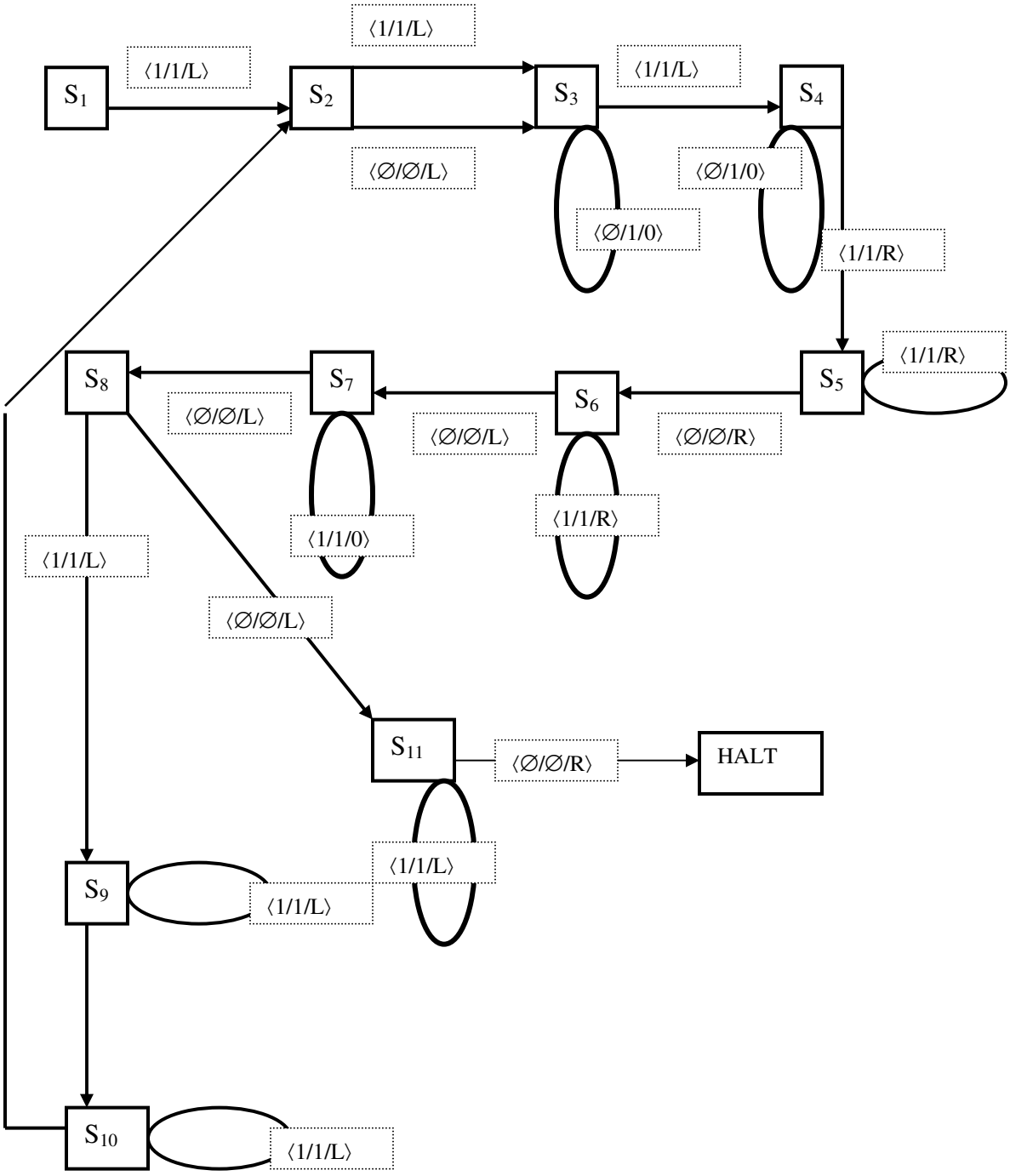
Assignment 4 Key **PHIL280** William Kallfelz, grader

