

# SCIE1000 Tutorial sheet 6

This tutorial contributes toward your final grade; see the Course Profile ([https://www.uq.edu.au/study/course.html?course\\_code=SCIE1000](https://www.uq.edu.au/study/course.html?course_code=SCIE1000)). The tutorial will be marked out of 6, with 3 marks for completing the "Before class" work, and 3 marks for completing the "In class" assessment and working on the remaining "In class" questions until you finish them or the tutorial ends.

**Goals:** This week you will work through some calculation and discussion questions, mostly relating to quantitative claims and calculations in medicine. As usual, the broad concepts and techniques are more important than the specific examples. Do not try to commit lots of facts to memory; instead, know **how** to do things, and **when** certain models and approaches are appropriate.

The aim of the computing component of this tutorial is to understand the concept of the *function* and how you can create new functions in your Python programs. Many people find writing new functions to be a bit confusing at first; ask your tutor if you want help with about anything.

## To be completed before class

Complete the following questions before class, write (or type if you wish) your answers on a sheet of paper, put your name and student number on the top of the paper, and hand it to your tutor as you enter the room. **If you do not hand in the answers at the start of the class, as you enter the room, then you will lose the marks for this component.** Note that in some cases there are no "right" or "wrong" answers.

## Question (1)

**This question involves watching a video that runs for about 13 minutes, then quickly reading a research paper. Give yourself plenty of time!**

Dr Ben Goldacre ([https://en.wikipedia.org/wiki/Ben\\_Goldacre](https://en.wikipedia.org/wiki/Ben_Goldacre)) contributes extensively to media commentary on science, and has created a website called *Bad Science* (<http://www.badsience.net/>). Dr Goldacre is a prolific writer and presenter about deliberate and accidental misunderstandings and misrepresentations of scientific information, particularly relating to quantitative claims in medical science. A video of one of his talks, titled *What doctors don't know about the drugs they prescribe*, can be found [here](https://www.ted.com/talks/ben_goldacre_what_doctors_don_t_know_about_the_drugs_they_prescribe) ([https://www.ted.com/talks/ben\\_goldacre\\_what\\_doctors\\_don\\_t\\_know\\_about\\_the\\_drugs\\_they\\_prescribe](https://www.ted.com/talks/ben_goldacre_what_doctors_don_t_know_about_the_drugs_they_prescribe)).

Watch the entire video, **and take some useful notes as you watch it**. (There may be questions relating to this on the final exam.) You do not need to note down details about particular drugs or companies. Instead, answer the following:

1. Did you find anything about the video particularly interesting? What new, broad ideas did you learn, if any? How did the video make you **feel**, and what did it make you **think**? Come along to class ready to discuss the answers to these questions. The notes you have taken will be the evidence that you can show your tutors to verify that you have done this task.
2. In the video, Dr Goldacre refers to a publication regarding the drug Tamiflu. A copy of that publication is available [here](http://journals.plos.org/plosmedicine/article/file?id=10.1371/journal.pmed.1001201&type=printable) (<http://journals.plos.org/plosmedicine/article/file?id=10.1371/journal.pmed.1001201&type=printable>).

Quickly read the publication, and take some useful notes. Again, only record key points. How did the contents of the publication make you **feel**, and what did it make you **think**? Governments have spent billions of dollars purchasing stockpiles of Tamiflu to prepare for pandemics; how do you feel about this? Come along to class ready to discuss the answers to these questions.

## Question (2)

Read and understand Section A.6 in the Python Appendix of the lecture notes, covering "Writing functions". (This material is in the book of lecture notes, near the end.) On your sheet of paper, write a short paragraph explaining the importance, role and use of writing new functions in programs.

### Question (3)

Write down all of the output generated by the following two partial Python programs.

Program 1.

```
def f(x):
    ans = x*5
    return ans

def g(x):
    ans = x+4
    return ans

a = 7
b = g(a)
print(f(b))
a = g(a-1)
print(a)
```

Program 2.

```
def grade(percent):
    if percent >= 85:
        return 7
    elif percent >= 75:
        return 6
    elif percent >= 65:
        return 5
    elif percent >= 50:
        return 4
    elif percent >= 45:
        return 3
    elif percent >= 20:
        return 2
    else:
        return 1

SCIE = 89
CHEM = 66
PHYS = 54
BIOL = 73
totGrade = grade(SCIE)+grade(CHEM)+grade(PHYS)+grade(BIOL)
GPA = totGrade / 4.0
print("GPA is ",GPA)
print("Grade is: ", grade(SCIE/2))
```

## To be completed in class

Complete the following questions in class. They involve a mix of individual work, and discussions with others. Make sure that you read the questions before class and think about how you might approach answering them. Don't rely on someone else doing all of the work. You need to work by yourself on the final exam, so it is important that you work hard now.

