Announcements

- Midterm on Thursday.
- Folio 2 due on Feb 16 Tuesday (if you are doing a folio!)
Student Talks
3-tier model common.

Sun’s version of 4-tier model not-common.

N-tier model where Webserver and Application Server on separate equipment also common.

Sun’s hardware business not strong.

- Linux on cheap PCs most common servers
- *Microsoft* desktops replacing Sun workstations
Last Class

- **Java**
  - Common in Server implementations
    - Example: Java Servlet implementing application logic in a banking application.
  - Often used to push simple applets onto client
  - Not common
    - For “big” desktop applications
    - Office Suite in Java not popular
  - *Microsoft is still in business*...
What could have Sun done?

• Compete on price with cheap PC servers running Linux?
• Sell a fat-client workstation that runs Windows and is price competitive with Dell, HP PCs, etc...
• Sell workstations at a price premium over PCs, focus on software reliability, run some Microsoft application, build brand cachet.
• Focus on Java based software and IT services for enterprises, withdraw from low-end hardware...
• Something else?
Cash Flows and Rate of Return
Time Value of Money

- A cash flow is a series of payments or receipts spaced out in time.
- The key concept in analyzing cash flows is that receiving a $1 today is more desirable than receiving a $1 some time in the future.
- How much more desirable $1 today is compared to $1 in the future depends on the person or firm’s view point.
The **discount factor**, $\delta$, is the number which a future cash flow, to be received at time $T$, must be multiplied by in order to obtain the current present value.

For example- If we ask decision maker how much she values $5 one year in the future, she would take $5 times the discount factor $\delta=0.80$ which yields $4$.

A cash flow where $5 is received one year from now would be drawn as:
The horizontal access is in units of years. It is common convention to label the current year as “0.” Because the decision maker’s discount factor $\delta$ is 0.80, the above cash flow is equally desirable as the cash flow:

\[ \delta \times \$5 = \$4 \]
Net Present Value (NPV)

- The net present value of a cash flow is a quantity of money, which if received today, would be equally desirable as the cash flow.

- So the cash flow of receiving $1 in year 2, has an NPV of $\delta_2 = 0.64$. Note that the answer depends on the value of our discount factor $\delta$. 

\[
\begin{align*}
\delta \times \$0.80 &= \delta (\delta \times \$1.00) = \\
\delta^2 \times \$1.00 &= 0.64
\end{align*}
\]
NPV contd...

- By this logic, $1 in year n is as desirable as $\delta^n.
- Thus, the NPV of $x_n received in year n is $x_n\delta^n$.
- Thus if we have a cash flow for which we receive of $x_0$ in year 0, $x_1$ in year 1, and $x_2$ in year 2, and so on, the NPV of the entire cash flow is:

$$NPV = x_0 + \delta x_1 + \delta^2 x_2 + \delta^3 x_3 + ... = \sum_{j=0}^{\infty} \delta^j x_j$$
Oftentimes, a decision maker’s discount factor is based on the interest rate or rate of return she could receive if she were to invest her capital in the bank or perhaps in another project.

For example, suppose the interest rate $i$, were 0.10 (10%).

- Then having $1 in the bank today would be worth $1 \times (1+i) = $1.10 a year from now.
- Conversely, receiving $1.10 a year from now would be as desirable as having $1 today that could be put in the bank.

Thus the NPV of getting $x$ one year from now is $x / (1+i)$.

Thus the relationship between the discount factor and the interest rate will be $\delta = 1/(1+i)$.
NPV equation in terms of interest rate $i$

$$NPV = x_0 + (1+i)^{-1}x_1 + (1+i)^{-2}x_2 + (1+i)^{-3}x_3 + ... = \sum_{j=0}^{\infty} (1+i)^{-j} x_j$$
Summary

- To compute NPV
  - If you are given an interest rate $i$, use
    \[ NPV = x_0 + (1+i)^{-1}x_1 + (1+i)^{-2}x_2 + (1+i)^{-3}x_3 + ... = \sum_{j=0}^{\infty} (1+i)^{-j} x_j \]
  - If you are given a discount factor $\delta$, use
    \[ NPV = x_0 + \delta x_1 + \delta^2 x_2 + \delta^3 x_3 + ... = \sum_{j=0}^{\infty} \delta^j x_j \]
  - If you do not have either a discount factor or an interest rate, you do not have enough information to compute the NPV.
Rate of Return or Return on Investment

- The return on investment, or more commonly called the rate of return (ROR), is an inverse problem to computing the NPV.
- When one computes the ROR on an investment decision one is essentially asking, “What would the interest rate at the bank have to be in order for me to be neutral about investing in my project?”
- Thus, we are trying to find an interest rate $i$ such that the NPV of the project is 0, as expressed by the equation:

$$x_0 + (1+i)^{-1}x_1 + (1+i)^{-2}x_2 + (1+i)^{-3}x_3 + ... = \sum_{j=0}^{\infty} (1+i)^{-j} x_j = 0$$
You have a plan to deploy an information system in your company.
Suppose the cash flow is as above (same as Assignment 2)
Your boss tells you to deploy your proposed information system if the return on investment is more than 20%.

- What is ROR?
- Should you deploy the information system? Why?
Solution

• Let \( i \) denote the RoR of this project. Then we could write the equation for RoR as

\[
-900 + 750(1 + i)^{-1} + 350(1 + i)^{-2} = 0
\]

• Solving this quadratic equation by quadratic formula (with variable substitution \(:= (1 + i)^{-1})

\[
-900 + 750\delta + 350\delta^2 = 0
\]

\[
350\delta^2 + 750\delta - 900 = 0 \quad \text{(with } a = 350, b = 750, c = -900)\]

\[
\implies \delta = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-750 \pm \sqrt{750^2 - 4 \cdot 350 \cdot (-900)}}{2 \times 350}
\]

\[
\implies \delta = -3, \text{ or } \frac{6}{7}
\]
Solution (contd..)

- Discard the root of $\delta = -3$ since it doesn't make sense in our context.
- Back substituting and solving for $i$,

\[
(1 + i)^{-1} = \frac{6}{7} \\
1 + i = \frac{7}{6} \\
\Rightarrow i = \frac{1}{6} \approx 0.1667
\]

- Thus, we get the RoR of this project is approximately 16.67%.
- Since the 16.67% < 20%, the rate of return is smaller than the targeted value, it is not worthy to deploy this project then.
Infinite Series

- Sometimes a series of payments or receipts is never ending.
- One special case is when the same payment or receipt is made or received every year forever.

\[ x + \delta x + \delta^2 x + \delta^3 x + \ldots = NPV \]
\[ \delta x + \delta^2 x + \delta^3 x + \delta^4 x + \ldots = \delta \times NPV \]
\[ x = (1 - \delta)NPV \]
\[ NPV = \frac{1}{1 - \delta} x \]