Network System Capstone HW3 110550039 劉詠

Code section:

Setting(host_num=3, total_time=100, packet_num=4, max_collision_wait_time=20, p_resend=0.3, packet_size=3, link_delay=1, seed= 110550039)

```
aloha
                V               V                       V   V
h0: ............<--->............<--->.....................<--><--->.............................
                                                                V   V         V V
h1: ..........................................................................<---|..<---|.............
                                                    V                       V   V   V
h2: ................................................<--->.....................<---|....<---|<--><--><
success_rate: 0.35
idle_rate: 0.52
collision_rate: 0.13
slotted_aloha
                V               V                       V   V
h0: ..............<--->..............<--->.................<--><--->.............................
                                                                V   V         V V
h1: ..........................................................................<---|..........<---|.....
                                                    V                       V   V   V
h2: ................................................<--->.....................<---|.....<--><---|.....
success_rate: 0.3
idle_rate: 0.6
collision_rate: 0.1
csma
                V               V                       V   V
h0: ............<--->............<--->.....................<--><--->.............................
                                                                V   V         V V
h1: ..........................................................................<---|..<--><--><--><--><--
                                                    V                       V   V   V
h2: ................................................<--->.....................<---|.....................
success_rate: 0.4
idle_rate: 0.52
collision_rate: 0.08
csma_cd
                V               V                       V   V
h0: ............<--->............<--->.....................<--><--->.............................
                                                                V   V         V V
h1: ..........................................................................<-|..<--><--><--><--->
                                                    V                       V   V   V
h2: ................................................<--->.....................<-|.....................
success_rate: 0.45
idle_rate: 0.52
collision_rate: 0.03
```

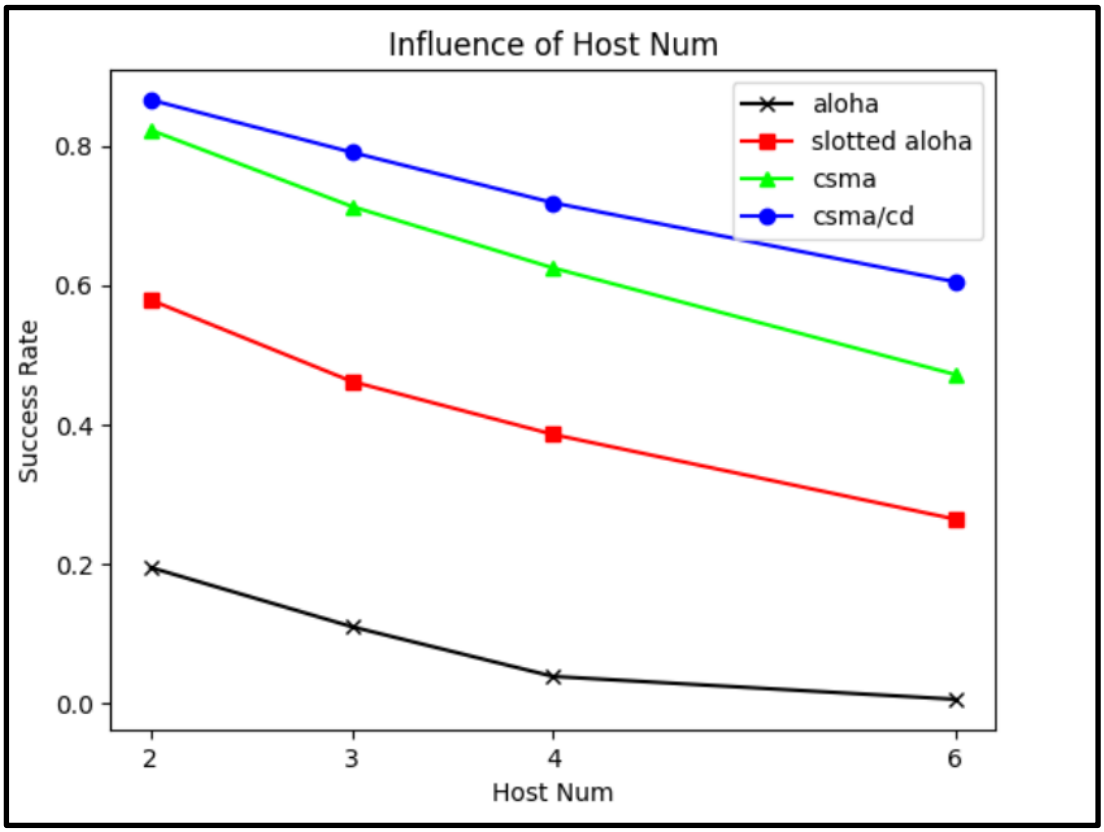
Question section:

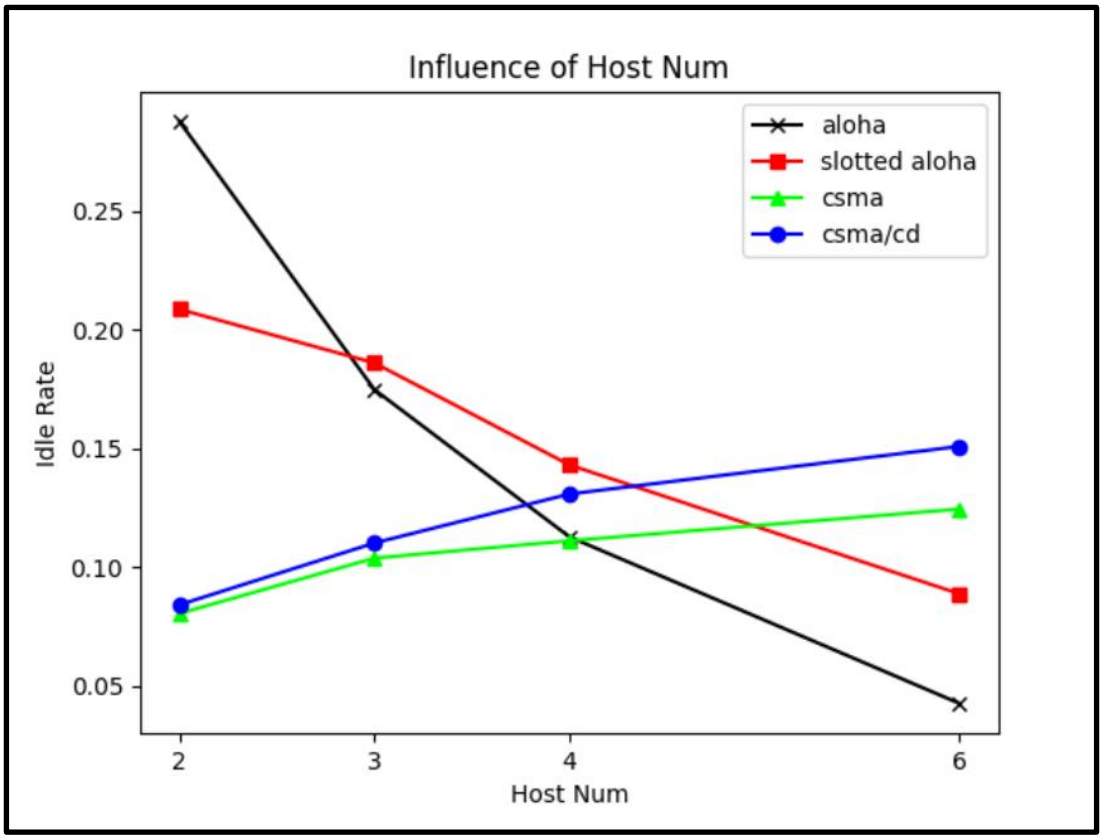
1. **Define two expressions for correctly calculating max_collision_wait_time and p_resend, respectively. Both expressions should be composed of a coefficient c ≥ 1 and other related setting attributes (as parameters). These expressions can use the add, subtract, multiply, and divide operations. Write down the expressions in your report and modify the Setting class accordingly. (8%)**

