Chapter 2

End of Chapter Exercises

1. *Suppose a certain car has a fuel tank with a capacity of 60 litres and an average fuel consumption of 14km/l. How many times must you fill the tank to travel 2,000km? How many miles can you travel on 10 gallons of fuel using the same car? You can answer this using imperial gallons (8 imperial pints, where 1 pint = 20 imperial fluid ounces) or US gallons (8 US pints, where 1 pint = 16 US fluid ounces). 1 US fluid ounce = 1.0408423 imperial fluid ounces. Thus, 1 litre = 0.219969157 imperial gallons = 0.264172051 US gallons. Or, 1 imperial gallon = 4.54609 litres, and 1 US gallon = 3.785411784 litres. 1 mile = 1.609344 km.*

Car's range = 840 km (60 × 14). 2000 km ÷ 840 km = 2.38, therefore we must fill the tank 3 times (doing it only twice causes the car to stop at 1,680 km).

How many miles can you travel on 10 gallons of fuel?

Fuel consumption = 14 km/l = (14 ÷ 1.609344) = 8.699 miles/litre.
8.699 miles/litre = 8.699 ÷ 0.219969157 = 39.55 miles/imperial gallon = 8.699 ÷ 0.264172051 = 32.93 miles/US gallon. Therefore, 10 imperial gallons will get you 39.55 × 10 = 395.5 miles. 10 US gallons will take you 32.93 × 10 = 329.3 miles.

2. *Getting dressed in the morning (that is, just the tasks associated with getting dressed; do not include getting up, washing, etc.).*

```
Put on underwear.
Put on socks.
Put on trousers.
Put on shirt.
Put on shoes.
```

Issues to deal with (steps 3 & 4 of strategy): what if there aren't any clean underpants, socks, shirts? What if I want formal trousers rather than jeans or khakis? What does 'appropriate shoes' mean? If it's cold, should I put on a sweater too? If it's formal dress, I guess I need a tie too. But then I'm assuming I'm a man. Well, I am, but you may not be. Grief! What about skirts, blouses, hose, etc??? What decisions do women have to make about getting dressed? Ouch, I only viewed this from my own perspective as a man....

3. *Using an electric filter machine (also called a percolator) make a pot of coffee and pour a cup.*

```
Measure water for one cup
```

```
Pour water into coffee machine's reservoir
Put filter paper into machine
Measure coffee for one cup
Put coffee into filter paper and close the door
Plug machine into electricity outlet
Switch on machine
Wait for coffee to filter through
Pour cup
Turn off machine
```

Question: Do I only make enough for one cup, or should I make more coffee but only **pour** one cup? More of this sort of thing in the next chapter.

4. *Filling a car with fuel.*

```
Drive to petrol station.
Unlock fuel cap.
Get out of and lock car (remember to take wallet).
Select correct fuel (diesel or unleaded).
Put nozzle into filler cap.
Pump desired amount of fuel.
Replace nozzle.
Replace fuel cap and secure.
Pay for fuel.
Unlock car, get in, drive away.
```

5. *Making a cheese and onion omelette.*

```
Get a bowl
Crack two eggs into bowl
Whisk the eggs
Add 'some' milk (full fat, half fat, skimmed?)
Add pinch of salt
Add pepper
Grate a little cheese
Find a small onion
Peel onion
Cut in half
Chop one half of the onion finely (dice it)
Add onion to bowl with egg mixture
Heat knob of button in a frying pan
When butter sizzling add mixture
Cook slowly (not too high a heat)
When the base starts to firm but top still runny sprinkle
the grated cheese on top
Wait for top to firm up
```

```
Fold in two
Serve
```

Issues: how much milk? How much cheese? How big is the onion? How big is a knob of butter? How hot is 'not too high a heat?'. How long does this all take really? Any differences between gas and electric cookers?

6. *Travelling from home to work/college.*

Here's how I do it by train:

```
Leave house 15 minutes before train arrives
Walk down hill to train station (approx 1 mile)
Wait on Platform 1 for train
Get on train when it arrives
If my weekly ticket has expired buy another one from
conductor otherwise show conductor my valid ticket
When train arrives at Newcastle, get off
Walk up the hill to the university (approx 1 mile)
```

Going by car is more complicated as there are three different routes I use depending on the time of day and traffic conditions.

