Project 2, Microsoft Excel Capstone

CS 0131, Software for Personal Computing
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Assigned: Tuesday 19 February 2013   **Due:** Thursday 28 February 2013, 11:59pm EST

Introduction

This is the second project of the term, covering the features of **Microsoft Excel 2010**. The project is split into three distinct parts, each with a distinct purpose, and each beginning with a 'C':

1. **Car Fuel Logging** — Analyzing trends in fuel economy and prices over time.

2. **Computus of Easter** — Calculating the date of Easter for an arbitrary year.

3. **Crossword Checking** — Create an interactive self-checking crossword puzzle game.

In this project, we'll be using a few new functions that we haven't used before, since there's simply no way to cover them all, but this is no cause for concern. In most cases, explanations of these functions are found in the project description and ScreenTips are always there to help you out. Of course, if you're unfamiliar with any function or the types of arguments it takes, or just need a refresher on any concept, Excel Help is wonderful first resource to help you explore.

All of the documents you need for this project can be found on the "Projects" page of the course website at http://people.cs.pitt.edu/~timparenti/teaching/cs0131/. The exact grading breakdown is to be determined, but each successive part will be worth a greater proportion than the last. Submission instructions are at the end of this document. All submissions are due **Thursday 28 February 2013, 11:59pm EST**.

1   Car Fuel Logging

Suppose you have a car. *(Some of you, perhaps, need not suppose!)* You've kept a detailed fueling log throughout the year 2012, listing the date of each time you filled your gas tank, the odometer reading (mileage) at the time, how many gallons of gasoline you purchased, and how much it cost.

Now, you're trying to determine some of the seasonal trends that affect how efficiently your car runs as well as how much it costs to run it. You decide to convert your meticulous records into a spreadsheet so that you can more easily chart and spot these trends that are hidden within your data.

1. Download `fuel.xlsx` from the "Projects" page of the course website and save the workbook as `fuel-trends.xlsx`.

2. Your friend from Canada asked how many kilometers your car has on it. Since you don't know this offhand, in the range **F4:F35**, calculate the number of kilometers travelled by multiplying the miles travelled (found in column **B**) by the conversion factor found in cell **C1**.

   Note: Don't forget there is an extra mileage value in row **4**. We'll see soon why it's there.

3. In the range **G5:G35**, calculate the price per gallon paid at each fueling by dividing the corresponding total cost by the number of gallons purchased.

4. In the range **H5:H35**, calculate the fuel economy (miles per gallon, or MPG) by dividing the miles travelled since the previous fueling by the number of gallons purchased.

   > **Hint:** Now we see why that extra mileage value is in row **4**. When we perform this calculation in row **5**, we need to take the difference of the current mileage and the previous one, then divide it by the number of gallons.

5. Now is a good time to do a sanity-check on all your results. If your formulas are telling you, for example, that gas was sold for less than $1.00 in 2012, you are sadly mistaken! Go back and fix it!

6. Format the values in the columns you just calculated:

   a. In column **F**, format the kilometer values with a comma separator but no decimal places.

   b. In column **G**, use the Accounting format, but increase the decimal precision to three places.

   c. In column **H**, display the values two two decimal places.

7. Use conditional formatting on the range **G5:G35** to observe the trends in price per gallon. Use a *Red-Yellow-Green Color Scale* so that the high (expensive) values are red and the low (cheap) values are green.

8. For the range **H5:H35**, use a *Blue-White-Red Color Scale* so that high fuel economies are blue and low fuel economies are red.

9. Select the ranges **A5:A35** and **G5:G35**, and create a chart plotting the price per gallon against the date. Use a *2-D Line* chart, which is the first choice under | Insert 》 Charts 》 Line |.

   > **Note:** Technically, since our dates are rather irregularly spaced, we should use a scatter chart; however, since our horizontal axis is a date series, Excel handles this properly in line chart mode as well. If we instead had arbitrary labels or included the headings and blank values on rows **3** and **4**, a line chart would be more likely to skew our horizontal axis labels.