## Feedback: Be proactive!

Australian government research shows that students often feel they don't receive adequate feedback on their work. In a class of 800 students, it is not possible for the course coordinator to give direct feedback to each student. Instead, tutorial classes are designed to be the place in which you can get feedback on your work from classmates and the tutors. You can ask for help, show them your answers, and discuss your understanding of any of the course material. As an adult learner, the onus is on **you** to seek feedback; tutors and classmates are happy to give it, if you want it.

### Question (4)

Briefly discuss with a partner the role, use and importance of writing new functions. Ensure that you both agree on the key points.

### Question (5)

Your tutors will record the marks for the sheet of paper you submitted with the notes you took while watching the video before class, and they will then return your sheet to you.

1. Discuss your notes with your partner. If they have written something that you think may be important and that you missed, then update your notes.
2. Discuss the content of the video and tamiflu publication as a group, and update your notes appropriately.

### Question (6)

(This question was on the final examination in 2010, and worth 5 marks. Expected working time for this question was about 5 minutes.)

The pH of Coca-Cola is about 2.5. Estimate the number of positive hydrogen ions (that is,  $H^+$  ions) in Coca-Cola consumed by the Australian population each year. **Use units in your calculations and clearly state any values you assume.**

### Question (7)

(This question was on the midsemester examination in 2011, and worth 8 marks. Expected working time for this question was about 8 minutes.)

Three measures of the effectiveness of a test for a given condition are the *sensitivity*, *specificity* and *accuracy* of the test. These are defined as follows, where  $A$ ,  $B$ ,  $C$  and  $D$  are the values in the table, and  $N$  is the total population.

- Sensitivity =  $A/(A + C)$
- Specificity =  $D/(B + D)$
- Accuracy =  $(A + D)/N$

	Condition is present	Condition is not present
Test positive	$A$	$B$
Test negative	$C$	$D$

Urine pregnancy tests may be purchased at pharmacies and conducted at home. As a young scientist, you wonder how the urine pregnancy test compares with the "gold standard" serum beta hCG (pregnancy) test. The following study compares the tests.

200 women who thought they may be pregnant underwent both urine and serum hCG pregnancy tests. The results of the blood test indicated that 155 women were pregnant. Of these, 139 had tested positive on the urine test. There was a total of 57 negative urine tests.

Calculate the sensitivity, specificity and accuracy of the urine test.

### Question (8)

This question uses the definitions of sensitivity, specificity and accuracy from Question 7.

1. (This question was on the final examination in 2011 and worth 4 marks. Expected working time for this question was about 4 minutes.)

A. Most medical tests produce some false negative test results (represented by  $C$  in the table) and some false positive test result ( $B$  in the table). Give some general reasons why such errors might occur.

B. List two potential harms arising from a false negative test result for cancer, and two potential harms arising from a false positive test result.

2. (This question was on the final examination in 2011 and worth 7 marks. Expected working time for this question was about 7 minutes.)

It is known that 10 % of the members of a male population have prostate cancer. A blood test for the cancer has a sensitivity of 34.9 % and a specificity of 63.1 %.

A. Find the values of  $A$ ,  $B$ ,  $C$  and  $D$  in the table.

B. Find the probability that a man who tests positive actually has prostate cancer.

C. Find the probability that a man who tests negative actually has prostate cancer.

D. On the basis of your answers to Parts B and C, what advice would you give to a man who was considering taking the blood test?

3. In the African country of Somalia, females spend (on average) 10 % of their (entire) lives pregnant. Researchers propose the following simple test to decide whether a Somali person is pregnant: the test is "Are you female?". If the answer is Yes, then the test says the person is pregnant. If the answer is *no*, then the test says the person is not pregnant.

A. In general terms, comment on the (likely) effectiveness of this test.

B. The sensitivity of this test is 100 %, and the specificity is about 53 %. Explain why the sensitivity is 100 %.

C. Noting the sensitivity and specificity of the pregnancy test, comment on the effectiveness of the (genuine) test for prostate cancer described in Part 2.

4. Tests with very high sensitivity are not necessarily very useful in practice (for example, see Part 3). However, a **negative** test result in a test with very high sensitivity is often used to *rule out* the presence of the condition. Justify this.

