COMP 5511

Assignment 4 – Theory Portion

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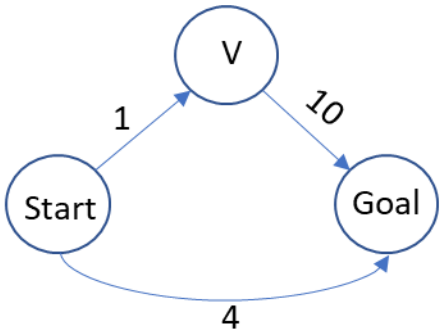
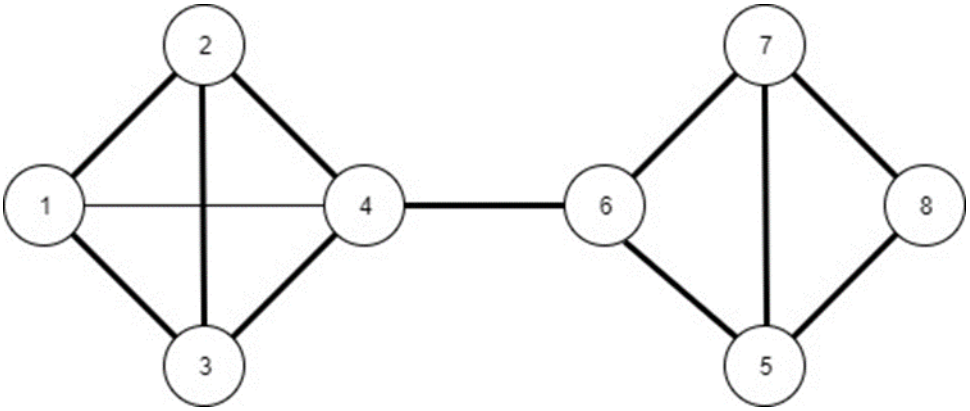
1) The greedy strategy cannot always find the shortest path. In the following the answer is proved by an example:



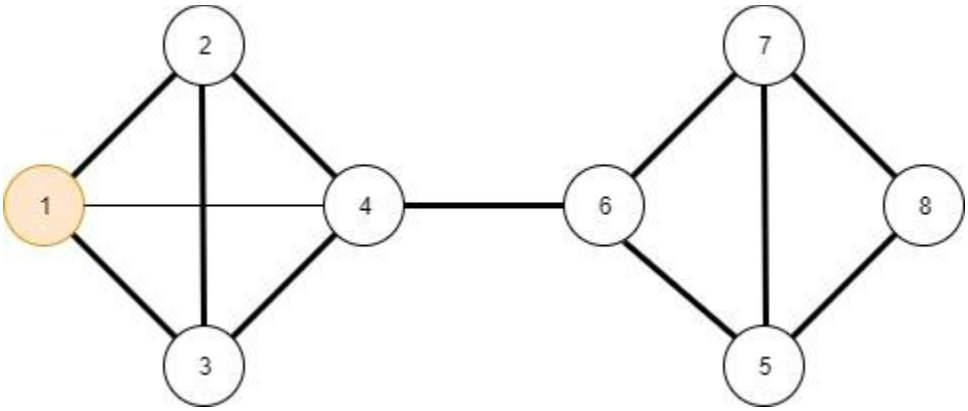
The greedy algorithm will return path start→v→goal, which has length 11 and is not the shortest path, which is actually the direct path start→goal with length 4.

2)

