EECS 16A Designing Information Devices and Systems I
Fall 2020 Homework 1

This homework is due September 4, 2020 at 23:59.
Self-grades are due September 7, 2020 at 23:59.

Submission Format
Your homework submission should consist of **one** file.

- `hw1.pdf`: A single PDF file that contains all of your answers (any handwritten answers should be scanned).

Submit the file to the appropriate assignment on Gradescope.

1. **Reading Assignment**

   For this homework, please read Note 0 and Note 1 until Section 1.6. This will provide an overview of linear equations and augmented matrices. You are always welcome and encouraged to read ahead beyond this as well. Write a paragraph about how this relates to what you have learned before and what is new.

2. **Survey** To complete this part of the HW, you only have to fill out the two surveys and indicate in your submitted answer that you filled them both out. Nothing else is required.

   (a) We would like to get to know you all a bit better, please do tell us about yourself!
   `https://forms.gle/WvHnBYhtynEUmBn36`

   (b) Since students won't have the chance to get to know each other in the usual way this semester, we are trying a new pilot plan to organize study groups for you all. Please give us some information that will help us create study groups for all of you.
   `https://forms.gle/BMquudoWAFTcmzm77`

3. **Syllabus**

   Read the course syllabus and answer the following questions. The syllabus can be found here: `https://eecs16a.org/policies.html`.

   (a) What are the dates and times for both midterms and the final exam? If you live in a timezone other than the Pacific Time zone (for Berkeley) compute what times these correspond to for you.

   Solution:

   Midterm 1 is on Monday, October 5, 2020, from 7pm-9pm Pacific Time.

   Midterm 2 is on Monday, November 2, 2020, from 7pm-9pm Pacific Time.

   The final exam is on Friday, December 18, 2020, from 8am-11am Pacific Time.

   (b) If you need exam accommodation whom do you contact and how?

   Solution:

   Head GSI via email at `eecs16a@berkeley.edu`. You have to contact the head GSI as soon as possible.

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(c) When is homework 1 due? When is homework 1's self-grade due? In general, what day of the week is the homework due and at what time? In general, what day of the week are the self-grades due and at what time? If you live in a timezone other than the Pacific Time zone (for Berkeley) compute what times these correspond to for you.

Solution:

Homework 1 is due Friday 9/4 at 23:59 Pacific Time. Self-grade for homework 1 is due Monday 9/7 23:59 Pacific Time.

All homeworks are due on Friday at 23:59 Pacific Time and their respective self-grades are due the following Monday at 23:59 Pacific Time.

(d) When are homework parties? Homework parties are where groups of students can get together to work on the homework together.

Solution:

Homework parties are online on Thursdays 9 - 11 am and 2 - 4 pm (Pacific Time).

(e) How many homework drops do you get? Reminder, the homework drop is for extenuating circumstance such as getting sick, family emergencies etc. You should plan on completing and submitting all homeworks and self-grades.

Solution:

You only get one homework drop. Please reserve this for emergencies.

(f) If you miss a homework, can you resubmit it for partial credit after the solutions are released? When do you have to submit it by?

Solution:

If you miss a homework, you can resubmit it by the self-grade deadline Monday at 23:59 Pacific Time (same time as self-grades) to get partial credit on it, you can get up to 70% of the credit on the HW. You will have to submit self-grades at the same time as the resubmission.

(g) What is the penalty if you turn in your self-grades up to one week late?

Solution:

You only receive 75% credit on that homework.

(h) What score will you get on a homework if you do not submit your self-grades?

Solution:

You will receive a 0% on that homework.

(i) There are two ways to get participation credit in the course — by either attending discussions live, or by watching a recorded discussion. Describe the procedures to get discussion credit for both types of participation. How many discussions do you need to attend to get full participation credit?

Solution:

If you attend a discussion section live, you will automatically get participation credit through the zoom attendance logs. If you watch a recorded discussion, you must submit the discussion checkoff form by Monday at 23:59 Pacific Time (same time as self-grades) the following week.

You must attend 16 discussions to get full participation credit.

(j) Fill in the blank: You should attend one discussion section on ______ and one discussion section on ______ each week.

