Introduction

Examples of OM (Operations Management)

- Where do I locate my facilities?
- How much inventory do I need?
- How do I bargain with suppliers?
- How do I ensure a quality product?
- How do I transport my product?
- How do I make my company's processes as efficient as possible?

Definition

Operations Management: Activities that relate to the creation of goods and services through the transformation of inputs to outputs.

Big Picture

Business Problem $\Longrightarrow$ (abstracted into) Math Problem $\Longrightarrow$ Solve it with math tools (Operations Research) $\Longrightarrow$ Put the result back into the business background

The ability to "**Abstract**" a business problem into a math problem is one of business students' core competences.

We have business problem – usually we have a trade off, something goes up, something will go down (inventory, if you want to stock, holding cost will increase, but the order cost/setup cost will decrease, then you will have a quadratic curve) – we need to find a balance point to maximize the profits or minimize the cost. Then we abstract this business problem to a math problem, and solve it, this is what OM does. How to solve it? It is about math, usually we call it OR (Operations Research).

Chapter 1 Decision

Session 1 Decision Strategy and Decision Table

Alternatives are something subjective, they are decided by ourselves.

Alternatives: A course of action or strategy that may be chosen by a decision maker (e.g. applying for UConn or CMU or GSU; whether to take umbrella tomorrow)

State of nature: An occurrence or a situation over which the decision maker has little or no control (e.g. bad application market-too many competitors and very few positions; tomorrow's weather)

Payoff: what we can get after our decision; salary, scholarship, utility

Objective: considering different states of nature, with some decision tools, we select the one(s) with the optimal payoff(s) from the alternatives.

Example

We want to determine the best real estate investment project given the following table of payoffs for three possible interest rate scenarios.

	Interest Rates (%)		
Projects	Decline	Stable	Increase
Office park	0.5	1.7	4.5
Office building	1.5	1.9	2.4
Warehouse	1.7	1.4	1.0
Shopping center	0.7	2.4	3.6
Apartment	3.2	1.5	0.6

S1.1 Decision making under uncertainty

The **optimistic** decision criteria. (Maximax)

	Interest Rates		
Projects	Decline	Stable	Increase
Office park	0.5	1.7	4.5
Office building	1.5	1.9	2.4
Warehouse	1.7	1.4	1.0
Shopping center	0.7	2.4	3.6
Apartment	3.2	1.5	0.6

Step 1: take the Maximum of each row

Step 2: take the Maximum of the column of maxima

The **pessimistic** (but also most safe) decision criteria. (Maximin)

Which project's lowest interest rate is highest?

Step 1: take the Minimum of each row

Step 2: take the Maximum of the column of minima

	Interest Rates		
Projects	Decline	Stable	Increase

Office park	0.5	1.7	4.5
Office building	1.5	1.9	2.4
Warehouse	1.7	1.4	1.0
Shopping center	0.7	2.4	3.6
Apartment	3.2	1.5	0.6

Take average of each row and choose the optimal one(s).

	Interest Rates			
Projects	Decline	Stable	Increase	Average
Office park	0.5	1.7	4.5	2.23
Office building	1.5	1.9	2.4	1.93
Warehouse	1.7	1.4	1.0	1.37
Shopping center	0.7	2.4	3.6	2.23
Apartment	3.2	1.5	0.6	1.77

Extension

Which one is generally the best? Taking average.

Max/min can be easily affected by outliers (extreme values).

e.g. We have a series of number, Kobe Bryant's scores per game (SPG) in each season:

7.6 15.4 19.9 22.5 28.5 …

min: 7.6 (96-97) max: 35.4 (05-06) average: 25.0 (whole career)

If we use one number to describe Kobe Bryant as an attacker, the min and max are not representative.

S1.2 Decision making under risk

Random Variable:

1. Real number on real line;

2. Can take different values with assigned probabilities, and all these probabilities should sum to **one**.

Using capital letter, alphabet (X/Y/Z)

Expectation (Expected Value) is a concept based on Random Variable.

How to calculate expectation (expected value)?

Expectation is the weighted average of all values.

e.g. Roll a fair die:

X	1	2	3	4	5	6
Prob.	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

Expected Value: $EX = \frac{1}{6} \times (1+2+3+4+5+6) = 3.5$

Expected value is equal to the sum of each value multiplying its corresponding probability.

	Interest Rates		
	Decline	Stable	Increase
Prob. of Scenarios	p_D	p_S	p_I
Office park	0.5	1.7	4.5
Office building	1.5	1.9	2.4
Warehouse	1.7	1.4	1.0
Shopping center	0.7	2.4	3.6
Apartment	3.2	1.5	0.6

Suppose $p_D = p_S = p_I = \frac{1}{3}$, which means we have equal likelihood for each case, then we calculate the EV as followings:

	Interest Rates			
	Decline	Stable	Increase	
Prob. of Scenarios	$p_D = \frac{1}{3}$	$p_S = \frac{1}{3}$	$p_I = \frac{1}{3}$	Expected Value
Office park	0.5	1.7	4.5	2.23
Office building	1.5	1.9	2.4	1.93
Warehouse	1.7	1.4	1.0	1.37
Shopping center	0.7	2.4	3.6	2.23
Apartment	3.2	1.5	0.6	1.77

We will select either the Office park or the Shopping center.

Suppose $p_D = 0.5$, $p_S = 0.35$, $p_I = 0.15$, then we calculate the EV as followings:

	Interest Rates			
	Decline	Stable	Increase	
Prob. of Scenarios	$p_D = 0.5$	$p_S = 0.35$	$p_I = 0.15$	Expected Value
Office park	0.5	1.7	4.5	1.52
Office building	1.5	1.9	2.4	1.775
Warehouse	1.7	1.4	1.0	1.49
Shopping center	0.7	2.4	3.6	1.73
Apartment	3.2	1.5	0.6	2.215

Extension

Why do we call it "under risk"? Risk is related to expected value.

Gamble: you pay $100, then we flip a coin. If head, you will get $200; if tail, you will get nothing. The expected payoff is exactly $100, which is equal to the cost you pay. If we repeat this game for millions of times, you will lose nothing.

If you refuse to play this game – risk-averse

If you do not care – risk-neutral

If you prefer – risk-lover

For risk-averse, risk is actually a type of cost/loss, people need extra money to make up their feeling of risk.

S1.3 Decision making under certainty

Expected Value under Certainty (EVUC)

What would we do if we knew which scenario would come true? For example, if we know it will be a decline scenario, then we will choose Apartment. Similarly, if we know it will be stable, we will choose shopping center; if increase, then office park.

Definition EVUC

Pick the decision that has the highest value for that column, and weight these values by the corresponding probabilities. We call this result the Expected Value under Certainty (EVUC)

$$EVUC = 0.5\times3.2 + 0.35\times2.4 + 0.15\times4.5 = 3.115$$

In this scenario, we **assume** we knew what would happen in the future, but actually it is "assumption". We still have three states of nature with their probabilities.

The number is larger than EV (=2.215), because we assume we knew "something", i.e. the **information,** which we should have not known. But how much does this information worth? Compare EVUC and EV, the difference is the value of information, we call this:

Expected Value of Perfect Information (EVPI)

$$EPVI = EVUC - EV = 3.115 - 2.215 = 0.9$$

Summary

Under uncertainty

The Optimistic Decision Criteria-Maximax

The Pessimistic Decision Criteria-Maximin

Taking average

Under risk

Expected Value (EV) or Expected Monetary Value

Under certainty

Expected Value under Certainty (EVUC)

Expected Value of Perfect Information (EVPI) = EVUC - EV