a) Graph G

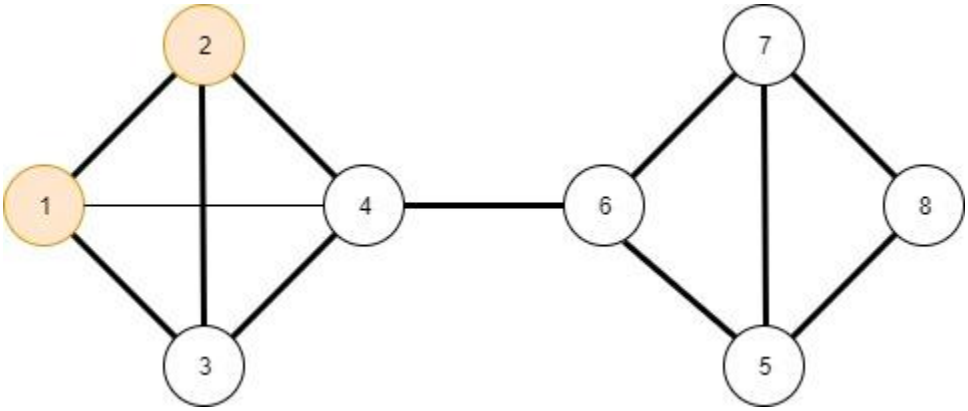


b) Depth-first search



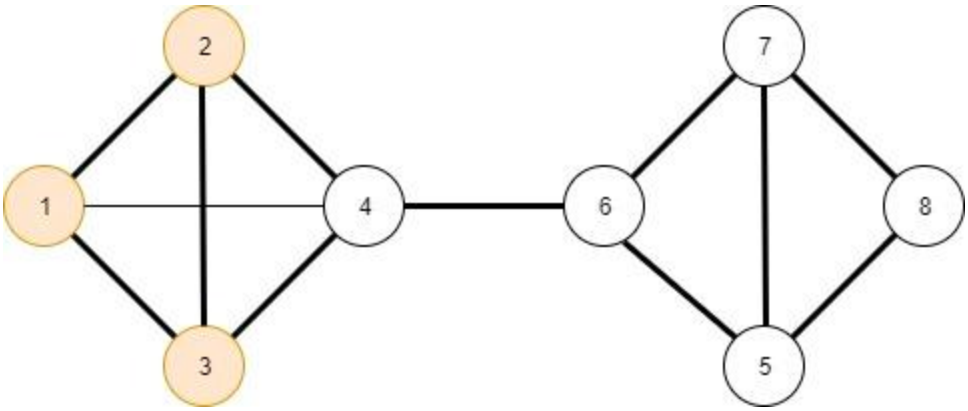
Visited vertex sequence: 1

Stack sequence: 1



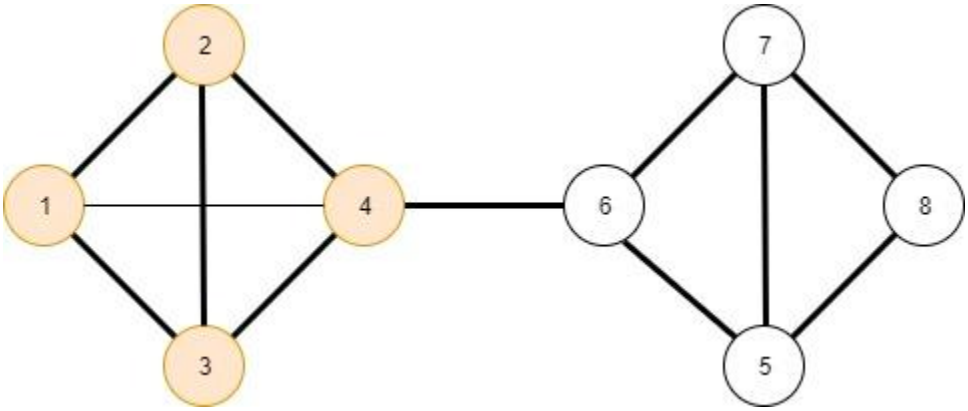
Visited vertex sequence: 1, 2

Stack sequence: 1,2



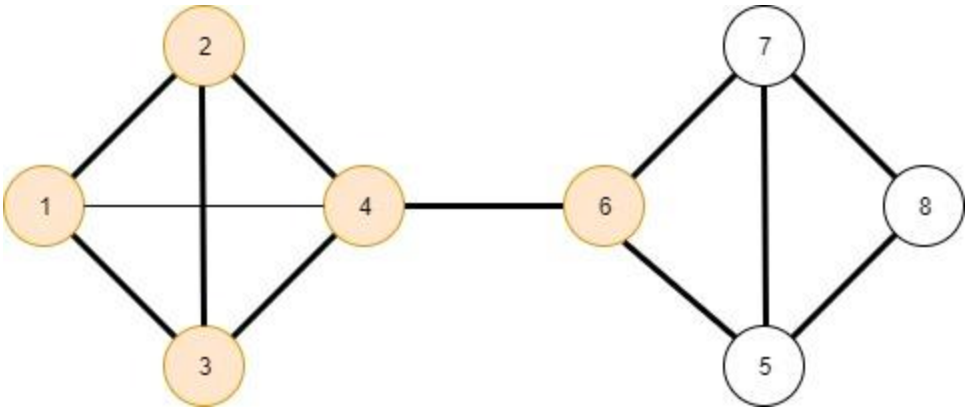
Visited vertex sequence: 1, 2, 3

Stack sequence: 1,2, 3



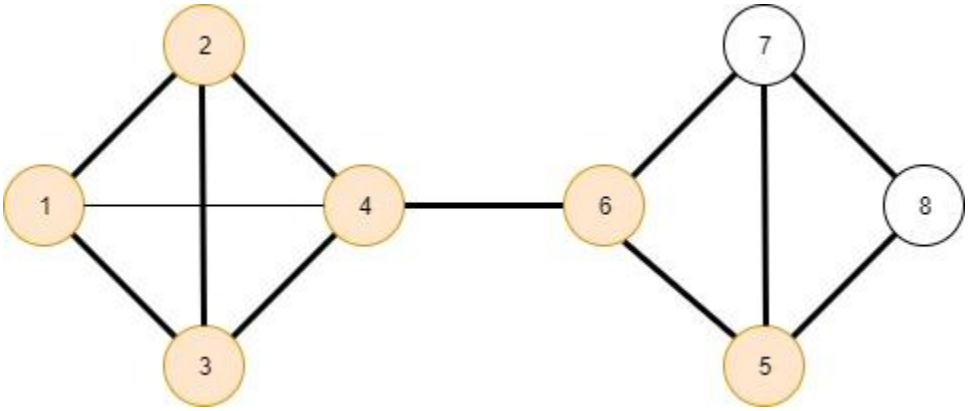
