likely to have most major purchases like a house or car already purchased.

All ages should be in years, and for simplicity, we will assume that all major events (start saving, retiring, and dying) occur on your birthday so that we don't have to mess with partial years. Also, for purposes of this project, you must not plan on retiring within the next 15 years. Round all dollar amounts to the nearest cent. Assume that all money is invested and earns interest at an annual nominal rate of 7.5%, compounded monthly.

Information Gathering Worksheet

_____ Age, in years, that you will be on your next birthday

_____ Age, in years, when you plan on retiring and _____ years until retirement

_____ Number of years that you expect to live and _____ years of retirement

_____ Amount, in dollars, that you anticipate needing *each month* during your retirement

Planning Document

_____ Amount of money that you need to have saved the day you retired in order to fund your retirement

_____ Amount of money that you will need to save each month until you retire in order for you to reach the amount needed to retire

_____ Amount of money you will have after 10 years of regular payments into your retirement fund

After 10 years, a trust fund established upon the death of your grandparents gives you a one-time payment of $125,000. You spend $75,000 of it to pay off your college and credit card debts and put the rest of it into your retirement fund and continue making your regular deposits until you retire.

_____ Amount of money the $50,000 from the trust fund will grow to before you retire

_____ Amount of money you'll be able to spend each month during retirement when you include the investment results from the trust fund

Project 2: Buying a Home (Chapter 3)

The purpose of this project is to help you understand purchasing a home. You will make a 20% down payment to avoid escrow costs and finance the balance over 30 years with a fixed loan rate of 3.6%. Payments and compounding will occur monthly. Round all dollar amounts to the nearest cent.

Find a home in the Decatur area that is between $80,000 and $200,000 by visiting
http://www.realtor.com/decaturil/

_____	Address of home
_____	Asking price of home
_____	Amount financed after 20% down payment
_____	Monthly payment needed to finance home
_____	Total cost to repay loan if regular payments are made for the full 30 years (the loan does not include the down payment)
_____	Amount of interest paid if the loan goes full term

For the next two questions, assume that ten years of regular payments have been made.

_____	Amount still owed on the house
_____	Equity in home if the house is appraised at 8% more than you originally paid for it

For the next two questions, assume that from the beginning of the loan, you have paid an extra $250 per month. This section has nothing to do with the 10 years in the previous two questions.

_____	The number of months it will take to pay off the loan when you pay an extra $250 per month
_____	The amount of interest you save by paying an extra $250 per month

Project 3: Baseball (Chapter 4)

A dominance relation matrix is a pre-cursor to transition matrices in chapter 9. You have a square matrix with the same labels for rows and columns. The value in any row and column represents the number of times the row player beat the column player.

For example, in the dominance relation shown in the table, Baltimore beat Boston 11 times, Boston beat New York 7 times, and Toronto beat Tampa Bay 11 times. The 0's on the main diagonal are because the teams never beat themselves (at least literally).

2013 American League East

	BAL	BOS	NYY	TBR	TOR
BAL	0	11	9	6	10
BOS	8	0	13	12	11
NYY	10	6	0	7	14
TBR	13	7	12	0	11
TOR	9	8	5	8	0

One use of the dominance relation matrix is in computing indirect winners. The idea being that if team A beats team B and team B beats team C, then team A is indirectly better than team C since they beat someone who beat team C.

Create a Google Spreadsheet for this project. Share it with the group members and the instructor. Create a dominance relation matrix for the 2014 National League Central Division of Major League Baseball and call it matrix A.

You can do this quickly by using the information at baseball-reference.com. Find a team, and then under the "Schedule & Results" for each team, they have a "Team Win/Loss Splits" that contains an "Opponent" table that lists how many times the team won or lost against the opponent. When gathering information, limit yourself to the National League Central Division teams.

For example, the 2014 Chicago Cubs information is at
http://www.baseball-reference.com/teams/CHC/2014-schedule-scores.shtml

In an effort to predict the rankings for the 2015 season, a bookie awards points as follows: 15 points for each time the row team directly beats the column team, 7 points for each time the row team beat a team who beat the column team, and 3 points for each time the row team beat a team who beat a team who beat the column team.

