

Module 1

Group 1

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I hereby declare that all solutions are entirely my own work, without having taken part of other solutions.

The number of hours spent: 15hours (Min Wu)

The number of hours has been present in supervision for this module: 5h

Explain units and unit conversions (possibly also including map scale conversions). Try to find a short, clear and readable explanation. Write as you like, with an example or with a more general explanation. It is all up to you what you are able to do and how you want to explain. Also think generally about what an “explanation” is. Is there a difference between describing and defining?

Units are defined precisely to measure quantity by a measurable magnitude in different situations.

A unit is an amount of something, whether it be a standard in science or defined by laws. In different countries or subjects different units can be used to describe the same measurement, such as, distance, where in the United States the imperial measurement system is still used. Most other countries use the metric system, so an example of a unit conversion would be 1 mile is equivalent to about 1.6 kilometres.

ESTIMATION

2. How many iPhones are sold in Sweden every year? (in order to practice your thinking, don't google anything - instead make an estimate based on whatever knowledge you may already have).

The population of Sweden is around 9 million. iPhone is likely to be popular in the age between 25-65. Those people who have work can afford the high price of iPhone.

- Reasons to buy a new iPhone:
 1. People is a iPhone-Enthusiast who will buy every latest published iPhone (assume 1% of the total Swedish populations)
 2. The old one does not work very well and they want to buy a new one (the replacing average is about 2 or 2.5 years)

Calculation:

Assume that people can live 80 years, the age distribution between 25-65 will be 50% of the total Swedish population. Assume all people will replace their iPhone in three years, average to a year will be 30% + the iPhone 1% the iPhone-Enthusiast. The final calculation will be:

$$50\% * 31\% * \text{Swedish populations} = 7.75\% * \text{Swedish populations} = 0.7\text{million}$$

3. If a horse with the height of h_1 weighs w_1 kg, what would you expect a horse with the height h_2 to weigh?

The weight is related to a density. The volume of a horse does not only depend on the height but also the width and length.

1. Assume the horse will be like a box.
2. Assume the height, width and length are the same lengths in the box
3. The density will be calculated as $(w1)/(h1^3)$
4. When height is increased from $h1$ to $h2$ and the width and length are also increased to $h2$.
5. The volume will be increased from $h1^3$ to $h2^3$
6. The weight will then be $(w1)*(h2^3)/(h1^3)$

INTERPRETING QUANTITATIVE INFORMATION

4. Carefully consider the following statements. We want you to consider the nature of the statements as you can understand them, and are not asking you to google facts.

• 843 pupils, of which 432 girls and 421 boys.

432 girls plus 421 boys are equal to 853 pupils, but the total number of pupils is 843 which is 10 fewer. Assume the counting is correct then the reason may be some pupil has neutral sex which belongs to both girl and boy

Calculation:

Assume the number of pupils who have neutral sex equals to X . The equation will be

$$(432 \text{ girls} - X) + (421 \text{ boys} - X) + X = 853$$

X is equals to 10

The number of pupils who have neutral sex is 10.

• Based on yearly weather statistics, we can statistically conclude that there is a 15% chance of rain on any day of the year.

The chance of rain on a certain day is not likely related to the yearly weather statistics. It is more likely related to the area and the seasons.

• It makes no difference what we do here in Sweden, because we are only responsible for 0.2% of greenhouse gases globally.

The Swedish population is about 0.13% of the total world population but now responsible for 0.2% of greenhouse gases globally. The greenhouse gases should be divided equally to everyone. It means Sweden take higher responsible for the greenhouse gases then.

• The city could easily afford to employ more unemployed people, since if we employ them, we also get more taxpayers.

