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## PROBLEM SET 1

\* Hard problems

+ Solutions provided

**Jogging.** You are a regular jogger. After each run, you record the distance covered in kilometers and the time taken in minutes and seconds. This information is in a small paper notebook. Looking at the data, it is difficult to evaluate how your performance has changed over time.

**Qn 1.01**

- Transfer the data to a spreadsheet and start tabulating them to compute other information, such as speed in kilometers per hour.
- As you enter more data, you notice some of the earlier runs have distances recorded in miles and time recorded in minutes (in 1 or 2 decimal places). For completeness, you want to capture these data as well. So you add columns for entering the data in the different dimensions convert them into standardized units and provide speed information in miles per hours as well. A mile is 1.60934 kilometers, 60 seconds makes a minute and 60 minutes make an hour.

**Physical health.** As a parent of a few children, you want to keep close track of their physical health. You record at birthdays, their heights and body weights. For the sake of overseas relatives and friends, with whom you share news of your children, the height and weight information have to be in meters and kilograms as well as feet and inches and pounds. To those not familiar with the different measures, one meter equals 39.3701 inches, one kilogram equals 2.20462 pounds, 12 inches is a foot, and 16 ounces is a pound. You recently learned that healthcare professionals use the *Body Mass Index (BMI)* to gauge whether a person is under or over weight. *BMI* is computed by dividing the person's body weight in kilograms by the square of his or her height in meters. *BMI Prime* is defined as the ratio of *BMI* to the maximum healthy *BMI*, currently set at 25. A healthy person should have a *BMI* between 18.5 and 25, or a *BMI Prime* of 0.74 to 1.00.

**Qn 1.02**

- Construct a spreadsheet for recording the children's information over time.
- Provide a table of *BMI* values for heights of 0.8 to 1.4 meters (31 to 55 inches) and weights of 10 to 55 kilograms (22 to 122 ounces).

**Windchill.** Temperatures are affected by wind. This is particularly important to residents of cold countries with sub-freezing weather. Scientists have determined a way to correct temperatures taken using a thermometer in still air to account for the chilling effect of the wind. In the metric system, this is given by the formula:  $T_w = 13.12 + 0.6215 \times T - 11.37 \times V^{0.16} + 0.3965 \times T \times V^{0.16}$ , where  $T_w$  is the windchill temperature in degree Celsius,  $T$  is the air temperature in degree Celsius and  $V$  is the wind velocity in kilometers per hour (kmph), taken at 10 meters height. . For those preferring the imperial system, using measurements in degrees F and miles per hour (mph), the formula is  $T_w = 35.74 + 0.6215 \times T - 35.75 \times V^{0.16} + 0.4275 \times T \times V^{0.16}$ .

**Qn 1.03<sup>+</sup>**

- Construct a spreadsheet model for either the metric or imperial system that gives the windchill temperature for any possible air temperature and wind velocity.
- Provide a table of windchill temperatures for ranges of air temperatures and wind velocities. Windchill temperature is only defined for air temperatures at or below 10 degrees C or 50 degrees F and wind velocity greater than 4.8 kmph or 3.0 mph.

**Foreign currency.** You are about to travel to an exotic country. The currency of the nation you are residing is not universally convertible and at your destinations, there are few banks and automatic teller machines. Therefore, you want to have sufficient foreign currency before leaving home. As your local money changer will not have enough foreign currency, you need to carry some amounts in United States Dollar (USD), European Euro, British Pound or Japanese Yen, in case you run out of cash during the trip.

**Qn 1.04<sup>+</sup>**

- Construct a spreadsheet model to compute the equivalents in your destination currency and these internationally convertible currencies.
- You want to convert about USD 2400's worth of your currency to the destination currency, subject to what is available. For the remaining amount, you would convert equally to USD, Euro, Pound and Yen.
- Make your model flexible so that you can vary the allocation proportions. Remember your local moneychanger do not carry small notes and loose change in foreign currencies.

**Time sheet.** A marine shipyard employs hour-rated workers to do odd jobs. Every four weeks, the shipyard grades these workers on their punctuality, skills, and work quality. According to their grading score, the workers are each assigned their hourly pay rates. Worked hours are clocked each day and recorded. At the end of the week, the workers' pay are tabulated and paid out. The government requires the employer to withhold as income tax 22% of each worker's gross pay. The shipyard also deducts on behalf of the house union \$8 per worker each week as union fees.

**Qn 1.05<sup>+</sup>**

- Construct a spreadsheet for the above. Enter the data for a few simulated workers: hours worked for each day of the week and individualized hourly rates. Use a variety of input values.
- Compute the total worked hours for the week, gross pay, tax, union fees and net pay.
- The spreadsheet should be pleasing to the eye, and easy to understand and use even for a large shipyard with many workers.

**Retail rice.** The International Rice Research Institute (IRRI) keeps excellent data on rice production and trade. Visit their website to learn what they do and download data using their online query form and analyze them. Here is a set of data taken from IRRI. It shows the milled rice retail price of years 2000 to 2009 for the top 10 rice producing countries.

**Qn 1.06**

- Using only years 2000 to 2004 data, construct a spreadsheet model to forecast by linear extrapolation the retail rice prices for year 2005 to 2009.
- Compare your forecasted prices against the actual prices. This back-testing approach is often used to evaluate forecasting methods. By doing so, you can know the accuracy of the methods without having to wait many years to find out.

