Exam Performance Feedback Form

COMP11120, Semester 1

2015/2016

First some general remarks. 186 students sat the exam. The median mark was 27 out of 60 (or 45%), and the average 28 (46%). This was a disappointing performance. We do not think that the exam was too hard, but that students made basic mistakes with many of the easier parts of the questions, and that on a couple of occasions they did not read the question properly and so failed to answer all or some of it as posed. See the discussion of each question below for more detail on this.

Sixty students had a failing mark, that is a mark of less than 24 out of 60, or a mark of less than 40%. Of these, twenty-three students had a mark below 18 (which is below 30%), with a lowest mark of 0. On the top end, thirteen students achieved first class marks with a top mark of 52, which is 87%.

Statistical analysis of individual questions:

Question 1. The average for Question 1 was 8, which corresponds to a mark of 40%, that is the pass mark. Seventy-six students had a failing and twelve students a first class mark.

Question 2. This had an average mark of 7 (35%), with more than half the students on a failing mark. One wonders how this relates to the very low attendance in the lectures on this material, and also the low attendance in particular for the last two examples classes.

Question 3. This had an average of 12.55 (62.8%), with 37 students on a failing, and 93 on a first class mark.

Question 1. Overall there were quite a few disappointing mistakes which meant that the average for this question was lower than anticipated.

a) This was meant to be an easy question which was not supposed to require a lot of thinking. In the lecture on injectivity we discussed examples that a programmer might care about in the form of student reg numbers, user ids, bar codes, and others. One mark was available for giving any suitable example. The remaining two marks were reserved for a sensible checking procedure. Many students failed to answer this part at all, and so could not get more than one of the three marks. Some checking procedures suggested did not fit the application at all, for example, typing in two names to check whether the user ids are identical is not feasible if there are more than a few users. I was looking for a simple procedure that checks all entries against ones already created, for example.

b) The injectivity part of this question was meant to be easy. I was assuming that all students would realise that $1^2 = (-1)^2$, and that both these are valid complex numbers, so that the function clearly is not injective. A surprising number of students reasoned that $x^2 = y^2$ implies $x = y$, and so did not get either of the two marks.

   Surjectivity was meant to be harder. The function is surjective, and there are two ways of proving this: either one solves a system with two equations (one of which can be solved in the usual way for quadratic equations), or one can use the fact that if one thinks of a complex number as being given by angle and absolute then one can find a number whose square is the given number by halving the angle and forming the square root of the absolute. Many students used a square root function in their answer.

However, there is no well-defined function which performs this task (and indeed nae was defined in the notes), and students who did this lost the marks for a valid proof.

c) This part was well-answered. Most students spotted quickly that $a \circledast c = c \neq a = c \circledast a$, so the operation is not commutative. The function is associative, which also most students correctly ascertained. The vast majority of students only checked one or two of the 27 cases, however, and only got one of the marks for the proof (worth three marks). There are two ways of getting all the marks here: Along the lines of giving all the possible interpretations of a proposition one can give a table that calculates $x \circledast (y \circledast z)$ and $(x \circledast y) \circledast z$ for all possible combinations. Alternatively one can look at the table a bit harder and see that $x \circledast a = a$ for all x, and $x \circledast c = c$ for all x, and that observation brings down the number of cases considerably.

   Curiously many students misread the table: The first argument of the operation appears in the column, the second in the row, and we had a number of examples of this in the notes. Quite a few students swapped the two arguments. I did not deduct any marks for this, but students should make sure that they understand correctly how to read such a table.

d) There are two possible proofs, both of which appear in the published material. One is to combine Exercises 33 (b) and 37 (a), and the other is to argue via the inverse functions.

   Just drawing a picture of the kind we have been drawing for small finite sets gave no marks since it is not a proof, nor did giving examples. Students typically lost marks because they missed some of the detail, or because they wrote ambiguous statements (every function assigns a unique value of the target set to each value from the source set, so this does not capture bijectivity), or some of what they wrote was wrong. This was the one part of this question that depended on an extensional exercise.

Question 2. Overall this was not well answered. It was particularly disappointing to see how many students made mistakes regarding the simplest parts of this question.

a) As is made explicit on page 112 of the notes (and as is practised in a number of solutions to exercises), in order to describe a probability space for a finite set of outcomes it is sufficient to describe all the outcomes, and give the probability for each outcome. The vast majority of students gave no probabilities at all, and many left it to the reader to judge what the set of outcomes might be since they did not write any text to describe it.

   The easiest way of describing the outcomes is as strings of the form of, for example TTH. There are eight such strings, and each outcome arises with the probability of 1/8. An even number of heads occurs for event

$$\{TTT, HHT, HTH, THH\},$$

   which means the probability of this happening is 1/2. The majority of students missed out TTT and did not get this mark.[1] The majority of students correctly calculated the second probability asked for to be equal to 7/8.

b) The easiest way of solving this question is to draw a tree that mimics the drawing of the two ribbons. This makes it easy to see that the probability

[1] For those wondering whether 0 is indeed an even number, this is Definition 2 of the notes.

of drawing two ribbons of the same colour is 7/15, which is not equal to 1/2 and thus the game is not fair. Quite a few students stated correctly that the game is not fair but could not come up with a valid reason.

c) This part was badly answered, with only a small number of students being able to carry out Bayesian updating. The question states that it is known that there are exactly two 0s in the string, so the options are 100, 010 and 001. At the beginning we assume that each occurs with probability 1/3. Many students did not get this far. For those who did the typical mistake was getting mixed up about how to use the numbers that appear in the question in the formulae that they wrote down. We have, for example,

$$P(\text{first symbol } = 0|001) = \frac{4}{5},$$

since the question states that the querying procedure gives the correct answer with a probability of 0.8..

