UG Exam Performance Feedback
First Year - Semester 2

Comments:

GDG (sem 1): Q1 This was generally well answered but there were a number of common errors. Many students failed to give a detailed enough description of the algorithm for converting to DNF; this is just bookwork so shouldn't be at all difficult. The other most common mistake was to ignore brackets. For example an expression such as
\[(a \land b) \lor c\]
suddenly became
\[a \land b \lor c\]
and was then interpreted to mean
\[a \land (b \lor c)\]
These two expressions are quite different.

Q2. This question was obviously far too easy, many students gained 20 marks for their answers. The most common mistake, apart from complete lack of understanding, was not giving the parse trees for the examples asked for.

SN (sem 1): Many students found the proof part of Question 4 difficult. Some also had difficulties with applying the formulas for Poisson and binomial distribution to real situations described in Question 3.

GDG (sem 2):
Q1 The answers to this question were, on the whole disappointing. 98 students attempted this question, with an average of 38.7%.
1a) i) This was a reasonably straightforward induction exercise. The main problem students seemed to have was handling the following simple algebra

\[2 - 1/2^n + 1/2^{n+1}\]

\[= 2 - 2/2^{n+1} + 1/2^{n+1}\]

\[= 2 - 1/2^{n+1}(2 -1)\]

\[= 2 - 1/2^{n+1}\]

Several students wrote several pages for this calculation, almost inevitably getting the answer wrong.

1a) ii) This was an induction over a simple formal language. In this example the base case was the empty string and the induction step required showing that the two rules for construction new strings maintained the property to be proved. The symbol x is used in the description of the language but there are no occurrences of x in any of the strings of the language.

1b) i) and ii). This question required you to come up with explicit functions satisfying the required properties. Many students didn't even suggest any such functions. Also many students ignored the given sources and targets. A popular wrong answer was \(k(x) = \sqrt{x}\). This is not a function from N to N.

Q2. This was answered better than question 1. 62 students attempted it with an average of 51.9%, still a disappointing average.

2a) i). The main loss of marks here was by not giving reasons for your answers. Just saying reflexive, symmetric and transitive without giving reasons is not enough. Also many people failed to give the equivalence classes. Drawing the digraph made this much easier to answer.

2a) ii). Quite well answered. It isn't transitive. 3 S 6 and 6 S 2 but 3 S 2 is false.
b) Ignored by many but some good answers.
c) A poset is not a female possum, as suggested by one candidate. Many lots marks though giving an incomplete description of a poset. Hardly anyone got the Hasse diagram correct.

CS (sem 2):
See PDF attached.
Section A

General remarks: 142 students answered questions from this part. The average mark for this part was 10.5 marks out of twenty. 37 students received a mark of 7 or fewer; of these two had 0 marks, the seven had 1 mark, and 4 students had 2 marks---these candidates seem to have done very little to prepare for the exam. 44 students received a mark of 14 or better, 3 of these got 20 out of 20.

Question 1. 111 students attempted this question. The average mark was 5.0 out of 10. 25 students received 2 marks or fewer, 27 students got 8 marks or higher.

Many students provided automata, regular expressions or grammars which only covered some of the words required. An infinite number of words was typically missed out, often:

- b, bb, bbb, ...
- abb, abbb, abbbb, ...
- cbc, cbcc, cbbbc, ... or any words in which the two c generated together had other letters between them,
- words containing more than two cs.

a) Most automata missed out at least one of the groups of words mentioned above, many several. Relatively few allowed words that shouldn't have been allowed, that is those containing an odd number of cs or those containing an a that was not immediately followed by b. The smallest automaton possible has four states. It is the product of the smallest automaton for the set of all words over \{a, b, c\} that contain an even number of cs and that for the set of all words over the same alphabet where every a is immediately followed by b. Alternatively one can think of what needs to be remembered about any word seen so far, namely whether the number of cs is even or odd, and whether the last letter seen is a. The combination of these lead to four states and the same automaton as above.

b) Again, many patterns given here failed to match one or more of the groups given above. Students whose automaton from a) was very complicated and who tried to apply Algorithm 2 did not manage to do so correctly. The easiest way of generating the desired regular expression is to realise that 'letters other than c' can come as ab or as b, leading to \((ab|b)^*c(ab|b)^*c(ab|b)^*\) or \((ab|b)c(ab|b)^*c)^*\). There are a number of further correct alternatives.

c) Some students had difficulties giving any context-free grammar, and some used non-terminal symbols without really understanding what they were doing. Typically the words generated by the given grammar missed some of the groups mentioned above. Given an automaton there is a way of generating a context-free grammar for it, and that is the most straightforward answer here if the automatic is correct. Alternatively, it is sufficient for the start symbol S to allow us to construct ScScS, abS, bS and the empty word. A number of students submitted answers where bcbbc could be generated but cbcb couldn't.

