Demonstration on
A Programming Approach to
Mathematical Statistics

Prepared by Hanlun Artificial Intelligence Limited

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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.

```
nCrListPrint(8,3)
```

```
The following is a list of 8C3 = 56 distinct combinations:
1.      ABC_____   22.     _BCD____   37.     __CDE___   47.     ___DEF__   53.     ____EFG_   56.     _____FGH
2.      AB_D____   23.     _BC_E___   38.     __CD_F__   48.     ___DE_G_   54.     ____EF_H
3.      AB__E___   24.     _BC__F__   39.     __CD__G_   49.     ___DE__H   55.     ____E_GH
4.      AB___F__   25.     _BC___G_   40.     __CD___H   50.     ___D_FG_
5.      AB____G_   26.     _BC____H   41.     __C_EF__   51.     ___D_F_H
6.      AB_____H   27.     _B_DE___   42.     __C_E_G_   52.     ___D__GH
7.      A_CD____   28.     _B_D_F__   43.     __C_E__H
8.      A_C_E___   29.     _B_D__G_   44.     __C__FG_
9.      A_C__F__   30.     _B_D___H   45.     __C__F_H
10.     A_C___G_   31.     _B__EF__   46.     __C___GH
11.     A_C____H   32.     _B__E_G_
12.     A__DE___   33.     _B__E__H
13.     A__D_F__   34.     _B___FG_
14.     A__D__G_   35.     _B___F_H
15.     A__D___H   36.     _B____GH
16.     A___EF__
17.     A___E_G_
18.     A___E__H
19.     A____FG_
20.     A____F_H
21.     A_____GH
```

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...