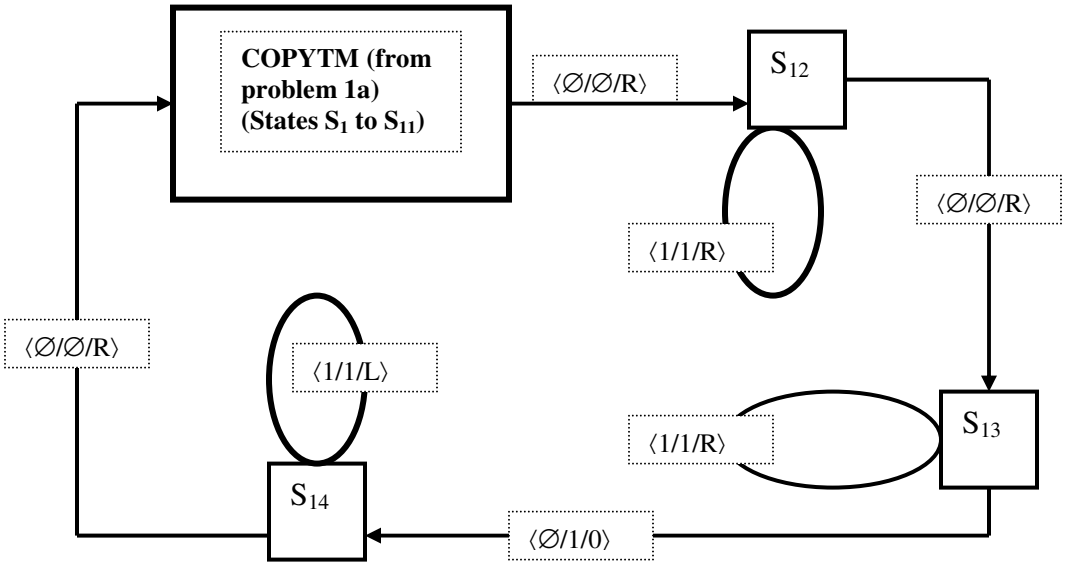
1(a) Detailed Description of a Copying TM[1]:

(Note: "0" means "move neither Left nor Right," while "∅" refers to the zero on the tape)



[1] Revised from Boolos, et. al (2002) *Computability and Logic*, Cambridge: Cambridge U Press, p.28

1(b) Detailed Description of an Enumerating TM:



- **The loop at S_{12} moves the cursor away from standard position (leftmost 1 of the first block of *n* "1"s) to the rightmost "1" of the first block of *n* "1"s:**

  1 … 1 ∅ 1 … 1
  $\Delta_{Begin} \rightarrow \Delta_{End}$

- **Going from S_{12} to S_{13} means hopping across the ∅ between the two blocks of *n* "1"s:**

  1 … 1 ∅ 1 … 1
  $\Delta_{Begin} \rightarrow \Delta_{End}$

- **The loop at S_{13} carries the cursor to the rightmost "1" in the second block of *n* "1"s:**

  1 … 1 ∅ 1 … 1
  $\Delta_{Begin} \rightarrow \Delta_{End}$

- **Going from S_{13} to S_{14} means adding an additional "1" to this string, to create a block of (*n* + 1) "1"s:**

  1 … 1 ∅ 1 … 1 1
  $\Delta_{Begin} \rightarrow \Delta_{End}$

- **The loop at S_{14} carries the cursor back to the leftmost "1" in the second block of $(n + 1)$ "1"s:**

  1 … 1 ∅ 1 … 1 1

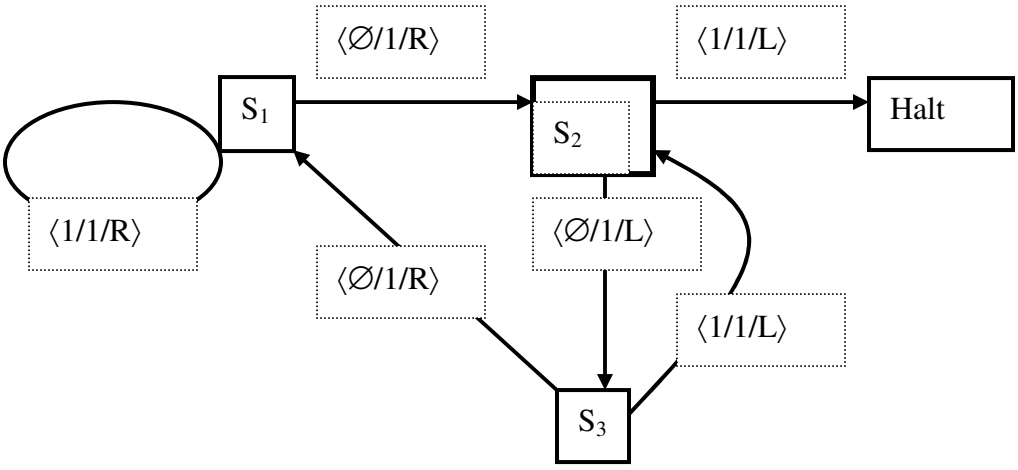
  Δ_{End} ← ← Δ_{Begin}

- **Going from S_{14} back to COPYTM means COPYTM will now copy this block of $(n + 1)$ "1"s, etc:**