### Question (9)

1. By hand, find the output produced by the following Python program when the values of 86 and 10 are entered from the keyboard.

```
# A program to investigate effectiveness of a medical test
from pylab import *

def getSens(A,C):
    # Calculate sensitivity
    s = A/(A+C)
    return s

print("Enter numbers of people with:")
A = eval(input("Condition Yes, Test +ve:"))
C = eval(input("Condition Yes, Test -ve:"))
sens = getSens(A, C)
print("Sensitivity =",sens)
```

2. Paste the program into the following Python cell and verify that your answer to Part 1 is correct.
3. Write two new functions in the program, called `getSpec` and `getAcc`, which calculate the specificity and accuracy of a test, respectively, when appropriate values are passed in to the functions.
4. Modify your program so that it inputs the values of  $A$ ,  $B$ ,  $C$  and  $D$ , and prints the sensitivity, specificity and accuracy of the test. Ensure that your program is appropriately commented and uses meaningful variable names.

```
In [ ]: # Paste program in here
```

### Question (10)

***This question is a required, in-class assessment piece. To receive the marks for this component, you and your partner must show your answers to a tutor during your tutorial.***

In the following Python cell, write a program that performs calculations relating to the sensitivity, specificity and accuracy of a test. Your program should:

- Print a suitable introductory message
- Prompt the user to enter the values of  $A$ ,  $B$ ,  $C$  and  $D$  with meaningful messages
- Use functions to calculate the sensitivity, specificity and accuracy of the test, and then print those values
- Print a message indicating which has the larger value out of sensitivity and specificity.

Note that you can modify your program from Question (9) to create this one. Run your program and enter the values of  $A$ ,  $B$ ,  $C$  and  $D$  you found in Question (8) Part 2A, and check that it finds the correct values for the sensitivity, specificity and accuracy of the test.

In [ ]: # Write your program here

### Question (11)

(This question was on the deferred examination in 2011, and worth 7 marks. Expected working time for this question was about 7 minutes.)

Critically evaluate the quantitative claims made in the following extract from a *BBC news* (<http://www.bbc.com/news/health-12999000>) article.

#### **Drinking over recommended limit "raises cancer risk"**

Drinking more than a pint of beer a day can substantially increase the risk of some cancers, research suggests. The Europe-wide study of 363,988 people reported in the British Medical Journal found one in 10 of all cancers in men and one in 33 in women were caused by past or current alcohol intake. More than 18 % of alcohol-related cancers in men and about 4 % in women were linked to excessive drinking.

The Department of Health said it was taking action to reduce drinking. Cancer charities say people should limit their drinking to lower the risk. The study calculated that in 2008 current and past drinking habits were responsible for about 13,000 cancer cases in the UK, out of a total of 304,000 cases.

Previous research has shown a link between alcohol consumption and cancers of the oesophagus, liver, bowel and female breast. The latest research found that individuals who drank more than two standard drinks a day for men and one drink a day for women were particularly at risk of alcohol-related cancers. Of the cancers known to be linked to alcohol, the researchers suggest that 40 % to 98 % occurred in people who drank more than the recommended maximum. The results were gathered as part of a study following 363,988 men and women in eight European countries aged between 35 and 70. The European Prospective Investigation into Cancer study tracked their levels of drinking and how this affected their risk of cancer. Researchers then looked at figures on how much people drank in each country, including the UK, taken from the World Health Organization.

## Question (12)

(This question was on the final examination in 2013, and worth 18 marks. Expected working time for this question was about 18 minutes.)

The following miscellaneous demographic data for the country Niger are useful when answering the question.

- Life expectancy at birth for males: 51.39 years
- Life expectancy at birth for females: 53.85 years
- Total fertility rate (TFR): 7.52 children per woman
- Proportion of the total population who are female: 50 %
- Proportion of **female** population aged 0–14: 48 %
- Proportion of **female** population aged 50 or more: 9 %

The *total fertility rate* (TFR) of a country is the average number of children born per woman. Niger has the highest TFR in the world.

1. Find the proportion of her entire life that an average Nigerien female spends pregnant. Show all working. (Hint: Assume that all pregnancies result in live births, and recall that an average pregnancy lasts for 9 months.)
2. Assume that 1000 Nigeriens (male and female, of any age) are chosen at random. On average, about 52 of these people will be currently pregnant. Use your answer to Part 1 to show how this figure is derived.
3. Consider a simple pregnancy test. When applied to females, the test returns positive; when applied to males, the test returns negative. For a group of 1000 randomly chosen Nigerien males and females, find the accuracy, sensitivity and specificity of the test. (Hint: from Part 2, assume that 52 of the people are pregnant.)
4. Consider a modified pregnancy test. When applied to females aged between 15 and 49, the test returns positive; when applied to males of any age or females younger than 15 or older than 49, the test returns negative. For a group of 1000 randomly chosen Nigerien males and females, find the accuracy, sensitivity and specificity of the test. (Hint: you may assume that no babies are born to mothers aged outside 15 to 49, and remember from Part 2 that 52 people will be pregnant.)