The income tax does not depend on the number of taxpayer. It more likely depends on the market. If the market is not increased, the total income tax will be decreased by hiring more people. it is because:

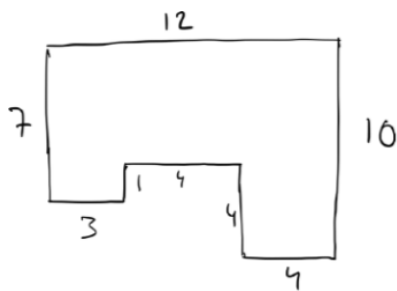
1. If the market is not increased, then to hire more people will decrease the average salary.
2. The income tax takes up a certain percentage of the salary. The lower the salary is the lower the percentage.
3. As the average salary decreased, the average percentage is also lowered. The total income tax will be reduced.

• **After rolling a die 100 times '6' appears 20 times, therefore the die is loaded.**

A die has six faces, The chance of rolling '6' has the same probability as rolling the other numbers. '6' is likely to appear about 16.7% of the total rolling. But now it appears 20% which is 4% higher than it is expected. It is likely indicated that either the die is not a normal die or the rolling times has not enough yet because the distribution of rolling '6' has not been converged yet.

• **Is there anything wrong or misleading with some of these statements and graphs? How? Can statements be wrong in different ways? Can you group them in some way?**

Consider this house plan!



The upside 12 is not the same length as the sum of the bottom side ($3+4+4=11$). (not reasonable house plan)

For every shirt you buy we will give 2 cents to tree plantations.

Missing other factors

Some statements missing results in misleading. For example, how good they give 2 cents to tree plantations by selling a shirt. It depends on:

1. The percentage of how much 2 cents takes up the earn.
2. The total cost to plant a tree.
3. How many trees need to produce a shirt.

Since almost 100% of violent crime is perpetrated by men, all men should take responsibility.

Wrong conclusion

The statement gives a hasty generalization. Almost 100% of violent crime is perpetrated by men which don't mean all men did violent crime. The responsibility should be taken by the one who did violent crime.

If we raise the income tax from 40% to 60% we would increase the income tax revenues by 50%.

Missing factors

The income tax doesn't only depend on the percentage takes up the income but also depends on the amount of income.

For example,

1. if the income tax is 40% of the income and the income is 100, then the income tax is 40.
2. if the income tax is 60% of the income and the income is 50, then the income tax is 30.
3. The income tax is increased from 40% to 60% but the income tax is reduced by the income decreased.

**An investigation has shown that if you only eat organic food, the levels of pesticides in your body decreases dramatically, on the average by 72% after only two weeks.
(claim used in marketing of organic foods)**

Missing factors

1. How many samples are in the investigation?
2. What is the levels of pesticides in the body before eating organic food?
3. How much organic food they eat every day?

Consider this world map!

Missing precise:

1. What does those different color mean?
2. What is the scale used in the map?
3. What Is the south or north direction?
4. No longitude and dimension



It will obviously take time, but our long term goal is for everyone to have their own personal assistant.

Missing precise:

1. What does it mean for taking time? (a week or a year)
2. What does it mean for a long term goal (a week or a year)

In the last years, Sweden has received 20 million refugees.

False. The Swedish population is about 9 million, to receive 20 million refugees is logically impossible.

Last Saturday, the King of Sweden died in an accident.

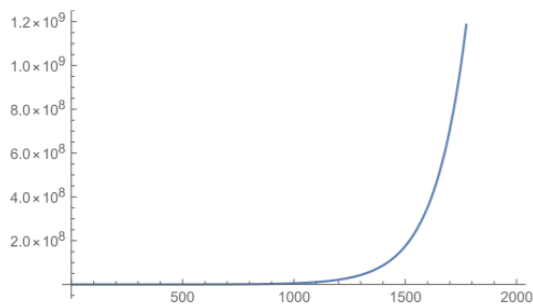
False. if the King of Sweden died in an accident last Saturday. It must become big news but I didn't hear anything about it. It must be a wrong statement.

99% fat free milk! (as written on milk cartons in North America)

Misleading statement

99% fat-free milk means 1% fat in the milk. Compared to "1% fat in the milk", 99% fat-free milk intends to let the customer think the milk has no fat.

We can see that the world population started to really take off from approximately 14-1500.



