Indian Institute of Technology Patna

End-Semester Assignment - 2021

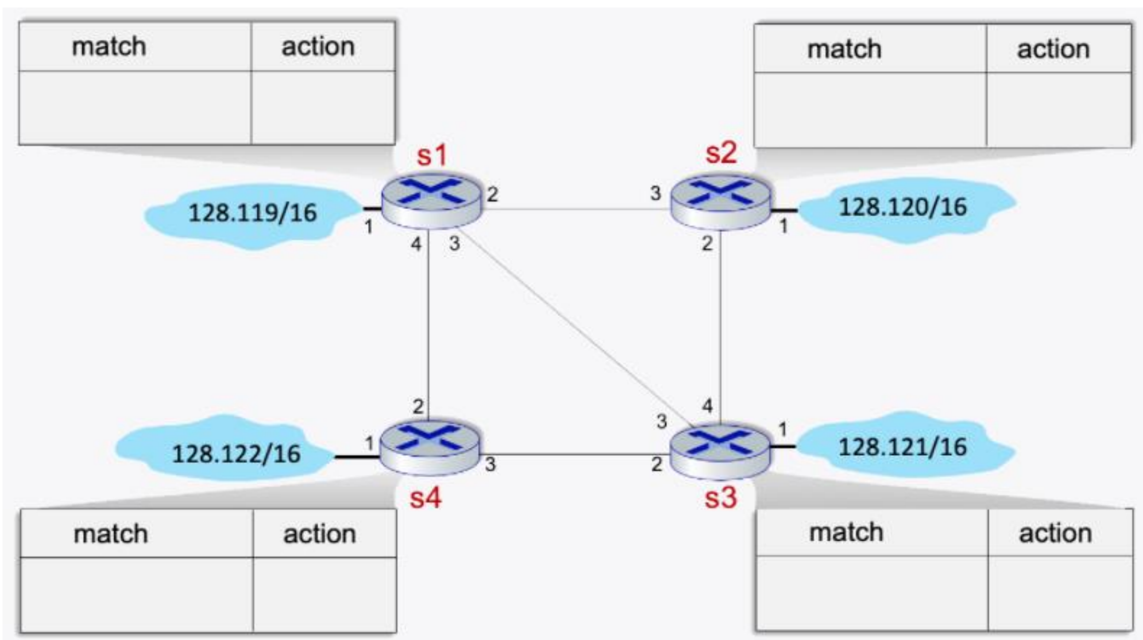
CS358 – Computer Networks

May 1st, 2021

All Questions are compulsory. **Maximum – 100 Marks**

Time: 24 hours

1. Consider the 4-router network shown below, where packet forwarding is controlled by flow tables (e.g., configured via OpenFlow in an SDN controller), rather than by a forwarding table computed by a routing algorithm. The addresses of networks attached to each of the router is also shown. The interfaces at each of the routers are also as indicated. **(5 x 2 = 10 marks)**