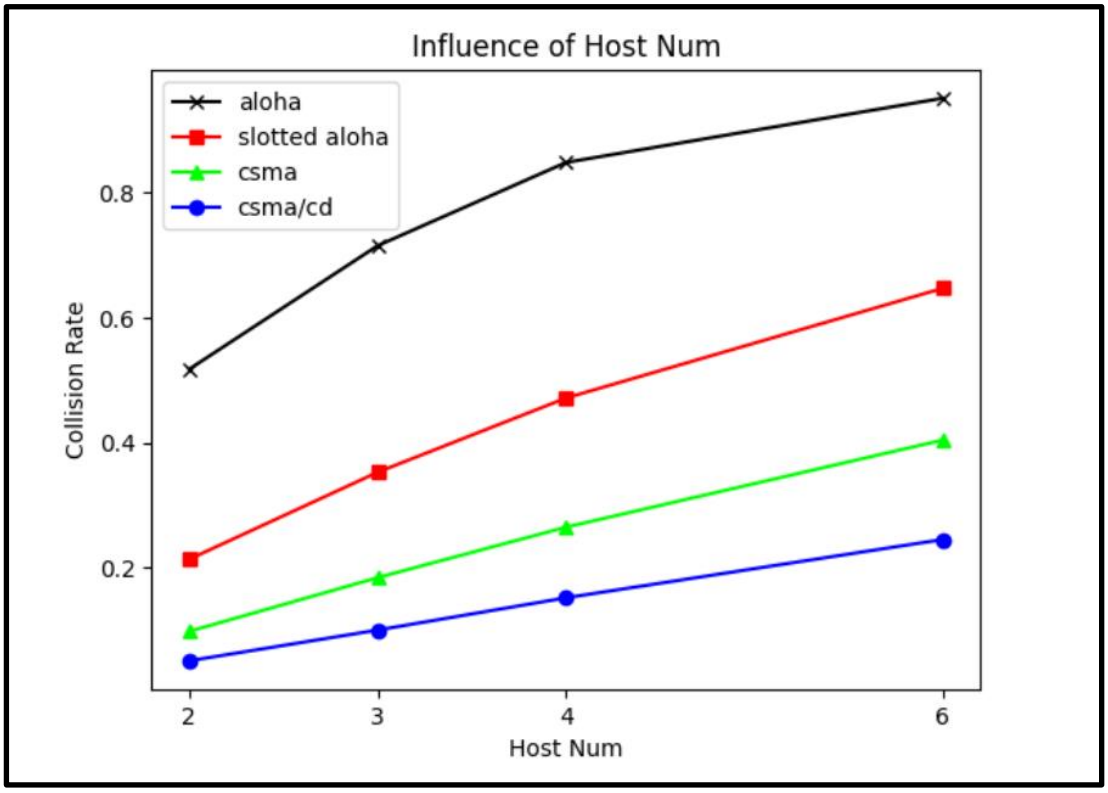
   Ans. max_collision_wait_time = coefficient * packet_time * host_num

   p_resend = 1 / (coefficient * host_num)

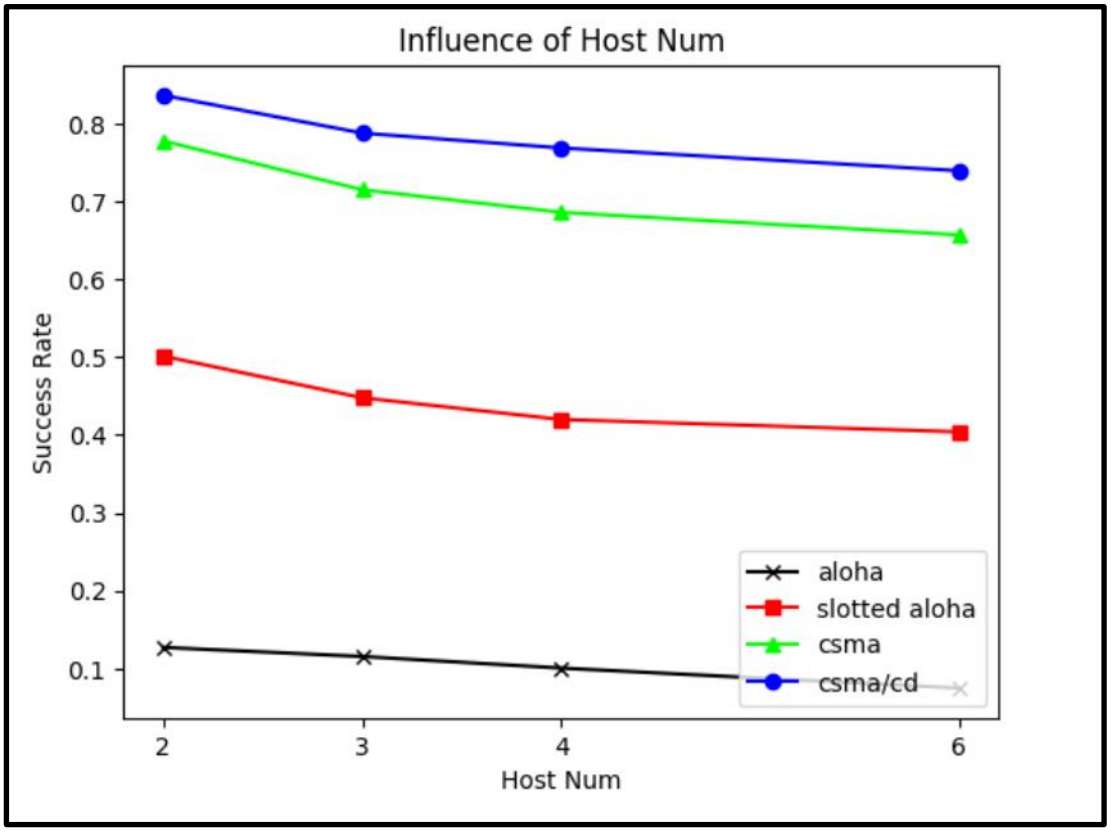
2. **Apply the following settings in all methods and plot the results. (2%)**
   host_num_list = [2,3,4,6]
   packet_num_list = [1200,800,600,400]
   Setting(host_num=h,packet_num=p, max_collision_wait_time=20,p_resend=0.3)
   for h,p in zip(host_num_list, packet_num_list)