## Extra questions

Here are some extra practise questions, for you to do in class (if you have time), or outside class. You do not need to do them all, but may like to choose some to help with your preparation for the final exam.

### Question (13)

(This question was on the draft copy of the final exam for 2010, but it was removed at the last editing stage and replaced by a different question.)

Critically evaluate the following statement:

The problem with mathematics is that it treats everything as being exact. But the "real world" doesn't follow exact equations, and nothing is certain or precise. Thus, mathematics may be nice in theory, but not very useful in practice.

### Question (14)

Discuss the quantitative and scientific claims in the following report, from the *BBC news* (<http://news.bbc.co.uk/2/hi/health/7918576.stm>). (Spend 5 - 10 minutes on this; comment on accuracy, completeness, clarity and so on.)

#### **TV linked to asthma risk doubling**

Young children who spend more than two hours a day watching TV double their risk of developing asthma, a UK study has found. Rather than telly per se being to blame, experts believe the viewing is symptomatic of a sedentary lifestyle which may be the root cause. Taking deep breaths, such as when exercising, may keep the lungs fit.

The study, published in Thorax journal, tracked the health of over 3,000 UK children from birth to 11. The parents were quizzed annually on symptoms of wheezing among their children and whether a doctor had diagnosed asthma. Parents were also asked to assess their children's TV viewing habits from the age of three-and-a-half years. All of the children were free of wheeze as babies and toddlers. At the age of eleven-and-a-half, 185 (6 %) of the children had developed asthma. And children who watched TV for more than two hours a day were almost twice as likely to have been diagnosed with asthma as those who watched the telly less. However, the odds were still small - about two in 100.

Of the children with asthma, 2 % did not watch TV, 20 % watched TV daily for less than an hour, 3 % watched 1-2 hours a day and 44 % watched more than two hours daily...

### Question (15)

(This question was on the final examination in 2010, and worth 6 marks. Expected working time for this question was about 6 minutes.)

Critically evaluate the quantitative claims made in the following article from the *Northern Territory News*.

#### **Swine flu rampant in the Northern Territory**

More than 80 per cent of all influenza cases in the Territory are swine flu, statistics reveal. Figures from the NT Centre for Disease Control show the H1N1 virus is rampant in the Territory. The new data says the percentage of swine flu cases compared to seasonal flu increased from just 8 per cent to 84 per cent between June and July. The centre's acting director, Dr Peter Markey, said that the drastic increase occurred because most Territorians were not immune to the virus. "Normally the flu changes a little bit every year," he said. "We were worried about the (swine) flu because it has made a big change in its structure. The majority of the community hasn't got the immunity and therefore it spreads more quickly."

Seasonal influenza began to climb in late May this year when surveillance increased in a bid to reduce swine flu cases. Up to 8.2 per cent of all reported cases were swine flu in the first week. But within six weeks the number jumped to 84 per cent.

### Question (16)

Critically evaluate the following, from *The Sunday Telegraph*, 13/3/2010.

#### **Sleepy students twice as likely to crash cars**

Young drivers who are sleep-deprived are twice as likely to crash while driving, say Italian researchers. A team at the University of Bologna collected data on 339 students aged 18 to 21. Researchers asked them about their sleeping habits and any traffic accidents they had been involved in. Eighty students had had at least one car accident, and of these, 56 per cent said they had driven while sleepy, while 15 per cent admitted that sleepiness was a prime cause of the accident...

### Question (17)

Critically evaluate the quantitative claims made in the following, from the *Courier Mail*.

Drinking red wine could reduce the risk of lung cancer among smokers and ex-smokers, according to new research from the United States. Smokers who drank at least a glass of red wine daily were 60 percent less likely to develop lung cancer than non-drinkers, a study found. However, white wine did not reduce the risk in the same way.

This suggests that it could be the compounds contained in red wine, such as resveratrol and flavonoids, rather than the healthier lifestyle sometimes associated with wine drinkers which offer protection, the researchers said.

Previous studies examining the relationship between lung cancer and alcohol consumption have had mixed results. But Dr Chun Chao of health-insurers Kaiser Permanente in the US told the journal *Cancer Epidemiology, Biomarkers & Prevention* that much of this research failed to consider factors such as social status. In the current study, Dr Chao and her colleagues looked at 84,170 men aged 45 to 69 between 2000 and 2006. After accounting for health and lifestyle differences, the researchers found that lung cancer risk steadily decreased as red wine drinking increased. A two per cent reduction was seen with each additional glass of red wine a man drank a month. For heavy smokers, the reduction was four per cent for each glass consumed per month.