MANAGEMENT DECISION MODELS

Description

Mathematical and modeling approaches to problems and issues of management and decision-making. Concepts of observation, factorization, open systems, possible worlds, state, function, boundary, constraint, stability, identity, simulation, and virtuality. Models from measurement theory, regression, inferential statistics, nonparametrics, game theory, logic, algebra, computational languages, artificial intelligence, knowledge engineering, situated activity, and boundary mathematics.

Text

Gerald M. Weinberg, *An Introduction to General Systems Thinking*
John Wiley & Sons, New York: 1975

Goal

The primary objective of this class is to expose participants to a diversity of formal techniques for aiding decision-making. We will emphasize exercises which provide both experience with making decisions and data for analysis of decision-making.

Management Decision Models

INFORMATION SURVEY

Please answer the following questions, so that we might tailor the scope and difficulty of the course to the skills of the class.

Name:

Department:

Year of study:

Major area of study:

Major areas of interest:

Rate your knowledge and experience in each of the following areas, using a five point scale:

1 = none, 2 = minor, 3 = competent, 4 = substantial, 5 = expert.

differential calculus:

linear algebra:

inferential statistics:

regression analysis:

classification analysis:

computer programming:

LISP:

propositional logic:

predicate calculus:

abstract algebra:

game theory:

simulation:

general systems theory:

laws of form:

Write the names of people in this class that you know, and rate how well you know them using a three point scale:

1 = acquaintence, 2 = friend, 3 = close friend.

Names and rating:

THE THIRSTY ARCHEOLOGIST

An archeologist was digging in a Paleozoic mudflat. She came across an imprint of a raindrop that fell 400 million years ago. The sun was hot, and she took a drink from her canteen. How many molecules of the original Paleozoic raindrop did she drink?

You will have fifteen minutes to generate an answer. Write down all assumptions, choices, and decisions you make. No justifications are needed.

Names of your team members:

THE TELEPHONE DRAWING

Describe the figure below so that a person on the other end of a phone line can draw it.

Record your decisions about accuracy.

CLASSIFICATION

Place the following items into groups. Describe each group.

tree	book	table	star
house	cup	fire	shirt
car	horse	foot	bird
string	door	heart	idea
water	road	fork	ball

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CRITICAL INCIDENTS

As you read the text (Chs 1-5), write down the location of sections which make you think. These critical incidents may be confusions, insights, daydreams, strong connections, disagreements, surprises, etc.

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FORMAL MODELS

We'll learn five card games today. Identify the formal organization of each.

FORMAL ORGANIZATION

mathematics:	domain, operations, axioms
algebra:	pattern, match and substitute, equations
modeling:	state space, state transitions, decision models
human factors:	functional problem space, tasks, strategies
life:	events, property maps, behaviors

THE GAMES

1. ***Pick a Card:***

Each player draws a card from a standard deck, without looking and without replacement. Everyone looks.

2. ***War:***

Each player picks a card. Everyone looks. Highest card wins all the other cards.

3. ***Indian Poker:***

Each player picks a card. Without looking, hold the card to your forehead so that all other players can see it. Simultaneously, every player either folds or bets. Highest betting card wins all bets.

4. ***Psychout:***

Each player's hand consists of one suit. A different suit defines the point cards (A = 1, ..., K = 13). A point card is exposed. Each player selects a card from the hand, without replacement, as a bid for the point card. Highest bid card wins the point card. Repeat for 13 plays. Highest accumulation of point cards wins.

5. ***Elusis:***

The game master writes down a secret pattern rule for a sequence of cards. In turn, each player freely selects a card from the deck, without replacement. The game master tells if the card fits the secret pattern. The player to name the secret pattern wins.

MEASUREMENT

Table Exercise

Measure the height of a table. Observe the techniques and the sources of variation.

Richardson Exercise

Measure the perimeter of your hand using three indivisible units of measurement (say 6 inches, 1 inch, and 1/10 inch). Observe and explain the relationship between the result of the measurement and the arbitrary choice of measurement unit.

Measurement Types Exercise

Consider the definitions of these seven types of measure. Each adds a new constraint to the previous type.

Indicative:	existence
Nominal:	set membership
Ordinal:	ordering relation
Interval:	composition relation maps onto addition
Ratio:	meaningful zero
Real:	continuity
Imaginary:	complex structure of a number

Which types of measurement can be used on common things like: people in a room, light in a room, hairs on your head, hunger, thoughts, ...