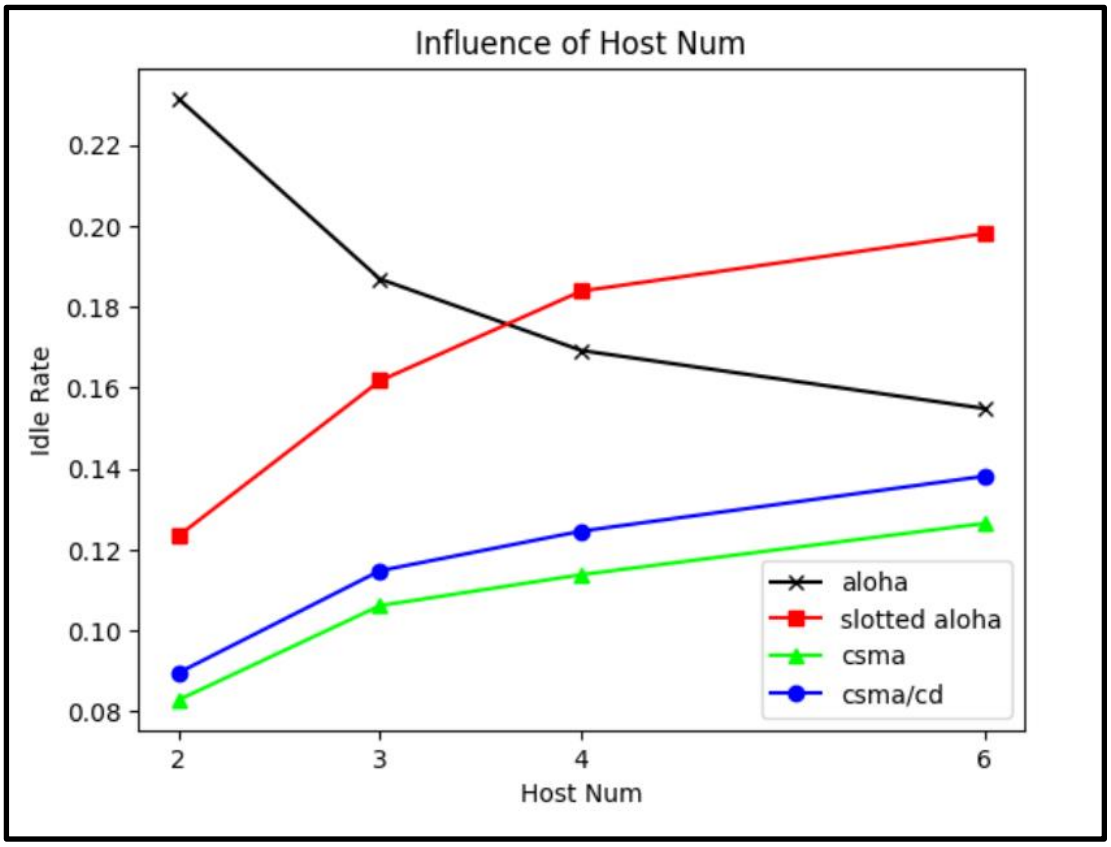


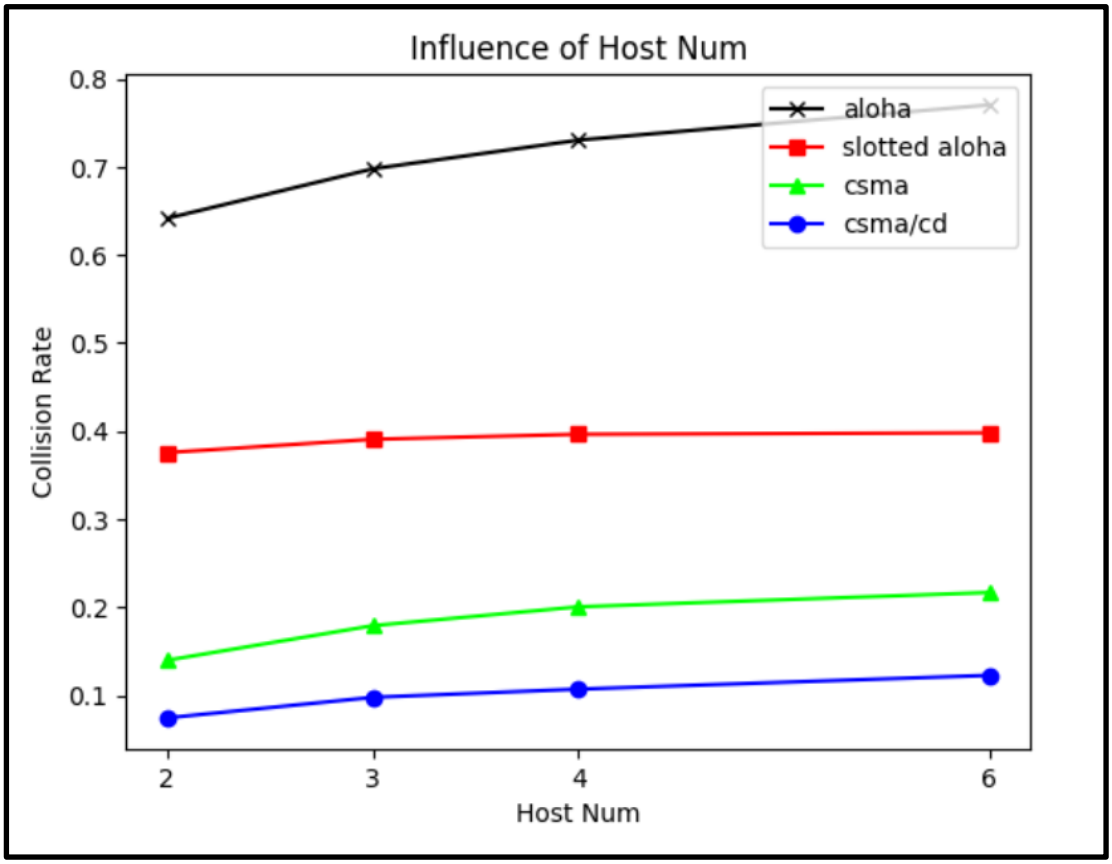

Influence of Host Num
aloha
slotted aloha
csma
csma/cd
Idle Rate
0.25
0.20
0.15
0.10
0.05
2
3
4
6
Host Num


Influence of Host Num
aloha
slotted aloha
csma
csma/cd
Collision Rate
0.8
0.6
0.4
0.2
2
3
4
6
Host Num

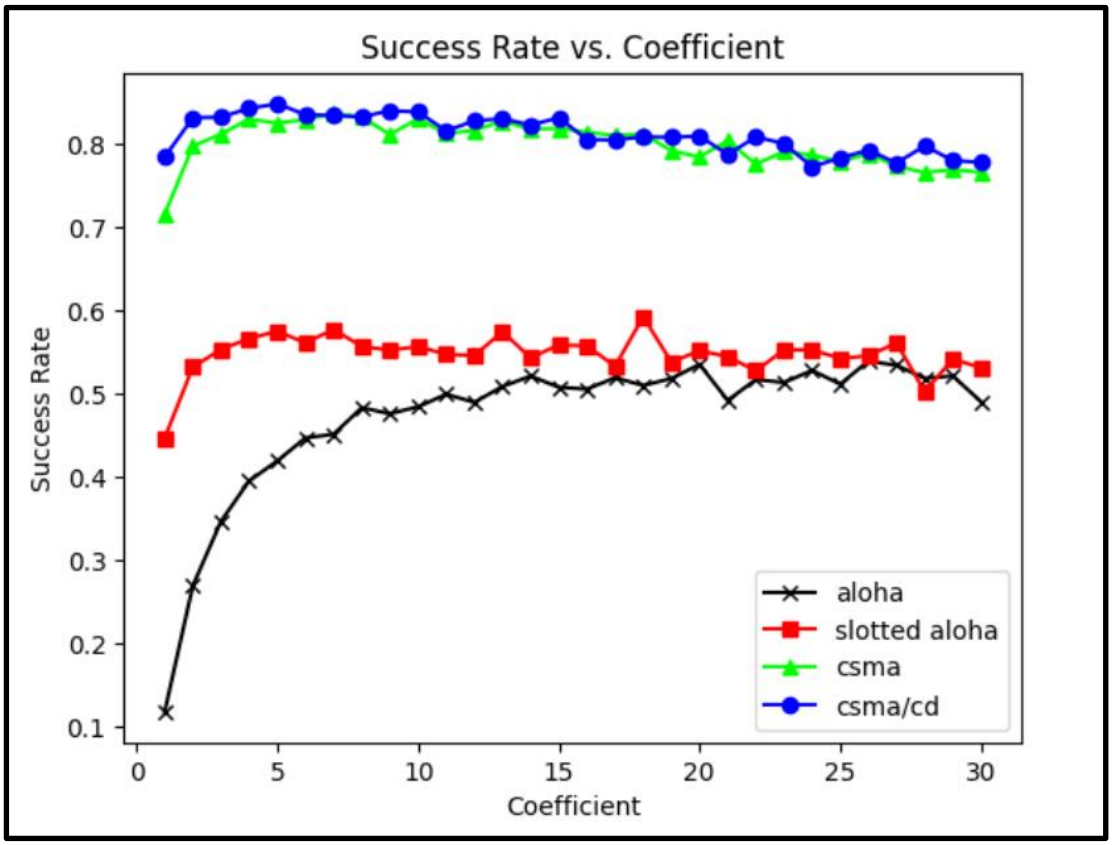
3. **Update the settings used in Q2 and compare the results. Plot the results and describe the influence. (10%)**
   host_num_list = [2,3,4,6], packet_num_list = [1200,800,600,400].
   Setting(host_num=h, packet_num=p, coefficient=1) for h,p in zip(host_num_list, packet_num_list)
   We can see that in the following pictures, the result is similar as the ones in question 2, however, since we have coefficient as 1, compare to coefficient used in question 2, which is 8, we will find that when the host number increases, it is observed that the rate of decrease in success rate for the four protocols becomes smaller. I observed that the idle rate of Slotted Aloha increases while it decreases in question2, I guess it is because that with more hosts, there are more opportunities for packet collisions. Since Slotted Aloha requires packets to be transmitted only in specific time slots, the probability of collisions between packets increases as the number of hosts increases. This leads to more time slots with no packet transmissions, resulting in an increase in the idle rate.