10. Format the price per gallon chart as follows:

    a. Apply *Layout 6* to the chart, and select a style which is predominantly green, since this chart is about money.

    b. Change the chart title to "2012 Fuel Prices".

    c. Change the vertical axis title to "Price per Gallon".

    d. Format the number labels on the vertical axis with the Currency format with two decimal places.

    e. Format the date labels on the horizontal axis with the date format represented by "Mar-01".

    f. Select the Plot Area, right-click and select | Select Data |. Select *Series1* from the Legend Entries and click | Edit |. Enter "Price" as the series name, then click | OK | twice.

    g. Select the data label at the end of the line and make it bold.

    h. Position the chart so that its upper-left corner is in cell **J2**.

11. Select the ranges **A5:A35** and **H5:H35**, and create a chart plotting fuel economy against the date. Use a *2-D Line* chart.

12. Format the fuel economy chart as follows:

    a. Apply *Layout 8* and *Style 8* to the chart.

    b. Change the chart title to "2012 Fuel Economy".

    c. Select the data labels along the line and delete them.

d. Format the date labels on the horizontal axis with the date format represented by "3/14".

e. Right-click the date labels on the horizontal axis and select $\boxed{\text{Add Major Gridlines}}$.

f. Format the Plot Area to have a gradient fill. Under "Preset Colors", select a visually appealing gradient, and click $\boxed{\text{Close}}$.

g. Right-click the *Series1* label in the legend and select $\boxed{\text{Select Data}}$. Select *Series1* from the Legend Entries and click $\boxed{\text{Edit}}$. Enter "`Miles per Gallon`" as the series name, then click $\boxed{\text{OK}}$ twice.

h. Position the chart so that its upper-left corner is in cell **J20**.

13. Now that you can better visualize the data, in cells **H38:H43**, answer questions 1 through 6 based on your assessment of the data. All of these can be one-word answers except your name.

14. Save all changes to your workbook.

2 Computus of Easter

Say you're an event booker for a convention center in a large city. You schedule events with clients years in advance so that all the planning can get done and everything can go off without a hitch. Obviously, when considering holidays, some dates are better than others. Scheduling an event for the Fourth of July would be rather obvious, but what about major religious holidays? We would probably want to take care to dissuade clients from accidentally scheduling anything major during these observances. So you decide to create a compact spreadsheet that takes a year and quickly spits out the right dates, nothing more!

One of the major religious observances in Christianity is Easter, held every spring. The history of the holiday, however, is heavily linked with the Jewish observance of Passover, the date of which depends on the Hebrew lunisolar calendar, so it is very difficult to generalize when Easter is held. Informally, the modern observance of Easter is the Sunday following the first full moon following the March (spring) equinox. By this definition, on the Gregorian calendar (our current civil calendar), Easter can fall as early as 22 March and as late as 25 April in any given year according to the traditions of Western Christianity.

Due in part to the fact that this definition relied too heavily on celestial events and that the ability to directly observe these events varied throughout the world, the Roman Emperor convened a council of bishops in 325 CE/AD, the Council of Nicaea, to establish a mathematical algorithm for determining the date of Easter in advance. This algorithm, called the Computus, relies solely on mathematics, but still very closely approximates the traditional astronomical definition...so well, in fact, that the two methods won't fall out of sync for another several millennia. **Not bad for fourth century astronomers!**

The original algorithms were developed to place Easter on the calendar in use at the time; however, our calendar has changed somewhat since then. So, while the Computus is still calculable, the algorithms have become a bit more complex. We'll be using two algorithms to calculate the dates of Easter according to the traditions of both Western and Eastern Orthodox Christianity. The latter group determines their date for Easter according to the Julian calendar instead, and so it often falls later when we convert into our Gregorian calendar, although sometimes the two groups celebrate concurrently. (There are, of course, many holidays in many religions which fluctuate on our calendar from year to year, but the Computus is especially well-suited for this type of formulaic calculation and its algorithms are well-established.)

1. Create a blank workbook in Excel and save it as `easter.xlsx`.

2. In cell **A1**, type "`Year:`". Enter 2013 into cell **B1**, because you want to start by calculating Easter for this year.

