**Eastern Goldfields College**

**Mathematics Essentials 2017**

**Application 3**

Time allowed: 60 minutes  Task Weighting: 8%

## Investigation – Probability and Simulations

Name: SOLUTIONS  Mark: /43 40

- **One A4 page of notes and scientific calculator allowed.**
- **Working is required for full marks for any question worth more than one mark.**

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**I want to win Lotto!**

Lotto is a gambling activity. You pay to enter according to how many games you purchase. Each game is one chance of winning a prize. The barrel is filled with numbered balls and a set amount of winning numbers are randomly selected from the barrel.

**Starting small.**

Let's assume that there are only a total of 5 balls numbered 1 to 5 and you need to choose one ball to win.

1. [ 1 mark]
   What are all the possible results of the draw?

   1, 2, 3, 4, 5 ✓

2. [ 5 marks – 1, 1, 1, 1, 1]
   a) What is the probability that you win in any one week if you purchase just one entry?

   1/5 ✓

   b) Describe how you could simulate this.

   random no. table ✓
   Generate random numbers 1–5 on calc, choose from hat

   c) Conduct a simulation of 20 trials and record your results below.

   ✓
   3, 3, 2, 1, 5, (4), 3, 2, 2, 5, 1, 1, (4), 5, (4), 3, 1, 3, 2, 2

   d) If 4 was the winning number, what was the probability of winning based on **your** simulation.

   3/20 or 0.15 or 15%. ✓ as per their results FT

   e) How close did your experiment get to the theoretical probability?

   0.15 v 0.2  0.05 difference ✓
   Fairly close (some may be exactly the same) FT

(6)

Now let's assume that there are two balls drawn out of the five balls.

3. [2 marks]
   What is the sample space?

   If repeats only ✓

   1,5 1,4 1,3 1,2 2,5 2,4 2,3 3,5
   3,4 4,5 ✓✓ or tree diagram/table.

4. [1 marks]
   If you purchase a single game, what is the likelihood that you will win?

   1/10 ✓ F.T.

5. [2 marks]
   Would it be more or less likely that you will win than when only one ball is drawn? Explain.

   Less likely as more possibilities. F.T
   ✓ ✓ (or prob is less)

Next, let's assume there are three balls drawn out of the five balls in the barrel?

6. [ 4 marks]
   List all the possible outcomes and work out the probability of winning? (Order does not matter)

   123 124 125 134 135 145
   234 235 245 345

   (must have all 10) (If repeats ✓✓)

   ✓✓✓ all
   ✓✓ 8/9
   ✓✓ 6/7
   ✓ 5

7. [ 2 marks]
   Is it harder to win than when two balls are drawn? Why?

   No, as same number of possibilities (or same prob)
   ✓ ✓
   F.T.

**Getting bigger**

Let's go back to looking at a Lotto draw where you need to draw two balls, but this time we'll work with a barrel of ten balls.

8. [1 mark]
   There are 45 possible outcomes in this Lotto draw. What is the theoretical probability of winning?

   1/45 ✓

9. [4 marks]
Design a simulation to find what the likelihood of winning is based on experimentation. Describe your method in detail.

Technique ✓ eg Number pieces of paper 1-10 & draw 2 (one
How/method ✓ after the other) from a hat
Non-replace ✓ Record your results in a table
Record ✓ OR Use Random no. generator 1-10 for
first ball, Reassign nos for second draw
Record results.

| DRAW | RESULT |
|---|---|
| 1 | 2, 7 |
| 2 | 3, 7 |
| 3 | 1, 10 |
| 4 | 8, 2 |
| . | |
| . | |
| 50 | |

10. [2 marks]
How many games (trials) are you going to play? Justify your choice.

Should be minimum of 50 trials. Need to do
sufficient trials so experimental result is close to
theoretical result.

1

11. [2 marks]
Run your simulation and write your results into a table.

Table of results or list of results. Show Simulated results.

eg

| DRAW | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 etc. |
|---|---|---|---|---|---|---|---|---|---|---|
| FIRST | 2 | 1 | 10 | 8 | 4 | 2 | 5 | 5 | 6 | |
| SECOND | 4 | 4 | 3 | 6 | 1 | 1 | 8 | 10 | 2 | |

✓

The winning two numbers drawn are 2 followed by 7.