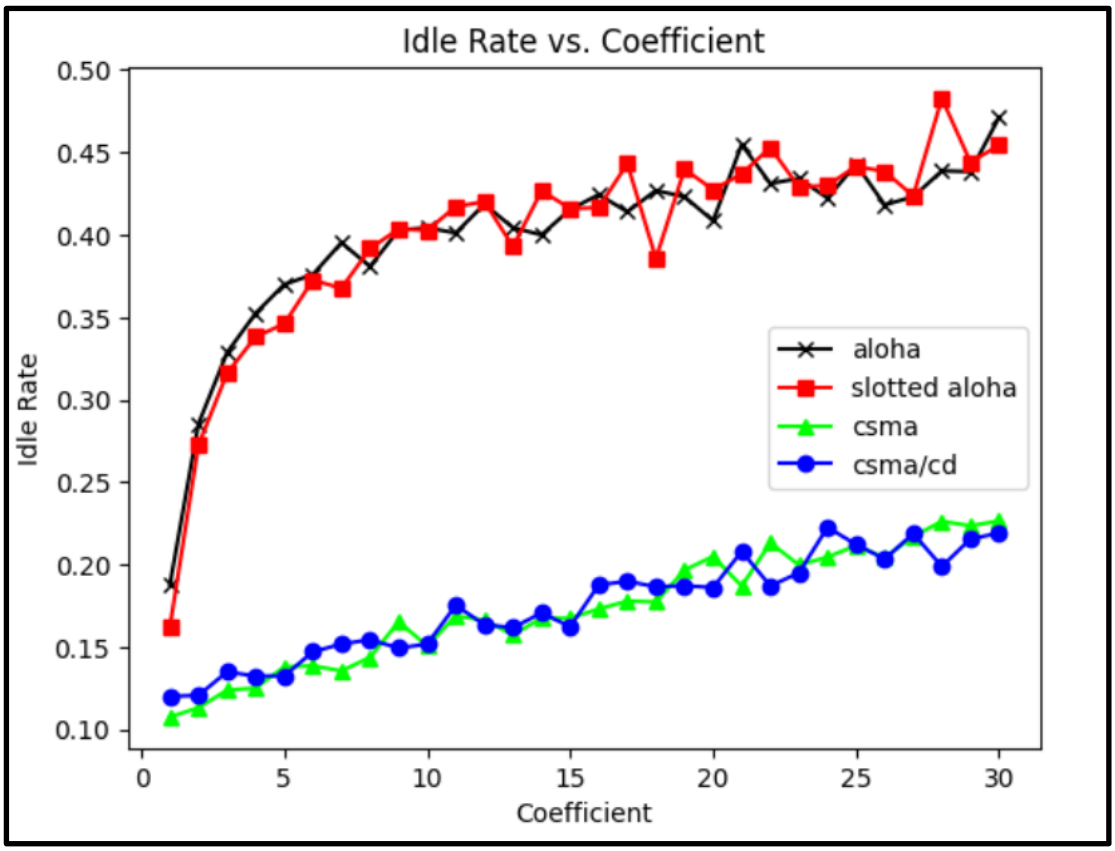


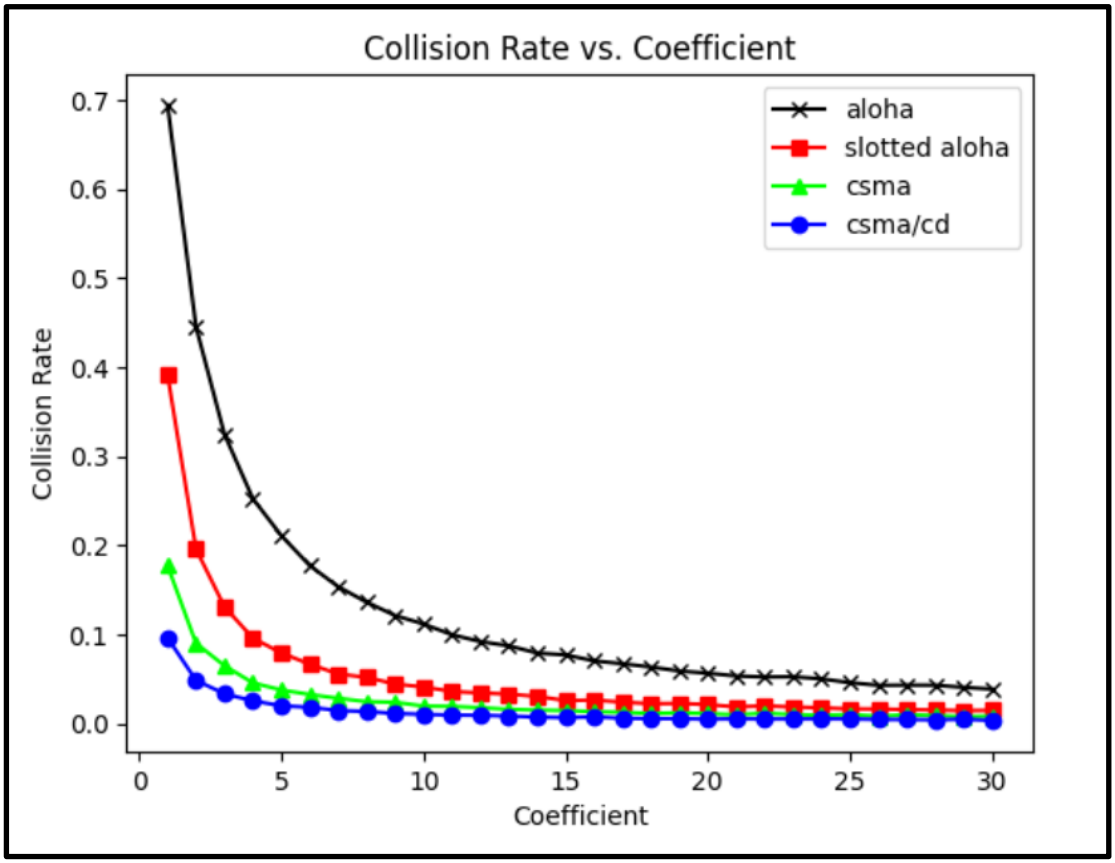

Influence of Host Num
Idle Rate
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
2
3
4
6
Host Num
aloha
slotted aloha
csma
csma/cd


Influence of Host Num
Collision Rate
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
2
3
4
6
Host Num
aloha
slotted aloha
csma
csma/cd

4. **What's the influence of "coefficient" in all methods. Apply the following settings, plot the results, and describe them. (10%)**
   Setting(coefficient=c) for c in range(start=1, stop=31, step=1)
   In the below results, we can observe that since coefficient becomes larger, the max collision wait time will become larger. Therefore, the time that packets will be sent would be more separate and thus the collision rate decreases when coefficient increases. However, as the collision rate become smaller, which means that there are more idle slots, so the idle rate will become larger when coefficient grows.



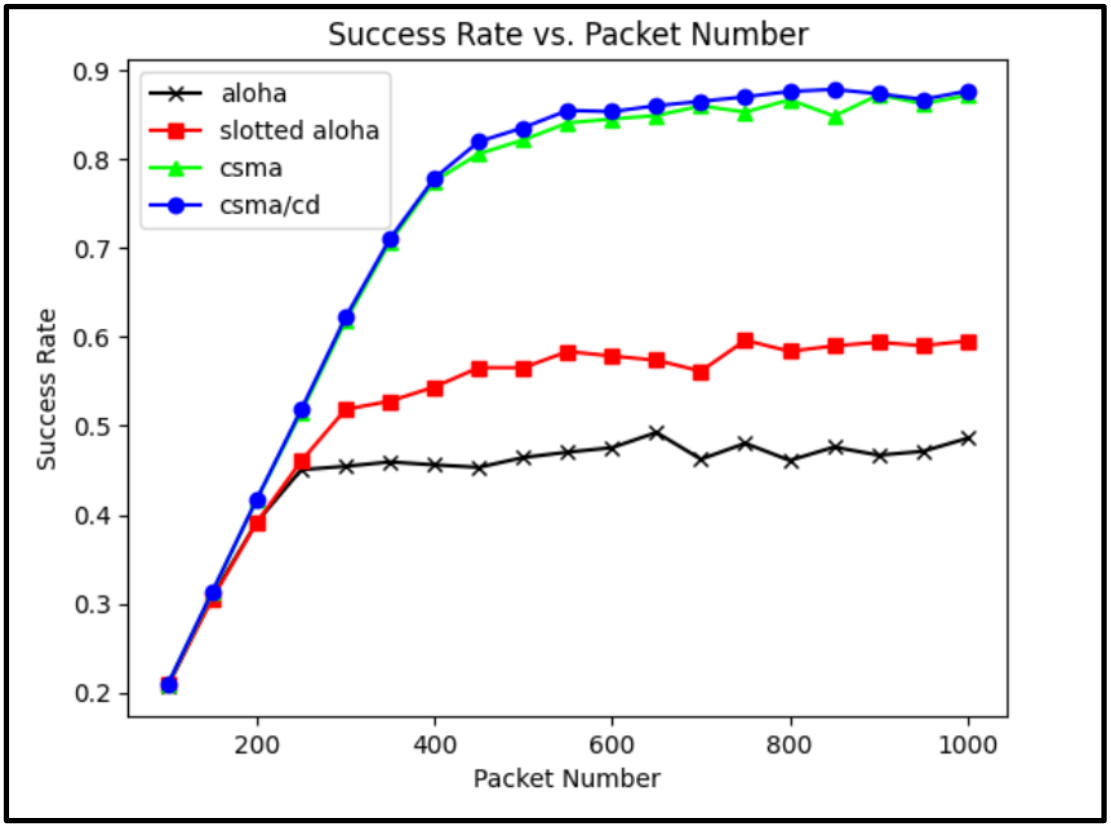

Idle Rate vs. Coefficient
Idle Rate
Coefficient
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0
5
10
15
20
25
30
aloha
slotted aloha
csma
csma/cd

