Data Structures and Algorithms 2, Course Project 2022

Submission Checklist – Very Important *Failure to satisfy these submission requirements may result in non-acceptance of your submission or reduced marks.*	
	Deadline is **strictly** on Friday 27th May 2022 at 23:59.
	Included the **completed** **plagiarism declaration form**.
	Included the **completed** **statement of completion** (template below).
	Report is in **PDF** – **NOT Word documents or any other format**; no exceptions.
	Source code is included in the submission – **NO links to Dropbox, GitHub, or anything else**; no exceptions.
	Archive is in **ZIP** format – **NOT RAR, 7z, or any other format**; no exceptions.
	Uploaded size limit is **100Mb** – the PDF report, source code, and any relevant datasets must fit. If there is no space, you may provide an external link to the datasets **ONLY** (e.g., Dropbox, GitHub, etc..). **Report and source code must always be in the uploaded package.** Do not let external links to expire until you have been graded.
	Your **name** and **student ID** are both on the front page of the report.
	Projects must be submitted only through **VLE** – **submissions made by email or any other way apart from VLE will not be considered**; no exceptions.
	A draft and final submission area is set up in VLE. Only projects submitted in the **final submission area** will be graded. **Projects submitted to the draft area will not be considered at all**; no exceptions.
	It is your responsibility to ensure that your upload is complete, valid, and not corrupted. You can reupload the assignment as many times as you wish within the deadline. Double-check your upload. **Corrupted uploads cannot be graded.**
	Plagiarism is a serious offence and will not be tolerated.
	This is **NOT** a group project.

Graph Algorithms on DFAs

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1. **Construct a deterministic finite state automaton** A according to the following recipe:
    a. Create n states, where n is a random number between 16 and 64 inclusive.
    b. For each state, flip a coin to determine whether the state is accepting or not.
    c. Every one of the n states must have two outgoing transitions leading to two other random states; one transition is labelled with the symbol a, and the other with the symbol b. Transitions from a state to itself (loops) are allowed.
    d. Choose any random state as the starting state of the DFA.
2. **Compute the depth** d_A of A. The depth of an automaton is defined as the maximum over all states of the length of the shortest string which leads to that state (hint: you can use breadth-first search to get this).

Print the number of states in A.
Print the depth d_A of A.

3. Minimise the automaton A using either the **Moore or Hopcroft minimization algorithm** to obtain a new automaton M.
4. **Compute the depth** d_M of M.

Print the number of states in M.
Print the depth d_M of M.

5. Learn what **strongly connected components** (SCCs) in graphs are and implement **Tarjan's algorithm** for finding the strongly connected components in M.

   Print the number of strongly connected components in M.
   Print the size of (number of states in) the largest SCC in M.
   Print the size of (number of states in) the smallest SCC in M.

6. In your report, write a discussion about how **Johnson's algorithm** works and how it is used for finding all simple (elementary) cycles in a directed graph. You do not need to implement this (but it's fun). Convince me that you understand the method well.

Statement of completion – MUST be included in your report

Item	**Completed (Yes/No/Partial)**
Created a random DFA	*Write your answer here*
Correctly computed the depth of the DFA	*Write your answer here*
Correctly implemented DFA minimization	*Write your answer here*
Correctly computed the depth of the minimized DFA	*Write your answer here*
Correctly implemented Tarjan's algorithm	*Write your answer here*
Printed number and size of SCCs	*Write your answer here*
Provided a good discussion on Johnson's algorithm	*Write your answer here*
Included a good evaluation in your report	*Write your answer here*
If partial, explain what has been done	

Marking Breakdown

Description	Marks allocated
Created a random DFA	15%
Correctly computed the depth of the DFA	10%
Correctly implemented DFA minimization and correctly computed the depth of the minimized DFA.	15%
Correctly implemented Tarjan's algorithm and printed number and size of SCCs.	15%
Provided a good discussion on Johnson's algorithm	10%
Included a good evaluation in your report	10%
Overall report quality	25%

Other notes

- I am not concerned with the programming language you choose; feel free to use anything that you're comfortable with. However, if you intend to use some 'exotic' programming language, please discuss with me beforehand.
- Regarding your report:
    - Make sure that the quality and writing style is up to the standard expected from you. Poor style, grammar, formatting, proofreading issues, and conclusions like "I had lots of fun doing this project" are not very helpful.
    - Include sections describing any algorithms or techniques you implement.
    - Test and evaluate your work well.
- Good luck!