Visited vertex sequence: 1, 2, 3, 4

Stack sequence: 1,2, 3, 4



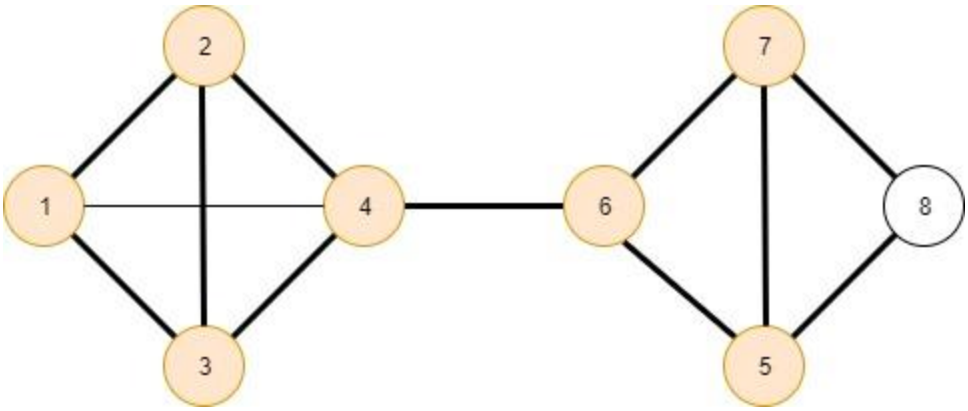
Visited vertex sequence: 1, 2, 3, 4, 6

Stack sequence: 1,2, 3, 4, 6



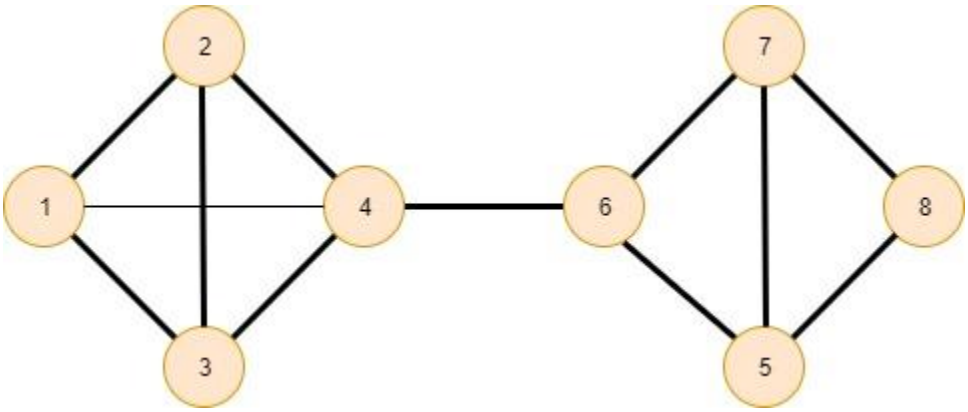
Visited vertex sequence: 1, 2, 3, 4, 6, 5

Stack sequence: 1,2, 3, 4, 6, 5



Visited vertex sequence: 1, 2, 3, 4, 6, 5, 7

Stack sequence: 1,2, 3, 4, 6, 5, 7

