

CSC 173: Computation and Formal Systems
Midterm

75 points

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Randal C. Nelson, Instructor

Relations and Relational Algebra

Consider the following relations on the next page

1. (5 points)

What attribute(s) constitute a key for each of the three relations?

2. (5 points)

What is the relation obtained by performing the natural join of the V-T relation and the T-F-L-G relation?

3. (5 points)

What relation is obtained by projecting the T-V-N-S relation onto the “Type” and “Native to” attributes?

4. (5 points)

What relation is obtained by selecting from the T-V-N-S relation using the condition “Variety = black OR Variety = white”?

5. (5 points)

Provide an expression (or an explicit sequence of operations) using selection, projection, and join that provides a (minimal) answer to the question “what is the common name (type and variety) of the tree whose scientific name (genus and species) is *Picea pungens*?” (The answer is Blue Spruce. I’m not interested in the answer, but in the relational operations used to obtain it.)

6. (5 points)

Under what conditions can selection be pushed below a join, and why might we want to do this?

Type	Variety	Native to	Species
oak	red	ENA	rubra
oak	white	ENA	alba
oak	black	ENA	velutina
maple	red	ENA	rubrum
maple	black	NNA	nigrum
maple	sugar	ENA	saccharum
pine	white	ENA	strobus
pine	red	ENA	resinosa
pine	lodgepole	WNA	contorta
spruce	blue	WNA	pungens
spruce	black	NNA	nigra
spruce	white	NNA	alba

Table 1: T-V-N-S tree relation

Type	Fruit	Leaves	Genus
pine	cone	evergreen	Pinus
oak	acorn	deciduous	Quercus
maple	samara	deciduous	Acer
spruce	cone	evergreen	Picea

Table 2: T-F-L-G tree relation

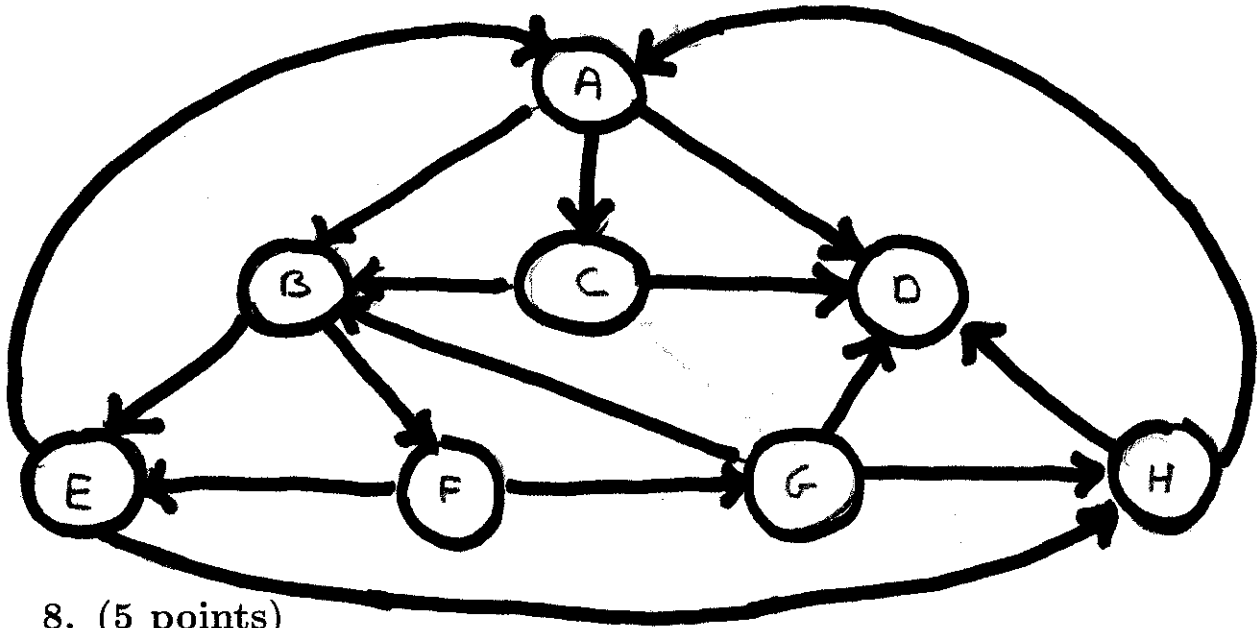
Variety	Type
white	oak
blue	spruce
red	oak
sugar	maple
red	maple
white	pine

