

Homework 3: Due March 22, 2024

You are welcome to use any resources available to you, and are free to discuss the homework with other students. Collaborative studying is encouraged, but the write-up you turn in should be your own. Please neatly write or type your results, showing your work and/or justifying your answers with equations (i.e. don't just use your computer to calculate the answer and then only give the result).

- 1) You measure your height with four different rulers, and obtain the following:  $165.6 \pm 0.3 \text{ cm}$ ,  $165.1 \pm 0.4 \text{ cm}$ ,  $166.4 \pm 1.0 \text{ cm}$ , and  $166.1 \pm 0.8 \text{ cm}$ . What is the best estimate of your height, and how accurate is it? What would have been the best estimate if you had neglected the accuracies of the individual measurements?
- 2) Find the mean, median, and mode of the following sets of grades.

| $i$ | $x_i$ | $i$ | $x_i$ | $i$ | $x_i$ | $i$ | $x_i$ |
|-----|-------|-----|-------|-----|-------|-----|-------|
| 1   | 73    | 11  | 73    | 21  | 69    | 31  | 56    |
| 2   | 91    | 12  | 46    | 22  | 70    | 32  | 94    |
| 3   | 72    | 13  | 64    | 23  | 82    | 33  | 51    |
| 4   | 81    | 14  | 61    | 24  | 90    | 34  | 79    |
| 5   | 82    | 15  | 50    | 25  | 63    | 35  | 63    |
| 6   | 46    | 16  | 89    | 26  | 70    | 36  | 87    |
| 7   | 89    | 17  | 91    | 27  | 94    | 37  | 54    |
| 8   | 75    | 18  | 82    | 28  | 44    | 38  | 100   |
| 9   | 62    | 19  | 71    | 29  | 100   | 39  | 72    |
| 10  | 58    | 20  | 76    | 30  | 88    | 40  | 81    |

Create a histogram for the distribution and mark these quantities on it.

Calculate the standard deviation of the data.

- 3) A proton-decay detector detects a burst of 8 neutrinos coincident with the optical observation of a nearby supernovae. The average number of neutrinos detected is 2 per day. What is the probability of detecting 8 or more in a single day? In fact, all 8 were detected within 10 minutes; what is the probability of this event? What can you conclude about this detection?
- 4) What are the advantages of differential photometry to all-sky (absolute) photometry? With this in mind, what advantages does the CCD have over the photomultiplier in both cases?
- 5) Assume you are observing a variable star that exhibits variations of 60 s and longer, with an amplitude of 0.02 magnitudes. At one setting, the readout time of your CCD camera is 17 s and the read noise is 4 electrons. At another setting the readout time is 2 s and the read noise is 6 electrons. In 10 s, the star produces 1500 counts. Assuming the gain is 3 electrons per count and the sky counts can be neglected, which is the preferred setting?