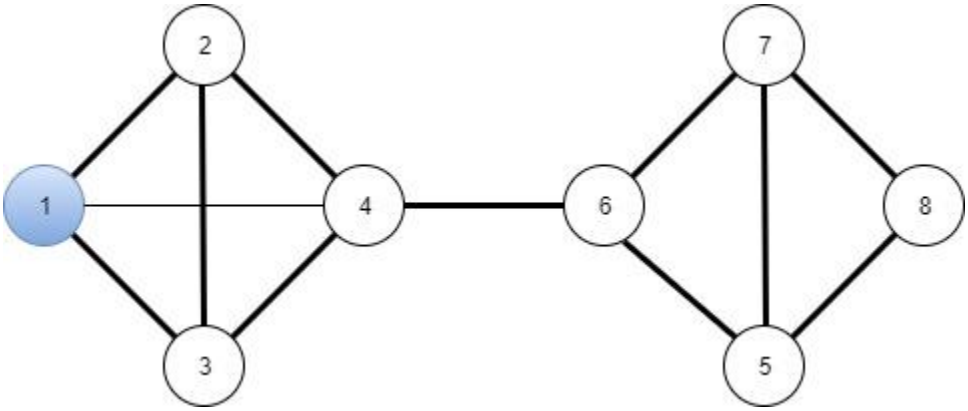


Visited vertex sequence: 1, 2, 3, 4, 6, 5, 7, 8

Stack sequence: 1,2, 3, 4, 6, 5, 7, 8

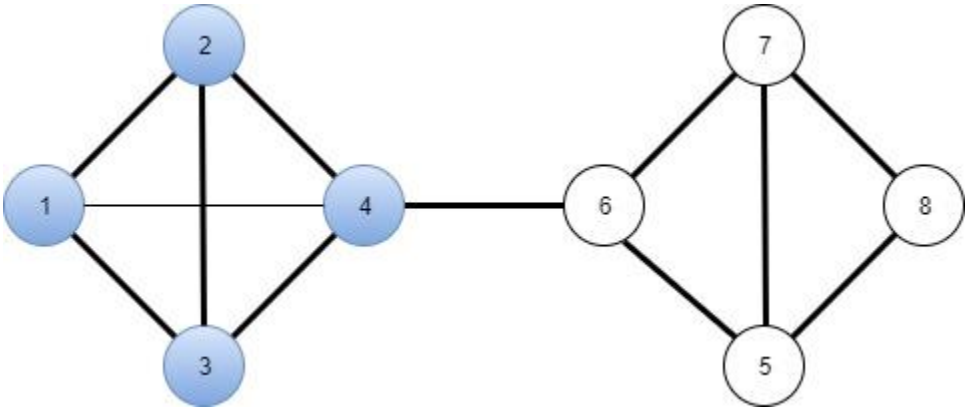
The vertex 8 pop-out from stack since all its adjacent vertices are already visited and the stack status become 1, 2, 3, 4, 6, 5, 7. Then the following vertices are popping out from stack in sequence of 7, 5, 6, 4, 3, 2, 1.