7. *Completing a piece of homework/college assignment.*

```
Read the assignment brief and put away
Wait 2 days
Get out assignment and read it again
Sketch some notes and put away
Wait 2 days
Get out assignment and draft full solution and put away
Wait 2 days
Get out assignment and check draft
Redraft final solution and put away
Wait 2 days
Check final submission and correct any errors
Hand it in
Wait for high grade. :-)
```

8. *A wedding ceremony. Note, this is very culturally dependent, so my solution may not resemble yours at all!*

Here's a typical Anglican/Episcopal ceremony

```
Ushers arrive at the church and help get everyone seated
Groom and best man arrive and sit at front on the right
Play some music while waiting for all to be seated
```

At appointed time bride arrives
Processional music begins
Bride escorted up aisle by father/person 'giving her away'
Bride stops and front
Music stops
Minister gives a Welcome
Say the declarations
Reading
Sermon
The vows
Exchange of rings
Proclamation of the marriage by the minister
Signing of the marriage register
Prayers
Dismissal
Bride and Groom leave first
Everyone else leaves

Hymns/songs usually sung at appropriate points during the service

9. *Choosing what to study at university.*

There are at least two approaches:

Ask: what subjects interest me most?
Ask: what skills do I have?
Ask: what are my strengths & weaknesses
Ask: where do I see myself in 10 years?
Write down answers to above
Discuss above list with careers adviser
Search university admission sites for courses using keywords from your list
Narrow down choice
Pick the most amazingly fantastic & appropriate course for myself

Here's another approach

Apply for a selection of different courses
Accept first offer received

Issues: what are the strengths/weaknesses of the two approaches???

10. *Hanging a picture on the wall.*

Choose best spot

```
Measure height hook should be placed
Nail hook into wall
Hang picture on hook
Stand back and assess if picture hanging straight
Straighten picture if necessary
```

Issues: what if not a brick wall? Maybe can't just bang a nail into it: need to select appropriate hanging system. Also, are there any hidden pipes/wires in the wall? Maybe need a detector gadget to see if intended spot is safe.

Projects

StockSnackz Vending Machine

A StockSnackz vending machine is being installed in the staff common room at theUniversity of Stocksfield for the free use of the faculty. The machine has 10 numbered buttons. Pushing Button 1 dispenses a milk chocolate bar, Button 2 a muesli bar, Button 3 a pack of cheese puffs, Button 4 an apple, Button 5 a pack of popcorn, while pushing Button 6 displays on the machine's small screen a summary of how many of each item have been dispensed. Pushing the Buttons 0, 7, 8, or 9 has no effect.

Using the HTTLAP strategy write down the series of steps needed to install the new machine, fill it with supplies, and let people obtain snacks from it over the course of the first day. You may assume that the machine can store unlimited supplies of each item. At the end of the day, the dean of faculty will want to know how many snacks have been dispensed. For now, treat the problem of lots of people obtaining lots of snacks over the course of a day as a single abstract activity "Dispense snacks."

```
1. Install the new machine.
2. Turn on power.
3. Load machine with snacks.
4. Dispense snacks.
5. Show dispensing report.
```

Stocksfield Fire Service: Hazchem Signs

Use HTTLAP *to write down the overall series of steps needed to translate each character of the three-character EAC.*

```
1. Decode first character and give fire-fighting instructions.
2. Decode second character and give precaution instructions.
3. Decode third character and state whether public hazard
exists.
```

Puzzle World: Roman Numerals and Chronograms

Without any other information, what steps might you perform in the process of converting a decimal number to Roman numerals? Or a Roman number to decimal? Outline the overall stages of the process now.

The information we are given is in Table 2.1:

Roman number	Decimal equivalent
III	3
IV	4
CIX	109
LVIII	58
XCIX	99 (why not IC?)
D	500
M	1000
MCMC	Invalid

There is some detective work needed here. Clearly the table isn't giving full information so I must infer some rules from it. What do I know for sure? Table 1.2 from Chapter 1 tells us:

Roman number	Decimal equivalent
I	1
V	5
X	10
L	50
C	100
D	500
M	1000

I also know from the description of the project in Chapter 1 that the number 51 is written as LI, the number 1,500 is written as MD, and so on. Further, the numbers 4, 9, 40, 90, 400, and 900 are written as IV, IX, XL, XC, CD, and CM respectively. Thus, 14 is XIV, 99 is XCIX, etc. (What is common to the numbers 9, 40, 90, and 900?). In this system, the year 1999 would be written as MCMXCIX and the year 2007 as MMVII.

