Demonstration on A Programming Approach to Mathematical Statistics

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Demonstration Details

1. Introduction

In the beginning, computers were invented with an aim to supplement human thinking methods, more specifically, to help us to think straight through the midst of complexity. In this proposal, we will demonstrate a journey of mathematical knowledge discovery accompanied with the nurturing of computer skills by the way. In practice, the Mathematics part will include some basic counting principles and statistics, and the Computer part will be some pre-written Python codes for high school students.

2. Motivation

Python is gaining popularity as a programming language, largely due to its great community and rich packages for various domains associated with data science. Google Colaboratory (Abbrev. as Colab) provides a programmable environment on a modern browser. With Colab, students could get rid of the distracting environment creation process and get straight to execute some Python codes prepared by the author of this proposal.

Our methodology of learning Mathematics supplemented by Python is beneficial to students in a wide range of mentality. We shall illustrate with a motivating example. In Figure 1, some pre-written code for listing combinations in lexicographic order is executed in Colab.

Student A may be satisfied in seeing all n-Choose-r combinations in a list in just a few clicks. The code makes the listing exercise feasible for much larger n and r as compared to traditional way of time-consuming handwriting.

Student B may be more eager to discover patterns observable from the listing. After experimenting with different n and r, some well-known formulas may be discovered. When given a proper visualization, student B may even scratch proofs to these formulas.

Student C could be the most ambitious one. Not satisfied with just executing pre-written codes, and yet still respecting copyright under the MIT License, one may fork a copy and dig down to the source code with a take-charge attitude. Student C could enjoy the challenge of picking up more sophisticated techniques, from list comprehension to algorithm design, through investigating our codes.

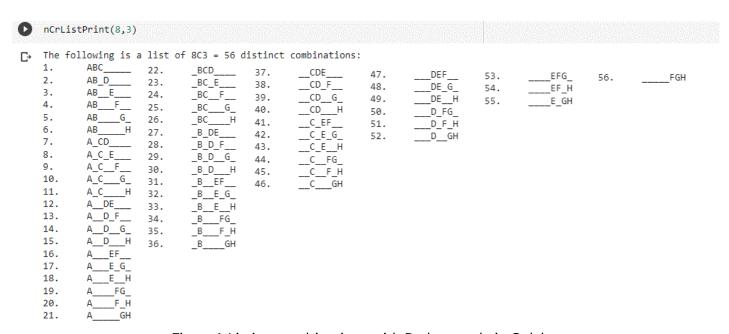


Figure 1. Listing combinations with Python code in Colab

3. Scope Coverage

Section 1	Mathematical Knowledge	Accompany Computer Skills
Section 1.1	Counting Principle: addition rule and multiplication rule	Introduction to Colab: basic data type and operation in Python
Section 1.2	Factorial and Permutation: list and computation	Python function, control flow and recursion
Section 1.3	Combination: list, computation and basic properties	Python function, control flow and recursion
Section 1.4	Application to expanding some polynomial: Binomial Theorem	

Section 2	Mathematical Knowledge	Accompany Computer Skills
Section 2.1	Example of cdf and pdf: careful present the normal distribution as a seemingly random selected case	Graph plotting and transformation with matplotlib; Other interactive online visualization tool
Section 2.2	Binomial distribution: definition, cdf, pmf and basic properties	Python package matplotlib
Section 2.3	Compare and Contrast cdf of binomial distribution and normal distribution	Python package matplotlib
Section 2.4	Story Telling: some relationship between binomial distribution and normal distribution and beyond (CLT)	

Table 1. A draft on the curriculum design

4. Collaboration and Timeline

The demonstration shall take place via Zoom in the seasonal school vacation of 2022. Number of sessions is to be determined. Target audiences are S3 and S4 students. Collaborative roles are proposed in Table 2.

Hanlun Artificial Intelligence Limited	St. Paul's College
To focus on curriculum design and Colab material development	To focus on students group organization and material teaching

Table 2. Collaborative Role

5. Evaluation and Further Work

To be determined...