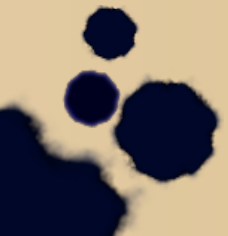
Intelligent Decision Making

by
Dr Brad Morantz

Intelligent Decision Making

- Should I go to this class?
  - Yes
  - Or No
  - First decision of the day

1) This is NOT the first decision of the day
2) Lets make it an intelligent decision



Well, what about it?

- What is the first decision of the day?
  - The alarm goes off.
  - Hit the snooze button or get up?
  - That is the first question of the day

- Second decision:
  - What should I wear today?
  - It goes on like this.
- 300 - 400 questions a day

How to make the decision

- Impulsive
  - I'm tired, late night last nite, hit the snooze
  - What the heck, I'll get up soon
- Emotional
  - Who cares, my boss hates me anyways, hit the snooze
- Intelligent
  - What will happen either way?
  - What are the costs of each alternative decision?
  - How do these compare to desired outcomes?

Important Decision

- Company A has the opportunity to buy Company B for $100 Million
  - If this is a good move,
    - Company A could grow, take a large portion of the market, and increase their net profit, increasing shareholder equity.
    - Would also give a big bonus to the executives
  - If this a bad move,
    - it could bankrupt Company A, ending their existence
    - The executives would lose their grossly overpaid position
- This is a very important decision

What is this 'Intelligence'?

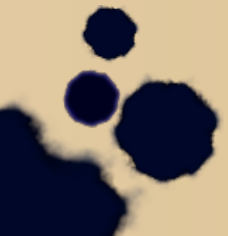
- Ability to understand or reason (dictionary)
- Mental Ability (Encyclopedia)
  - Learning
  - Problem solving
  - Abstract thinking
  - Reasoning
  - Spatial manipulation
  - Language acquisition
  - That which is measured on an IQ test
- Herb Simon
  - Involves associations, pattern recognition, inference, experience, and intuition

Definitions

- Decision
  - A conclusion or selection after consideration
  - Considers needs, preferences, and values one has or seeks
- Decision-Making
  - Cognitive process resulting in the selection of a belief or course of action among several alternative possibilities, based on values and preferences of the decision maker
- Intelligent Decision-Making
  - Using intelligence in making a decision
  - To improve the quality of the decision

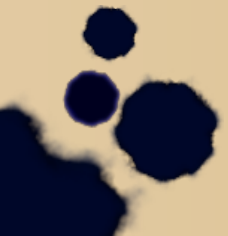
Axiom

- The best decisions are made based on knowledge and information
  - Harvey Brightman



