

ECE 341 - Homework #1

Monte-Carlo & Enumeration

Monte-Carlo

1) In 7-card stud poker, each player is dealt 7 cards. The best 5 cards constitutes your hand. Determine using a Monte-Carlo simulation the odds of being dealt the following hands in 7-card stud poker:

- 4-of-a-Kind
- Full House
- Flush
- 3-of-a-Kind

Result for 100,000 5-card hands (checks the validity of the code)

```
4 of a kind   (expected result 24.00)
    33

Full House    (expected result: 144.09)
    145

Flush         (expected result: 196.54)
    193

3 of a kind   (expected result: 2112.82)
    2096

Elapsed time is 13.822798 seconds.
```

Result for 100,000 7-card hands

```
4 of a kind
    180

Full House
    2582

Flush
    2845

3 of a kind
    4925
```

Elapsed time is 13.653567 seconds.

Matlab Code

```
% 7-Card Stud
% Probability of 2-pair & 2 of a kind

tic
Pair4 = 0;
Pair32 = 0;
Flush = 0;
Pair3 = 0;

for i=1:1e5
    N = rand(1,52);
    [N,Deck] = sort(N);
    Hand = Deck(1:7);
    Value = mod(Hand, 13) + 1;
    Suit = floor(Hand/13) + 1;
    %check for a flush
    S = zeros(1,4);
    for i=1:4
        S(i) = sum(Suit == i);
    end
    S = sort(S, 'descend');
    if(S(1) >= 5)
        Flush = Flush + 1;
    end
    % check for pairs
    V = zeros(1,13);
    for i=1:13
        V(i) = sum(Value == i);
    end
    V = sort(V, 'descend');
    if(V(1) == 4)
        Pair4 = Pair4 + 1;
    elseif( (V(1)==3)*(V(2)>=2) )
        Pair32 = Pair32 + 1;
    elseif( (V(1)==3)*(V(2)==1) )
        Pair3 = Pair3 + 1;
    end
end
disp('-----')
disp('4 of a kind')
disp(Pair4)
disp('Full House')
disp(Pair32)
disp('Flush')
disp(Flush)
disp('3 of a kind')
disp(Pair3)

toc
```

2) Determine the probability of getting the following dice combinations when eight 6-sided dice (8d6) using a Monte-Carlo simulation:

- 5-of-a-kind (xxxxx abc) where (abc) can be any value other than x (could all be the same)
- Two tripples (xxx yyy ab) or (xxx yyy aa)

Matlab Results for 100,000 rolls:

**5 of a kind
2510**

**Two tripples
7943**

Elapsed time is 5.472255 seconds.

Matlab Code:

```
tic
Pair5 = 0;
Pair33 = 0;

for i=1:1e5
    Dice = ceil(6*rand(1,8));
    V = zeros(1,6);
    for i=1:6
        V(i) = sum(Dice == i);
    end
    V = sort(V, 'descend');
    if( (V(1)==5) )
        Pair5 = Pair5 + 1;
    elseif( (V(1)==3)*(V(2)==3) )
        Pair33 = Pair33 + 1;
    end
end

disp('-----')
disp('5 of a kind')
disp(Pair5)
disp('Two tripples')
disp(Pair33)
toc
```

3) Player A and B are playhing a game of dice

- Player A rolls a 10-sided die (d10)
- Player B rolls two 6-sided dice (2d6)

The highest score wins (A wins on ties). Determine the odds that player A will win this game using a Monte Carlo simulation.

Results

--- Problem 3 ---

A Wins	B Wins
40208	59792

Elapsed time is 1.326373 seconds.

Matlab Code

```
tic
Wa = 0;
Wb = 0;

for i=1:1e5
    A = sum( ceil(10*rand(1,1)) );
    B = sum( ceil(6*rand(1,2)) );
    if(A >= B)
        Wa = Wa + 1;
    else
        Wb = Wb + 1;
    end
end
disp('--- Problem 3 ---')
disp('A Wins    B Wins')
disp([Wa,Wb])
toc
```

Enumeration

4) Using enumeration, determining the odds of getting the following dice combinations when rolling eight 6-sided dice (8d6):

- 5-of-a-kind (xxxxx abc) where (abc) can be any value other than x (could all be the same)
- Two tripples (xxx yyy ab) or (xxx yyy aa)

Matlab Results

```
--- Problem 4 ---
```

```
Number of Rolls
```

```
1679616
```

```
5 of a kind
```

```
42000
```

```
Two tripples
```

```
134400
```

Elapsed time is 69.766563 seconds.

Comparing with Monte-Carlo:

	Monte-Carlo	Enumeration
5 of a kind	2,510	2,500.57
Two Tripples	7,943	8,001.83

Frequency in 100,000 Hands

Enumeration matches up with Monte Carlo

- Enumeration is exact (assuming no program errors)
- It takes 10x longer to run

Matlab Code:

```
tic
Pair5 = 0;
Pair33 = 0;
N = 0;

for d1=1:6
    disp(d1)
    for d2=1:6
        for d3=1:6
            for d4=1:6
                for d5=1:6
                    for d6=1:6
                        for d7=1:6
                            for d8=1:6
                                Dice = [d1,d2,d3,d4,d5,d6,d7,d8];
                                N = N + 1;
                                V = zeros(1,6);
                                for i=1:6
                                    V(i) = sum(Dice == i);
                                end
                                V = sort(V, 'descend');
                                if( (V(1)==5)*(V(2)==1) )
                                    Pair5 = Pair5 + 1;
                                elseif( (V(1)==3)*(V(2)==3) )
                                    Pair33 = Pair33 + 1;
                                end
                            end
                        end
                    end
                end
            end
        end
    end
end

disp('--- Problem 4 ---')
disp('Number of Rolls')
disp(N)
disp('5 of a kind')
disp(Pair5)
disp('Two tripples')
disp(Pair33)
toc
```

5) Player A and B are playing a game of dice

- Player A rolls a 10-sided die (d10)
- Player B rolls two 6-sided dice (2d6)

The highest score wins (A wins on ties). Determine the odds that player A will win this game using enumeration.

Result

--- Problem 5 ---

Numer of Rolls

360

A Wins B Wins

145 215

Elapsed time is 0.000842 seconds.

omparing with Monte-Carlo:

	Monte-Carlo	Enumeration
A Wins	40,208	40,277.78
B Wins	59,279	59,722.22

Frequency in 100,000 games

Enumeration matches up with Monte Carlo

- Enumeration is exact (assuming no program errors)
- It takes 1000x faster

For some problems, enumeration makes more sense than Monte Carlo

For other problems, enumeration takes too long. Monte-Carlos is the better option