3. Calculate the date of Easter for Western Christianity:

   a. Starting in cell **A3** and continuing down to cell **A10**, type the labels a, b, c, d, d', e, f, q. Notice that there is both d and d', as well as q.

   b. Starting in cell **B3**, fill in the proper formulas used in the Western Computus as follows:

i. The value corresponding to a should be the remainder when the year is divided by 19.

Hint: This can be calculated using the MOD() function, which returns the remainder after a number is divided by a divisor. Since the year is the thing being divided, the first argument, *number*, should be equal to **B1**. The second argument, *divisor*, should be 19.

Note that "mod" stands for "modulus", which is the name of this operation. The Computus relies heavily on the cyclical nature of modular arithmetic like this, so we'll need to become very familiar with this function.

ii. The value for b should be $225 - 11a$. Think about which cell represents a and multiply in your formula accordingly.

iii. The value for c should be the remainder when $b - 21$ is divided by 30.

Note: Mathematically, this expression can also be written as $(b - 21) \bmod 30$. How should you write the corresponding formula for Excel?

iv. Next, let $d = c + 21$.

v. For d', we need a conditional function. If $d > 48$, then $d' = d + 1$. Otherwise, $d' = d$.

vi. For e, add the year to the integer part obtained when the year is divided by 4. The formula for this is =B1+INT(B1/4), since the INT() function returns the integer part (whole number) of a calculation which could result in a fractional value.

vii. Next, let $f = (e + d' + 1) \bmod 7$. Make sure you're using d' and not d.

viii. Finally, $q = d' + 7 - f$.

c. Double-check that your formulas are producing the correct outputs. For the year 2013, the correct values should be $a = 18, b = 27, c = 6, d = d' = 27, e = 2516, f = 3, q = 31$.

d. Skip a line in the worksheet and label cell **A12** with "Month", then calculate the month in cell **B12**: If $q \leq 31$, then the month is 3; otherwise, 4.

e. Label cell **A13** with "Day" and calculate the day of the month in cell **B13**: If $q \leq 31$, then the day of the month is q itself; otherwise, $q - 31$.

f. In cell **B14**, construct an Excel-formatted version of this date using the DATE() function. Pass as arguments to this function the year in cell **B1** as well as the month and day you just calculated. Label this date "Western".

4. Calculate the date of Easter for Eastern Orthodox Christianity:

a. Starting in cell **A16** and continuing down to cell **A25**, type the labels $a, b, c, d, e, x, y, z, r, q$.

b. Starting in cell **B16**, fill in the proper formulas used in the Eastern Orthodox Computus as follows:

i. Let a be the remainder when the year (still in cell **B1**) is divided by 4.

ii. Let b be the remainder when the year is divided by 7.

iii. Let c be the remainder when the year is divided by 19.

iv. Let $d = (19c + 15) \bmod 30$.

Note: We've begun a different algorithm for the Eastern date. Make sure your formula is referring to the correct c.

v. Let $e = (2a + 4b - d + 34) \bmod 7$.

vi. For x, take the integer part when the year is divided by 100. *(Do you remember what function to use here?)*

vii. For y, take the integer part when the year is divided by 400.

viii. Let $z = x \bmod 4$.

ix. Let $r = 3y + z - 2$.

x. Let $q = d + e + 114$.

c. Double-check that your formulas are producing the correct outputs. For the year 2013, the correct values should be $a = 1, b = 4, c = 18, d = 27, e = 4, x = 20, y = 5, z = 0, r = 13, q = 145$.

d. Skip a line in the worksheet and label cell **A27** with "Julian Month", then calculate the month in cell **B27** as the integer part when q is divided by 31.

e. Label cell **A28** with "Julian Day" and calculate the day of the month in cell **B28** as $(q \bmod 31)+1$.

   Note: This time, we're adding 1 *after* we take the modulus, not before.

f. In cell **B29**, construct an Excel-formatted version of this date using the DATE() function as you did earlier.

g. The date we just calculated is based on the older Julian calendar; label it "Julian".

h. We must correct the date to match the current Gregorian calendar using the other values we calculated. In cell **B30**, add r days to the Julian date in cell **B29**, then label this new date "Eastern".