Missing comparable standardised reference

The world's population started to take off from 1000 in the range of 0-1500, but in the range of 0-2000, the world population started to take off from 1500.

INVESTIGATING THE ABSTRACT SQUARE ROOT ALGORITHM

The following iterative algorithm for calculating the square root was known already to the Babylonians:

$$X_{n+1} = \frac{X_n + \frac{a}{X_n}}{2}$$

a) Try it out on a couple of numbers and show an example. (a is the number we want to calculate the square root of). You can use `sqrt.py`. If you do not have Python installed, you can use the [Online Python link](#).

a	X	a	X	a	X
5	1.0	15	1.0	20	1.0
	3.0		8.0		10.5
	2.33333		4.9375		6.20238
	2.23810		3.98774		4.71347
	2.23607		3.87463		4.47831
	2.23607		3.87298		4.47214

	2.23607		3.87298		4.47214
	2.23607		3.87298		4.47214
	2.23607		3.87298		4.47214
	2.23607		3.87298		4.47214

(PROVE ALGEBRAIC LAWS)

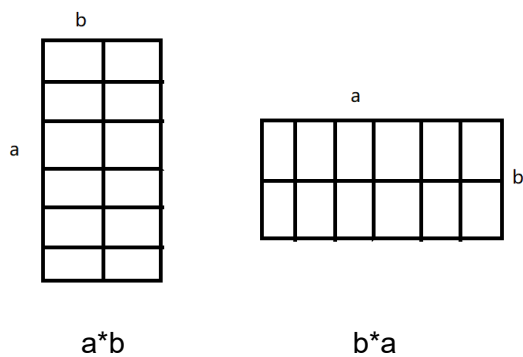
a) Prove the algebraic laws $ab=ba$ and $(a+b)^2=a^2+2ab+b^2$

$ab=ba$

Till examplel

$$2*5=5+5=10$$

$$5*2=2+2+2+2+2=10$$



$$a*b = b*a$$

$(a+b)^2=a^2+2ab+b^2$

$$(a+b)^2=(a+b)(a+b)=a^2+ab+ba+b^2=a^2+ab+ab+b^2=a^2+2ab+b^2$$

(SQRT(2) IS IRRATIONAL)

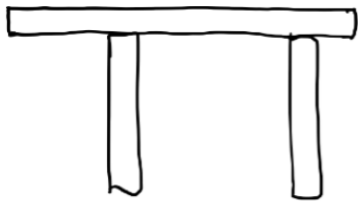
Read and understand this proof. Consider how it feels when you understand the proof, compared to just before you understood it. Explain the main idea of the proof. (there are many links about this on the web, feel free to have a look if you like!)

Square root of a number is not an integer, then it is irrational.

INVESTIGATING THE WORLD

(BEAM ON TWO SUPPORTS)

You have a beam on two supports, see the figure. Imagine that the beam and the supports can be moved sideways. What can you say about the weight on each support?



1. If the two supports stay on the two sides of the centre of mass separately, the support which is closer to the centre of mass will have more stress on it.
2. If two supports both stay on one side of the centre of mass, the beam will fall down.

DESIGN

(ROTARY ENCODER)

For a rotary sensor, we can construct hardware with electrical connectors so that a binary number indicates one out of many possible angle measurements. However, in the transitions between adjacent sectors, it would be very desirable if only one bit changes, to prevent spurious erratic readings of angles that are nowhere close. Try – if possible - to construct a binary code so that this condition is satisfied!



Four sectors	Six sectors	Eight sectors	Ten sectors	
0 0	0 0 0 0 0 0	0 0 0 0	0 0 0 0 0	1 1 0 0 0
0 1	0 0 1 0 0 1	0 0 0 1	0 0 0 0 1	1 0 0 0 0
1 1	0 1 1 0 1 1	0 0 1 1	0 0 0 1 1	
1 0	1 1 1 0 1 0	0 1 1 1	0 0 1 1 1	
	1 1 0 1 1 0	1 1 1 1	0 1 1 1 1	
	1 0 0 1 1 1	1 1 1 0	1 1 1 1 1	
	1 0 1	1 1 0 0	1 1 1 1 0	
	1 0 0	1 0 0 0	1 1 1 0 0	

The different binary number combinations related to the number of sectors are listed in the table above. It turns out a function of relationship between the number of the sectors and binary number: $\text{sectors} = 2^{\text{the number of binary number}}$.