Table 3: V-T trees on campus relation

Graphs

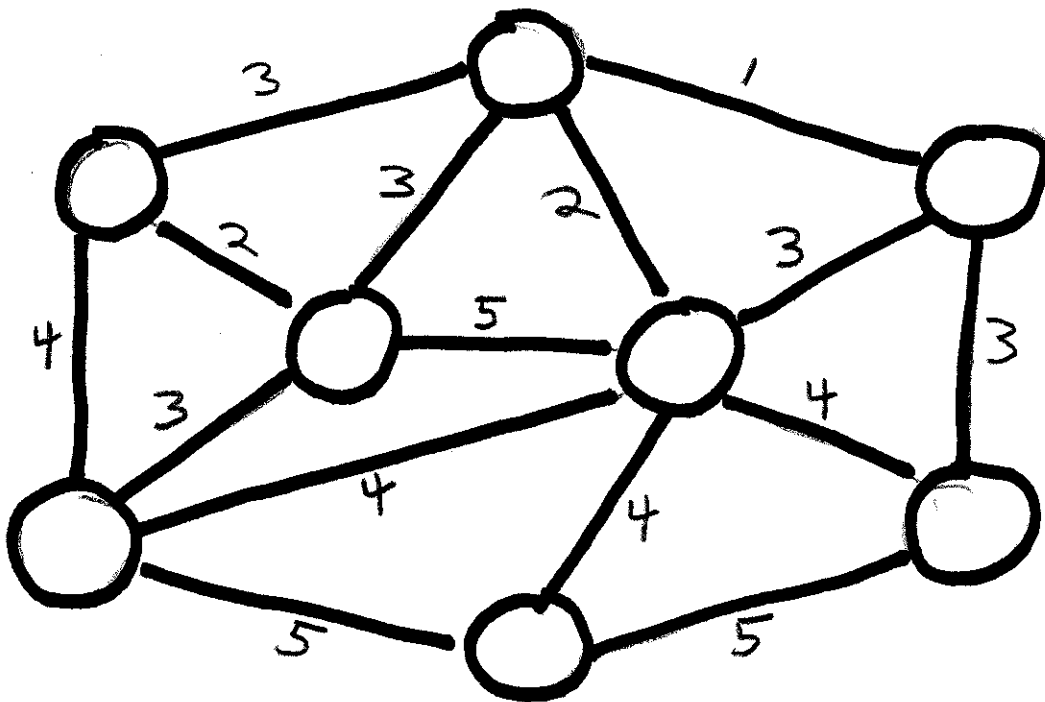
7. (10 points)

Provide a depth-first and a breadth-first traversal order for the following graph starting at the node marked A. Visit links counterclockwise from the top.