DIMENSION

1. Name one system of ***fundamental units*** (attributes which all other physical attributes can be expressed with) [Hint: QOMLTA]. What are the maximal and minimal dimensions of each?

2. ***What do you see?***

   Station A (50 yards):
   Station B (10 yards):
   Station C (5 feet):
   Station D (6 inches):
   Station E (1/2 inch):
   Station F (magnified):

   What is the dimension of what you saw at each station?

3. What is the ***dimensional projection*** of each of these activities?

   print
   music
   photography
   film
   live television
   sculpture
   stage play
   football game

4. ***Dimensional analysis:***

A pendulum with length and mass within a gravitational field is deflected by an angle, generating an oscillation with a period. Derive an equation for the period.

CONSENSUS

Each class member has contributed $5 to form a relatively large cash reserve. Your task is to *give* the resource to one and only one member of the class.

The purpose of this exercise is to observe the process of consensual decision making.

Rules

1. The decision of who gets the resource must be a *consensus*. Class members must unanimously agree on a single recipient.

2. No explicit or implicit agreements to divide the resource (now or later) are permitted. The gift is to have no strings attached.

3. The decision must be made before class ends today.

4. Violation of the above rules will result in a class failure for this exercise.

VARIATION

Types

stability of measurement over time
stability as variation within limits
repeatability
observational time-frame
reliability
resilience via absorbing perturbation (instability)

Using the following rules, simplify the expressions. Show your work.

RULES

( ) ( ) = ( )

(( )) =

Expressions

1. ( ) ( ) ( ) ( )

2. (((( ))))

3. (( ) ( ))

4. (( ) (( ) ( )))

5. ((( ) (( )) ( )))

Management Decision Models

MIDTERM

Rules

take home exercise
unlimited resources, unlimited class interaction

Develop a decision model for grading students in this class. Include a discussion of the conceptual, formal, experiential, and management tools you used to develop the model.

Apply the model you develop to yourself, to generate your midterm grade for this class.

The quality of your midterm grade decision will effect your final grade. The actual grade you assign yourself will establish expectations for your performance on the Final Examination.

GAME THEORY

The class will form into four teams of two, with two superobservers. The game will consist of alternating periods of discussion, voting, and resolution.

During discussion, teams can decide on a voting strategy among themselves, and they can negotiate with other teams for coordinated voting. The only constraints on negotiation is that resource exchanges must be recorded with a superobserver.

During voting, each team will cast one of their three possible voting options.

During resolution, the four votes will be combined to determine a ***group outcome*** from the outcome table.

The superobservers will collect information on the processes and strategies of each team and keep records.

Each team is different. The initial assets (expressed in units), and the voting choices of each team are below.

Teams	**A**	**B**	**C**	**D**
Initial assets:	2	5	10	20
Voting options:	{V, 0, 1}	{V, 0, 2}	{0, 1, 2}	{0, 2, S}

V	can be interpreted as Veto
{0, 1, 2}	can be interpreted as a strength of monetary support
S	can be interpreted as Strong monetary support

Under these interpretations,

Team A	poor
Team B	workers
Team C	professionals
Team D	wealthy

The game is to increase the wealth of each team.

The outcome is each game round is expressed by a decision table:

TEAM	A	B	C	D
OUTCOMES				
VVS	x2	x1.5	x.7	x.2
VV	x1	x1	x.6	x.5
VS	if V then	x2 else x1	x.9	x.7
V0123	if V then	-5 else +5	+ 5	0
V456	if V then	+10 else +2	- 5	+ 5
012	0	+ 1	+ 5	+10
34	+4	+ 6	+10	+ 8
567	+6	+10	+12	+10
S012	+5	+ 6	+ 7	+ 5
S345	x2	x3	x4	x5

Some outcomes are triggered by several different voting results. For example, a vote sum of 4, 5, or 6 all trigger the **V456** outcome row, even if one team voted V.

"+" means add the specified amount to the team assets

"-" means subtract the specified amount to the team assets

"x" means multiply the current assets of the team by the specified factor.
note that multiplication by less than 1 is a loss of assets.

The *expected gain* for each team for each round is 5.

BLOCKS WORLD, DESCRIPTION

Blocks World is a simple exercise in generative specification. A specification is generative if there is enough information for a computer to implement the described world. The specification below has *not* been implemented, it is a first pass at knowledge engineering the Blocks World domain.

Domain:	{a, b, c, d}	are Blocks.
	{Table}	is the Table.
Variables:	x, y, z,...	represent single, unique objects from the domain.
Relations:	x On y	Block x is directly resting on Block y.
Terms:	X, Y, Z	are collections of On relations that specify a (true) configuration of Blocks and Table.