THINK

(REASONING – AMBIGUITY AND INTERPRETATION)

This is to raise your awareness of the imprecise nature of most communication. You must be aware of this and as well as possible interpret to your own precise understanding. The same holds for the problems in this course! Briefly explain the imprecision in each of the following statements:

- **July is a summer month**

It depends on the location. In the southern hemisphere, July is a winter month.

- **You will receive the payment if you meet the deadline.**

The statement does not clarify the task to be finished before the deadline.

- **You can choose A and B, but not C.**

I can choose both A and B, or I can choose only one of them(A and B)

- **“Is there anything behind the car?” “I don’t see anything.”**

It depends on what they are looking for.

- **The temperature is high.**

If the temperature is high or not, it really depends on the situation. For example, in Sweden, if the temperature is 30 which means very high but in Africa, 30 is not high.

- **We want you to design a better solution**

It is hard to design a better solution, we need a standard to compare with.

(REASONING - WHAT IS KNOWN AND NOT?)

This kind of abstract thinking is important for being able to plan what you need in order to determine something, and to understand what you can determine from what you know. (Briefly write out each question for clarity for the reader)

- **You have two sides and an angle. Is the triangle “known” (= unambiguously determined)? Does it matter which angle?**

Yes, but the angle is not 0 or 180.

- **You know the value of $x^2 - bx$ where b is a known number. Is x known?**

Yes, by solving the question.

- **You know a-b and a*b. Is a and b known?**

Yes

we can substitute in $b+c$ into $a*b$:

$$a-b=c$$

$$a=c+b$$

$$a*b=d$$

$$(c+b)*b=d$$

$$cb+b^2=d$$

$$b+b^2=c/d \text{ etc see notes}$$

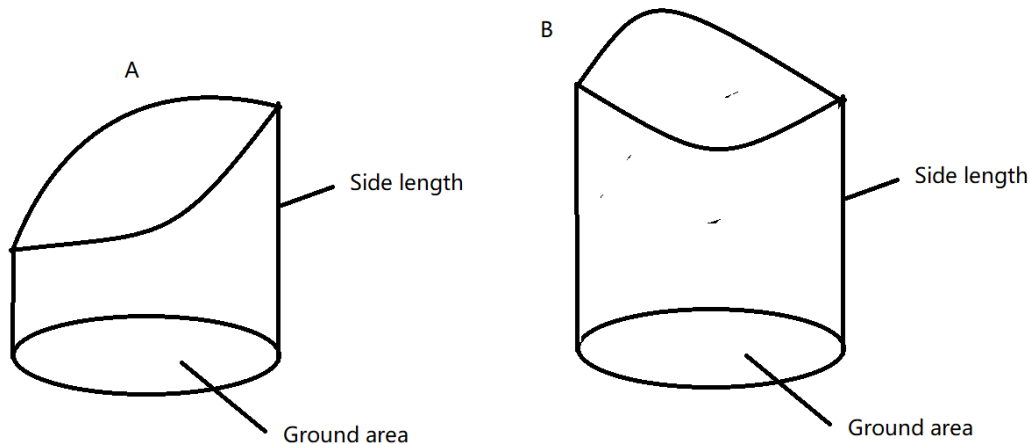
and the same for a

- **You have a point in the plane. Is the line that passes through this point known?**

No, infinity lines can pass through the point.

- You know the shape of a ground floor plan for a building and the length of one side. Is the area known?

No. Building A and B have the same shape ground floor and the same length as one side but the area A is not same as B.



- There are 26 sheep and 10 goats on a ship. How old is the captain?

No, I can't know the age of the captain by the animals on the ship.