c) Breadth-first search



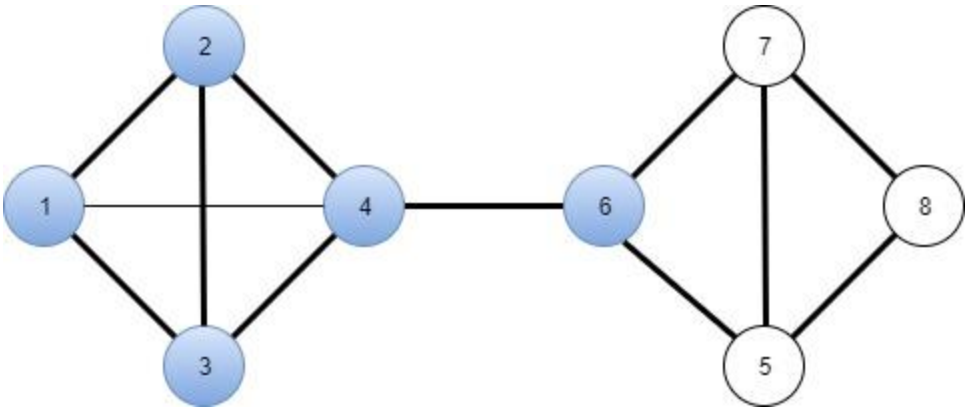
Visited vertex sequence: 1

Queue status: empty



Visited vertex sequence: 1,2, 3, 4

Queue status: 2, 3, 4



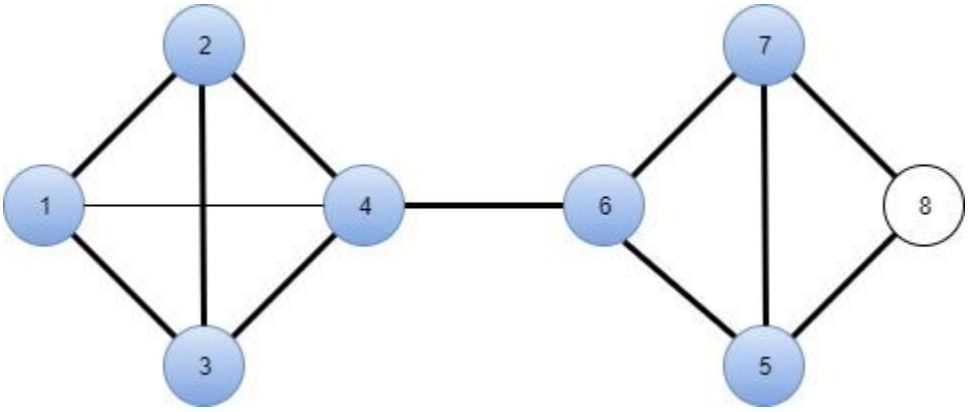
Visited vertex sequence: 1,2, 3, 4, 6

Vertex 2 is removed from queue since all its adjacent vertices has been visited. Then the vertex 3 is removed with the same logic.

Queue status: 4, 6

The vertex 4 is removed from queue since all its adjacent vertices has been visited.