Question 2. This question was attempted by 98 students. The average mark was 5.7 out of ten. 16 students received a mark of 2 or lower, while 25 students got a mark of eight or more.

It was no accident that I asked for a regular expression before wanting a DFA---this is one example where it is easier to read off the expression from the NFA.

a) Most students got something very close to the correct answer, which is \((abb^*aa^*|acc^*aa^*)^*\) or, equivalently, \((a(bb|cc)^*aa^*)^*\). A lot of students forgot the outermost star, losing a mark, and a number failed to realize that it is not sufficient to replace \(bb^*\) by \(b^*\) (or similarly for \(aa^*\) or \(cc^*\)). A very few wrote \((b|b)^*c^*\) for the middle part, which allows mixing bs and cs and is therefore incorrect. Also few wrote \((aa)^*a\) for the last part, which only allows an odd number of as in that position, which is also incorrect. Some students did b) first and then tried to apply Algorithm 2 but ended up with expressions so long that they could not finish the calculation.
b) This is asking for Algorithm 1, and all students who started that correctly got at least partial marks. Some students drew another NFA here (some seemed to do so at random) and got no marks. Mistakes were frequently made in carrying out the algorithm, leading to fewer states than required, or missing some transitions. The result needs to be symmetric in b and c, and some people missed that. The correct automaton has 8 states.

Question 3. This question was attempted by 69 students. It had an average mark of 5.3. 9 students received a mark of at most 2, while 9 managed 8 or more.

A) Almost all students correctly found that three of the four words were generated by the grammar and got two marks.

B) Most students recognized that the language defined by the grammar is that of all words over the alphabet \{a, b\} which contain at least one a and got full marks.

C) Many students did this part correctly but a number could not give properly formed parse trees. If they still had discernibly the right idea they got one mark. The shortest word with two parse trees is aa, but any correct word got full marks.

D) There were few right answers here. The fundamental problem with the grammar given is that the a that is required to exist in the word, and which is generated in the first step, can be matched against any a in a given word. One solution is to ensure that it is the leftmost (or rightmost) a that is matched here. A number of solutions offered did not describe the same language, typically not allowing words like bab to be created. A number of solutions given were still ambiguous, and some seemed to be only random alternations carried out on the given rules. No marks were given for those, but one or two marks were available where it was discernible that the student had something of a right idea.

Section B
(1) I received 143 scripts out of 158 listed students + 1 added to the list, so 16 students did not turn up (10%).

(2) Based on totals for 2 questions, the distribution of results is as follows, over 143 scripts:

<table>
<thead>
<tr>
<th>Marks out of 100</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 25:</td>
<td>29 (20%)</td>
</tr>
<tr>
<td>26 – 50:</td>
<td>24 (17%)</td>
</tr>
<tr>
<td>51 – 75:</td>
<td>55 (38%)</td>
</tr>
<tr>
<td>76 – 100:</td>
<td>35 (24%)</td>
</tr>
</tbody>
</table>

35 students (25%) got less than 40%.

5 students got full marks.

3) Most attempted Q4 and Q5, based on answer sheets i.e. involving a number of English statements (12 and 13 respectively) to formalise, a format close to most home and example class exercises. The results for these 2 questions were similar, and from these the questions proved appropriate.

4) Only 11 took Q6, and of those 7 answered it very badly and had poor total marks. I think the question was appropriate. It certainly was not particularly difficult. I guess students felt more at home with Q4 and Q5 as they had had more exercise practice.

5) By far the most common cause of faults is simply a lack of elementary intellectual discipline: failing to learn and apply a few fundamental notational rules and their precise meaning. A few examples are as follows:

a) Confusing a proposition and the denotation of a set \{x | – x – \} (set-theoretical abstraction)
b) Quantifying x universally in \{x | – x – \}
c) Inappropriate use of special symbols e.g. parentheses for braces and vice-versa, ‘|’ in propositions, etc.

