Introduction to Computing: Tutorial 6

BSDS I Year, 2026–2027

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Try different ways of solving each of the following problems. Compare the efficiency of your solutions using the `%timeit` magic function.

1. (a) Construct a chessboard-type 8×8 matrix. The elements of the matrix should be alternately 1 and 0 along both axes.

   (b) Write a function that takes an integer $n \geq 1$ as an argument, and creates an $n \times n$ matrix whose border elements are 1, and internal elements are 0. For $n = 1, 2, 3, 4$, the matrices should look like the following.

1

1	1
1	1

1	1	1
1	0	1
1	1	1

1	1	1	1
1	0	0	1
1	0	0	1
1	1	1	1

2. Write functions with the following properties.

   (a) Input parameter: a positive integer n;
   Return value: an $n \times n$ matrix with i.i.d. elements $\sim U[0, 1)$.

   (b) Input parameter: a matrix A and $\theta \in \mathbb{R}$;
   Return value: the 'binarised' form $A_{(\text{bin})}$, in which all elements of A that are $\geq \theta$ are replaced with 1, and all other elements are replaced with 0.

   (c) Input parameter: the random matrix generated in (a);
   Return value: two vectors $\mathbf{r}$ and $\mathbf{c}$ corresponding to the row-wise and column-wise means.
   What are $\mathbb{E}[\mathbf{r}]$ and $\mathbb{E}[\mathbf{c}]$, the expected values of these two mean vectors?

   (d) Use (a) to generate N random matrices, and use (c) to obtain the row-wise and column-wise means ($\mathbf{r}$ and $\mathbf{c}$) for each matrix. Finally, compute the mean of the N row-mean vectors, and the mean of the N column-mean vector separately. Experimentally find a value of N for which the total squared error between the calculated $\bar{\mathbf{r}}$, $\bar{\mathbf{c}}$ and $\mathbb{E}[\mathbf{r}]$, $\mathbb{E}[\mathbf{c}]$ drops to 10^{-4} or less.

3. Experimentally find out what `np.argmin()` and `np.argmax()` return when the input array has multiple maxima / minima.

4. Write a function that takes an ndarray A and a real number θ as inputs, and returns the value in A that is closest to θ.