Queue status: 6

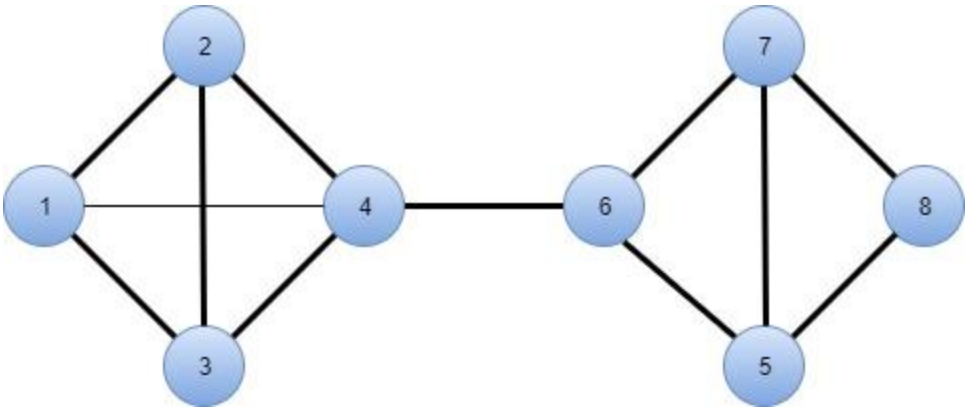


Visited vertex sequence: 1,2, 3, 4, 6, 5, 7

Queue status: 6, 5, 7

Vertex 6 is removed from queue.

Queue status: 5, 7



Visited vertex sequence: 1,2, 3, 4, 6, 5, 7, 8

Queue status: 5, 7, 8

The vertex 5 is removed from queue after visitation of all its adjacent vertices. Then the vertex 7 has been removed.

The last vertex is 8 which is removed after visiting of all its vertices.

The queue is emty.

3) In case of 2-way we get following the equation: T(N) = 2T(N/2) + O(N)
Similarly, for 3-way Merge sort we get the equation: T(N) = 3T(N/3) + O(N)
By solving it using Master method, we get its complexity as

$O(N \log_3 N)$

Although time complexity compared to 2 way merge sort decreased, the time may become higher because number of comparisons in merge function go higher.

To do a 3-way merge, you need to find the minimum of three elements (2 comparisons) for each item you place in the output array. This can happen for 3N/3 – 3 items. The last three items take 3 more comparisons, for a total of

2*(3*N/3 – 3) + 3 = 2N –3.

There's actually a way to do this in about 5N/3 comparisons: merge two of the arrays in the usual way and then merge the array of size 2N/3 with the other array (of size N/3). This takes 5N/3 comparisons, but it does more assignments

4) The number of strongly connected components can only decrease as the number of edges increase. The number of strongly connected components (SCCs) may remain the same or reduced to any number no less than 1.

   m'≤ m and m'≥ 1.

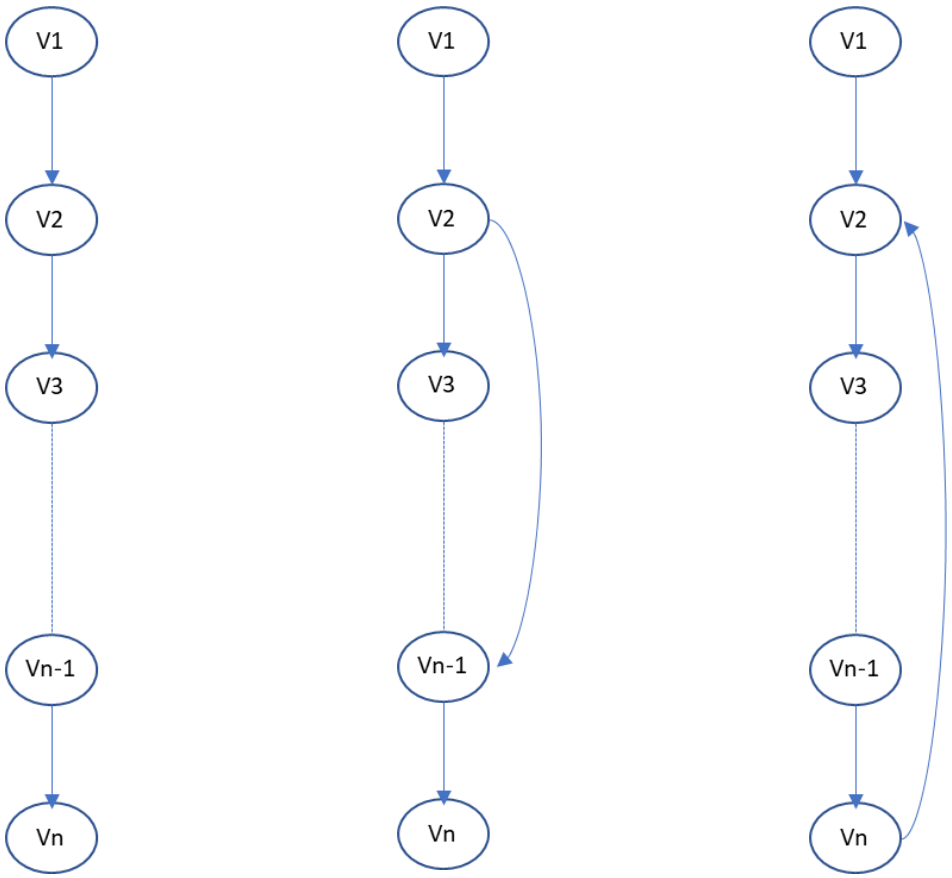
   Which m is the number of strongly connected component and m' is the number of strongly connected component after adding the new edge.