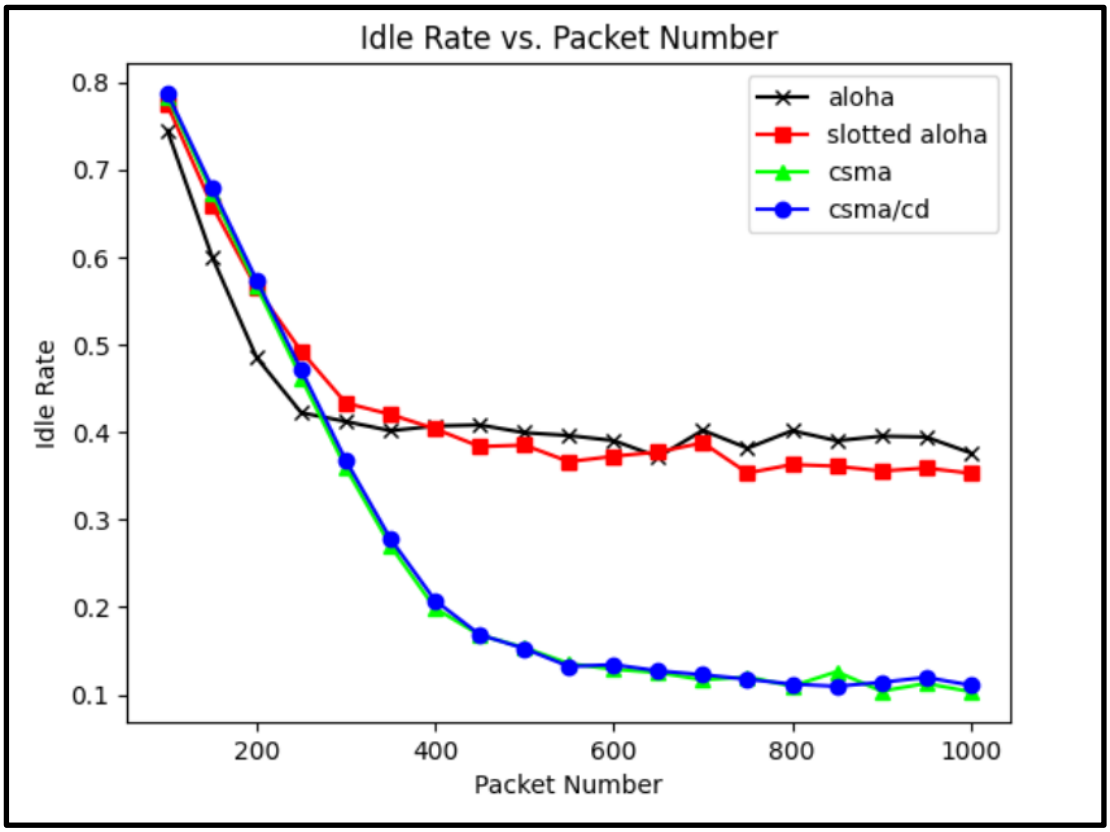

Collision Rate vs. Coefficient
Collision Rate
Coefficient
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
aloha
slotted aloha
csma
csma/cd

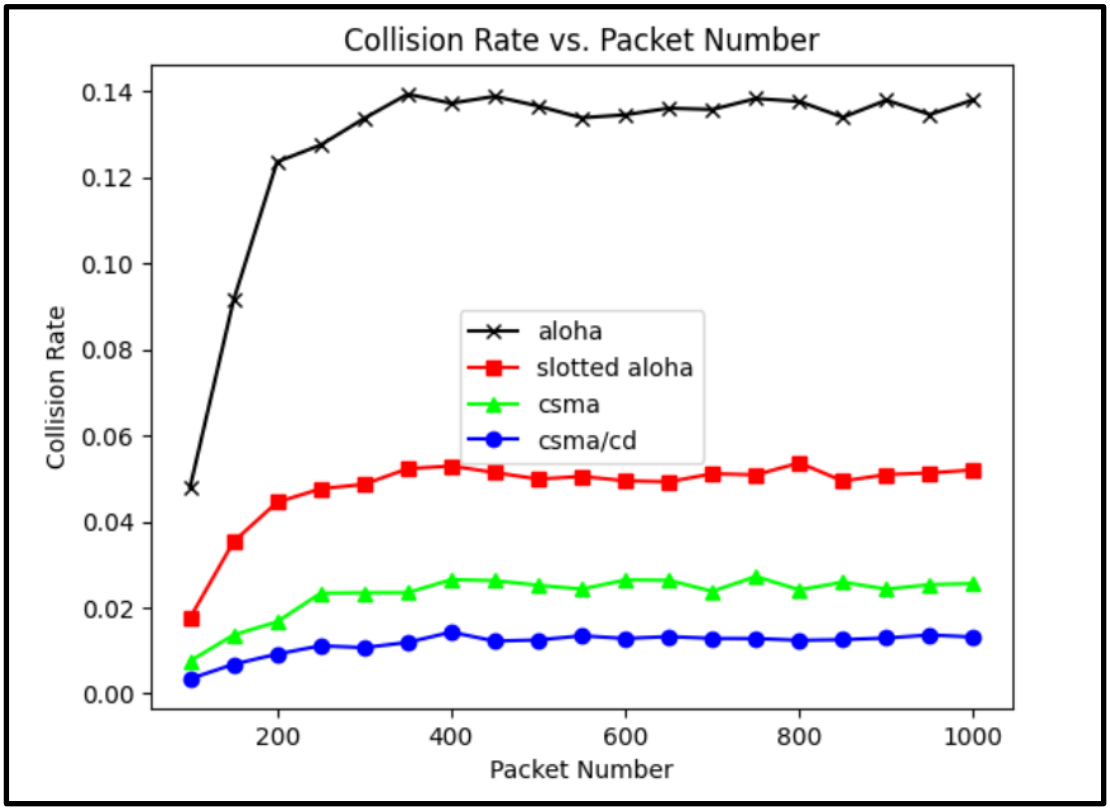
5. **What's the influence of "packet_num" in all methods. Apply the following settings, plot the results, and describe them. (10%)**

   Setting(packet_num=p) for p in range(start=100, stop=1050, step=50)

   As packet number grows, collisions will happen more frequently. Since CSMA and CSMA/CD will sense before sending, they can prevent collision well when packet number grows, and we can see this effect in the results below. And if a collision happens with Slotted Aloha, it will only affect that slot; however, Aloha will keep colliding. Thus, in the results, Slotted Aloha is better than Aloha in this experiment.



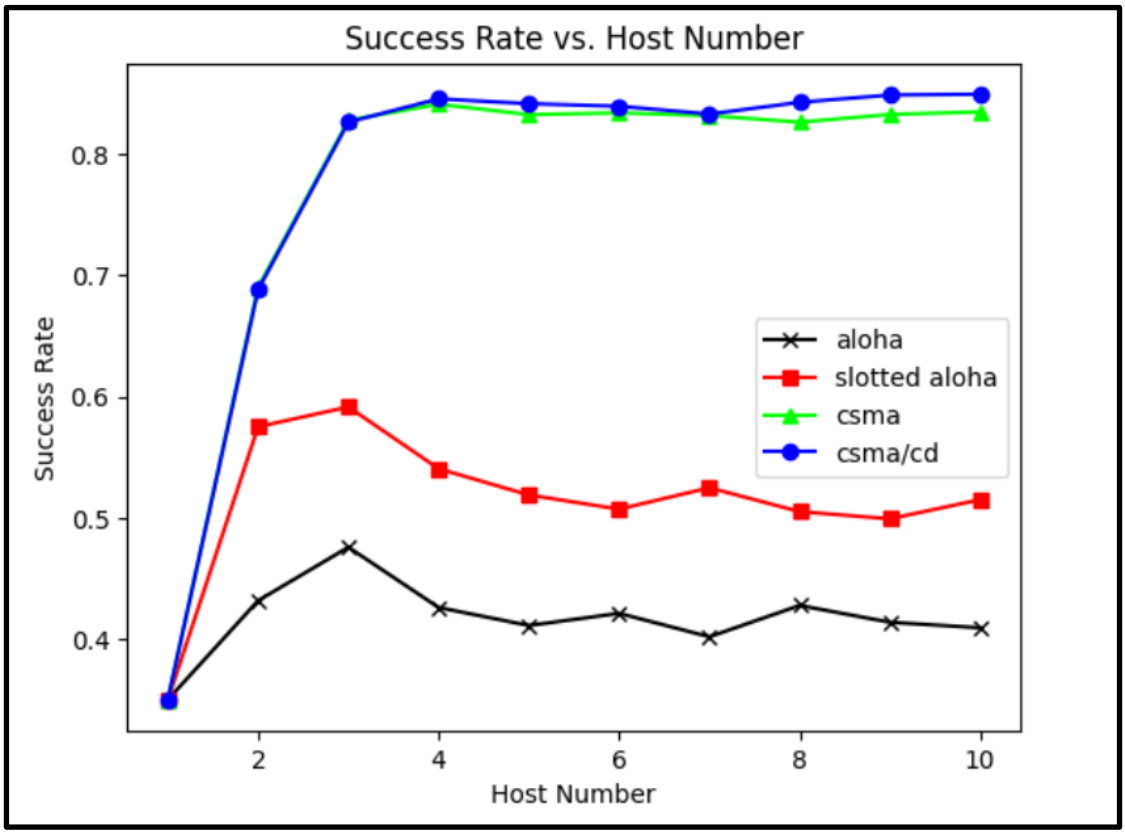

Idle Rate vs. Packet Number
aloha
slotted aloha
csma
csma/cd
Idle Rate
Packet Number
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
200
400
600
800
1000

