

ECE 376 - Homework #6

Chi-squared Test. Due Monday, February 27th

Please email to jacob.glower@yahoo.com, or submit as a hard copy, or submit on BlackBoard

Fair Dice

1) Determine experimentally using a chi-squared test whether or not the following C code produces a fair 6-sided die:

```
while(1) {  
    while(!RB0);  
    while(RB0) DIE = (DIE + 1) % 6;  
    DIE += 1;  
    LCD_Move(1,0); LCD_Out(DIE, 1, 0);  
    SCI_Out(DIE, 1, 0);  
    SCI_CRLF();  
}
```

Step 1: Collect data. I rolled the dice 60 times and got the following results

Roll	1	2	3	4	5	6
Frequency	11	7	9	7	14	12

Step 2: Compute the chi-squared value

Roll	p	np	N	chi-squared
1	1/6	10	11	0.1
2	1/6	10	7	0.9
3	1/6	10	9	0.1
4	1/6	10	7	0.9
5	1/6	10	14	1.6
6	1/6	10	12	0.4
			Total	4

Step 3: Convert the chi-squared score to a probability using a chi-squared table

- Six bins means five degrees of freedom
- From StatTrek, $p = 0.45058$

I am 45.058% certain that this die is not fair

- there is no evidence to say I'm not just guessing (probability < 0.99)
- there is no evidence to say that I rigged the experiment (probability > 0.01)

- Enter value for degrees of freedom.
- Enter a value for one, and only one, of the other textboxes.
- Click **Calculate** to compute a value for the remaining textbox.

Degrees of freedom

5

Chi-square critical value (x)

4

Probability: $P(X^2 \leq 4)$

0.45058

Probability: $P(X^2 \geq 4)$

0.54942

Calculate

Loaded Dice

2) Determine experimentally using a chi-squared test whether or not the following C code produces a fair 6-sided die:

```
while(1) {
    while(!RB0);
    while(RB0) {
        DIE = (DIE + 1) % 6;
        X = (X + 1) % 101;
    }
    DIE = DIE + 1;
    if(X < 15) DIE = 6;

    LCD_Move(1,0); LCD_Out(DIE, 1, 0);
    SCI_Out(DIE, 1, 0);
    SCI_CRLF();
}
```

Step 1: Collect data. I rolled the dice 60 times and got the following results

Roll	1	2	3	4	5	6
Frequency	10	9	6	8	6	21

Step 2: Compute the chi-squared value

Roll	p	np	N	chi-squared
1	1/6	10	10	0
2	1/6	10	9	0.1
3	1/6	10	6	1.6
4	1/6	10	8	0.4
5	1/6	10	6	1.6
6	1/6	10	21	12.1
Total				15.8

Step 3: Convert the chi-squared score to a probability using a chi-squared table

- Six bins means five degrees of freedom
- From StatTrek, $p(\text{reject}) = 99.256\%$

I am 99.256% certain that this die is not fair

- Enter value for degrees of freedom.
- Enter a value for one, and only one, of the other textboxes.
- Click **Calculate** to compute a value for the remaining textbox.

Degrees of freedom

5

Chi-square critical value (x)

15.8

Probability: $P(X^2 \leq 15.8)$

0.99256

Probability: $P(X^2 \geq 15.8)$

0.00744

Calculate

Am I Psychic?

3) Write a C program which tests if you're psychic:

- Each round, predict which number is going to come up (0..3)
- Press the corresponding button RB0..RB3.
- When you release the button, a random number in the range of 0..3 is generated
- If you were right, the PIC records that. Likewise if you were wrong.
- The LCD display displays how many times you were right and wrong.

```
// Global Variables

const unsigned char MSG0[21] = "Right          ";
const unsigned char MSG1[21] = "Wrong         ";

// Subroutine Declarations
#include <pic18.h>

// Subroutines
#include "lcd_portd.c"

// Main Routine

void main(void)
{
    unsigned int i, j;
    int GUESS, X, RIGHT, WRONG;

    TRISA = 0;
    TRISB = 0xFF;
    TRISC = 0;
    TRISD = 0;
    TRISE = 0;
    TRISA = 0;
    ADCON1 = 15;

    PORTA = 0;

    LCD_Init(); // initialize the LCD

    LCD_Move(0,0); for (i=0; i<20; i++) LCD_Write(MSG0[i]);
    LCD_Move(1,0); for (i=0; i<20; i++) LCD_Write(MSG1[i]);

    X = 0;
    RIGHT = 0;
    WRONG = 0;

    while(1) {
        while(PORTB == 0);
        while(PORTB) {
            if(RB0) GUESS = 0;
            if(RB1) GUESS = 1;
            if(RB2) GUESS = 2;
            if(RB3) GUESS = 3;
            X = (X + 1)%4;
        }
        if(GUESS == X) RIGHT += 1;
        else WRONG += 1;

        LCD_Move(0,8); LCD_Out(RIGHT, 3, 0);
        LCD_Move(1,8); LCD_Out(WRONG, 3, 0);
    }
}
```

4) Collect data with your program.

Right	Wrong
15	49

5) Determine the chance that you were not just guessing using a chi-squared test

- Null hypothesis: you are just guessing (correct 25% of the time).

Guess	p	np	N	chi-squared
Right	1/4	16	15	0.06
Wrong	3/4	48	49	0.02
Total				0.08

From StatTrek, a chi-squared score of 0.08 with one degree of freedom corresponds to a probability of 0.2227

I am 22.27% certain that I'm not just guessing

- there is no evidence to say I'm not just guessing (probability < 0.99)
- there is no evidence to say that I rigged the experiment (probability > 0.01)

- Enter value for degrees of freedom.
- Enter a value for one, and only one, of the other textboxes.
- Click **Calculate** to compute a value for the remaining textbox.

Degrees of freedom

1

Chi-square critical value (x)

0.08

Probability: $P(X^2 \leq 0.08)$

0.22270

Probability: $P(X^2 \geq 0.08)$

0.77730

Calculate