SCT212-0056/2020 FAVOUR PAUL MUTURI
LAB 3

Problem (Hazard Identification)

a.
LD R1, 0(R2)
DADD R3, R1, R2

- Hazard Type: *Data hazard* (Read After Write - RAW)
- Registers involved: R1
- Explanation: `DADD` reads R1 which is being written by `LD`.

b.
MULT R1, R2, R3
DADD R1, R2, R3

- Hazard Type: *Write After Write* (WAW) and possibly *structural hazard* if MULT uses a long latency and there's no forwarding/bypassing
- Registers involved: R1
- Explanation: Both instructions write to R1. If MULT is not yet finished when DADD starts, WAW hazard occurs.

c.
MULT R1, R2, R3
MULT R4, R5, R6

- Hazard Type: *Structural hazard*
- Registers involved: None directly (R1, R4 are written but no overlap in destination)

- Explanation: If MULT uses a single functional unit, the second MULT has to wait for the first.

d.

```
DADD R1, R2, R3
SD 2000(R0), R1
```

- Hazard Type: *Data hazard* (RAW)
- Registers involved: R1
- Explanation: SD stores value from R1 which is written by DADD.

e.

```
DADD R1, R2, R3
SD 2000(R1), R4
```

- Hazard Type: *Data hazard* (RAW) involving address computation
- Registers involved: R1
- Explanation: SD uses R1 as the address (store destination) which is being written by DADD.

2-bit Saturating Counter Predictor

This predictor has four states:

State	Meaning	Transition if Taken	Transition if Not Taken
00	Strongly NT	→ 01	Stay in 00
01	Weakly NT	→ 10	→ 00
10	Weakly Taken	→ 11	→ 01

11	Strongly Taken	Stay in 11	→ 10

Initial state is 00 (Strongly Not Taken)

Prediction Pattern Analysis:

Since every other element in `x[i]` is zero (starting with the first), the pattern of the condition `if (x[i] == 0)` is:

T (x[i] == 0) → branch not taken
F (x[i] != 0) → branch taken
T, F, T, F, ...

Iteration	Actual Outcome	Prediction	State Before	State After
1	Not Taken	NT	00	00 (no change)
2	Taken	NT	00	01
3	Not Taken	NT	01	00
4	Taken	NT	00	01
5	Not Taken	NT	01	00
6	Taken	NT	00	01

Summary:

- Predictions: All predicted Not Taken.
- Correct predictions: Iterations 1, 3, 5 → 3/6
- Mispredictions: Iterations 2, 4, 6 → 3/6