_____ Explain how matrices can be used to find the total points for each team.

_____ What is the number of points the Brewers directly received from the Cubs?

_____ What is the total number of points the Cubs received from the Reds?

_____ List the teams and their overall scores. Who is the master beater (best team)?

Project 4: Networking (Chapter 4)

The incidence matrix is similar to the dominance relation matrix, except that the value in a row and column represent the number of direct routes from the row to the column.

Although they don't service Central Illinois, Cox is a major cable company. They have a map of their business network at

http://ww2.cox.com/wcm/en/business/datasheet/national-ip-backbone-map.pdf

Create a Google Spreadsheet for this project and share it with the group members.

Create an incidence matrix for the Cox business network, assuming that all traffic is bi-directional, between the regional data centers and call it matrix A. Ignore any local market backbone nodes. List all the cities alphabetically. A hop occurs every time a data packet goes from one center to another along a network segment.

Be careful: You can get from Atlanta to Dallas directly or by going through Pensacola, so you would enter a 2 in that path. You would not include Atlanta to Baton Rogue to Dallas since Baton Rouge is a regional data center itself.

_____   The minimum number of hops needed to get from Omaha to Orange County

_____   The regional data centers that are the furthest apart network-wise. That is, which sites require the most segments to get between them?

_____   The minimum number of hops needed to guarantee a packet can travel from any data center to any other data center

_____   The mathematical expression used to find the previous two answers.

Part of designing a good network is building in redundancy. If a regional center goes offline, the traffic needs to be able to get from it source to its destination, although it may need additional hops to do so.

_____   The minimum number of hops needed to guarantee a packet can travel from any data to any other data center if Kansas City were to go offline.

Project 5: Decision Theory (Chapter 8)

John and Mitchy run a computer store.

They can purchase 10 computers from Zol and Denny for $1400 each, 30 computers from McGuinn and McGuire for $1300 each, or 50 computers from Sebastian for $1250 each (they can buy from more than one dealer, but only one order per dealer).

John and Mitchy sell the computers for $1500 each. Each computer that is left at the end of the month will be sold in a clearance sale for $900. John and Mitchy estimate a loss of goodwill of $50 for each customer which comes into the store, but is unable to purchase a computer.

During the month, the customers will either demand 15, 30, 45, or 60 computers. Assume the probability of 15, 30, 45, or 60 computers is 0.10, 0.15, 0.50, and 0.25 respectively.

_____ Create a payoff table with the five actions (remember that you can combine purchases from more than one dealer and some plans don't make any sense when the demand is considered) and four states of nature (demand)

Payoff Table	Buy 10	Buy 30	Buy 40	Buy 50	Buy 60
Demand 15					
Demand 30					
Demand 45					
Demand 60					

_____ Create the opportunistic loss (regret) table.

_____ For each decision criteria (expected value, maximax, maximin, minimax), find the payoff or loss for each action and the best action.

Criterion	Buy 10	Buy 30	Buy 40	Buy 50	Buy 60	Best Action
Expected Val						
Maximax						
Maximin						
Minimax						

Project 6: Airline Loyalty (Chapter 9)

The Central Illinois Regional Airport (CIRA) in Bloomington-Normal is served by American Airlines, Delta, and Allegiant. Of these, only American Airlines and Delta have daily flight service, so we will consider only those two airlines in this analysis.

Trip Advisor has airline recommendations and ratings at http://www.tripadvisor.com/Airlines. Assume that if a customer would recommend an airline to someone that they will fly that airline again the next time they fly. If they would not recommend an airline to someone, then they will fly a competitor airline the next time they fly. Cost or destination is not a factor in choosing an airline.

John has recently started a new job in Bloomington that will require him to fly often. He has no previous experience flying, so he looks at the number of ratings each airline has received on Trip Advisor and randomly chooses an airline based on the relative frequency of ratings. Example: If American has received 250 ratings and Delta has received 175 ratings, then there is a 250/425 chance John will pick American and a 175/425 chance he will pick Delta for the initial flight.

_____ Draw a transition diagram and give the transition matrix for John's flights out of CIRA.

_____ What is the probability that John's initial flight will be with Delta?

_____ What is the probability that John's fourth flight will be with American Airlines?

_____ What is the long term probability that John will fly with Delta?

Project 7: Maze Movement (Chapter 9)

A 5×5 grid is laid out as shown in the figure.