Country	Output '000 ton	Milled retail rice at '000 local currency/ton									
	2011	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
China	202,600	1.323	1.422	1.580	1.637	2.362	2.225	2.174	2.430	2.400	3.930
India	105,700	11.84	10.85	10.73	10.59	10.92	11.41	11.92	13.38	16.56	17.96
Indonesia	65,700	2778	2851	3389	3202	3317	3318	3381	3445	3510	
Bangladesh	50,600	13.34	13.25	14.21	14.49	16.34	15.96	16.44	20.60	29.79	20.71
Vietnam	42,300	2783	2510	3423	3455	3665	4316	4463	5765	9336	8908
Thailand	34,500										
Myanmar	32,800	46.26	47.00	98.00			155.80	217.28	259.41	352.34	340.92
Philippines	16,600	19.45	19.43	19.98	20.20	21.04	22.88	23.56	24.72	32.71	34.12
Brazil	13,500										
Pakistan	9,200	16.57	16.62	16.59	18.69				20.73	31.00	43.36

+ Prices are rounded to 4 significant digits

**Sprocket hub.** The *Sprocket* production line requires 10,000 *Sprocket* hubs per year. Purchasing estimated that processing each order costs them \$0.50 in manpower and computing cost. In stock, hubs cost \$15.00 per unit per year in space, damage, loss, and

**Qn 1.07<sup>+</sup>**

insurance costs. Your job as a logistic planner is to calculate how many hubs should be ordered at each replenishment request. If you order 200 hubs, deliveries will be arriving almost weekly with very low carry costs. If you order at one go the whole annual requirement of 10,000 hubs, the purchase order cost is lowest but carry cost will be highest. The *Economic Order Quantity (EOQ)* is the order amount that minimizes the sum of order and carry costs. It is given by the formula  $EOQ = (2DO/C)^{0.5}$ , where  $D$  is the annual demand quantity,  $O$  is the cost per order, and  $C$  is the unit carry cost per year.

- Construct a spreadsheet model that shows the *EOQ* for any input values and test it on the above data as base case.
- Compute the annual order and inventory carry costs. Assume the hub stock is drawn out evenly over time by the production line and typically ordered early enough for its level to be at just above 10% of the order size when new stocks arrive.
- If the demand for sprockets increases dramatically to require 20,000 hubs per year as input material, what is the optimal quantity of hubs to order each time?

**Paper Products.** *Paper Products* is a traditional maker of customized stationery. Their handcrafted cards and envelopes are popular for corporate offices, weddings and other special occasions. To expand their production capacity to meet rapidly growing demand and shorter turnaround time, the owner is studying the possibility of using more machinery on some product lines. Mechanization can be crudely divided into three levels: manual with electric hand tools, semi-automated machinery, and fully automated mass production. Their cost structures are low-fixed high-variable, mid-fixed mid-variable, and high-fixed low-variable respectively. Considering the substantial initial financial outlays, she wonders at what sales volumes would the automation investments breakeven for each mechanization level.

**Qn 1.08<sup>+</sup>**

She decided to focus on one product line at a time. Their envelopes are now priced at about \$0.30 each and current sales volume is 50,000 per year. From the various equipment suppliers' quotations and internal production costing, they estimated that the (fixed, variable) costs combinations available are (\$10,000, \$0.23), (\$20,000, \$0.18) and (\$50,000, \$0.15).

- Construct a spreadsheet model for this problem.
- Which level of technology should she implement? Can there be a hybrid solution?
- What if the sales volume fails to meet up?
- What if the variable cost estimates are incorrect?

**Plan-track.** Construct a spreadsheet to help a university student analyze how she spends her time on various weekly activities. These include attending classes and studying, sleeping and napping, eating meals and tea breaks, exercising, reading newspapers and non-academic materials, watching television, and playing computer games.

**Qn 1.09<sup>\*</sup>**

- The student should be able to view each activity laid out against the days of the week.
- Use the spreadsheet to sketch out a plan for better allocation of her time. To test the plan, to see how effective it is, record her actual behavior and compare this against the plan.
- Enter some data into your spreadsheet and compute basic statistics such as average, maximum and distribution. Type in short comments as analysis of the situation.

**Largest countries.** The top 10 largest countries in the world according to the 2012 population data are China, 1,343,239,923; India, 1,205,073,612; United States, 313,847,465; Indonesia, 248,645,008; Brazil, 193,946,886; Pakistan, 190,291,129;

**Qn 1.10<sup>\*</sup>**

Nigeria, 170,123,740; Bangladesh, 161,083,804; Russia, 142,517,670; and Japan, 127,368,088. The top 10 largest countries by square kilometer land area are Russia, 17,075,400; Canada, 9,984,670; United States, 9,826,675; China, 9,598,094; Brazil, 8,514,877; Australia, 7,617,930; India, 3,287,263; Argentina, 2,766,890; Kazakhstan, 2,724,900; and Sudan, 2,505,813. In the year 2012, the world's population was 7,017,846,922 and land area was 148,940,000 square km.

- a. Tabulate the above data in a spreadsheet. Add more columns to present information derived from the data that may be helpful to the user. For example, show the population and area of each country as percentages of the top 10 countries and of the world.
- b. Your information should anticipate questions the user may ask about the top 10 countries, such as which country is smallest or largest, what is their average population and land area of the group, and how much of the world's population or area is accounted for by the top 1, 2, ..., 10 countries.



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