Solution:

You should attend one discussion section on Monday and one discussion section on Wednesday each week.

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(k) Provide a complete list of everything you must do in order to receive credit for your homework assignments.

Solution:

A complete submission requires turning a scan of your work, a printout/screenshot of the Python component, and your Python code, all before the submission deadline on Friday. To receive credit for an assignment, you must submit your self-grades after the assignment has been submitted and before the Monday deadline.

(l) Read the following guide: `www.tinyurl.com/ee16a-gradescope`. What are the five steps in the submission process for a PDF on Gradescope? Please note that if you do not select pages for each question/subquestion we cannot grade your homework and we will be forced to give you a 0.

Solution:

1. Find the appropriate assignment in the Gradescope portal.

2. Select "Submit PDF".

3. Upload your single PDF, containing both your (scanned) handwritten answers and a "printout" of your iPython code (can be concatenated with www.pdfmerge.com).

4. Assign questions to pages of your submission. Each page must be assigned a question, and each question must be assigned a page (except optional or practice questions) before you click "Submit".

5. Click "Submit" in the lower right-hand corner. If you have selected pages correctly, you will not have to click through a warning message.

(m) If you submit your homework but forget to select pages, can you reselect pages?

Solution: Yes, you can go back in to Gradescope and reselect the pages.
Grading will usually start the morning after homework is due, so if you reselect pages by then, you should be fine.

(n) What percentage do you need to get on a homework assignment for you to get full credit for the assignment?

Solution: 80%. If you get x% of the homework correct, where x < 80, you will get (x/80) * 100 points on that assignment.

(o) Will the exams in this class be proctored via personal zoom recordings?

Solution:

Yes, the exams in this class will be proctored via zoom recordings. You may find more information here `https://docs.google.com/document/d/1EVb4Ca6FWSAykExY7X5ynFW4KdmHd0BI6KZ0ktM8ows` `edit`.

(p) Fill in the blank:
If you miss ___ or more labs you will fail the class.

Solution:

If you miss 4 or more labs you will fail the class.

(q) Fill in the blank:

During buffer lab periods, you may get checked off for atmost _______ missed lab that occurred during that lab module by attending your ______ section.

Solution:

During buffer lab periods, you may get checked off for **only one** missed lab that occurred during that lab module by attending your **assigned** section.

4. Homework resources

If you need help on a homework problem or have a question about the material, what are some of the resources you might be able to use?

(i) Homework party
(ii) TA office hours
(iii) Professor office hours
(iv) Asking a friend taking 16A
(v) Posting on Piazza
(vi) Going to discussion
(vii) All of the above

Solution:

vii.

5. Counting Solutions

Learning Goal: *(This problem is meant to illustrate the different types of systems of equations. Some have a unique solution and others have no solutions or infinitely many solutions. We will learn in this class how to systematically figure out which of the three above cases holds.)*

Directions: For each of the following systems of linear equations, determine if there is a unique solution, no solution, or an infinite number of solutions. If there is a unique solution, find it. If there is an infinite number of solutions, describe the set of solutions. If there is no solution, explain why. **Show your work**.

Example: We first provide an example to show two ways to solve systems of linear equations. At this point, we only expect you to be able to follow the first approach. The second approach, Gaussian elimination, will be covered in class and in Note 1. **You may use either approach to solve the following problems. You will receive many more practice problems on Gaussian Elimination later on, do not worry if you do not want to use the Gaussian Elimination approach.**

$$\begin{aligned} 2x &+ 3y &= 5 \\ x &+ y &= 2 \end{aligned}$$

Solution A

$$2x+3y=5 \quad (1)$$
$$x+y=2 \quad (2)$$

Subtract: (1) - 2*(2)

$$y=1 \quad (3)$$

Now we plug in (3) into (2) and solve for x

$$x+1=2$$
$$\rightarrow \quad x=1 \quad (4)$$

From (3) and (4), we get the unique solution:

