DTM to decide $\{\ 0^{2^n}\ |\ n \geq 0\ \}$, the powers of 2 in unary notation (Example 3.7 in the book)

- Keep dividing by 2 and it never becomes an odd integer until 1.
- Implement division by 2 by crossing off every other 0.
- The number of remaining 0's on the tape is an even integer until 1 is reached.

Algorithm

"_" denotes the blank symbol.

```
     start in q₁
     blank 1st 0 to mark the leftmost cell and enter q₂
L:   let k = the # of 0's on the tape, including the leftmost "_"
     scan the tape to right, alternating between q₃ and q₄ to cross of every other 0
          if no 0 is found in the scan, accept
          if k is an odd integer > 1, "_" will be found on q₄ and reject
          otherwise "_" will be found on q₃ and continue
     enter q₅ and move the head back to the leftmost "_"
     enter q₂ and goto L
```
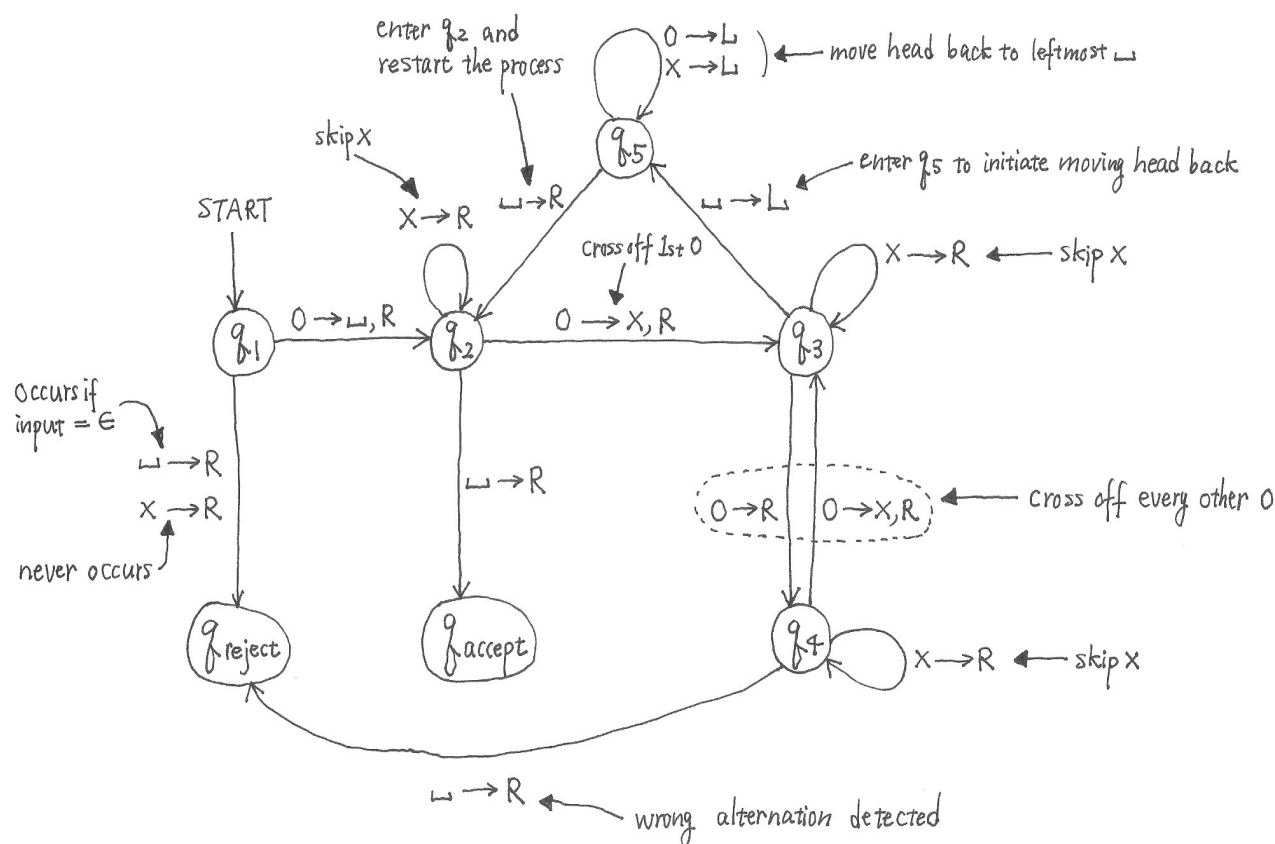

$$\Sigma = \{0\}$$
$$\Gamma = \{0, X, \sqcup\}$$

The following is the transition sequence on the input 000000.

$q_1 000000 \vdash$

$\_q_200000 \vdash$

$\_xq_30000 \vdash$

$\_x0q_4000 \vdash$

$\_x0xq_300 \vdash$

$\_x0x0q_40 \vdash$

$\_x0x0xq_3\_ \vdash$

$\_x0x0q_5x \vdash$

$\_x0xq_50x \vdash$

$\_x0q_5x0x \vdash$

$\_xq_50x0x \vdash$

$\_q_5x0x0x \vdash$

$q_5\_x0x0x \vdash$

$\_q_2x0x0x \vdash$

$\_xq_20x0x \vdash$

$\_xxq_3x0x \vdash$

$\_xxxq_30x \vdash$

$\_xxx0q_4x \vdash$

$\_xxx0xq_4\_ \vdash$

$\_xxx0x\_q_{reject}\vdash$