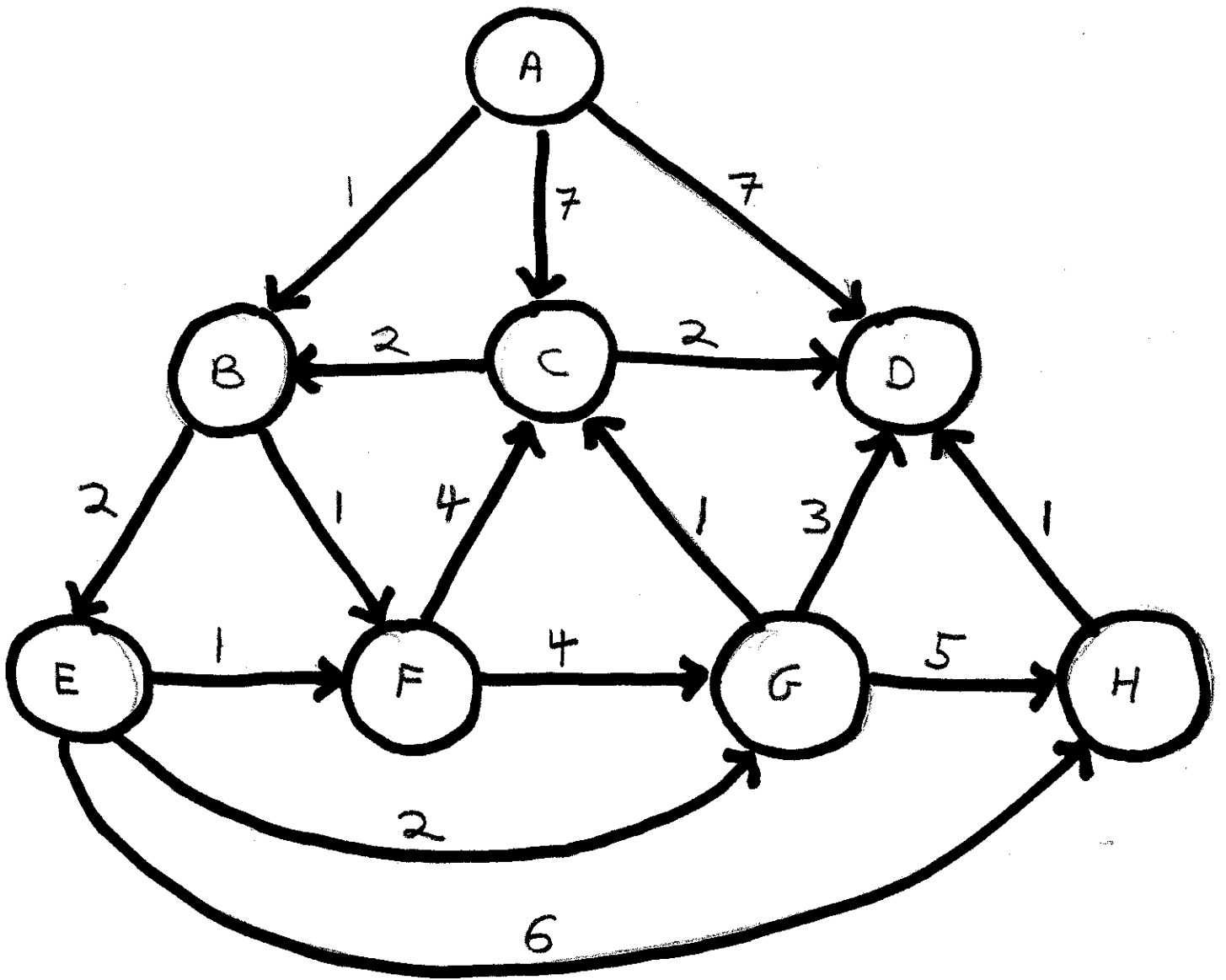
8. (5 points)

Provide a minimum spanning tree for the following graph.



9. (5 points)

In what order does Dijkstra's algorithm add the nodes of the following graph to the shortest path set, starting at node A? Show the corresponding tree.