1

12. [3 marks]
Record your results below;

| | |
|---|---|
| Wins | 0 |
| No win | 50 |
| Total | 50 |

✓ F.T.

13. [2 marks]
How close did your experiment get to the theoretical probability?

✓ I got 0% and the theoretical prob F.T.
is 2% which is about the same/close ✓

10

14. [2 marks]

How could you be sure of getting a result close to the theoretical probability?

Conduct more trials as it will approach the theoretical probability (Law of large Nos).

15. [1 mark]

Identify a factor that may cause your simulation to no longer model the real world event.

Second number is not equally likely if leave first no. in. Rules change? (should relate to their simulation)

**The real thing**

For Oz Lotto 9 balls are randomly drawn from balls numbered 1 to 45. The first seven balls drawn are the winning numbers" and the last two numbers are the "supplementary numbers"

To win first division you need to match 7 numbers in a single game with the 7 winning numbers from the draw.

**The probability of choosing the correct 7 numbers is** $\frac{1}{45379620}$ or 0.00000002203

Consider the following information:

**Hot Numbers**

| | | | | | |
|---|---|---|---|---|---|
| 1 | 18 | 40 | 25 | 11 | 12 |

These numbers have been drawn most frequently.

**Cold Numbers**

| | | | | | |
|---|---|---|---|---|---|
| 14 | 44 | 2 | 17 | 35 | 30 |

These numbers have been drawn least frequently.

16. [2 marks]

What numbers would you choose and why?

Any numbers as all are equally likely each week.

## Most Profitable Numbers

**Some numbers are statistically more profitable than others when they win.**

This is because some numbers are less popular than others. When a less popular number is a winning number, fewer people share the prize which results in a larger dividend in that division.

***Most Profitable Numbers***

| | | | | | |
|---|---|---|---|---|---|
| 31 | 40 | 16 | 28 | 35 | 27 |

These numbers resulted in larger dividends.

***Least Profitable Numbers***

| | | | | | |
|---|---|---|---|---|---|
| 41 | 26 | 22 | 38 | 12 | 9 |

These numbers resulted in smaller dividends.

17. [2 marks]
What numbers would you choose and why?

Again, any numbers could be chosen as each is equally likely in any game. ✓

18. [2 marks]
Statistician Professor Peter Adams advises choosing unusual or unpopular numbers however, so that if you do win, there will be fewer other winners to share the spoils with.

"Lots of people pick their birthday as a lucky number, so I'd only ever pick numbers larger than 31".

Comment on this statement.

True, if you are lucky enough to pick the 7 correct numbers but as stated this is extremely unlikely. Probability remains the same for any numbers in any given week. ✓

19. [3marks]

What guidance might you give to someone who said;

"I have no money but it will be OK because I have been playing Lotto each week for 3 years so I know I will win soon!"

**Marked Coupons**

(minimum play: 1 standard games)

| Entry Name | Equiv. Standard Games | Cost |
|---|---|---|
| Standard 1 game | 1 | $1.30 |
| Standard 2 game | 2 | $2.60 |
| Standard 3 game | 3 | $3.90 |
| Standard 4 game | 4 | $5.25 |
| Standard 5 game | 5 | $6.55 |
| Standard 6 game | 6 | $7.90 |
| Standard 7 game | 7 | $9.20 |
| Standard 8 game | 8 | $10.50 |
| Standard 9 game | 9 | $11.85 |
| Standard 10 game | 10 | $13.10 |
| Standard 11 game | 11 | $14.45 |
| Standard 12 game | 12 | $15.75 |
| Standard 13 game | 13 | $17.05 |
| Standard 14 game | 14 | $18.35 |
| Standard 15 game | 15 | $19.70 |
| Standard 16 game | 16 | $21.00 |
| Standard 17 game | 17 | $22.30 |
| Standard 18 game | 18 | $23.60 |

Not true

Playing each week does not enhance your chances of winning Lotto (There is no cumulative effect)

Each week probability is the same.

You could save $202.50 if you play one game a week for 3yrs (3x52x1.3)

or $2457 if you play 12 games/wk in that time.

(15.75 x 3 x 52)

Suggest saving money for 6 mths instead.

✓ referencing the cost

✓ " probability

✓ guidance

End of Application