Example:

```
    [a]     is expressed as     {(a On b)
[b] [c]                           (b On T)
-------                           (c On T)}
```

The curly brackets indicate a term.

Constraints on Terms:

Every block is On something:	(x On y) or (x = T)
The Table is On nothing:	not(T On x)
Asymmetric:	if (x On y) then not(y On x)
Not default:	

not(x On y) means (x On y) cannot exist in term set

Get-rid-of-Table: make a binary relation into a unary predicate

(x On T) = (x OnT)

Functions: Move(x Onto y) maps terms onto terms

preconditions:	(y = T) or not(u On y)	y has empty top
	not(v On x)	x has empty top
action:	Remove(x On z)	Pickup x
	Add(x On y)	Putdown x
postconditions:	(z = T) or not(w On z)	z has empty top

BLOCKS WORLD, DECISION-MAKING

Example problem:

```
                                [a]
        [a]                     [b]
        [b] [c]      ==>        [c]
        -------                 ---
```

Term representation:

```
        (a On b)                (a On b)
        (b On T)                (b On c)
        (c On T)                (c On T)
```

Strategy I: direct transformation of non matching relations

Move(b Onto c) fails

Strategy II: find out what can be Moved (find all true preconditions)

Move(a Onto x), Move(c Onto x)

have to select one, many possible places indicated by "x", search

Strategy III: Level maps terms onto normalized terms

Level(term):

```
pre:     (x On y) and (y =/= T)
act:     Move(x Onto T)
until:   all x: (x On T)
```

Strategy IV: Build from Level maps normalized terms onto term template

Construct(new From old):

```
pre:     level(old)
act:     when (x On y) in new, Move(x Onto y)
until:   new
```

Strategy IVa: Order introduces new concept, an Ordered Term

Order(term):

```
when (x On y) and (y On z),
     Move(y On z) then Move(x On y)
```

Note: apply Move to (y On z) first

Strategy V: Stack, is an ordered term

Subdivide entire term into ordered stacks

```
[(a On b) (b On T)] [(c On T)]
```

Now, Move applies only to first item in each stack

BLOCKS WORLD, BOUNDARY REPRESENTATION

An appropriate change in representation can make a problem trivial.

New notation: The ***stack*** [...]

A stack contains ordered labels, the right most is OnT.

[ ] is the empty Table

[ ][ ] = [ ]   Infinite Table Space Axiom

][=   minimal form of axiom

[a] = (a On T)

[a b] = {(a On b)
(b On T)}

[a][ ] = [a]

Representation of example problem: [a b][c] ==> [a b c]

Move(a Onto b): [a . X][b . Y] = [. X] [a b . Y]

Dot means "the rest of the stack".

Level(stack): [a b] ==> [a][b]

==>][minimal form of Level

PutInOrder(level stack to pattern stack):

term: [b][a]   pattern: [a b]   order: [a][b]

To PutInOrder,
match the sequence of labels in level term to pattern term.

Convert(old to new): new = Move(PutInOrder(Level(old)))

FEEDFORWARD

Organic systems are capable of projection and planning, of letting the present effect the future.

Feedforward without information:

Even though you have not yet seen the final exam, estimate your final grade for the course. Use a scale from 0.0 to 4.0

Feedforward with information:

Estimate you final grade now that you have seen the final exam.

FINAL EXAMINATION

Next week, you will be asked to complete a final exam. This sheet contains the final examination question, the rules of the game, and hints about how to do your best on the exam.

Final Exam Question

Record what you have learned in this class.

Final Exam Rules

Answer the question in real-time, during the exam time slot. However, you may do any amount of preparation and bring any resources to the examination room.

Materials prepared at home can be attached to the real-time exam so long as your exam discusses them.

Hints for Doing Well

Honesty counts double.

Use any media, but writing is the obvious default.

Be abstract. Don't recount every activity and every thought. Rather, summarize and condense.

Be brief. This is not a justification of your learning, it is a recording.

Charts, graphs, decision networks, and mathematical models are highly encouraged. These techniques summarize information well.

Be self-referential. It's a big win if you can illustrate what you have learned in the way you talk about what you have learned.

Avoid fantasy. Don't talk about what you wish you have learned.

Use succinct nuggets, piercing clarity, meaningful indicators.

Illustrate ideas with brief personal stories.

The idea is for you to generate a real-time reflection of what you have learned. When you know something, it is easy to record.