   As It is clearly depicted in the figure, The left figure is the original graph in which each node is an strongly connected component.

   The total number of strongly connected component is n

   - If the new added edge is a self-loop of any node, or if the new added edge is pointing down, then then number of SCCs will not change.
   - If the new added edge is a pointing up, it forms an SCC, and it may reduce.

   The number of SCC to any number between 1 and n.



PROGRAMMING QUESTIONS

Question1)

Please note that the output for question1 is very long and spans over several pages. The results for questions 2 and 3 are after the table for question1 (they are at page 14).

TC#	Field to search for	User input pattern	Result
TC#1	Name	Kn	Knight, Will: Knight@USofA.org: ConfSys.org: United States Ouaknine, Keren: Ouaknine@Israel.org: Hebrew University of Jerusalem: Israel
TC#2	Email Address	Ojha	Ojha, Shri: Ojha@India.org: DRDO: India
TC#3	Organization	hec	Babin, Gilbert: Babin@Canada.org: HEC Montreal: Canada Gerbé, Olivier: Gerbé@Canada.org: HEC Montreal: Canada Behera, Rasananda: Behera@USofA.org: CheckFree Corporation: United States
TC#4	Country	India	Ojha, Shri: Ojha@India.org: DRDO: India Kumar, Naveen: Kumar@India.org: University of Delhi: India Agrawal, R.: Agrawal@India.org: Jawaharlal Nehru University: India Kummamuru, Krishna: Kummamuru@India.org: IBM Research - India: India Ganguly, Sumit: Ganguly@India.org: Indian Institute of Technology, Kanpur: India Bedi, Punam: Bedi@India.org: University of Delhi: India Kush, Ashwani: Kush@India.org: Kurukshetra University: India Shanker, Udai: Shanker@India.org: M. M. M. Engineering College: India Bellur, Umesh: Bellur@India.org: Indian Institute of Technology, Bombay: India Kwatra, Divya: Kwatra@India.org: University of Delhi: India Sakthivelu, Rathinavelu: Sakthivelu@India.org: Pondicherry University: India Jaiswal, Ajay: Jaiswal@India.org: Jawaharlal Nehru University: India I, Ravi: I@India.org: Jawaharlal Nehru Technological University: India Venkatakrishnan, Roopak: Venkatakrishnan@India.org: Anna University: India Annadurai, Ajitha: Annadurai@India.org: Anna University: India Kumar, Nitin: Kumar@India.org: Jawaharlal Nehru University: India Bella, Isa: Bella@India.org: Karunya Institute Of Technology: India Kaur, Manpreet: Kaur@India.org: National Institute of Technology - Jalandhar: India Mehan, Vineet: Mehan@India.org: Nagpur University: India Gugale, Rohit: Gugale@India.org: University of Pune: India