All this despite the very large number of examples provided in the lecture notes, and the fact
that the notation is introduced or used in several other course units as well.

6) On the positive side, I was impressed by the quality of the top 35 students (a quarter), those who got 16-20 out of 20. Their answers demonstrate a real mastery of the material, a solid foundation on which they will be able to build in years 2 and 3.

Section C
Too many of the scripts were almost illegible with answers scrawled/scribbled across pages (at any angle), subparts out of order (with no real indication that that's the case), little explanation, and so on.

It seems the School must take a much tougher stance during the first year in order to help students present their handwritten work and, hence, themselves, in a clean, clear and professional way --- the school shouldn't have to do this, however, it clearly doesn't happen properly at secondary education level. The School should be prepared to refuse to mark coursework that doesn't reach appropriate levels of good presentation, giving clearly directed feedback to the students to ensure they can present their work in future so others can follow their thoughts and labours.

Q7:
This question was aimed to show some appreciation of rates of growth of functions and a simple analysis of an iterative program via operation counting.

120 out of 140 students answered the question.

Most answers were able to produce the required graphs of the two functions. However, many lacked the accuracy you'd expect for such a trivial exercise: plots without scales on axes, linear scales that were far from linear, plots disregarding the requirement to be within the range x=0 to x=4, etc.

Many answers struggled with solving the quadratic equation arising from f(x) = g(x), in order to determine the crossing points. Surprisingly many answers failed to choose the appropriate crossing point. Quite often students didn't appear to bother to check their presented answers against their own plots.

Several answers gave polynomial functions in answer to the next part, which asked for two examples of real-valued functions that grow faster than ANY polynomial function.

The comparison counting exercise seemed to flaw most students -- even when the correct number of comparisons was given, quite often the answers then showed misunderstanding/misreading of the actual program in order to get the right number of array element pair swaps.

Again, there appeared to be confusion for a surprising number of students between the sum of numbers from 1 to n-1 and the factorial of n-1...

Q8:
This question was aimed to show some appreciation of intractable and unsolvable problems.

20 out of 140 students answered the question.

For the first part on the Tower of Hanoi problem, most answers used the right formula for the number of disk moves, however, it was disappointing to see that not so many were able to calculate, or even approximate, what, for example, 216, was, let alone 232...

For the second part, answers were highly varied. Several answers didn't address "computational" problems, but were related to "philosophical" problems, e.g. "how long is a piece of string", thereby missing the real point of the question. Close to a quarter of the answers gave description of an unsolvable problem, such as the halting problem, program verification, tiling problem, etc. Others either missed the part or misunderstood what was required. It is important to stay brief, relevant and coherent in answering such questions.
Question B1.
The majority of students attempted this question which had four parts. It was not such a difficult question and the marks should have been much higher. There were some excellent answers showing real insight and interest.

There were a lot of good answers and some unnecessarily long answers. Unfortunately there were an inexplicable number of extremely poor answers - it was clear that some students who produced such answers had no knowledge of the subject matter whatsoever and were just trying to make educated (or uneducated) guesses about the subject. The question was mainly about buffering in distributed systems as exemplified by their use in VoIP.

Part 1 explored the basic ideas, what buffering does and why it is needed. Part 2 concerned the occurrence of 'lost packets' when using VoIP over wired networks. It was easy to spot who had attended the lectures and thought about this, as it is fundamental that most lost packets (by wire) are delivered eventually (for reasons that had to be explained) but too late to be useful. This is fundamental for the final part of the question.

Part 3 concerned timing 'jitter' in interactive real time comms over the Internet, and the employment of jitter buffers. Actually it was pleasing that the majority understood the apparent dilemma that you can measure variation in 'one-way delay', but not 'one way delay' itself, and that you do not have a global clock (and you don't need one) to do this. Part 4 Those who realised that this was mainly to do with trying to control 'lost packets' at the expense of delay had a good time with this part - and got good marks. Sadly, a sizeable minority did not address this and 'made it all up as they went along'.

Although I do not penalise this directly, some of the hand-writing was very hard to read, and there were occasions where I could not, initially, read a word or phrase that turned out to be mark-bearing. I do not think anybody actually lost marks through poor hand writing, but there must be a danger of this happening. If your hand-writing is poor, spell out the key words or phrases with particular care - maybe in CAPITALS.