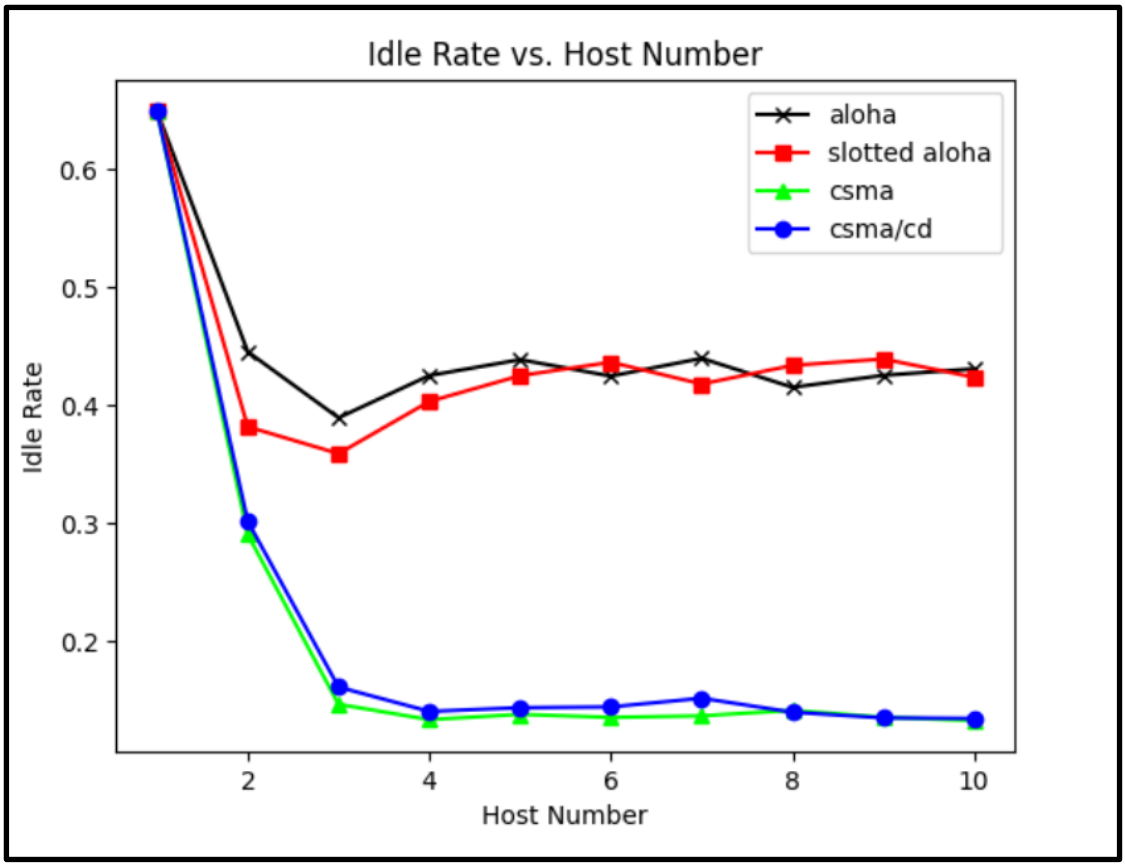

Collision Rate vs. Packet Number
aloha
slotted aloha
csma
csma/cd
Collision Rate
Packet Number
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
200
400
600
800
1000

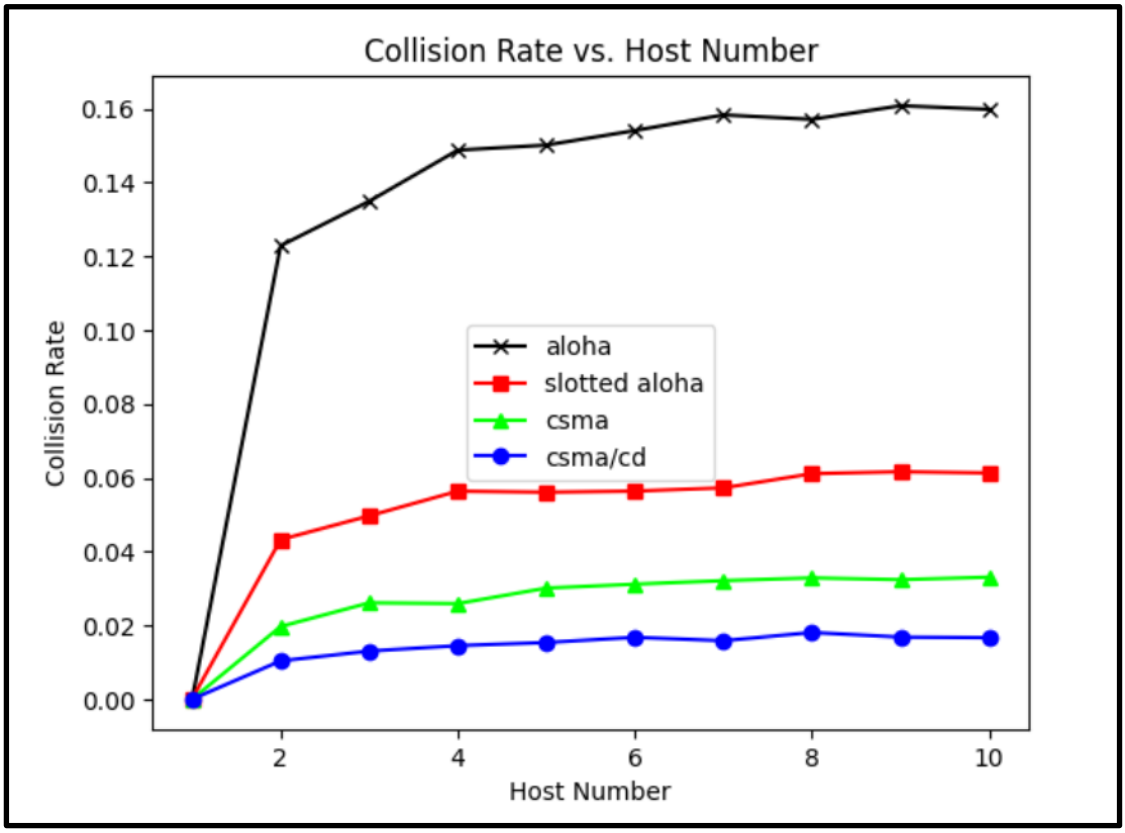
6. **What's the influence of "host_num" in all methods. Apply the following settings, plot the results, and describe them. (10%)**

   Setting(host_num=h) for h in range(start=1, stop=11, step=1)

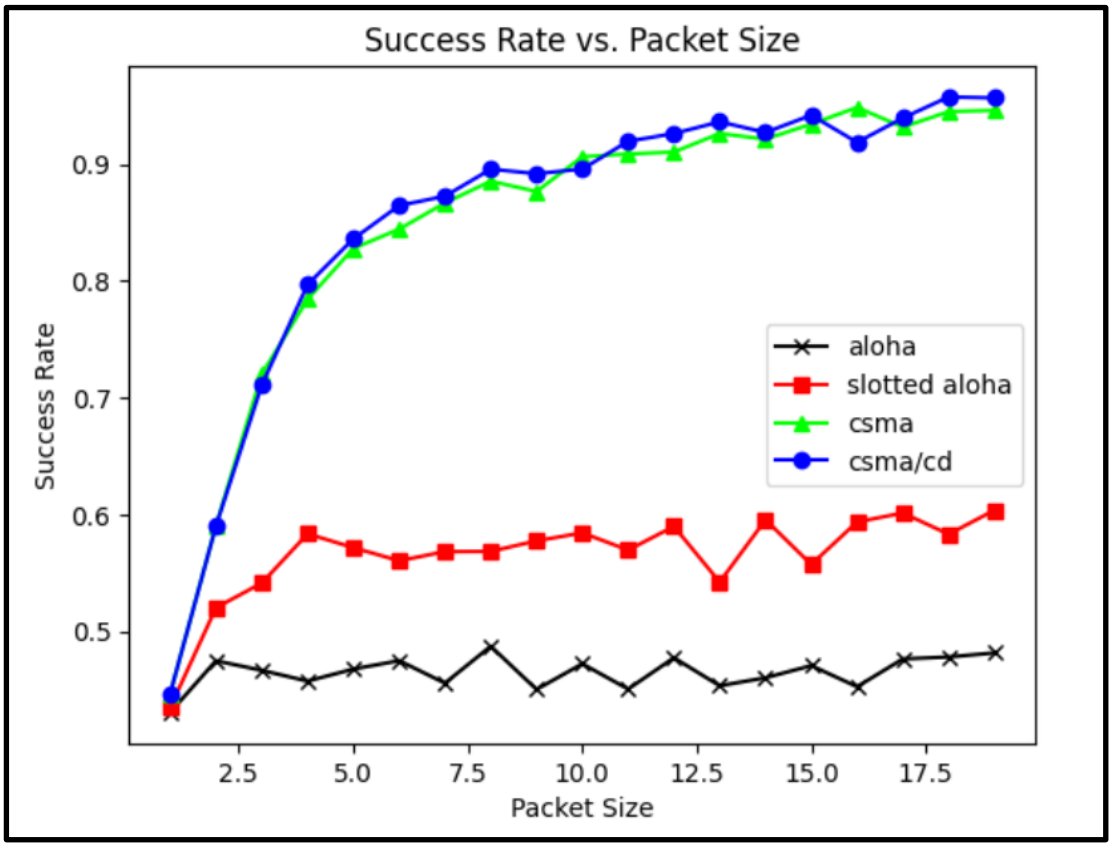
   As host number grows, the results are similar as the ones when packet number increases. This is because increasing host number and increasing packet number are both all increasing the number of packets. Thus, the collision will happen more frequently when using Aloha and Slotted Aloha. As for CSMA and CSMA/CD, they will reach saturated situation as host number increases for the reason that they can not deal with more ones.

