**深 圳 大 学 实 验 报 告**

**课程名称：­ 概率论与数理统计**

**实验项目名称： Axiom of Probability in Python**

**学院： 电子与信息工程学院**

**专业： 电子与信息工程**

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**实验时间： 2023.9.8——2023.9.30**

**实验报告提交时间： 2023.9.27**

**教务处制**

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| **Aim of Experiment:**  • Familiar with some basic syntax in Python.  • Interpret the randomness in probability experiment.  • Understand the set operations in Python. |
| **Experiment Content:**  **1. Probability**  **1.1 Exercise 1:**  Write a function, seq\_sum(n), which generates 𝑛 random coin flips from a fair coin and then returns the number of heads. A fair coin is defined to be a coin where 𝑃(heads)=1/2  The output type should be a numpy integer, hint: use np.random.rand()  **1.2 Exercise 2:**  Write a function, estimate\_prob(n,k1,k2,m), that uses seq\_sum(n) to estimate the following probability:  𝑃(𝑘1<=number of heads in 𝑛 flips<𝑘2)(1<=number of heads in  flips<2)  The function should estimate the probability by running 𝑚 different trials of seq\_sum(n), probably using a *for* loop.  In order to receive full credit **estimate\_prob** MUST call **seq\_sum** (aka: seq\_sum is located inside the **estimate\_prob** function)  **2. Sets**  **2.1 Import Stuff**  Notice that we do not import *numpy* or *scipy* neither of these packages are need for this homework. For our solutions, the only command we needed to import was itertools.product()  **2.2 Exercise 1:**  Write the function **complement\_of\_union** that first determines 𝐴∪𝐵∪ and then evaluates the complement of this set. Output the tuple: (𝐴∪𝐵,(𝐴∪𝐵)𝑐)  **2.3 Exercsise 2:**  Write the function **intersection\_of\_complements** that first determines 𝐴𝑐 and 𝐵𝑐 and then evaluates the intersection of their complements. Output the tuple: (𝐴𝑐,𝐴𝑐∩𝐵𝑐)  **2.4 Exercise 3:**  The inclusion-exclusion principle states that for two sets 𝐴 and 𝐵,  |𝐴∪𝐵|=|𝐴|+|𝐵|−|𝐴∩𝐵|.  Write the following functions to determine |𝐴∪𝐵|in two different ways.  A function **union** that determines first 𝐴∪𝐵 and then evaluates the union's size. Output the ordered pair (𝐴∪𝐵,|𝐴∪𝐵|)  **2.5 Exercise 4:**  A function **inclusion\_exclusion** that first deterimines |𝐴||, |𝐵|, 𝐴∩𝐵, and |𝐴∩𝐵|, and then uses the inclusion-exclusion formula to determine |𝐴∪𝐵|. Output the tuple (|𝐴|,|𝐵|,|𝐴∩𝐵|,|𝐴∪𝐵|).  **2.6 Exercise 5:**  The inclusion-exclusion principle says that for three sets 𝐴, 𝐵 and 𝐶,  |𝐴∪𝐵∪𝐶|=|𝐴|+|𝐵|+|𝐶|−|𝐴∩𝐵|−|𝐵∩𝐶|−|𝐶∩𝐴|+|𝐴∩𝐵∩𝐶|  We will write the following functions to determine |𝐴∪𝐵∪𝐶|| in two different ways.  Write function **union3** that first determines 𝐴∪𝐵∪𝐶 and then evaluates the size of this union. Output the tuple (𝐴∪𝐵∪𝐶,|𝐴∪𝐵∪𝐶|).  **2.7 Exercise 6:**  A function **inclusion\_exclusion3** that first deterimines the sizes of 𝐴, 𝐵, 𝐶 and their mutual intersections, and then uses the inclusion-exclusion principle to determine the size of the union. Output the tuple (|𝐴∩𝐵∩𝐶|,|𝐴∪𝐵∪𝐶|). Note that for brevity we are asking you to output the intermediate answer just for 𝐴∩𝐵∩𝐶, but you need to calculate all. |
| **Experiment Process：**  **1.1 Exercise 1:**    **1.2 Exercise 2:**    **2.2 Exercise 1:**    **2.3 Exercsise 2:**    **2.4 Exercise 3:**    **2.5 Exercise 4:**    **2.6 Exercise 5:**    **2.7 Exercise 6:** |
| **Data Logging and Processing:**  For 1.Exercise, the results of tests are as follows:  #### test no. 1  computed prob=0.954, std=0.021  ran estimator 100 times, with parameters n=100,k1=40,k2=60,m=100  median of estimates=0.950, error of median estimator=-0.004, std= 0.0208405.3  normalized error of median= 0.21591965634481614 should be <1.0  #### test no. 2  computed prob=0.159, std=0.037  ran estimator 100 times, with parameters n=100,k1=55,k2=100,m=100  median of estimates=0.175, error of median estimator=0.016, std= 0.0365355.3  normalized error of median= 0.447367010066922 should be <1.0  #### test no. 3  computed prob=0.146, std=0.035  ran estimator 100 times, with parameters n=100,k1=47,k2=49,m=100  median of estimates=0.140, error of median estimator=-0.006, std= 0.0353595.3  normalized error of median= 0.1834639088948734 should be <1.0  #### test no. 4  computed prob=1.000, std=0.000  ran estimator 100 times, with parameters n=1000,k1=400,k2=600,m=100  median of estimates=1.000, error of median estimator=0.000, std= 0.0000025.3  normalized error of median= 0.0001593621193426113 should be <1.0  #### test no. 5  computed prob=0.001, std=0.003  ran estimator 100 times, with parameters n=1000,k1=550,k2=1000,m=100  median of estimates=0.000, error of median estimator=-0.001, std= 0.0027975.3  normalized error of median= 0.27987751426889984 should be <1.0  #### test no. 6  computed prob=0.446, std=0.050  ran estimator 100 times, with parameters n=1000,k1=470,k2=499,m=100  median of estimates=0.430, error of median estimator=-0.016, std= 0.0497065.3  normalized error of median= 0.31979175011881933 should be <1.0      The second part results turn out all right. |
| **Experimental Results and Analysis:**   * From the experiment, I am familiar with some basic syntax in Python. When meeting some troubles, I try to seek for some tips in Internet or sort it out again from beginning to end; * It is important to analyze the error message below the compiler when catching an error; * A better understanding of the set operations in Python; * After the experiment, I understand the Probability Theory clearly; * Through verifying the theory of De Morgan's law, and verifying the inclusion-exclusion principle by calculate |𝐴∪𝐵∪𝐶| and |𝐴∩𝐵∩𝐶| in two different ways, my understand the Axioms of Probability bettter. * Deepen my understanding and application of set principle. |
| 指导教师批阅意见：  成绩评定：  指导教师签字：  年 月 日 |
| 备注： |

注：1、报告内的项目或内容设置，可根据实际情况加以调整和补充。

2、教师批改学生实验报告时间应在学生提交实验报告时间后10日内。