Define the Problem

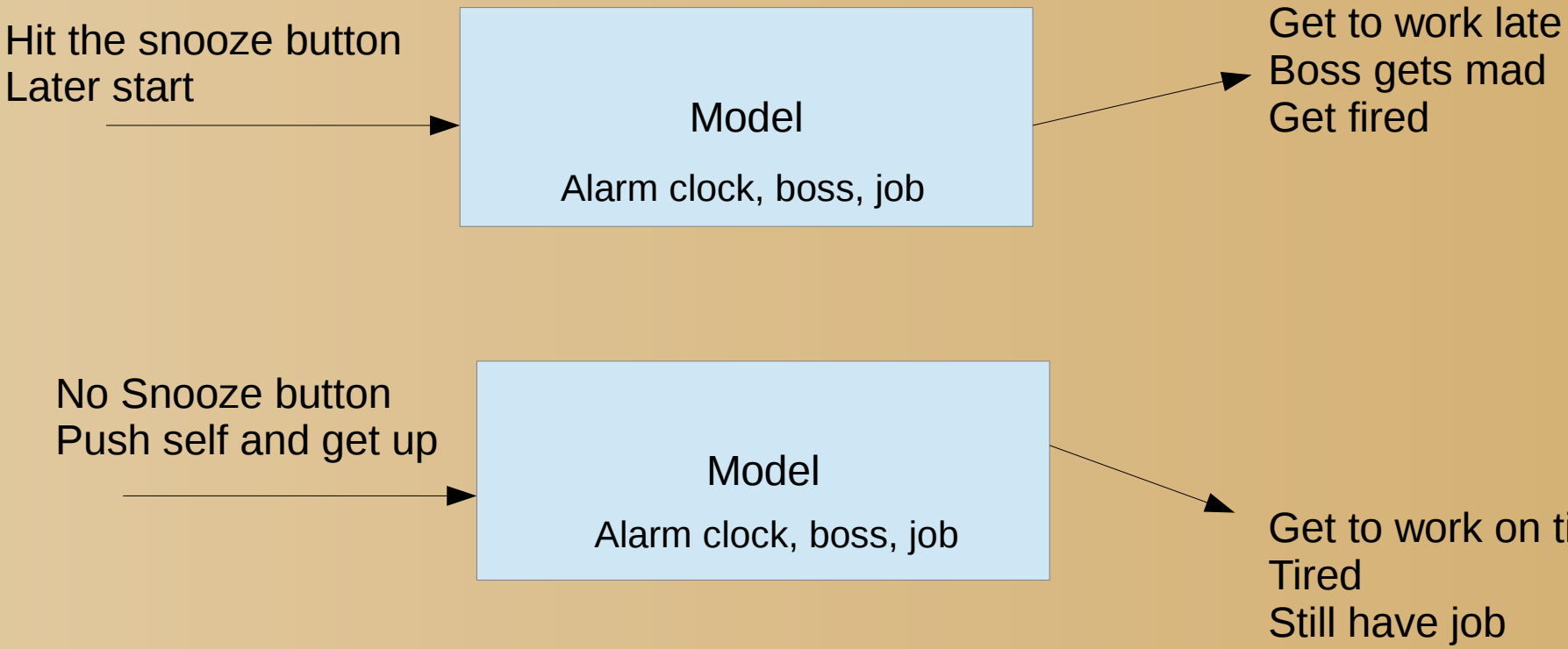
- What exactly are we trying to decide?
- Important step, if not correct, answer may not be
- Avoid type III error → right answer to wrong problem



Model Based Decision-Making

- Build a model of the system
  - In this case the alarm clock, the boss, and the job
  - Capable of forecasting results of any action option
- Input the action options (alternatives)
- Record the results
- Compare them to the desired results
- This is a Model Based Decision Support System (MBDSS)
- Decisions are made based on what the model predicts

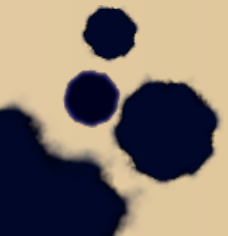
Model Based Decision-Making



Does this help you make the decision?

Simple Mathematics

- The grocery store says that if I buy from them, then I will get a discount on my gasoline.
- Lets put some numbers to these facts
  - They will give me a $1 discount per gallon if I spend $1000.00
  - My car has an 11 gallon tank, and does not go on empty
  - I can save 10 to 15% by watching sales and shopping around
- Result: It will cost $100 to $150 at the store in order to save at best $10 at the gas pump



Expected Monetary Value (EMV)

- A lottery ticket
  - 1 chance in 100 to win (1% or 0.01)
  - Ticket costs $1
  - Can win $100

- If bought all 100 tickets, would win for sure
  - Spend $100
  - Win $100
  - No gain
- EMV (of a ticket) = Probability of win times prize (P(w) * $)
  - In this case → 0.01 * $100 = $1
- Cost of ticket equals the EMV, do not bother with it, unless you like the thrill

Using EMV to Help Decision-Making

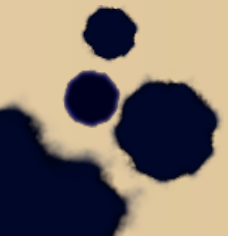
- Magazine company has sweepstakes
  - Chance of winning is 1 in 20 million
  - Cost to enter is 1 postage stamp ($0.49)
  - Grand prize is $1.5 million
- EMV = $(5 * 10^{-8}) * (\$1.5 * 10^{6}) = \$0.075$ (7 ½ cents)
- Compare to cost of entry
- Does this help make an intelligent decision?

Inference

- A friend invites you to a multi-level marketing meeting
- They tell you that you will make much money
- Time to get the facts & statistics
  - How many people get involved with this?
  - How many make lots of money?
  - What are the descriptive statistics?
  - How many sigma out is this?
  - What can be inferred from the statistics?
  - Does this help you make a decision?