			Agarwal, Shikha: Agarwal@India.org: University of Delhi: India Agrawal, Deepak: Agrawal@India.org: Vivekanand Education Society Institute of Technology: India Jagtap, Sanjeet: Jagtap@India.org: University of Kerala: India Tomar, Pradeep: Tomar@India.org: Gautam Buddha University: India Kumar, Lalith: Kumar@India.org: Vellore Institute of Technology: India Sodhi, Balwinder: Sodhi@India.org: Indian Institute of Technology, Kanpur: India Pandey, Parul: Pandey@India.org: Bangalore University: India Khetarpaul, Sonia: Khetarpaul@India.org: Indian Institute of Technology, Delhi: India Nathan, Jeffson: Nathan@India.org: Indian Institute of Technology, Bombay: India Subramaniam, L venkata: Subramaniam@India.org: IBM Research - India: India Gupta, S k: Gupta@India.org: Indian Institute of Technology, Delhi: India Lalchandani, Jayprakash: Lalchandani@India.org: International Institute of Information Technology, Bangalore: India Ev, Sunitha: Ev@India.org: Cochin University of Science and Technology: India Bairi, Ramakrishna: Bairi@India.org: Indian Institute of Technology, Bombay: India Vijaya, Aparna: Vijaya@India.org: Vellore Institute of Technology: India Ramachandran, Shankar: Ramachandran@India.org: Bharathiar University: India Sethia, Neetu: Sethia@India.org: Hindustan University: India Appusamy Venkataraman, Senthil Kumar: Appusamy Venkataraman@India.org: Bharathiar University: India Sureka, Ashish: Sureka@India.org: Indraprastha Institute of Information Technology: India Sachdev, Astha: Sachdev@India.org: Indraprastha Institute of Information Technology: India Gupta, Kunal: Gupta@India.org: Indraprastha Institute of Information Technology: India Joishi, Jeevan: Joishi@India.org: Indraprastha Institute of Information Technology: India Goyal, Vikram: Goyal@India.org: Indraprastha Institute of Information Technology: India Dawar, Siddharth: Dawar@India.org: Indraprastha Institute of Information Technology: India Thalia, Asma: Thalia@India.org: Birla Institute of Technology and Science: India Singhal, Rekha: Singhal@India.org: Tata Consultancy Services: India

			Singh, Ashish: Singh@India.org: M. M. M. Engineering College: India Kumar, Saurabh: Kumar@India.org: Indian Institute of Management Lucknow: India Saxena, Anuj: Saxena@India.org: National Defence Academy: India Bera, Debajyoti: Bera@India.org: Indraprastha Institute of Information Technology: India Verma, Amandeep: Verma@India.org: Punjabi University Patiala: India Singh, Mandeep: Singh@India.org: Punjabi University Patiala: India Padiya, Trupti: Padiya@India.org: Dhirubhai Ambani Institute for Information and Communication Technology: India Bhise, Minal: Bhise@India.org: Dhirubhai Ambani Institute for Information and Communication Technology: India Patgiri, Ripon: Patgiri@India.org: National Institute of Technology Silchar: India Leeka, Jyoti: Leeka@India.org: Indraprastha Institute of Information Technology: India Howlader, Prantik: Howlader@India.org: Cisco Systems, Inc India: India Pal, Kuntal: Pal@India.org: Cavium Networks: India Ghate, Pinak: Ghate@India.org: University of Pune: India Yadav, Rimmy: Yadav@India.org: Lovely Professional university: India Gupta, Varun: Gupta@India.org: Canon Inc. India: India Chittimalla, Anil: Chittimalla@India.org: Jawaharlal Nehru Technological University: India

Question2)

Keyword Used	Number of Individuals with Keyword in their organization
Technology	80
Saudi	4
Isfahan	1
University	672
Hamdard	1
Punjabi	2
Institute	69
McGill	13

Please note that the table above as well as the raw output data for the keywords have also been included in the file corresponding to question 2 in the submitted zip file.

Question 3)

Name Searched	Number of Nodes Accessed
Azevedo, Ana	9
Silva, Rui	12
Boussebough, Imane	9
Terracina, Giorgio	11
Lefebvre, Peter	6 (But the result was not found)
Houghten, Sher	10 (But the result was not found)
Revesz, Peter	11