Question B2 was taken by 10 students, a very small proportion of the cohort. The average was very high a little over 73%, with very low standard deviation. There were no significant issues of conceptual misunderstanding, or misguided answers. Most students that took the question showed a very good command of the concepts, were able to apply them specifically and wrote answers that were clear and to the point.

Question B3. Very few students attempted this question; of those that did, it was typically answered reasonably well. Marks were lost by not putting the answers in the specific contexts specified by the question, i.e. don't just give a theoretical answer about a two-phase commit situation, put this in the specific context of transferring money between bank accounts. Some answers confused the concept of two-phase commit with deadlock; others confused the idea of deadlock “avoidance” with deadlock “detection”.

Comments:
MCQ paper - for feedback please see Howard Barringer, Sean Bechhofer or John Latham
The following only concerns Section A of this exam. There are two questions in this section and the students only need to answer one of the questions.

General Feedback:
• There were 138 students who answered questions from this section/part;
• The average mark for this part was 53% (i.e., 10.6 marks out of twenty);
• 32 or 23% students received a mark of less than 40% (i.e., 7 marks or fewer);
• Among those students with less than 40% marks, there is about 11% or 15 students seems having done very little to prepare for the exam, as their marks are below 20% or 4 marks. The details of this group of students are: 5 students had 1 mark, 3 had 2 marks, 3 has 3 marks, and 4 has 4 marks;
• 36 or 26% students received a mark of 70% or better (i.e., 14 marks or more), in which 6 students had 18 marks (90%) and one student had the highest 19 (95%) marks.
• General speaking, the students' performance in the exam is satisfactory from the teaching outcome point of view. In particular, it is very encouraged that 26% students achieved the 1st class marks

Detailed Feedback for Question 1:
• 89 or 65% students selected this question to answer;
• Question a). Most students answered this question well, except that a small number of students somehow did not answer some part of this question;
• Question b). This question is to ask the main events which led to AI boom from 1980 to 1987. The correct answer is “expert systems” and “Japan’s 5th generation computer project”. Generally speaking, this is a simple question related to the brief history of AI. However, this question has been poorly answered. Many students failed to answer this question or only gave partially answer. Taking into account that more difficult questions have been well answered, the possible reason here is that the students may not expect this type of question and so less well prepared for it;
• Question c). Most students got 3 or 4 marks from this 5-marks question. This was expected as the last question (i.e., question iv) was designed to test how carefully the students checked the condition and assumption given. It is only assumed in the question that “the robot is equally likely to be in each possible pose” and need to use the probability formula related to the partition to answer this question. But many students had added their own assumptions such as “the robot is equally likely to be in each possible position and orientation”. This led to a much simpler but incorrect formula for solving the problem. This is the reason that 1 or 2 marks had to be taken off for many students;
• Question d). Most students answered this question well except that a small number of students used the wrong (extended total probability) formula. The correct formula here is Bayes’ Theorem whereas the extended total probability formula should be used in updating the location information when some action/move is taken;
• Question e). About half students answered this question well. For the remaining half of students, the main problems are, firstly, some students only give the text description of the definition of the conditional probability without the mathematical formula; secondly, some students failed to do the proof;
• Question f). Only a small number of students correctly answered this question. As this type of questions has never been exercised in the example class, this outcome was expected. However, as this is not a difficult question to answer, this result highlights the need to include the related exercises in the example classes,

Detailed Feedback for Question 2:
• 49 or 35% students selected this question to answer;
• Question a). Most students answered this question well except a small number of students who gave some irrelevant example;
• Question b). About half students answered this question well. For the remaining half of students, the main problems are, firstly, some students gave incorrect or incomplete definition of the probability distribution, especially missing the K1 and K2 conditions; secondly, some students failed to do the proof;
• Question c). Most students answered this question well except that a small number of students used the wrong (Bayes’ theorem) formula. The correct formula here is the extended total probability formula whereas the Bayes’ Theorem should be used in updating the location information.
information when some new observation from sensors is received;

•Question d). About half students answered this question well. For the remaining half of students, the main problems are, firstly, some students misunderstood the probability distribution by saying: “if the disjoint condition (i.e., ) does not hold, then the agent’s degree of belief fails to satisfy the probability distribution.” This is incorrect as the correct meaning is “if then”; secondly, some students claims that the Dutch book will not occur as the given events do not lead to the always loss scenarios. This is incorrect, because the always loss scenarios/events can be constructed from the given events (although the given events may not always lead to a loss);

•Question e). About half students answered this question well. For the remaining students, the main problems are the incomplete/incorrect solution or missing the required steps and formulas for calculating.