Inference Logic

- Someone wants to sign you up to sell Pway
- This person is not loaded with money (same person that is always borrowing money to buy a soda)
- You can infer that selling Pway is not the way to make lots of money

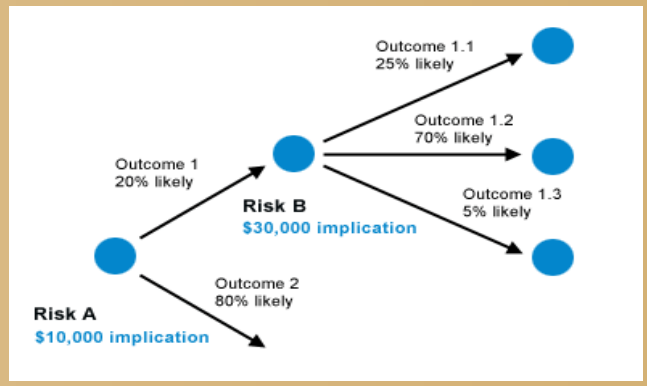


Statistical Inference

- Marketing director at tire company
- Must make decision on how long of a warranty on new tire
- Sell tires to employees
- Monitor them in the parking lot
- Get statistics and test results
  - Plot time and mileage life of test tires
  - Do the statistics
  - How much time and miles is included in 2 sigma?
- Does this help you make a decision?

Decision Trees

- A tree like graph that models decisions and possible consequences, including stochastic nodes
- Similar to flow chart
- Each path is a decision rule
- Allows calculation of expected values
- Most can be implemented in a spreadsheet
  - Very handy, does all math and formulas
- A great tool for assisting in decision-making



Understanding Decision Trees

- What does each path in the decision tree indicate
  - What impact will it have?
  - How will it solve your problem?
  - What other actions will it cause, negative & positive?
  - Is this the best solution?
  - What risks does it present?
- Shows all of the possibilities
  - Can now compare them
  - Find the one that best meets desired outcome

Decision Table

- Build a table
- Criteria on the left column
- Next column is importance
- Alternatives across the top
- Rate each alternative for each criterion
- Multiply by importance
- Add weighted average
- Look for highest score

Decision Table Example

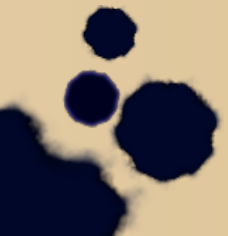
Basis	Weight	Job A	Job B	Job C
Pay	.75	$100K	$90K	$60K
City	.75	Bad	so-so	Good
Benefits	.55	Fair	None	Good
Climate	.60	Cold	Moderate	Good
Advancement	.80	Good	so-so	Good

Pattern Recognition

- Think about your job
- Reasons that the boss promoted people
- Reasons that the boss fired people
- Is there a common pattern for each?
  - Sleeping at desk
  - Personal phone calls
  - Getting to work late
  - Landing a big contract

Computerized Pattern Recognition

- Specialized programs
  - e.g. Image pattern recognition, statistical, temporal, ANN, etc
  - Learns on historical data (training)
  - Recognizes it when it sees it again



Military Use of Pattern Recognition

- Person is manning a radar station
  - Sees incoming blip on radar screen
- Look at Radar Cross Section (RCS)
  - Can the object be identified/ pattern recognized?
- Watch behavior
  - Recognize behavior of friend or foe?
- Combine with information from other sources
- C.O. must make decision on action to take based on information and pattern recognition

Data Mining

- A friend tries to sign you up to sell peanut butter
  - Promises big profit
  - Popular product, sell great quantities
- Do data mining of grocery store data
  - Find that only 1 in 5 people buy peanut butter
  - See that they buy 1 jar for every 3 loaves of bread
- Data mining shows sales of peanut butter are not great

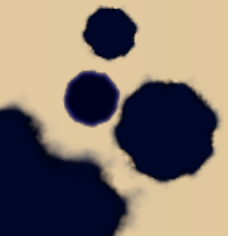
- * Numbers are only made up

Abstract Thinking

- Use the same example of the snooze alarm
- First list the action options
- Then think about each one
- What will happen if you select each one
- Think about what will happen, do not just act

