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Management Information Systems
Spring 2008
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# Assignment 1 (Due: Tuesday, Feb 12, 2008)

**Instructions and guidelines**

- You will need the file moore.xls to complete this assignment. It is available on the course web site.
- This assignment will be graded on a pass/fail basis. You will pass this assignment if you have attempted parts (a) through (e), obtained satisfactory results, and submitted the deliverable. All passing assignments will receive full score. You may consult with your team members, but submit you own version of the solution.
- **This is a long document because it gives you detailed step-by-step instructions**. As you will discover when completing your work, the actual assignment is pretty short. I suggest that you read through pages 1-5 before starting your work.

**Deliverable:** Upload of completed Excel file *your_lastnameAssign1.xls* .

This assignment asks you to analyze the growth of microprocessor complexity and Moore's Law. To perform this analysis, you will use a couple of simple Excel features. Broadly, Moore's law predicted the exponential progress of semiconductor technology that has resulted in the rapid growth of microprocessor speed over the last few decades. More precisely, Gordon Moore predicted that the number of transistors on each microprocessor would double periodically. This prediction was made in 1965 (in Moore's article Cramming more components onto integrated circuits), and is probably the most pervasive and famous statement anyone has made about information technology.

You have been provided with an Excel workbook called moore.xls. Start by downloading this workbook to your hard drive or network drive and saving it under the name *your_lastnameAssign1.xls*. For instance, if your last name is **Smith**, save the workbook under the name **SmithAssign1.xls**.

The workbook has two worksheets. The first worksheet is called *Basic Data*. It contains data about the year of release and the number of transistors on each new generation of microprocessors Intel has released over the last 35 years or so. This data was obtained from Intel's web site The worksheet also has cells that you will use to enter your name, NetID, and written answers. The Basic Data worksheet is illustrated on the next page.

| | |
|---|---|
| **Last Name:** | *enter your last name here* |
| **First Name:** | *enter your first name here* |
| **NetID:** | *enter your NetID here* |

| Processor | Year of release | Number of transistors (1000's) |
|---|---|---|
| *8008* | 1972 | 2.5 |
| *8080* | 1974 | 5 |
| *8086* | 1978 | 29 |
| *80286* | 1982 | 120 |
| *80386* | 1985 | 275 |
| *80486* | 1989 | 1,180 |
| *Pentium* | 1993 | 3,100 |
| *Pentium II* | 1997 | 7,500 |
| *Pentium III* | 1999 | 24,000 |
| *Pentium 4* | 2000 | 42,000 |
| *Itanium 2* | 2003 | 220,000 |
| *Itanium 2 (9MB cache)* | 2004 | 592,000 |

*Enter your answer to part (d) here. Refer to the assignment instructions for details*

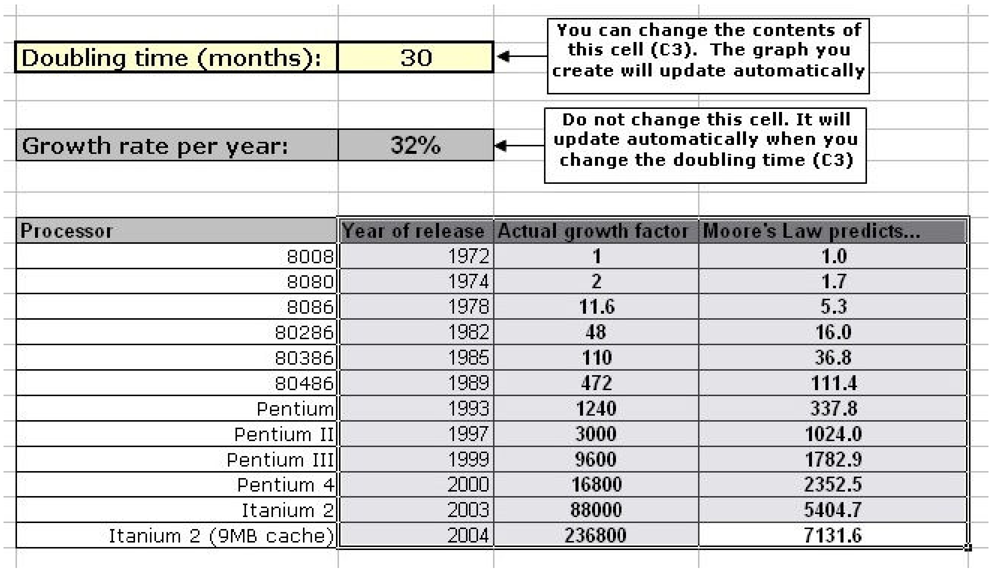
The second worksheet, which is called *Model of Moores Law,* contains a simple model of Moore's law. You **do not** have to understand exactly how the formulas in the worksheet work (although, if you are interested, you should read through part (e) of the assignment). Column D contains data corresponding to the actual growth rate of microprocessors (from the data we have in the first worksheet). Column E contains the prediction of our model of Moore's Law.

