Project, Modeling the Basic Paxos Protocol, due on 8 Nov 2024

Objective:

Practice: Model a real-world algorithm, protocol, or system using the Process Analysis Toolkit (PAT).

Paxos is a family of protocols used to achieve consensus in a network of unreliable or fallible processors. For detailed information about the protocol, please refer to the Paxos Wikipedia page (https://en.wikipedia.org/wiki/Paxos_(computer_science)).

In this project, your task is to model the Basic Paxos protocol. After the modelling, you need to check if your model works as expected. The Wikipedia page outlines one error-free scenario and seven error cases, which you will need to check:

1. Error-Free Scenario
2. Basic Paxos with Acceptor Failure
3. Basic Paxos with Redundant Learner Failure
4. Basic Paxos with Proposer Failure
5. Basic Paxos with Conflicting Proposers
6. Basic Paxos with Acceptor Accepting Two Different Values
7. Basic Paxos with Insufficient Multi-Identifier Majority
8. Basic Paxos with New Proposers Unable to Change Existing Consensus

You may **make reasonable assumptions to simplify the model and its scenarios**. In other words, you don't need to follow the exact description from the Wikipedia page, as long as your model accurately reflects the fundamental behavior of Basic Paxos.

Submission Requirements:

- Submit your model in a `.csp` file format.

- Name your file as <student_id>_<student_id>...<student_id>.csp, to include all teammember's student ID (eg. Axxxxxxx). For each group, please submit only one file.

- Ensure your model is thoroughly commented to explain each part clearly.

- Include several traces at the end of your model.

Marking Criteria (we have defined the progressive marking scheme):

1. Basic Paxos in Error-Free Scenario: Provide a trace that demonstrates Basic Paxos operates as expected in the error-free scenario. (4 marks)

2. Traces for Error Cases: For each of the 7 error scenarios, provide a trace that demonstrates whether Basic Paxos operates or fails as expected. (7 marks)

3. LTL Assertions for Error Cases: Design and include an LTL (Linear Temporal Logic) assertion for each error case to verify whether Basic Paxos operates or fails as expected. (7 marks)

4. Documentation and Clarity: Your model should be concise and well-documented with comments. (2 marks)

Progressive Marking: we will award 50% of the marks for submissions which are 50% correct. To achieve 50% correct, your model should satisfy the following 2 criteria:

(1) It has at least 2 proposers and 3 acceptors.
(2) The model (and its traces) is correct until the end of phase 1 (prepare and promise), although not correct in phase 2.

For example, if your submission is 50% correct for item 1, 50% correct for 3 of the 7 error scenarios in item2, and 50% correct for 2 of the 7 LTL assertions in item 3, then we will award: 0.5*4+0.5*3+0.5*2=4.5.

For another example, if your submission is 100% correct for item 1, 100% correct for 2 of the 7 error scenarios in item 2, and 50% correct for 4 of the rest 7 scenarios in item 2, and 50% correct for 2 of the 7 LTL assertions in item 3, then we will award: 4+2+0.5*4+0.5*2=9.

We will also award 50% (that is 1 out of 2 marks) for item 4 if it is either concise or well-documented but not both.