

Project objective:

- Realize and explain the procedure in which unitary matrices are decomposed.
- Produce a pseudo code algorithm that can decompose a unitary matrix
- Successfully implement the algorithm in python, or MATLAB

Decomposing (factorizing) unitary Matrix.

- Matrix decomposition is a field of linear algebra. There are many different matrix decompositions, each find use among a class of problems.
- For this project, the aim is to figure out an algorithm that can decompose unitary matrices of shape 2^k by 2^k .

Approach

My approach to this project to tackle it in 3 phases:

- Understand the mathematical practice of unitary matrix decomposition,
- Research how to write an algorithm.
- Based on the algorithm I have written, write code that executes the algorithm.

How will the program be coded?

The program will be initially coded using python. This is because of personal preference as well because of the python NumPy features which allows users to code matrices in python. If an unsuccessful attempt is done with python, then MATLAB will be used instead.

Predicted conclusion

The predicted conclusion is that the program will successfully be completed on pseudocode. However if the python implementation of the algorithm is non functioning, then a MATLAB implementation will be attempted in its stead.

Challenges

- Designing and implementing and algorithm
- Researching how unitary matrices work when being factorized.
- Ensuring that the algorithm will not crash regardless of the size of the matrix.

$$U = \begin{pmatrix} 1/2 & \frac{1}{2\sqrt{3}} & \sqrt{2/3} \\ -1/2 & \sqrt{3}/2 & 0 \\ 1/\sqrt{2} & 1/\sqrt{6} & -1/\sqrt{3} \end{pmatrix}.$$

$$U_1 = \begin{pmatrix} 1/\sqrt{3} & 0 & \sqrt{2/3} \\ 0 & 1 & 0 \\ -\sqrt{2/3} & 0 & 1/\sqrt{3} \end{pmatrix}.$$

$$U_1 U = \begin{pmatrix} \sqrt{3}/2 & 1/2 & 0 \\ -1/2 & \sqrt{3}/2 & 0 \\ 0 & 0 & -1 \end{pmatrix}.$$

$$U_2 = \begin{pmatrix} -\sqrt{3}/2 & 1/2 & 0 \\ 1/2 & \sqrt{3}/2 & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

$$U_2 U_1 U = \begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}.$$

Unitary matrix decomposition example.