| | | |
|---|---|---|
| Doubling time (months): | 30 | You can change the contents of this cell (C3). The graph you create will update automatically |
| Growth rate per year: | 32% | Do not change this cell. It will update automatically when you change the doubling time (C3) |

| Processor | Year of release | Actual growth factor | Moore's Law predicts... |
|---|---|---|---|
| 8008 | 1972 | **1** | **1.0** |
| 8080 | 1974 | **2** | **1.7** |
| 8086 | 1978 | **11.6** | **5.3** |
| 80286 | 1982 | **48** | **16.0** |
| 80386 | 1985 | **110** | **36.8** |
| 80486 | 1989 | **472** | **111.4** |
| Pentium | 1993 | **1240** | **337.8** |
| Pentium II | 1997 | **3000** | **1024.0** |
| Pentium III | 1999 | **9600** | **1782.9** |
| Pentium 4 | 2000 | **16800** | **2352.5** |
| Itanium 2 | 2003 | **88000** | **5404.7** |
| Itanium 2 (9MB cache) | 2004 | **236800** | **7131.6** |

**Part (a):** Enter your name and NetID into cells C3, C4 and C5 of the worksheet *Basic Data.*

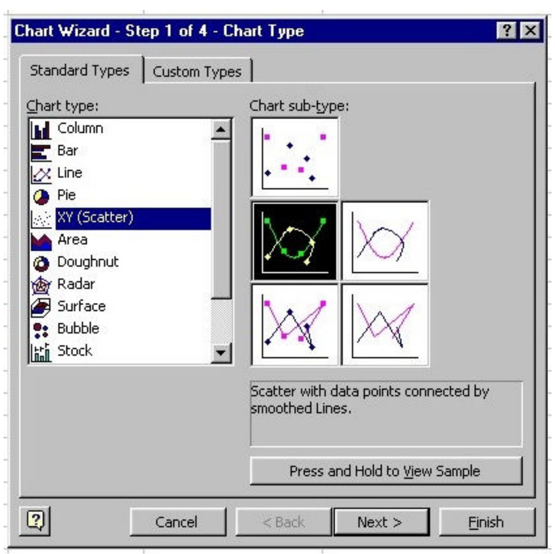
**Part (b):** Create a chart which will enable you to visually compare the prediction of our model of Moore's Law to the actual data. To do this, first select the range **C9:E21** in the worksheet *Model of Moores Law.* Next, click on Chart Wizard to create the chart.



| | | |
|---|---|---|
| Doubling time (months): | 30 | You can change the contents of this cell (C3). The graph you create will update automatically |
| Growth rate per year: | 32% | Do not change this cell. It will update automatically when you change the doubling time (C3) |

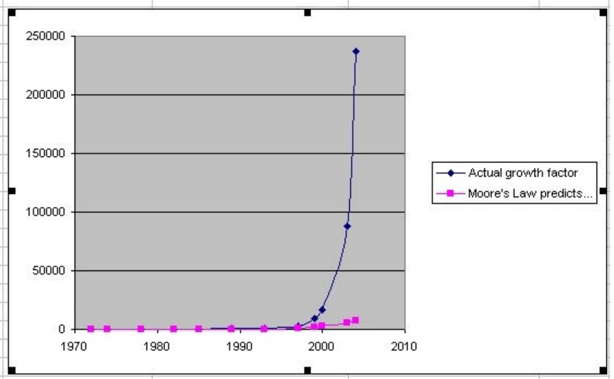
| Processor | Year of release | Actual growth factor | Moore's Law predicts... |
|---|---|---|---|
| 8008 | 1972 | 1 | 1.0 |
| 8080 | 1974 | 2 | 1.7 |
| 8086 | 1978 | 11.6 | 5.3 |
| 80286 | 1982 | 48 | 16.0 |
| 80386 | 1985 | 110 | 36.8 |
| 80486 | 1989 | 472 | 111.4 |
| Pentium | 1993 | 1240 | 337.8 |
| Pentium II | 1997 | 3000 | 1024.0 |
| Pentium III | 1999 | 9600 | 1782.9 |
| Pentium 4 | 2000 | 16800 | 2352.5 |
| Itanium 2 | 2003 | 88000 | 5404.7 |
| Itanium 2 (9MB cache) | 2004 | 236800 | 7131.6 |