Each node is labeled using a letter A-E for the row and a number 1-5 for the column. The top-left node would be A1, the bottom-right would be E5, while the center would be C3.

The arrows indicate the direction of movement between nodes. Movement continues until reaching a node with no exit (shaded red in the diagram).

	1	2	3	4	5
A					
B					
C					
D					
E					
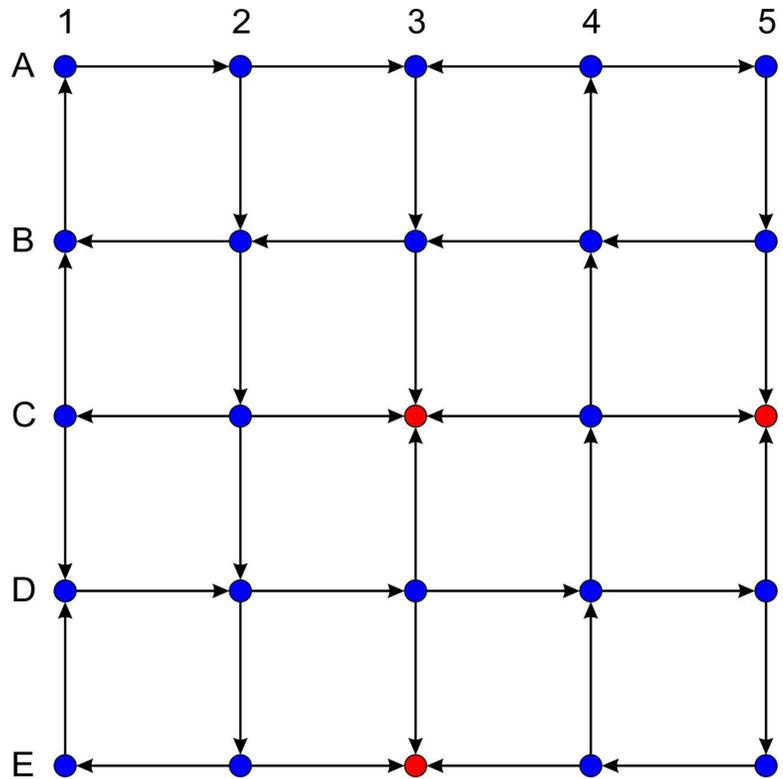
_____   Create a transition matrix in standard form.

_____   Find the fundamental matrix F.

_____   If you start at node C1, how many transitions can be expected before ending?

_____   If you start at node E5, how many transitions can be expected before ending?

_____   If you start at node A2, what is the probability of eventually ending up in cell C5?

_____   If the object is to take as many turns as possible, at which node(s) should you start?

_____   If the object is to end at cell C3, in which transient node(s) should you start?

Project 8: Competing Stores (Chapter 10)

Rick and Corissa own the only two grocery stores in town. This means that a sale for Rick is a loss for Corissa and vice versa. Each week, they each run a special on exactly one type of food in an effort to draw business into their store. The matrix showing the choices and the gain in sales for Rick's store are shown.

<div align="center">

Corissa's Country Market

</div>

		Cereal	Dairy	Health	Meats
Rick's Ready Mart	Baking	-3	1	-5	4
	Fruits	2	-1	-2	3
	Pasta	-1	1	3	-2
	Seafood	3	4	-1	2

Answer the following questions.

_____ If Rick and Corissa each randomly select a food type to put on sale, what are the strategies and what is the value of the game for Rick?

_____ What are the optimal strategies for Rick and Corissa? What is the value of the game for Rick under that those strategies?

_____ Find the expected payoff values for each of Rick's actions if Corissa plays her optimal strategies. Find the expected loss values for each of Corissa's actions if Rick plays his optimal strategies.

Rick finds out that Corissa is going to spin the spinner from the game Life (10 slots) and place Cereal on sale if a 1 shows up, Dairy on sale if a 2 or 3 shows up, Health on sale if a 4, 5, or 6 shows up, and Meats on sale if a 7, 8, 9, or 10 shows up.

_____ What is the expected value of each action for Rick?

_____ What should Rick's _a priori_ strategy be using the expected value criterion? _a priori_ means with prior knowledge – that is, if Rick knows what Corissa is going to do, then what should Rick do?

_____ What should Corissa's strategy really be (not what she said) if the intent was to trick Rick into playing a particular strategy?