5. Select cells **B14** and **B29:B30** (those containing dates), and apply the Custom Number Format "d mmmm" (with four 'm's) so that your dates are formatted, for example, like "8 April".

6. Check your final answers against several different years by changing the value in cell **B1**. Your results should be as follows:

Year	1963	1988	1992	2012	2013	2014	2040	2063
Western	14 April	3 April	26 April	8 April	**31 March**	20 April	1 April	15 April
Eastern	14 April	10 April	26 April	15 April	**5 May**	20 April	6 May	22 April

   Note: This exercise is meant solely to give you confidence that your calculations are correct. I will be checking how your spreadsheet handles years other than those listed here! Since one of the limitations of the DATE() function is that it only works with years between 1900 and 9999, our calculations won't work outside that range... but I can pick any years inside that range to test your spreadsheet! The point is that if your spreadsheet gets all of the above dates correct, chances are quite good that it is correct for all years in that range.

7. Once we're done checking, set the year to 2016 to prepare your workbook for submission.

8. Select rows **2** through **13** and **15** through **29** and hide them from view. Only the year, along with the calculated Western and Eastern dates, should be showing now. If you did everything right, neither date should be in the month of April.

9. Type your name in cell **A32** and save all changes to your workbook.

3 Crossword Checking

Guess what, class? We're going into the computer games business now! There's only one problem: This isn't a programming course. **Never fear!** Your fearless ~~boss~~ instructor has determined that a simple crossword game can be implemented in Excel.

We can use worksheets to separate the puzzle from the solution, and conditional formatting can help the players check their answers as they go along! Sure, it won't have high-end graphics or anything fancy, but we're catering to the intellectual crowd. Crosswords don't need that stuff anyway.

1. Create a blank workbook in Excel and save it as crossword.xlsx.

2. Delete *Sheet2* and *Sheet3* from the workbook. Rename *Sheet1* to "Solution".

3. Select the entire worksheet with Ctrl + A . Change all column widths and heights to **40 pixels** and change the font size of the entire worksheet to a 20-point font. Also set all cells to be center-aligned both horizontally and vertically.

4. On this grid of squares, create the "solution" to your own crossword puzzle. You may use any appropriate words or names for your puzzle, but **must** keep in mind the following requirements:

a. You must have at least eight answers in your puzzle, and each answer must be at least four letters in length. (You can, of course, have more if you want!)

b. Each answer must be spelled left-to-right horizontally or top-to-bottom vertically, one letter to a cell.

c. All answers must be connected contiguously with the rest of the answers.

d. If multiple answers exist in the same row or column, they must be separated with at least one blank space between them.

e. All letters must be entered as uppercase. It may be convenient to turn on ⌈Caps Lock⌉ for this part... just don't forget to turn it off when you're done!

5. Create a blank document in Word. Type up the answers to your clues, sort them in alphabetical order, and save it as `crossword-answers.docx`.

   Note: This simple step is required in order to help me grade this part of the project. I'll test out your crosswords with some right and wrong answers, but I won't have the time to solve them from scratch!

6. Now go back to the spreadsheet. Hold down ⌈Ctrl⌉ and carefully select **only** the cells which contain letters. (If you accidentally select a cell that does not contain a letter, you will need to start this part over.) Use the Name Box to name this range *CrosswordCells*.

7. With the *CrosswordCells* range selected, apply a thin border around each of these cells and give them a white fill.

   Important! A white fill is different from no fill at all! Be sure to set this fill, or this difference will become quite apparent soon!

8. Create a copy of the *Solution* worksheet. Put it before the original *Solution* sheet, and rename the resulting *Solution (2)* sheet to be called *Puzzle*.

9. Make sure you're on the *Puzzle* sheet. Then, for each of your answers in turn, select the cell which contains its first letter (either the leftmost or topmost cell) and create a clue for that answer using ⌈Review⌉ ≫ ⌈New Comment⌉. Write your clue in the comment for the corresponding cell.

   Note: If you have two answers starting in the same cell, you'll need to have two clues in the same comment. Label them with "`ACROSS:`" and "`DOWN:`" to distinguish which is which.