$$x=1$$
$$y=1$$

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Solution B

$$\left[\begin{array}{cc|c} 2 & 3 & 5 \\ 1 & 1 & 2 \end{array}\right] \rightarrow \left[\begin{array}{cc|c} 1 & \frac{3}{2} & \frac{5}{2} \\ 1 & 1 & 2 \end{array}\right] \text{using } R_1 \leftarrow \frac{1}{2}R_1$$
$$\rightarrow \left[\begin{array}{cc|c} 1 & \frac{3}{2} & \frac{5}{2} \\ 0 & -\frac{1}{2} & -\frac{1}{2} \end{array}\right] \text{using } R_2 \leftarrow R_2 - R_1$$
$$\rightarrow \left[\begin{array}{cc|c} 1 & \frac{3}{2} & \frac{5}{2} \\ 0 & 1 & 1 \end{array}\right] \text{using } R_2 \leftarrow -2R_2$$
$$\rightarrow \left[\begin{array}{cc|c} 1 & 0 & 1 \\ 0 & 1 & 1 \end{array}\right] \text{using } R_1 \leftarrow R_1 - \frac{3}{2}R_2$$

Unique solution, $\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$

(a)

$$\begin{array}{ccccccc} x & + & y & + & z & = 3 \\ 2x & + & 2y & + & 2z & = 5 \end{array}$$

Solution:

Solution A:

$$x + y + z = 3 \quad (5)$$
$$2x + 2y + 2z = 5 \quad (6)$$

Subtract: (6) - 2*(5)

$$0 = -1 \quad (7)$$

We see this results in a contradiction in (7), indicating that no values of x,y,z can satisfy both equations. Therefore there are no solutions.

Solution B:

$$\left[\begin{array}{ccc|c} 1 & 1 & 1 & 3 \\ 2 & 2 & 2 & 5 \end{array}\right] \rightarrow \left[\begin{array}{ccc|c} 1 & 1 & 1 & 3 \\ 0 & 0 & 0 & -1 \end{array}\right] \text{using } R_2 \leftarrow R_2 - 2R_1$$

No solution. The fact that there are fewer equations than there are unknowns immediately means that it is not possible to have a unique solution; however, this does not guarantee that there is a solution to begin with. From Gaussian Elimination, we can see that these equations are contradictory since $0 \neq -1$. In other words, no values of x, y, and z can satisfy both equations simultaneously.

(b)

$$\begin{array}{ccccccc} & - & y & + & 2z & = 1 \\ 2x & & & + & z & = 2 \end{array}$$

Solution:

Solution A:

Because there are two equations and three unknowns, we immediately see that there can be no unique solution. The question then becomes if there are an infinite number of solutions, or no solution at all.

We notice that because we cannot cancel out x or y using the other equation, the equations do not contradict each other so there must exist an infinite number of solutions. We choose z to be our free variable and can then solve each equation in terms of z.

$$x = 1 - \frac{1}{2}z$$
$$y = 2z - 1$$

Solution B:

Because there are two equations and three unknowns, we immediately see that there can be no unique solution. The question then becomes if there are an infinite number of solutions, or no solution at all.

$$\left[\begin{array}{ccc|c} 0 & -1 & 2 & 1 \\ 2 & 0 & 1 & 2 \end{array}\right] \rightarrow \left[\begin{array}{ccc|c} 2 & 0 & 1 & 2 \\ 0 & -1 & 2 & 1 \end{array}\right] \text{swapping } R_1 \text{ and } R_2$$
$$\rightarrow \left[\begin{array}{ccc|c} 1 & 0 & \frac{1}{2} & 1 \\ 0 & -1 & 2 & 1 \end{array}\right] \text{using } R_1 \leftarrow \tfrac{1}{2}R_1$$
$$\rightarrow \left[\begin{array}{ccc|c} 1 & 0 & \frac{1}{2} & 1 \\ 0 & 1 & -2 & -1 \end{array}\right] \text{using } R_2 \leftarrow -R_2$$

We have now completed Gaussian elimination because we have a leading 1 in each row with zeros below that 1 in its column. In this way we can explicitly see that z is a free variable (x and y depend on z and there are no constraints on the value of z). Thus there are an infinite number of solutions. The set of infinite solutions has the form (for some $z \in \mathbb{R}$):

$$x = 1 - \frac{1}{2}z$$
$$y = 2z - 1$$

To get full credit it is enough to state "Infinite solutions" and give one possible solution that fits the form above.