I know that III=3. S, perhaps I can infer that II=2 and I=1. WE know from above that I=1, so this looks ok. But why does IV=4? Why not IIII? We know from above that V=5? There is another occurrence of V in the table: LVIII which equals 58. I can see the III again, so perhaps the III part contributes 3 to the value which would mean that LV = 55. It looks then as if roman numbers are sums of terms. III = I + I + I = 3. LVIII then might equal L + V + III. We know V is 5 and L is 50 (see table above), so this looks right too.

What's different between IV and VIII? Why is the first one 4 and the second one 8? Perhaps it depends on the ordering. In IV we have a small number followed by a larger one, whereas in VIII we have a larger number V followed by a smaller number III. Perhaps roman numbers are summed when the sequence is large-small but

subtracted when small-large? Lets look at row 3 of Table 2.1 which says CIX=109. We can get 9 by subtracting 1 from 10 and we know from above that IX=9. So, we have another example of a smaller number coming before a larger one to give a subtraction (as in IV) Apply this to row 5.

In row 5 we see XCIX=99. We know the IX=9. We also know C=100 and X=10 which would make XC=90 -- it's a small number followed by a larger one, so we subtract the first from the second, which means take 10 (X) from 100 (C). So, XCIX = 90+9 (rather, 100-10 + 10-1 !). Why is 99 not simply IC, i.e, 100-1? Apparently it's invalid, so perhaps there is a rule about how big the difference can be.

Ok, there's a lot going on and I still don't know all the precise rules, but I think I can say that (1) roman numbers are sequences of smaller sub-sequences. The sub-sequences themselves are added, but the 'digits' of the sub-sequences are either added (if the sub-sequence is larger followed by smaller) or subtracted (if it's smaller followed by larger). There is some rule governing the maximum difference between the numbers in subtraction sub-sequencs. So:

III = I + I + I + = 3.
IV = I subtracted from V = 4
CIX = 100 + (1 subtracted from 10) = 99
LVIII = L + V + III = 50 + 5 + 3 = 58
XCIX = (10 subtracted from 100) + (1 subtracted from 10) = 90 + 9 = 99
D = 500
M = 1000
MCMC = invalid. Why? I think it's meant to mean 1100 + 1100 = 2200. Perhaps you have to put all the like digits together so that the sequence has an overall descending order of magnitude. We can see that in all the examples above. XCIX = 90 + 9, LVIII = 50 + 5 + 3. So, perhaps 2200 should be MMCC? 2000 + 200?

Converting decimal numbers to roman numerals is going to be a lot easier. We know what the various sequences are for certain numbers: I=1, IV=4, V=5, IX=9, X=10, XL=40, L=50, XC=90, C=100, D=500, M=1000. The outline process, therefore, must involve dividing the decimal number repeatedly into small units until we get down to the 1s. For example, 20 = XX. Why? X is the largest roman numeral we can fit into 20. But 1 X only gives us 10 with a left over of 10. The left over can also be represented by an X. The number 70 = LXX. 70 can be divided by 50 once, so that gives us one L. The left over is 20 which divides by 10 twice to give XX. Put it together and we get LXX. 39 = 3 × X + 1 × IX: 3 10s plus a leftover of 9. We have a symbol for 9 = IX, so 39 = XXXIX.

The outline, then might look like this:

1. Number of 'M's needed = number ÷ 1000
2. Leftover = remainder after dividing number by 1000
3. Number of 'D's needed = leftover ÷ 500
4. Leftover = remainder after dividing leftover by 500
5. Number of 'C's needed = leftover ÷ 100

6. Leftover = remainder after dividing leftover by 100
7. Number of 'L's needed = leftover ÷ 50
8. Leftover = remainder after dividing leftover by 50
9. Number of 'X's needed = leftover ÷ 10
10. Leftover = remainder after dividing leftover by 10
11. Number of 'V's needed = leftover ÷ 5
12. Number of 'I's needed = remainder after dividing leftover by 5

Reflecting upon this algorithm reveals a few limitations. No attempt is made to deal with the special terms IV, IX, LX, XC, CM. That is, the number 9 would come out as VIIII rather than IX; 40 would be XXXX rather than XL, etc. We will address these issues in later chapters as our problem solving vocabulary expands.