The chart type you should use is *XY (Scatter).*




Click on through the steps. When you're done your sheet should end up looking something like the one on the next page. Don't worry if the chart hides part of the worksheet containing the data. **Save your work.**

| Year of release | Actual growth factor | Moore's Law predicts... |
|---|---|---|
| 1972 | 1 | 1.0 |
| 1974 | 2 | 1.7 |
| 1978 | 11.6 | 5.3 |
| 1982 | 48 | 16.0 |
| 1985 | 110 | 36.8 |
| 1989 | 472 | 111.4 |
| 1993 | 1240 | 337.8 |
| 1997 | 3000 | 1024.0 |
| 1999 | 9600 | 1782.9 |
| 2000 | 16800 | 2352.5 |
| 2003 | 88000 | 5404.7 |
| 2004 | 236800 | 7131.6 |

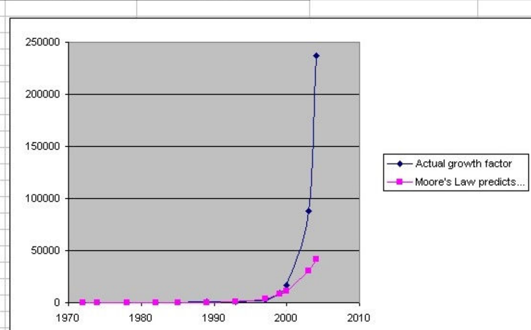



**Part (c):** You may have noticed that the 'Moore's Law predicts' graph is pretty different from the 'Actual growth factor' graph. Your next task is to try and improve the similarity between the two graphs. To do this, change the value of the cell C3 in the worksheet *Model of Moores Law*. Notice that the graph changes automatically when you change this value. **DO NOT change the value in cell C6, or any other formulas. These will automatically adjust when you vary the doubling period in cell C3.**

For instance, if we change the doubling time from 30 to *25* months, the graph looks something like this:

| | | |
|---|---|---|
| Doubling time (months): | 25 | You can change the contents of this cell (C3). The graph you create will update automatically |
| Growth rate per year: | 39% | Do not change this cell. It will update automatically when you change the doubling time (C3) |

| Processor | Year of release | Actual growth factor | Moore's Law predicts... |
|---|---|---|---|
| 8008 | 1972 | 1 | 1.0 |
| 8080 | 1974 | 2 | 1.9 |
| 8086 | 1978 | 11.6 | 7.4 |
| 80286 | 1982 | 48 | 27.9 |
| 80386 | 1985 | 110 | 75.6 |
| 80486 | 1989 | 472 | 286.0 |
| Pentium | 1993 | 1240 | 1082.4 |
| Pentium II | 1997 | 3000 | 4096.0 |
| Pentium III | 1999 | 9600 | 7968.0 |
| Pentium 4 | 2000 | 16800 | 11113.3 |
| Itanium 2 | 2003 | 88000 | 30152.7 |
| Itanium 2 (9MB cache) | 2004 | 236800 | 42055.3 |



Try a few different values (intelligently deciding whether to increase or decrease the value of cell C3. Decide on a doubling time that seems to work well. After you decide on a final doubling time, leave this value in cell C3. **Save your work**.

**Part (d)**: Write 1-2 sentences about your best estimate of doubling time and d growth rate in the answer Box in the Basic Data worksheet.

Now, What is the prediction (using your version of Moore's Law) for the growth factor for the years 2010 and 2020?

To evaluate this, you can add two more rows, filling in for the Year of Release column (C22 and C23) the values 2010 and 2020, and copying the formula for Moore's law prediction to E22 and E23. Leave the celss D22 and D23 empty as we do no thave actual values for these years.

Write your answer for the predictions in the Answer Box in Basic Data Workshhet.