(c)

$$\begin{array}{rcrl} x & + & 2y & = 3 \\ 2x & - & y & = 1 \\ 3x & + & y & = 4 \end{array}$$

Solution:

Solution A:

In this case, there are three equations with only two unknowns. However, this fact alone does not tell us whether there is a unique solution, no solution, or an infinite number of solutions.

$$x + 2y = 3 \tag{8}$$
$$2x - y = 1 \tag{9}$$
$$3x + y = 4 \tag{10}$$

Adding (8) and (9), we obtain

$$3x+y \quad = 4 \tag{11}$$

Notice that equation (11) = equation (10)! Put another way, equation (10) provides no new information about the system that equations (8) and (9) could not tell us (importantly, it also does not contradict any information from the previous equations as well). Knowing this, we focus only on (8) and (9).

Add (8) + 2*(9)

$$5x \quad = 5$$
$$\rightarrow \quad x = 1 \tag{12}$$

Plugging this value of x back into (8), we obtain

$$1 \ +2y \quad = 3$$
$$\rightarrow \quad y = 1 \tag{13}$$

Yielding the unique solution

$$x = 1$$
$$y = 1$$

Solution B:

$$\left[\begin{array}{cc|c} 1 & 2 & 3 \\ 2 & -1 & 1 \\ 3 & 1 & 4 \end{array}\right] \rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & -5 & -5 \\ 3 & 1 & 4 \end{array}\right] \text{using } R_2 \leftarrow R_2 - 2R_1$$
$$\rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & -5 & -5 \\ 0 & -5 & -5 \end{array}\right] \text{using } R_3 \leftarrow R_3 - 3R_1$$
$$\rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & 1 & 1 \\ 0 & -5 & -5 \end{array}\right] \text{using } R_2 \leftarrow -\tfrac{1}{5}R_2$$
$$\rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{array}\right] \text{using } R_3 \leftarrow R_3 + 5R_2$$
$$\rightarrow \left[\begin{array}{cc|c} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{array}\right] \text{using } R_1 \leftarrow R_1 - 2R_2$$

Unique solution, $\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$

The system of linear equations at the end of the Gaussian Elimination above simply reads out

$$x = 1$$
$$y = 1$$
$$0 = 0$$

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(d)

$$\begin{aligned} x &+ 2y &= 3 \\ 2x &- y &= 1 \\ x &- 3y &= -5 \end{aligned}$$

Solution:

Solution A:

$$x + 2y = 3 \tag{14}$$

$$2x - y = 1 \tag{15}$$

$$x - 3y = -5 \tag{16}$$

Add: (14) + (16)

$$2x - y = -2 \tag{17}$$

Subtract: (15) - (17)

$$0 = 3$$

This is a contradiction, so there is no solution.

There is no solution for this system as no choice of x and y can satisfy all equations simultaneously. This is often what happens when you have more equations than unknowns, although as you saw in the previous part, it doesn't always happen.

Solution B:

$$\left[\begin{array}{cc|c} 1 & 2 & 3 \\ 2 & -1 & 1 \\ 1 & -3 & -5 \end{array}\right] \rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & -5 & -5 \\ 1 & -3 & -5 \end{array}\right] \text{using } R_2 \leftarrow R_2 - 2R_1$$

$$\rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & -5 & -5 \\ 0 & -5 & -8 \end{array}\right] \text{using } R_3 \leftarrow R_3 - R_1$$

$$\rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & 1 & 1 \\ 0 & -5 & -8 \end{array}\right] \text{using } R_2 \leftarrow -\frac{1}{5}R_2$$

$$\rightarrow \left[\begin{array}{cc|c} 1 & 2 & 3 \\ 0 & 1 & 1 \\ 0 & 0 & -3 \end{array}\right] \text{using } R_3 \leftarrow R_3 + 5R_2$$

No solution. We can think of this to mean that there are no values of x and y which satisfy the conditions in all three equations simultaneously, because in order to satisfy all three equations, the last row $0 = -3$ would need to be true.

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