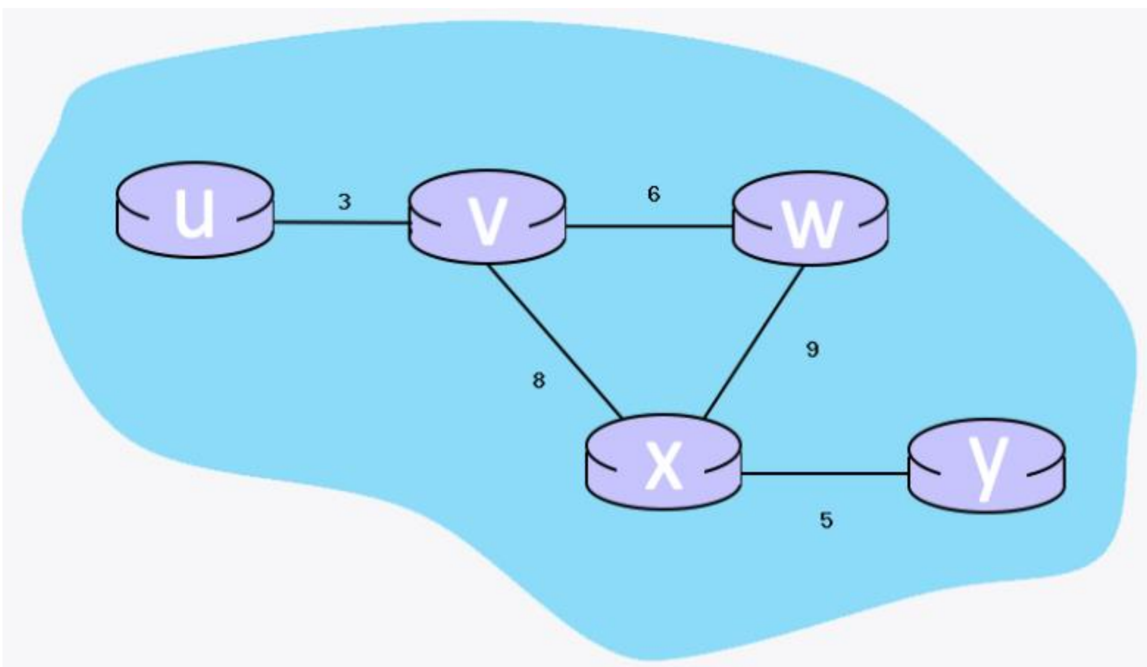


Suppose we want the following forwarding behavior of packets to be implemented:

TCP packets coming from the source network attached to s1 and destined to the network attached to s3 should be forwarded along the path: s1 -> s4 -> s3. UDP packets coming from the source network attached to s1 and destined to the network attached to s3 should be forwarded along the different path: s1 -> s2 -> s3.
Complete the match-plus-action tables in each of the routers, s1, s2, s3, and s4, that implement these forwarding behaviors. Your rules should be as strict as possible (should only allow these behaviors, and no other forwarding behaviors). You can assume that any packet arriving at a router that does not match a rule in that table will be dropped.

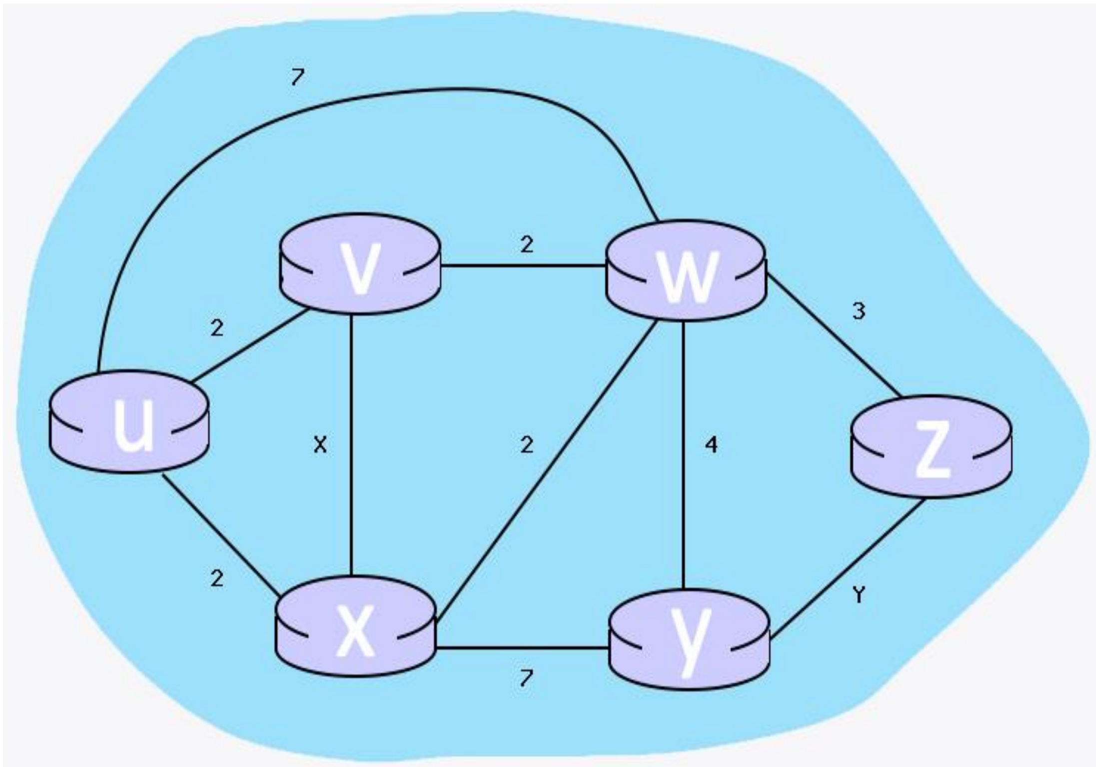
a. For router s1, what should the value of the 'Dst Port' be? Pick either a specific port, or any.
b. For router s1, what should the value of the 'IP Proto' be? Pick either TCP, UDP, or any.
c. For router s2, what should the value of the 'IP Src' be? Pick either a specific address (including CIDR), any, or none.
d. For router s3, what should the action of the rule be? Some examples include forward, allow, deny, etc.
e. For router s4, what interface should the packets be forwarded to?