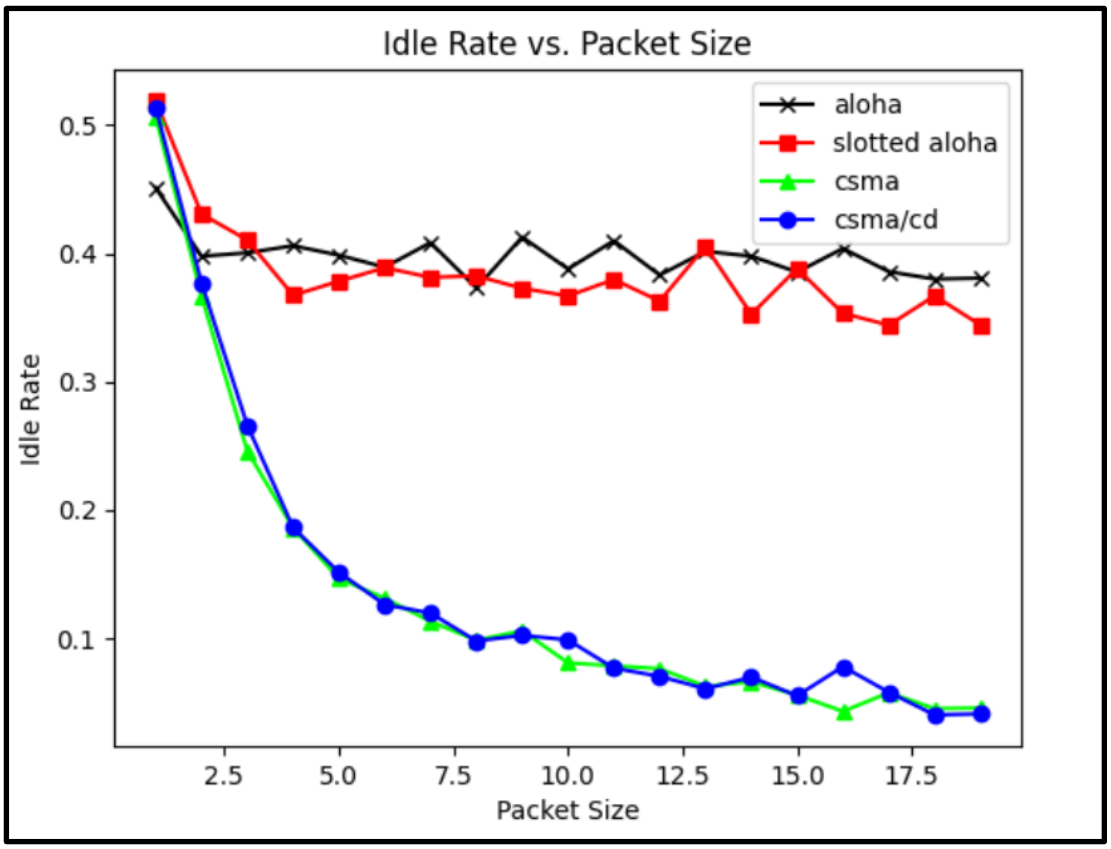


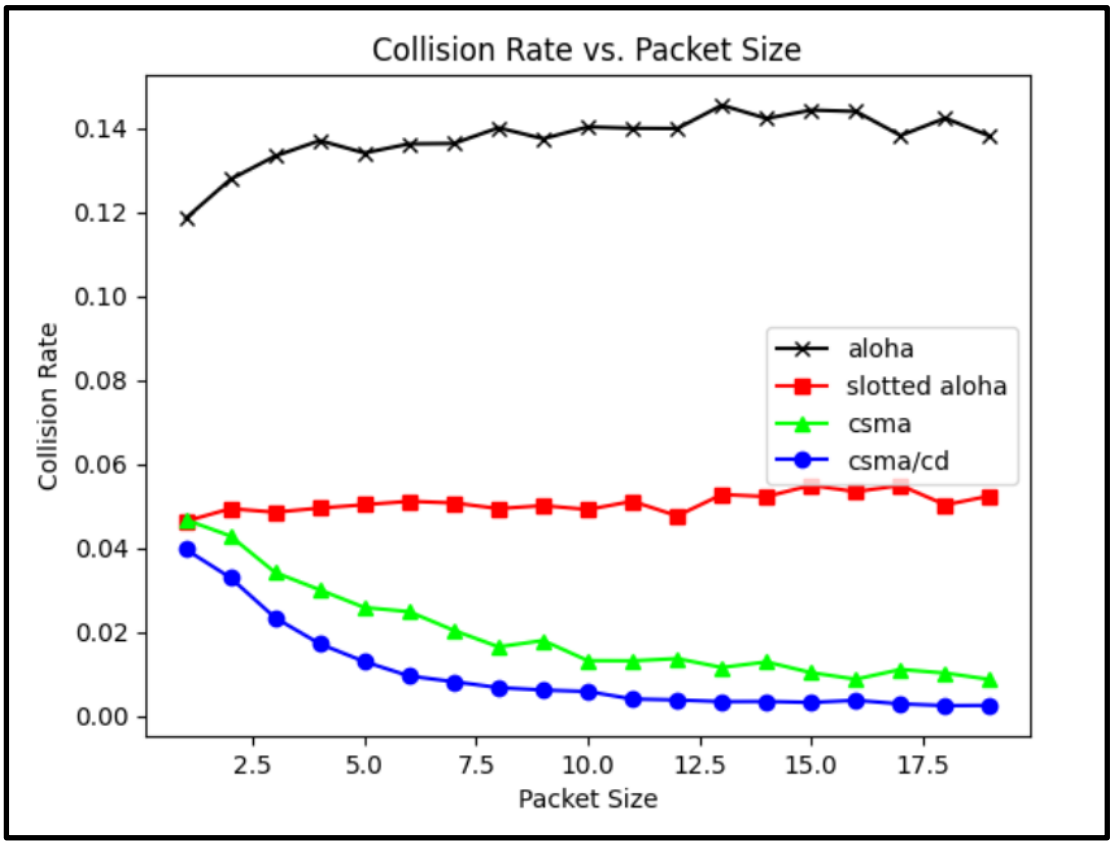

Idle Rate vs. Host Number
aloha
slotted aloha
csma
csma/cd
Idle Rate
0.6
0.5
0.4
0.3
0.2
2
4
6
8
10
Host Number


Collision Rate vs. Host Number
aloha
slotted aloha
csma
csma/cd
Collision Rate
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2
4
6
8
10
Host Number

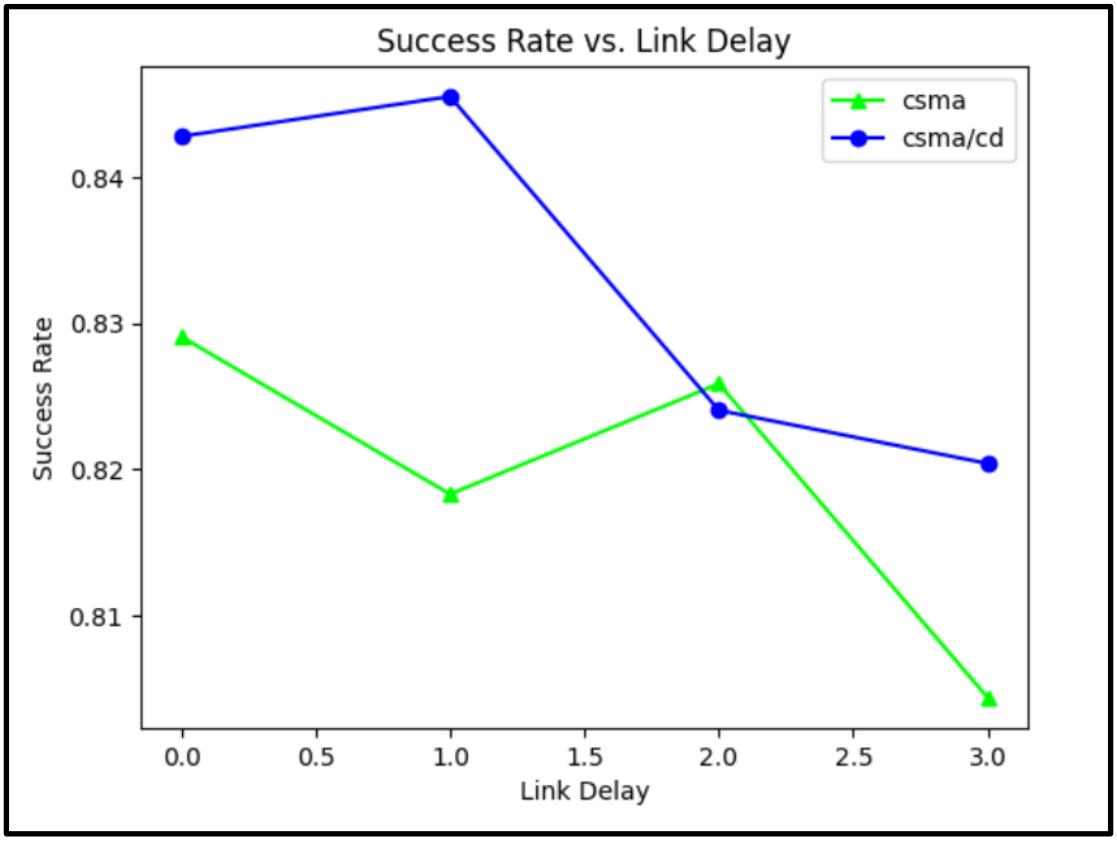
7. **What's the influence of "packet_size" in all methods. Apply the following settings, plot the results, and describe them. (10%)**
   Setting(packet_size=p) for p in range(start=1, stop=20, step=1)
   When packet size increases, the time that send the packet will become longer, thus in CSMA and CSMA/CD, the success rate will become larger. But in Aloha and Slotted Aloha, more time that need to send the packet, more collisions will happen, hence in the results, the success rates, idle rates and collision rate of them are poor.