- You have a graph where each edge has a known length. Is then the shortest path from node A to another node B known? What if some "lengths" are negative?

We would need to know the positions of the nodes.

To calculate distance we would use the absolute value of the lengths, so negative lengths would not affect the distance calculation.

- You don't know x. Can you say anything about the sign of $x^2 - x$?

$$x^2 - x = A$$

$$\Rightarrow (x - 0.5)^2 - \frac{1}{4} = A$$

$$\Rightarrow (x - 0.5)^2 = A + \frac{1}{4}$$

$$\text{Because } (x - 0.5)^2 \geq 0$$

$$\Rightarrow A + \frac{1}{4} \geq 0$$

$$\Rightarrow A \geq -\frac{1}{4}$$

The sign of $x^2 - x$ is larger than $-1/4$

MODELLING - EQUALITIES AND INEQUALITIES)

For each of the situations below, give examples of equalities or inequalities that you could use to describe the situation quantitatively. You may use words in the formulas, like in money after = money before – price

- Two given objects on a balance scale



Angle of Scale = w_1, w_2 , length

•**Three persons of different height**

$p_1 \text{ height} < p_2 \text{ height} < p_3 \text{ height}$

•**Weights of three suitcases at airport (in a typical situation there)**

suitcase 1 + suitcase 2 > suitcase3

•**Water in two glasses**



$$wg_1 = w - wg_2, \quad wg_2 = w - wg_1$$

•**In this game there is exactly one winner! (hint: use one binary variable for each person, 1 if the person wins, 0 otherwise)**

winner + losers = 1

REFLECTION

I. (SUPERVISION AND FOLLOW-UP LECTURE)

a) Did you have your checkpoint meeting for this module?

Yes, I think I did.

b) Did both of you attend the compulsory follow-up lecture? If you already talked to us about this, please explain.

Yes. I attended the compulsory follow-up lecture.

c) If you were asked to talk to a supervisor about the main submission, who did you talk to?

I talked to TA Jean Baptiste Jolly.

II. (WHAT DID YOU EXPERIENCE AND LEARN?)

Reflect on your experiences from working with the module and try to make the most out of them. You are also encouraged to discuss your experiences with other groups.

If you reflect around individual problems (which is good), try to also draw general conclusions that may be helpful for you going forward in this course and long-term.

I spent about 20 hours to do those problems. I went through the questions in the evening and bring my questions to daily handling. The handling is very good. Those teacher assistants are all very nice. I could always find a teacher assistant and discuss with them. I always feel safe and comfortable because I could find someone around during the week. They always help me to realize that mathematical knowledge that stays in my mind for a long time but I didn't use it in my daily thinking. Through the module and its follow-up lecture, it helps to realize those mathematical thinking I studied in high school and how I could use it to solve the questions in real life.

In the module some of the problems, for example, the statements I can find those missed factors which could result in misleading results

On the other hand, the problems ,for example design and beam on two supports , they are hard for me. In the design part, it is supposed to have the number of sectors= $2^{\text{the number of bits}}$ but I could only get the number of sectors = $2 \times$ the number of bits. But the follow-up lecture helps me to find out the missing part. The beam on two supports, I could not list those boundary situations, for example, one support is located at the center of mass or the two supports stays symmetrically on the two sides of the center of mass.

III. (HOW WELL DID YOU SOLVE THE PROBLEMS?)

Give a single assessment for the whole module and motivate with a sentence or two. This is for your own practice.

Use the scale "insufficient/sufficient/good/very good", or a combination such as "between good and very good" or "good or very good". Use the grading criteria we have suggested, or clearly motivate your own.

(We as teachers will then set the grade for this module. We think it is better if you are able to make a fair assessment rather than an inflated one.)

Summary, in this module, I think I did quite well. I spent a lot of time and tried my best to solve all those questions and I came to the handling and discussed with the teacher and the teacher assistants to find out what I missed in the solutions. I worked hard and it turns out quite good results which could convince me quite well before I submitted the report.