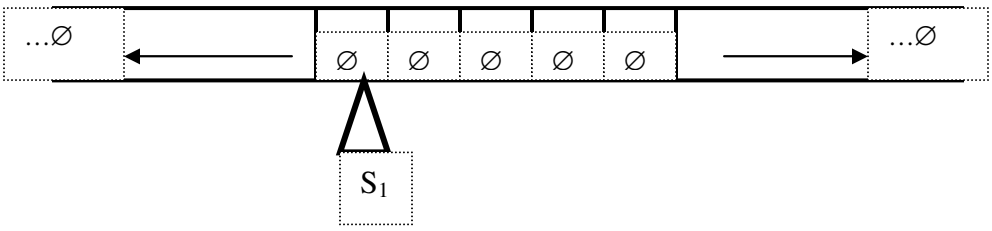
  1 … 1 ∅ 1 … 1 1

  $\Delta_{Start\ COPYTM}$

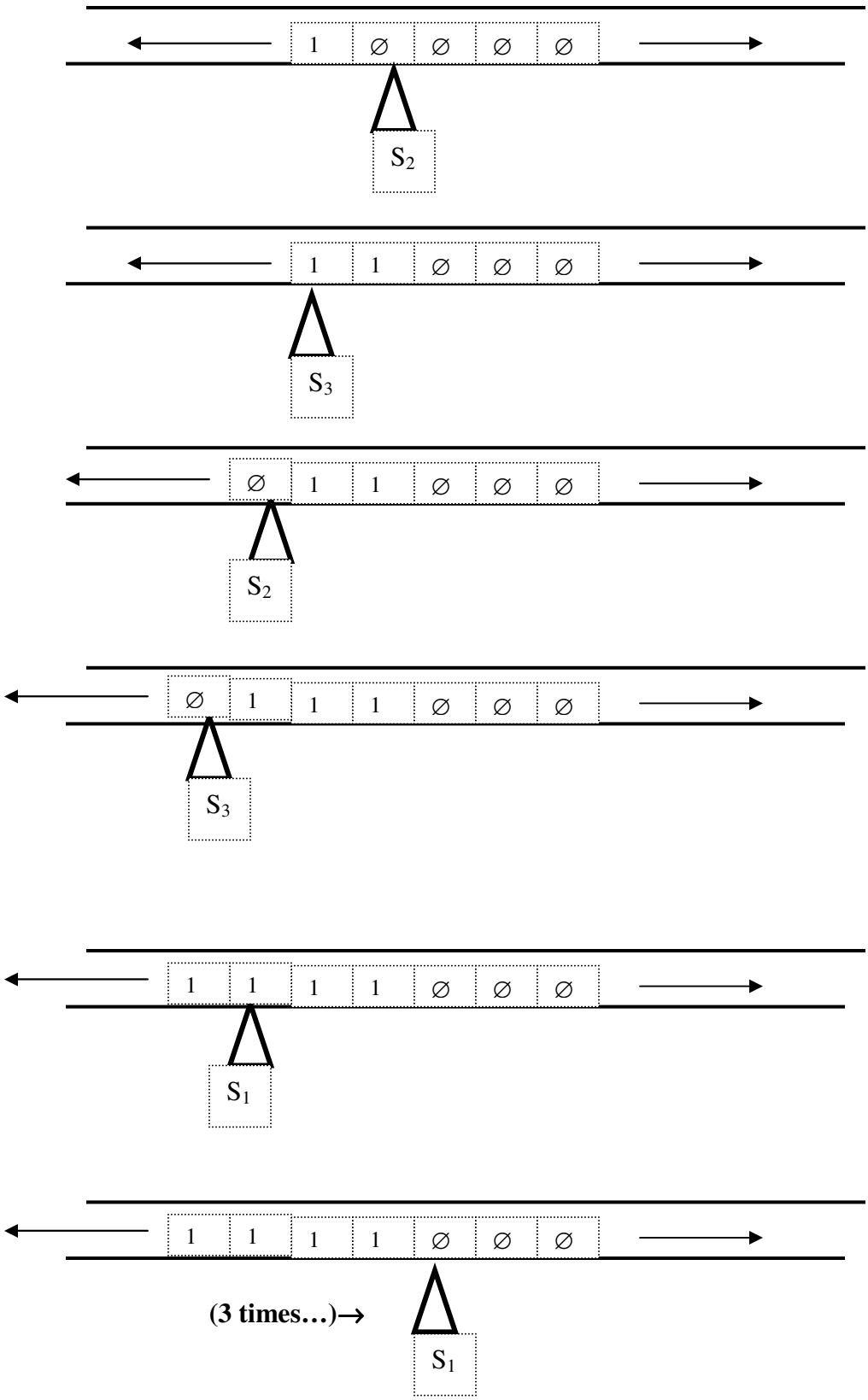
2. Detailed description of a 3-state BBTM[2]