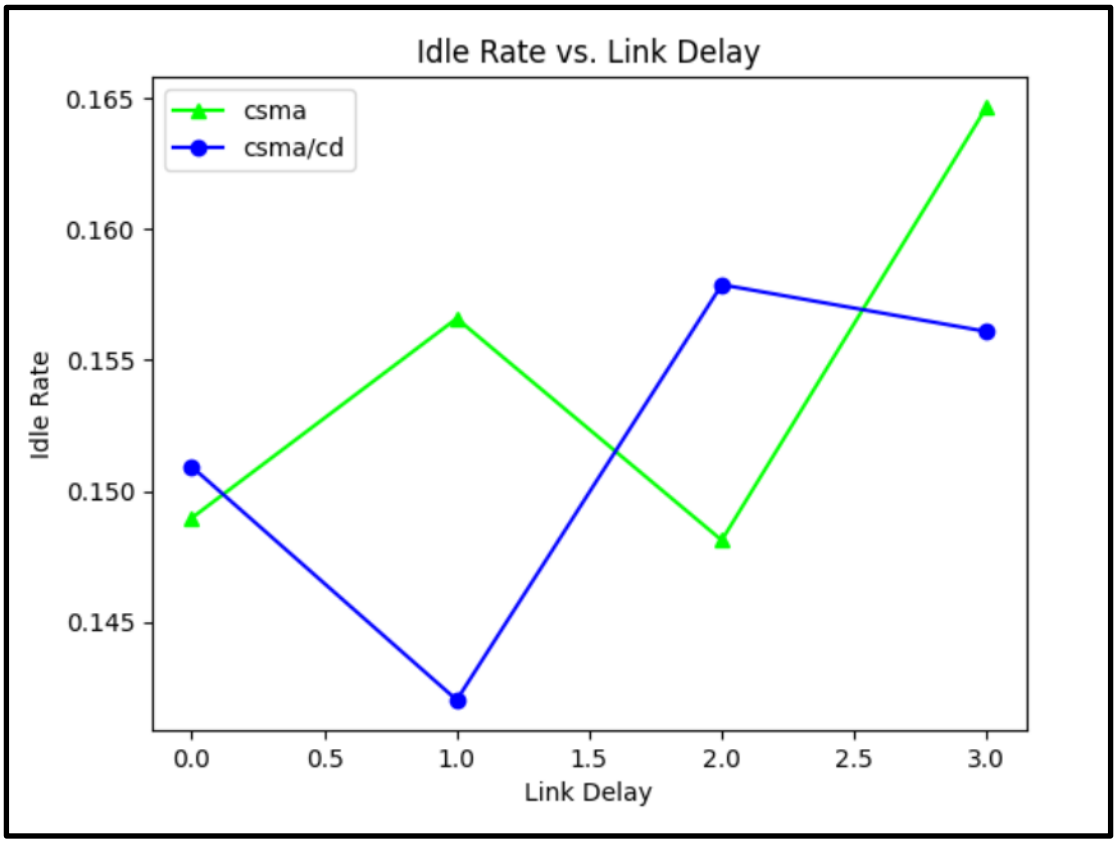


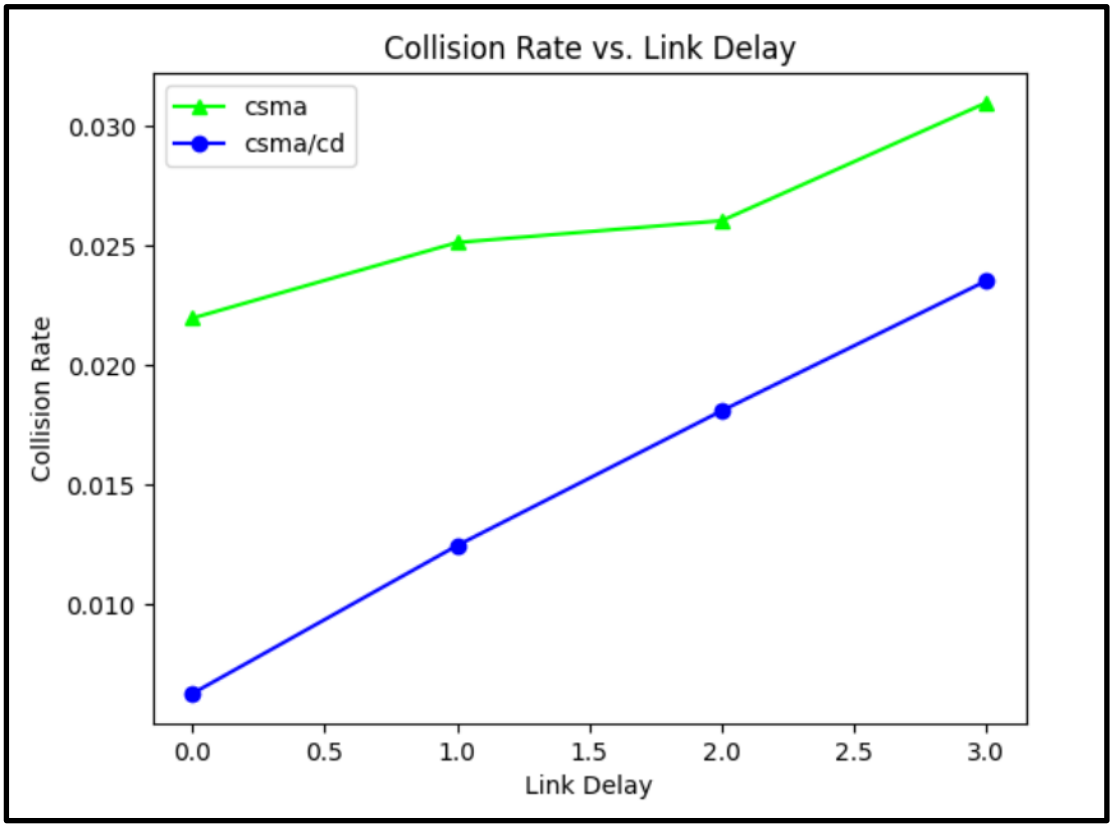

Idle Rate vs. Packet Size
aloha
slotted aloha
csma
csma/cd
Idle Rate
0.5
0.4
0.3
0.2
0.1
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Packet Size


Collision Rate vs. Packet Size
aloha
slotted aloha
csma
csma/cd
Collision Rate
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2.5
5.0
7.5
10.0
12.5
15.0
17.5
Packet Size

8. **What's the influence of "link_delay" in CSMA and CSMA/CD? Apply the following settings, plot the results, and describe them. (10%)**
   link_delay_list= [0,1,2,3]
   packet_size_list= [7,5,3,1] # You should make sure that the packet_time remains constant.
   Setting(link_delay=l, packet_siz=p) for l,p in zip(link_delay_list, packet_size_list)
   If link delay become longer, the delay will also become longer when CSMA and CSMA/CD sense medium, which will get incorrect information about the usage of the medium. So, the success rate has the tendency of decreasing, idle rate and collision rate have the tendency of increasing.




Idle Rate vs. Link Delay
csma
csma/cd
Idle Rate
0.165
0.160
0.155
0.150
0.145
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Link Delay


Collision Rate vs. Link Delay
csma
csma/cd
Collision Rate
0.030
0.025
0.020
0.015
0.010
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Link Delay