Finite State Automata and Regular Expressions

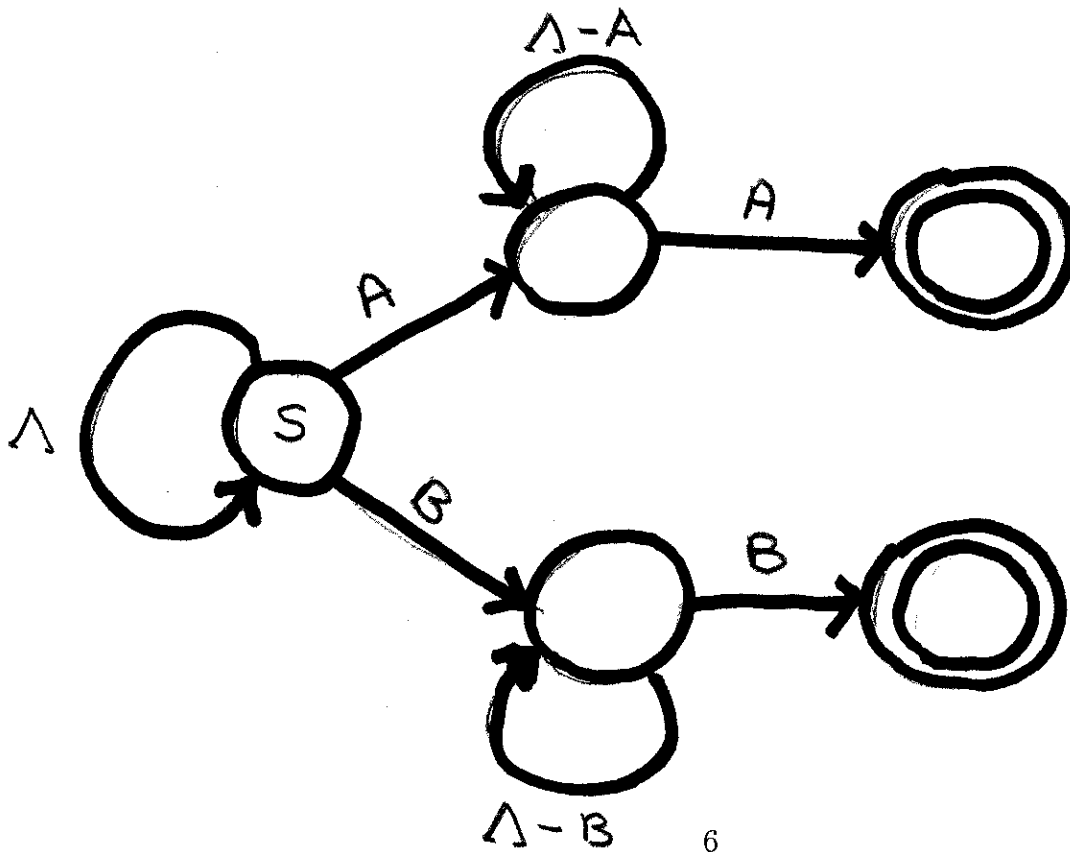
10. (10 points)

Provide a graph representation for a DFSA that accepts all strings over the alphabet $\{A,B\}$ that have an even number of As *and* at least 3 Bs.

11. (5 points)

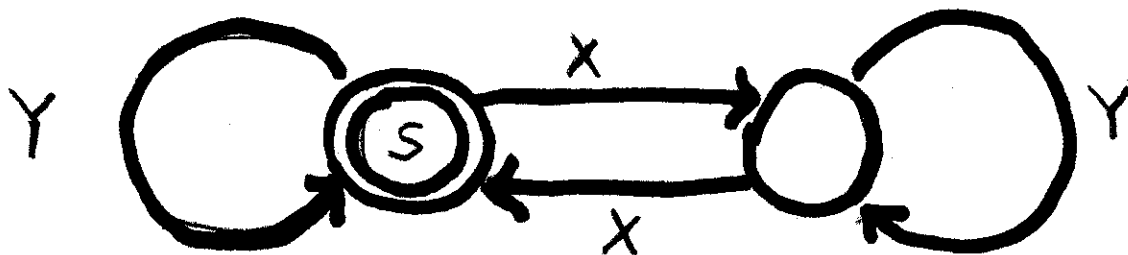
Convert the following NFSA to a DFSA.

$\Lambda = \text{Alphabet}$



12. (5 points)

Provide a regular expression that produces exactly the set of strings that is accepted by the following DFSA.



13. (5 points)

Provide a DFSA that accepts exactly the set of strings that is generated by the following regular expression.

$$(A B | B A)^*$$