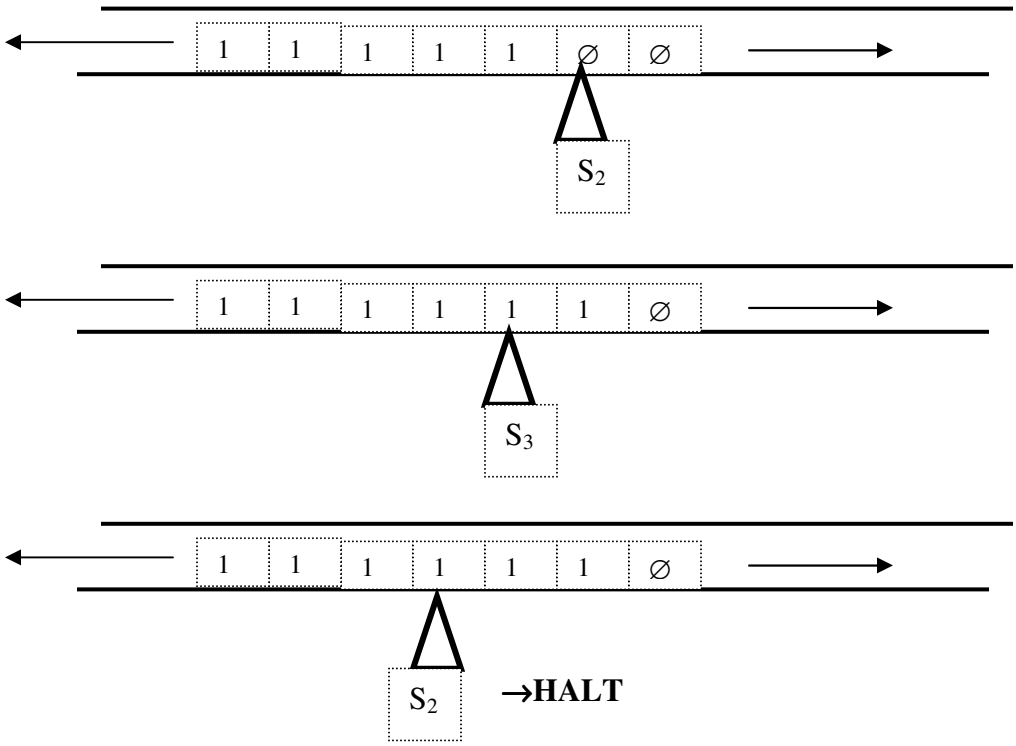


Example Run:



[2] From James L Hein (2002), *Discrete Structures, Logic, and Computability*, Boston: Jones & Bartlett, p. 911


1 ∅ ∅ ∅ ∅
S2
1 1 ∅ ∅ ∅
S3
∅ 1 1 ∅ ∅ ∅
S2
∅ 1 1 1 ∅ ∅ ∅
S3
1 1 1 1 ∅ ∅ ∅
S1
1 1 1 1 ∅ ∅ ∅
(3 times…)→
S1


1 1 1 1 1 ∅ ∅
S2
1 1 1 1 1 1 ∅
S3
1 1 1 1 1 1 ∅
S2
→HALT