2. Consider Bellman ford distance vector algorithm (for computing least cost paths) with the 6-node network shown below, with the given link costs. When the algorithm converges, what are the distance vectors from router 'X' to all routers? Write your answer as (u,v,w,x,y). **(3 x 2 = 6 marks)**



a. When the algorithm converges, what are the distance vectors from router 'X' to all routers? Write your answer as (u,v,w,x,y)
b. What are the initial distance vectors for router 'Y'? Write your answer as (u,v,w,x,y).
c. The phrase 'Good news travels fast' is very applicable to distance vector routing when link costs decrease; what is the name of the problem that can occur when link costs increase?

3. Consider Dijkstra's link state algorithm in the incomplete 6-node network shown below, with the given link costs. **(2 x 3 = 6 marks)**



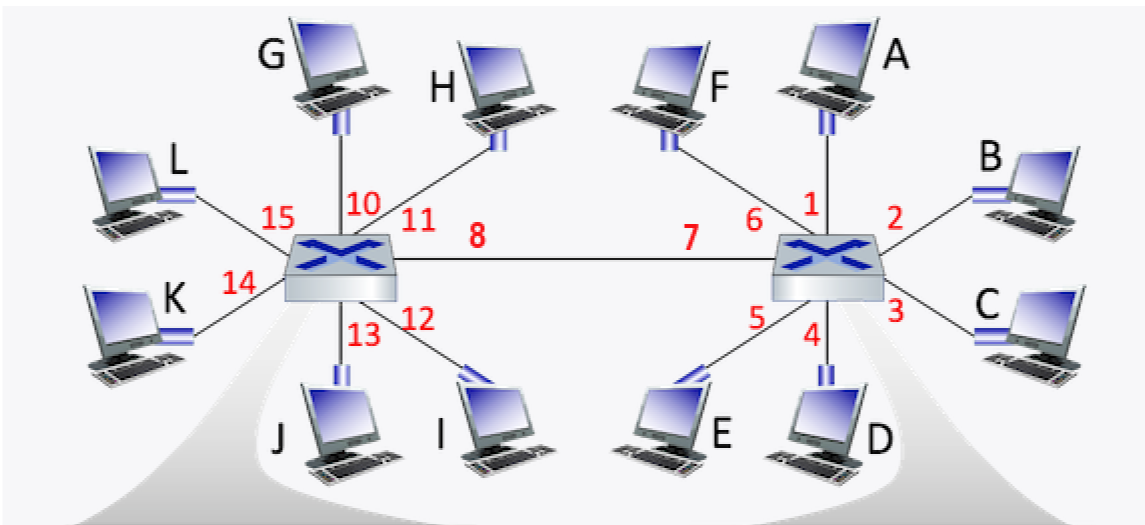
Consider the completed table below, which calculates the shortest distance to all nodes from X:

Node	Shortest distance from X	Previous Node
X	0	n/a
U	2	X
W	2	X
V	3	X
Z	5	W
Y	6	W

a. For link X, what is the cost associated with this link? If the answer can't be determined given the information, respond with 'n/a'.

b. For link Y, what is the cost associated with this link? If the answer can't be determined given the information, respond with 'n/a'.