Many students seemed to assume that the querying process is perfect, or alternatively that the probability was 2/3 because there were twice as many 0s in the three possible strings as 1s. Most students also did not use the law of total probability to calculate the probability that the first string is indeed 0.

Given that we spent a whole lecture on this, and that this was a core exercise, and that I had explicitly said in the revision session that much of the exam would be along the lines of core exercises I found the quality of answers disappointing. Examples classes in that week were not well attended, but it is the responsibility of the students to make up for missed events.

d) The expected value is n. Many students did not try this part at all, or did not get anywhere. Quite a few of those who did could work out the correct answer, but could not give a rigorous argument why. The most appealing answer I saw calculated the expected value of $X - n$, which is easier to do, and showed that to be 0.

Question 3.

a) Average mark: 83%. 37% of students achieved full marks

i) Posed no problems. Most got 3/3 and a few 2/3. Very few got less. If marks were lost then for not say whether the formula is a tautology and why (note, explanations did not need to be long), or not knowing the truth values for implication.

ii) & iii) were generally answered well. Approx 1/3 achieved full marks (4/4).

Common mistakes for which marks were lost:

- Problems with applying Step 4 (distributivity) lead to most errors.
- Departing from CNF algorithm in significant other ways, e.g., not applying Step 4; doing simplification early.
- Not providing justifications for the steps in the derivation, i.e., not saying which laws/Steps were applied, or providing incorrect justifications.
- Mistakes in applying laws (e.g., when applying De Morgan laws forgetting that the second operand needs to be negated as well and the operator changes from disjunction to conjunction).
- Not applying the absorption law during simplification.

Only partial marks were given if no laws were used for the simplification sub-question and either only the answer given or the simplified form was derived from the truth table.

b) Average mark: 51%. 11% of students achieved full marks

This was a bookwork question where two concepts needed to be explained. iii) was already used in the midterm test.

Quality to answers varied from perfect and very good to weak. The answers were generally better than in the mid-term test which was pleasing to see. Under 1/3 achieved 3/4 or full marks, a bit more than 1/3 got 2/4 and just under 1/3 obtained 1 or 0 marks.

Only perfect explanations gained full marks. In case somebody inadvertently answered more than 2 parts, the marks of the best two parts were taken, but full marks were only given if there were no incorrect claims in the other parts. Not as many students as in the mid-term test made this mistake.

Common mistakes:

- Vague and imprecise explanations; in such cases no marks were awarded.
- Answers not to the point or the question was misread. No marks were awarded for just an example of the concept to be explained, or its use. For example, reciting the equivalent replacement theorem does not explain the operation of replacement, thus no marks could be given.

c) Average mark: 52%. 31% of students achieved full marks

Over 1/4 achieved 4/4, about the same 3/4, 1/4 achieved 2/4 and fewer than 1/4 got 0.

Common mistakes:

- Not writing the rule that was applied and also the premises used to perform an inference step.
- For the Implication Elimination rule and Conjunction Introduction rule, both premises that were used need to be specified.
- Applying the Implication Elimination or Conjunction Introduction rules without the LHSs of all premises as well as the conclusion agreeing.
- Using the axiom rule to obtain a judgement with two formulas on the RHS of the turn style. Every judgement always has exactly one formula on the RHS.
- Using the weakening rule without a premise.
- Not realising that the rules of ND system were included with the exam paper or intentionally ignoring them. Some invented their own rules or used other rules not at all in the system. The fundamental logical laws may not be used, only the rules of the ND system can be used.

d) Average mark: 54%. 1 student achieved full marks

For i) - iii) a very common mistake was to just translate the formulas to English, but not calculate the truth value of the formulas in the given interpretation.

Only about 25% of the students calculated the truth values of the formulas. For these:

i) and ii) posed no problems.

The existential quantifier in iii) caused some problems. Since it is part of the left-hand side of the implication, reading the formula as ‘for all students x and y there is a student z ...’ is not correct. Correct is ‘for all students x and y *if* there is a student z ...’.

It was decided to award marks for correct translations, good translations were awarded more marks than literal translation using variables.

Translations of i) and ii) were generally very good.

For iii) it was harder to find a good translation, but some good ones are: Two students are in the same tutorial group, if there is someone (z) with whom one of the students is in a tutorial group and the other student is in a lab group with them (z). Also accepted, or similar: For all students (and staff) if there is a student in the same tutorial group as student a and in the same lab group as student b the two students (a and b) must be in the same tutorial group.

For iv) only one student gave the correct answer. Everybody else did not notice that the arguments of F need to be switched to express the ‘has friend’ relation, because F is defined as the ‘is friend of’ relation. Another common mistake was to use implication as the connective rather than conjunction. Usually conjunction is used immediately following an existential quantifier.

For v) several students got correct answers, but students struggled to find the right quantifier pattern and negate in the right place. Easiest is to realise that a statement starting with ”No one ...” is equivalent to the statement ”It is not the case that someone...”. Then the negation is at the beginning of the formula. Any equivalent formula was accepted as correct.