10. Once you've created all of your clues in this fashion, select the entire worksheet using ⌈Ctrl⌉+⌈A⌉ and delete all of the text. After all, this is where the player is going to put in their guesses.

11. Download the `black-fill.png` image from the "Projects" page of the course website and save it in the same folder as your spreadsheet.

12. With the entire *Puzzle* sheet still selected, go to ⌈Page Layout⌉ ≫ ⌈Background⌉ and select the `black-fill.png` image you just downloaded. Also apply a thin black border to all of the cells on this sheet.

13. Use the Name Box to select the *CrosswordCells* range on the *Puzzle* sheet. Create the self-checking functionality by going to ⌈Conditional Formatting⌉ ≫ ⌈Manage Rules⌉:

    a. First create a rule to determine whether the entered letter is correct:
       i. Select "Use a formula to determine which cells to format".
       ii. Enter the following formula **exactly**:
          ```
          =EXACT(UPPER(INDIRECT("R"&ROW()&"C"&COLUMN(),FALSE)),
          UPPER(INDIRECT("Solution!R"&ROW()&"C"&COLUMN(),FALSE)))
          ```

Note: The `EXACT()` function compares two arguments and asks if they are exactly the same. In this case, this is the letter the player will enter and the corresponding letter in the solution. The `UPPER()` function makes sure that these are both uppercase before they are compared.

The `INDIRECT()` function is complicated, and it's not important that you understand it. Basically, it's a way to refer to the same cell on the two different worksheets. `INDIRECT()` is aided by the `ROW()` and `COLUMN()` functions as well as the ampersand (`&`) operator.

    iii. Click ⌗Format⌗ and apply a light green fill to cells which match this criterion. Then click ⌗OK⌗.

  b. Next, create a rule to determine whether any other (incorrect) letter has been entered. This one is easier because correctness is handled by the first rule, so we need only check whether the input is blank:

    i. Select "Format only cells that contain".

    ii. In the rule description, select "No Blanks".

    iii. Click ⌗Format⌗ and apply a light red fill to cells which match this criterion. Also apply a bright red font color and make the font bold. Then click ⌗OK⌗.

  c. Check the order of these rules. Use the ⌗Move Up⌗ and ⌗Move Down⌗ buttons (which look like arrows) to make sure the correctness criterion comes before the criterion for non-blanks.

  d. On the first criterion, check the "Stop If True" box, since if this criterion is met, the letter is correct, so we do not want to move onto the next criterion. Then click ⌗OK⌗.

14. Try putting some letters into the white squares on the *Puzzle* sheet to make sure your conditional formatting works. Try letters that are correct as well as letters that are incorrect. Once you are satisfied that everything is working, remove all text from all cells once again.

15. As it stands now, the player could potentially edit the solution. Switch to the *Solution* worksheet and protect it from edits using ⌗Review⌗ ≫ ⌗Protect Sheet⌗. Uncheck the box "Select locked cells" and enter the password "cs0131" to lock the sheet.

    Note: Again, for the sake of grading, please make sure that the password is **exactly** "cs0131", all lowercase, no space, no quotes.

16. Now the solution is protected, but we also want to hide it. First, switch back to the *Puzzle* sheet, which is where the player will play. Then go to ⌗File⌗ ≫ ⌗Options⌗ ≫ ⌗Advanced⌗, and under "Display options for this workbook", uncheck the box "Show sheet tabs".

17. To create a less distracting experience for the player, go to ⌗View⌗ ≫ ⌗Show⌗ and uncheck "Formula Bar" and "Headings".

18. Save all changes to your workbook.

Submission

Use the "Assignment Submission" section in CourseWeb to submit your files for **Project 2** by the deadline. Please make sure you attach **all** of the following files to the same submission in CourseWeb:

1. `fuel-trends.xlsx`

2. `easter.xlsx`

3. `crossword.xlsx`

4. `crossword-answers.docx`

If you need to resubmit for any reason, you must attach **all** files again. All submissions are due **Thursday 28 February 2013, 11:59pm EST**.