Physics 3610H: Assignment I

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Problem 1.

(a) Write the value of Euler's number e including 24 digits after the decimal point.

(b) Imagine you took this number, cut it out, and chopped it into 25 pieces such that each piece had one digit. Put these pieces in a bag, and choose one at random. What is the probability that the number you choose will be a 5?

(c) What is the most probable value

(d) What is the average value

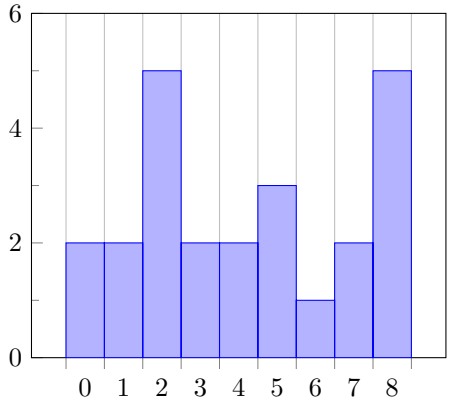
(e) What is the standard deviation

Solution 1.

(a) $e \approx 2.718\,281\,828\,459\,045\,235\,360\,287$

(b) $n_5/N = 3/25 = 12\%$

(c)



As can be seen by the chart, 8 and 2 are the most probable values in a random draw.

(d) The average is given by

$$\mu = \frac{1}{N}\sum_{k=0}^{N} k n_i = \frac{1}{25}\left[0\cdot 2 + 1\cdot 2 + 2\cdot 5 + 3\cdot 2 + 4\cdot 2 + 5\cdot 3 + 6\cdot 1 + 7\cdot 2 + 8\cdot 5 + 9\cdot 1\right] = 4.4$$

(e) Standard deviation is given by

$$\sqrt{\frac{\sum_{k=0}^{N}(n_k-\mu)^2}{N}} \approx 2.83$$

(calculated using Python)

Problem 2.

(a) Consider the complex number $z = 3 - 5i$.

(i) If we express z as $Ae^{i\phi}$, what are A and ϕ?

(ii) What is z^* in both cartesian and polar form?

(iii) What is $|z|^2$

(b) Consider the function $f(x) = xe^{ix}$

(i) Make a plot of the real part of $f(x)$ as a function of x in the range $(0, 4)$.

(ii) Make a plot of the Imaginary part of $f(x)$ as a function of x in the range $(0, 4)$.

Solution 2.

(a)

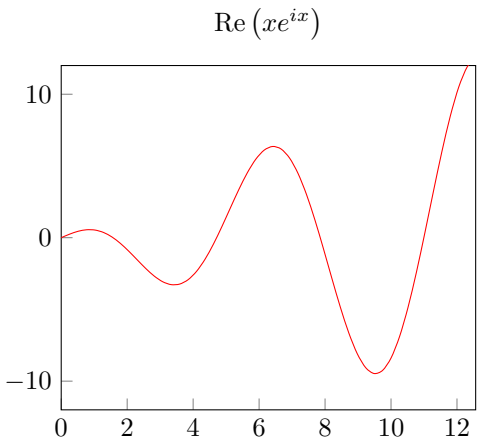
(i) $A = \sqrt{3^2 + 5^2} = \sqrt{34}$, $\phi = \arctan\left(-\frac{5}{3}\right) \approx -1.03\,\text{rad}$

(ii) $z^* = 3 + 5i \approx \sqrt{34}e^{i1.03\,\text{rad}}$

(iii) $|z|^2 = 34$

(b) For ease of plotting, $f(x) = xe^{ix} = x\left(\cos x + i \sin x\right)$ by Euler's formula

(i)



(ii)