4. Consider the LAN below consisting of 10 computers connected by two self-learning Ethernet switches. (You may want to re-read section 6.4.3 in the text). At t=0 the switch table entries for both switches are empty. At t = 1, 2, 3, 4, 5, 6, 7, 8, and 9, a source sends to a destination as shown below, and the destination replies immediately (well before the next time step). **(4 x 2 = 8 marks)**



MAC addr	interface	TTL
L	15	6
G	10	9
C	8	4
H	11	2
J	13	3
A	8	5
K	14	5
F	8	6
B	8	9

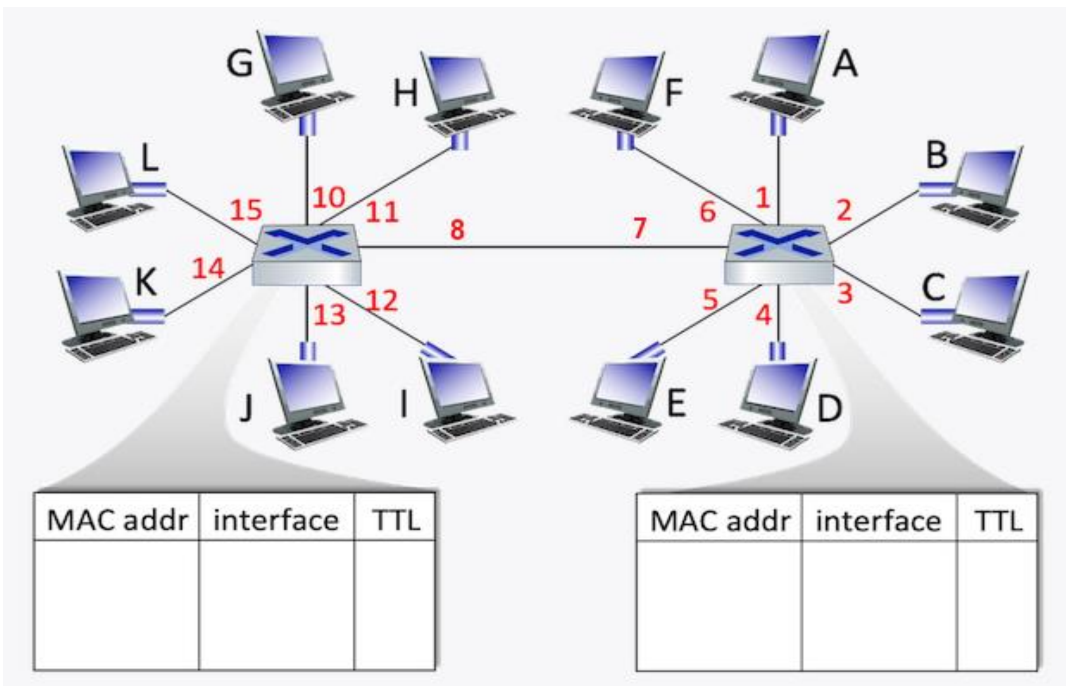
MAC addr	interface	TTL
L	7	6
C	3	8
H	7	2
J	7	3
A	1	7
G	7	9
K	7	5
F	6	8
E	5	7
B	2	9

a. At t=4, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a').

b. At t=8, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a').

c. At t=3, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a').
d. At t=2, what two nodes communicated? Write your answer in alphabetical order as x,y (If there is only enough information for 1 node, write that, and if there's no information, write 'n/a').

5. Consider the LAN below consisting of 10 computers connected by two self-learning Ethernet switches. (You may want to re-read section 6.4.3 in the text). At t=0 the switch table entries for both switches are empty. At t = 1, 2, 3, and 4, a source ends to a destination as shown below, and the destination replies immediately (well before the next time step). **(5 x 1 = 5 marks)**



Assume that the following connections occur:

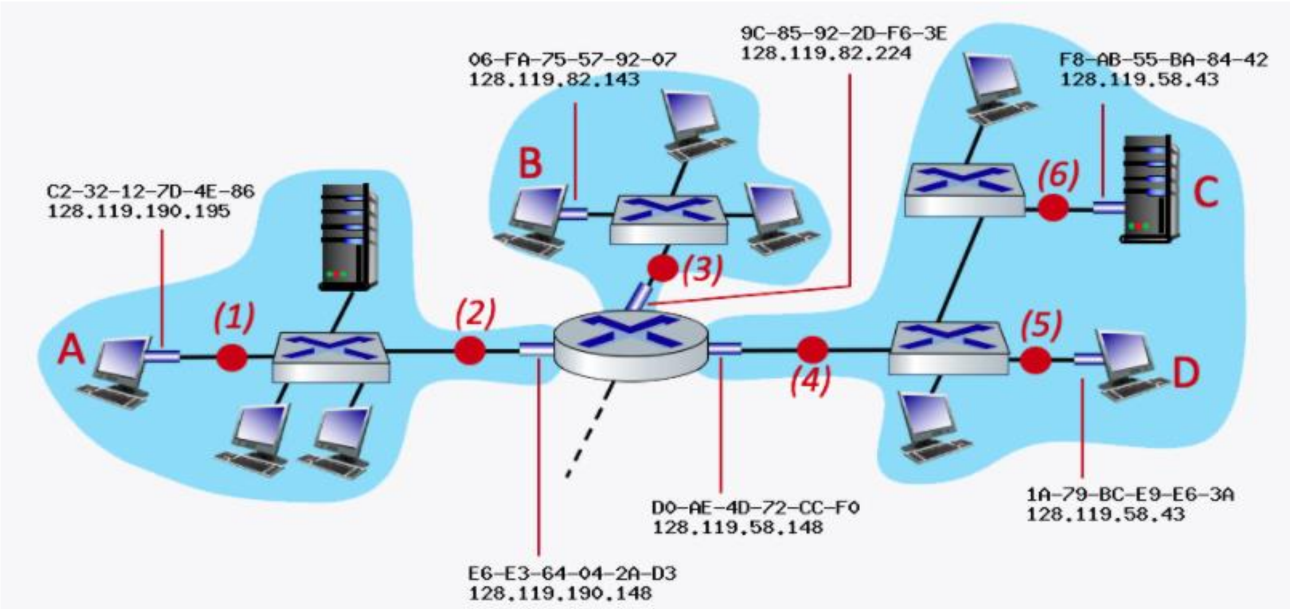
t=1: F -> I
t=2: C -> J
t=3: E -> G
t=4: F -> C

Fill out the two switch tables and answer the questions below (Format your answer as letter, number or 'n/a').

a. At t=1, what is the source entry for switch 1?
b. At t=1, what is the destination entry for switch 1?
c. At t=2, what is the destination entry for switch 2?
d. At t=3, what is the source entry for switch 1?
e. At t=3, what is the destination entry for switch 2?

6. Consider the Cyclic Redundancy Check (CRC) algorithm. Suppose that the 4-bit generator (G) is 1001, that the data payload (D) is 10011010 and that r = 3. What are the CRC bits (R) associated with the data payload D, given that r = 3? **(5 marks)**

7. Consider the figure below. The IP and MAC addresses are shown for nodes A, B, C and D, as well as for the router's interfaces. **(6 x 1 = 6 marks)**



a. What is the source mac address at point 5?
b. What is the destination mac address at point 5?
c. What is the source IP address at point 5?
d. What is the destination IP address at point 5?
e. What is the source mac address at point 2?
f. What is the destination mac address at point 2?

8. Suppose that a packet's payload consists of 10 eight-bit values (e.g., representing ten ASCII-encoded characters) shown below. (Here, there are arranged the ten eight-bit values as five sixteen-bit values). **(2 x 2 = 4 marks)**

   10100111 01001000
   10111101 00110000
   10111010 01010110
   01100001 10011000
   00101101 11101000

   a. Compute the two-dimensional parity bits for the 16 columns. Combine the bits into one string.
   b. Compute the two-dimensional parity bits for the 5 rows (starting from the top). Combine the bits into one string.

9. What is the oscillation problem faced in the traditional computer network? Explain with the help of the link cost diagram? **(5 marks)**

10. What is the motivation for adopting a Software defined network over the traditional network? Identify the network substrate formation for the existing routing protocols? **(2 + 3 marks)**

11. Diagramatically explain the SDN architecture with seperate identification for the control and data plane with SDN controller? **(4 marks)**

12. How do you perform Data center transport impairment and requirements ? Take the case study of microsoft bing and facebook DC for schematic explaination. **(6 marks)**

13. Write short notes on: **(3 + 3 + 4 = 10 marks)**

    a. Forwarding abstraction
    b. Network function virtualization
    c. Service function chaining