Q4 was the most popular from Section B. This was answered well by many students. Most marks were dropped in the last two parts. In (b.iv) the probability of bye for words of length 3 was 2/3. This is calculated by considering the probability of b-ay-ay, b-b-ay, hh-hh-ay and hh-ay-ay and using p(bye|3) = p(b-ay-ay)+p(b-b-ay)/(p(b-ay-ay) + p(b-b-ay)+p(hh-hh-ay)+p(hh-ay-ay)). Some students made the mistake of working out p(bye and T=3) rather than p(bye given T=3). In (b.v) the main extension is to make the model into an HMM which requires emission probability densities to be associated with each state. These densities could then be trained on feature data (sequences of MFCC vectors) extracted from speech data.

Q3 was answered quite well by most who attempted it. In some cases students lost marks by not explaining what they were doing, e.g. just presenting numbers without using symbols to explain what they are doing. In part (c) the classification probability is 3/4 and that corresponds to a positive classification (assuming we classify by the class with highest probability) which agrees with the rule.
This exam (at least my half of it) was fairly well done, with some very high marks and very few low ones.

1 a) A standard CNF/DNF question, generally well answered
   b) Main problems were with parts iii and iv. In part iii I don't think it reasonable to assume that the two students both passed the same exam. In part iv many of you forgot to qualify the exams students as passed by those they had taken.

2a) Standard induction, well answered
   b) Again, well answered
   c) Not one candidate gave example functions from $\mathbb{Z} \rightarrow \mathbb{Z}$. Many gave functions between subsets of $\mathbb{Z}$ and got most of the marks.

Feedback: First question referred to is the matrix question.

MOST COMMON MISTAKE: #3c or 4c(?) For the matrix inversion problem, any correctly executed method was acceptable. However the method we learnt in class was the Gauss-Jordan algorithm. In using this method one must be fairly explicit, so it is easy for the reader to identify mistakes and award partial credit accordingly. Indeed, sometimes for trivial arithmetic mistakes no deduction was taken.

But a number of students use a method learnt elsewhere, likely in secondary school, the so-called Adjoint Method. The temptation is to do a number of steps mentally. That's fine when the end result is correct; but when it is not it is difficult to know what has gone wrong. Also, it is easy to make sign errors and/or to forget a crucial step (multiplying by the inverse of the determinant). Given the directions to show one's work clearly the marking was done by assessing the seriousness of the most likely errors. Again, deductions against obvious mistakes of arithmetic were small to nil.

#3b OR 4b(?) Computing the determinant of a related matrix to the one given: mostly very good. Most common mistakes: (1) forgetting to take account of row permutations. Benefit of the doubt and credit given to those who did not show the work but got it right (because it can reasonably be done mentally); (2) forgetting to multiply your result by 7. Minimal deduction.

3(a) or 4(a) Computing a straightforward determinant. For the most part the mistakes, though arithmetic in nature, reflected mistakes in the process of computing determinants. These are somewhat serious. The main exception is that there was a tempting sign error and little deduction was made for succumbing.

Next is the series and limit question.

3(a) or 4(a): The numerical coefficient of the nth term is $2^n/n!$. The most common mistake was forgetting the $^n$ bit. If no work was shown this appeared to be a significant mistake.

3(b) or 4(b) This limit cannot be found directly: that is the point. No credit was given for attempting to do so, especially in a haphazard manner, even if the correct answer was reached. On the other hand simply citing L'Hopital's Rule was worth credit and applying it more or less correctly was worth most of the credit. Getting to the correct answer from there was only worth a couple of points.
Over the lecture period [as usual] one coursework component was undertaken. The results from this piece of coursework showed the students had a moderately good understanding of a subset of concepts presented during the lectures. The exam results enforced this view – with a good spread of results. The exam results show the module's learning outcomes were sufficiently exercised. Both the courses and the lecture learning outcomes (Los) were tested and the students [as a whole] showed good comprehension of the Los. The exam and coursework validated the pedagogical approach.

The students can get individual feedback just by logging back into the exam online.