Pangrams: Holoalphabetic Sentences

Consider how you would go about systematically determining whether a sentence is a pangram. You might want to use a bag of Scrabble tiles as an aid. Write down the basic sequence of actions you would take. As before, make use of the HTTLAP *questions to guide you.*

I know from Chapter 1 that a pangram uses all the letters of the alphabet. That is one of the 'knowns'. What I don't know is how to determine if a sentence is a pangram, so that's the 'unknown' which we must solve. The principal parts of the problem are: the letters in a sentence, knowledge of the alphabet, the number of occurrences of each letter of the alphabet in the sentence. A pangram may have multiple occurrences of a letter, but if each letter occurs once only then the sentence is a *perfect* pangram.

How then to determine if a sentence is a pangram? Here's my attempt:

1. Write each letter of the alphabet on a piece of paper
2. Starting at the first letter of the sentence, work through the sentence letter by letter. Strike through the corresponding letter on the piece of paper from step 1 until the whole sentence has been processed.
3. Take the piece of paper from step 1. If there are any letters that haven't been crossed out, then the sentence is not a pangram.

We could adapt this for testing perfect pangrams by writing a tally above each letter on the paper. If all the letters on the paper have at least one tally mark then the sentence is a pangram. If all the letters have one and only one tally mark then the sentence is a perfect pangram.

Online Bookstore: ISBNs

To begin our investigation of ISBNs, think about how you would approach the problem of adding hyphens to an unformatted ISBN. Doing this makes them easier to read and so would make an Internet bookshop more user-friendly. Go back to the projects section in the Chapter 1 exercises and look again at Figure 1.5 and Table 1.3. What patterns you can spot in the way the numbers are hyphenated? Write down the sequence of actions necessary to write out the various parts of the ISBN

with hyphens in between.

What is the 'known'? Fig 1.5 tells me a lot.

I can see that a 10-digit ISBN has 4 elements: group code, publisher code, title code, check digit. If I look at the back of this book I find a 13-digit ISBN 978-1-84480-900-4. This is the new ISBN-13 format which has an extra element (typically '978' but it can be '979') at the beginning (all ISBN-13s start with 978 or 979). Amazon also gives me the 10-digit ISBN: 1844809005. From the back cover of this book the hyphenation tells me that the group code for this book's ISBN is 1, the publisher code is 84480, the title code is 900,and the check digit is 4. Thus, I can hyphenate the ISBN-10 version thus:

1-84480-900-5

I notice that the check digit for the ISBN-10 is different from the ISBN-13.

So, the overall sequence of actions to correctly hyphenate an ISBN-10 is:

1. Determine the group code and write it out
2. Write a hyphen
3. Determine the publisher code and write it out
4. Write a hyphen
5. Determine the title code and write it out
6. Write a hyphen
7. Write out the check digit

I could add a step 0 to deal with ISBN-13:

0. Write '978' followed by a hyphen
1. Determine the group code and write it out
2. Write a hyphen
3. Determine the publisher code and write it out
4. Write a hyphen
5. Determine the title code and write it out
6. Write a hyphen
7. Write out the check digit

What I don't know yet is how to determine how many of the ISBN's digits are used for the group code, the publisher code and the title code. For instance, Table 1.3 on page 18 shows three books with different length codes:

Raw ISBN	**Hyphenated ISBN**	**Book title**
0140124993	0-14-012499-3	How to Solve It
999361419X	99936-14-19-X	Gross National Happiness and

		Development
8466605037	84-666-0503-7	Los Simpson ¡Por Siempre!

So, unless I knew this book was published in group area 1 and that the Course Technology publisher code was 84480 I would not have enough information yet to work out which digit's in this book's ISBN of 1844809005 were which. All I can say for sure is that it must have 10 digits overall and the last digit is the check digit. Therefore, the algorithm above is the best I can do at the moment until I can find more information about the length of group, publisher, and title codes.
Gavrilo Princip" is too simplistic and will not receive credit.

Projects

There are no solutions provided for the projects in this chapter.