**Save your work**..

**Part (e)**

Our model of Moore's law uses the formula:

$$\frac{N(t)}{N(t_0)} = (1+r)^{(t-t_0)},$$

where $N(t)$ is the number of transistors per microprocessor in year $t$, $N(t_0)$ is the number of transistors per microprocessor in the first year $t_0$ that we consider (so $t_0$ is 1972 in this model), and $r$ is the annual growth rate of transistors per microprocessor. The **actual growth factor** in year $t$ (over year $t_0$) is $\frac{N(t)}{N(t_0)}$, and this is what we have computed on the worksheet *Model of Moores Law*. This is calculated directly from the data in Column D. Correspondingly, we have calculated the **predicted growth factor** in column E, using the formula $(1+r)^{(t-t_0)}$. This is similar to formulas that you will deal with if you decide to work in finance or economics (if you've worked with compound interest, you may see a similarity as well).

The exercise you have performed in parts (b) and (c) simply compares these two sets of growth factors, and tries to find a doubling time[1] that matches them up reasonably well.

Now, let's return to the formula for Moore's Law:

$$\frac{N(t)}{N(t_0)} = (1+r)^{(t-t_0)}.$$

If one takes the logarithm of both sides of this formula, one gets:

$$log\left[\frac{N(t)}{N(t_0)}\right] = (t-t_0)\log[1+r].$$

The advantage of this equivalent formula is that it converts an exponential growth formula into a linear growth formula. The information in each formula is exactly the same (as you may recall from high school math when you studied logarithms). However, lines are easier to compare, and this is what this optional part of the assignment asks you to do.

Here is what you need to do.

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[1] The way we convert a **doubling time** of $d$ months into an **annual growth rate** $r$ is by starting with the formula:

$$(1+r)^{(d/12)} = 2,$$

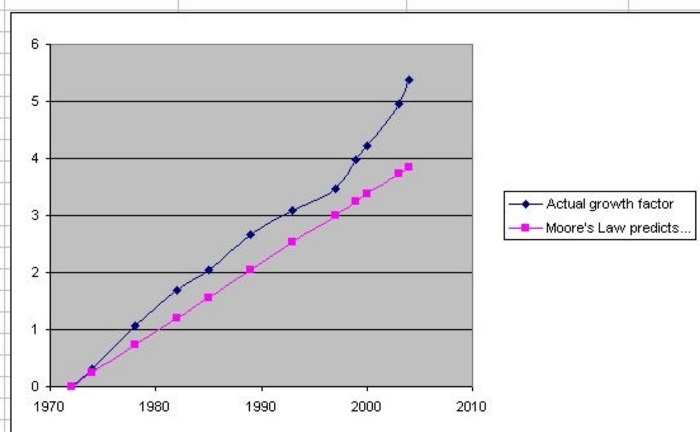
since $d/12$ is the doubling time in years. This can be rearranged into the formula $r = (2^{(12/d)} - 1)$, which is what you may have noticed is in cell C6. You don't need to alter this conversion to complete part (e).

Create a copy of the worksheet *Model of Moores Law*, and name it *Log Model of Moores Law*. You may delete the rows 22 and 23. Leave all the formulas in rows 1 through 8 as they are. Using Excel's LOG function, change the formulas in column D so that they are the logarithms of the actual growth rates (of the form $log[\frac{N(t)}{N(t_0)}]$). Change the formulas in column E so that they are of the form $(t-t_0)\log[1+r]$.

You'll notice that the chart adjusts automatically, and you'll get something that looks like this:

| | | |
|---|---|---|
| Doubling time (months): | 30 | You can change the contents of this cell (C3). The graph you create will update automatically |
| Growth rate per year: | 32% | Do not change this cell. It will update automatically when you change the doubling time (C3) |

| Processor | Year of release | Actual growth factor | Moore's Law predicts... |
|---|---|---|---|
| 8008 | 1972 | 0 | 0.0 |
| 8080 | 1974 | 0.301029996 | 0.2 |
| 8086 | 1978 | 1.064457989 | 0.7 |
| 80286 | 1982 | 1.681241237 | 1.2 |
| 80386 | 1985 | 2.041392685 | 1.6 |
| 80486 | 1989 | 2.673941999 | 2.0 |
| Pentium | 1993 | 3.093421685 | 2.5 |
| Pentium II | 1997 | 3.477121255 | 3.0 |
| Pentium III | 1999 | 3.982271233 | 3.3 |
| Pentium 4 | 2000 | 4.225309282 | 3.4 |
| Itanium 2 | 2003 | 4.944482672 | 3.7 |
| Itanium 2 (9MB cache) | 2004 | 5.374381698 | 3.9 |




Now, experiment with a few values of the doubling time in cell C3. You'll notice that it is easier to observe how well the two curves match up (especially for the earlier years). See if this confirms your earlier estimate of doubling time.

**Save your work**. You have now successfully completed the assignment, and can submit it.