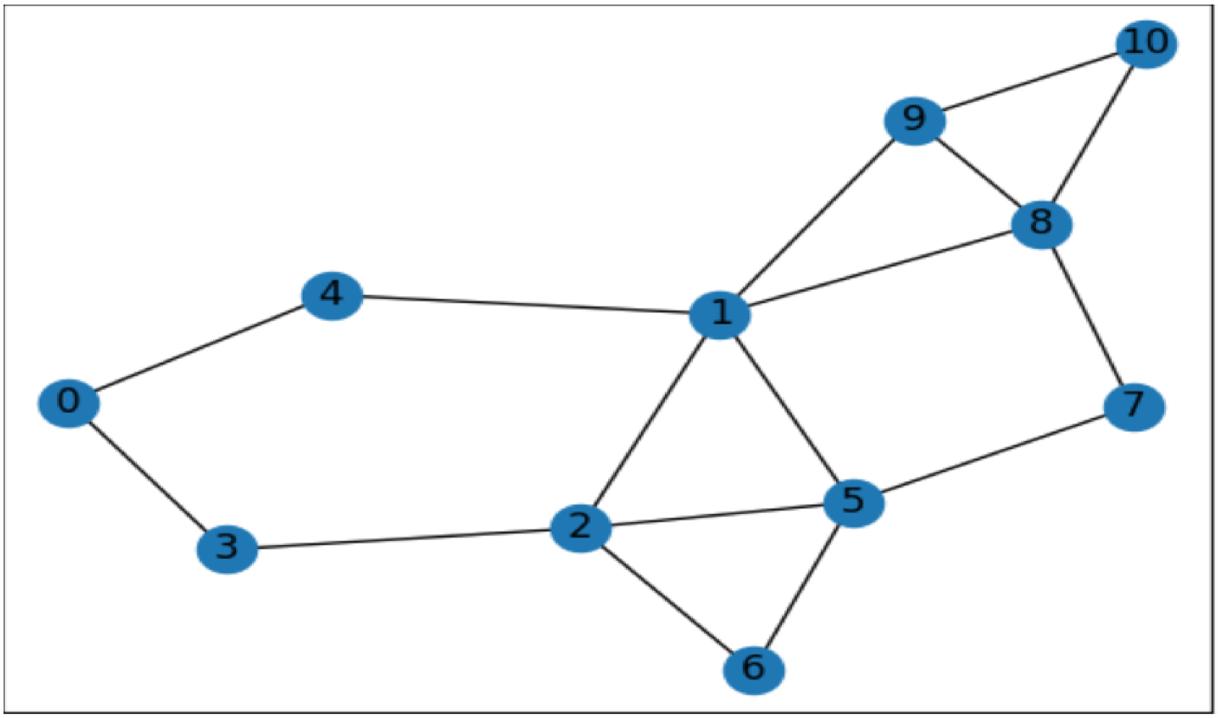
14. Diagramaically explain the incast problem in datacenters? Also, identify the steps to resolve them? **(5 marks)**

15. Differentiate Q-learning with Markov decision process (MDP), explain with example? Under what process Q-learning performs worse than MDP? **(5 marks)**

16. For Q-learning to converge we need to correctly manage the exploration vs. exploitation tradeoff. What property needs to be hold for the exploration strategy? **(5 marks)**

17. Finding Shortest Path using Q-Learning Algorithm from 0 to 10 using Q-matrix.

(5 marks)



Q-Matrix

	0	1	2	3	4	5	6	7	8	9	10
0	-100.0	-100.0	-100.0	110.0	138.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
1	-100.0	-100.0	138.0	-100.0	138.0	138.0	-100.0	-100.0	218.0	218.0	-100.0
2	-100.0	174.0	-100.0	110.0	-100.0	138.0	110.0	-100.0	-100.0	-100.0	-100.0
3	110.0	-100.0	138.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
4	110.0	174.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
5	-100.0	174.0	138.0	-100.0	-100.0	-100.0	110.0	174.0	-100.0	-100.0	-100.0
6	-100.0	-100.0	138.0	-100.0	-100.0	138.0	-100.0	-100.0	-100.0	-100.0	-100.0
7	-100.0	-100.0	-100.0	-100.0	-100.0	138.0	-100.0	-100.0	218.0	-100.0	-100.0
8	-100.0	174.0	-100.0	-100.0	-100.0	-100.0	-100.0	174.0	-100.0	218.0	274.0
9	-100.0	174.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	218.0	-100.0	274.0
10	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	218.0	218.0	-100.0