Intuition

- Just get an email that you won a million dollars in the Spanish lottery.
  - Just send in bank account numbers as they request
- Wait a minute, I have a bad feeling about this



Experience

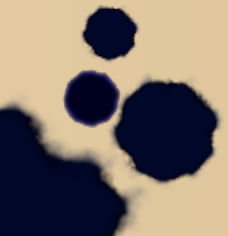
- Someone comes up and asks to borrow $10 for lunch
- Must decide whether to do it or not
- Experiences:
  - Did he/she ever borrow from you before
  - Did he/she ever borrow from someone you know
  - If so, was the debt paid back
- Apply this to the decision making process

Use Knowledge to Improve Quality

- One needs to buy a car, the decision is which one to buy
- Emotional decision-making
  - The red sports car is shnazzy, I choose to buy that one
- Intelligent decision-making
  - Use learning
    - Learn about the various cars out there
    - Go to library and look in Consumer Reports
    - Get on the internet and read reviews
    - Go talk to your mechanic
    - Speak with owners of various models
    - Employ an AI method to learn
    - Build a spread sheet of your finances, include a budget
  - Other aspects such as purpose, features, requirements, etc.

Knowledge Based DSS

- System that has many knowledge/information sources
- May have rule base
- Example: Auto Rental System
  - What is current inventory
  - Know what is reserved for when
  - Tap into knowledge base for each customer
    - Credit
    - Driving history
  - Compeitors pricing

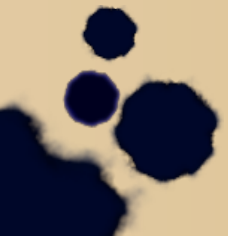


Multiple Criteria

- Decisions with one output are much easier
  - How much money, winnings, etc
- Multi-criteria are more complex
  - Can have trade-offs
  - Multiple results
    - One can get better
    - As other gets worse
    - How to decide
    - Example: Drive faster to go to work, risk getting speeding ticket
    - The cost of a speeding ticket can more than offset the extra made at work
    - Optimal is fastest can drive without getting ticket

Utility

- How important is it to keep this job?
  - Inherited a bazillion* dollars?
  - Or, working paycheck to paycheck
- Must consider the value to the person at that time
- A dime laying on the ground as Bill Gates walks by
- A bottle of water to a guy walking across the desert



* A bazillion is the largest number known to man

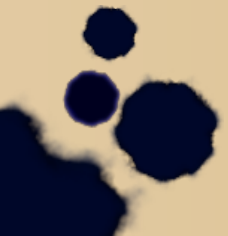
Utility Example

- A raffle to win a big fancy steak dinner for two
  - $100 value
  - $1 ticket
  - 1 in 5 chance of winning
  - Non-transferrable

- Math says expected monetary value is $20, much more than ticket
- For a vegetarian it is a poor decision to buy a ticket
  - No utility so why spend the $1

Cost of Decision

- Every decision has a cost
- Often making a wrong (or not best/optimal) decision has a cost
- These costs must be considered when decision-making



Cost Example

- In military or computer game, enemy can make surprise attack
- If call up reserves and prepare for an attack, there is an expense.
- If not call up and there is no attack then no expense
- If not call up and there is an attack, can be a gigantic expense, loss of life, property, finances, freedom, etc

Information Processing

- Computers can be very helpful
- Focus on the problem, NOT the computer
- Model for MBDSS (Opnet, Arena, GPSS, etc)
- Forecasting (SAS, R, SPSS, PSPP, S+, ANN, etc)
- Data mining (Clementine, Enterprise Miner, etc)
- Decision Trees (C4.5, Answer Tree, Excel, etc)
- Pattern recognition (ANN, OLS, specialized programs)
- Prolog for logic comprehension (Prolog, Turbo Prolog)

References

- Zeleny, M., *Multi Criteria Decision Making*, McGraw-Hill
- Morantz, B., *Neural Network Time Series Forecasting Using Recency Weighting*, The Encyclopedia of Decision Support Systems
- My Website www.machine-cognition.com
- Lapin, L., *Quanititative Methods for Business Decisions*
- Bennett, J., *Building Decision Support Systems*
- Dharr, V. & Stein, R., *Intelligent Decision Support Methods*
- Russell, S, & Norvig, P., *Artificial Intelligence: A Modern Approach*