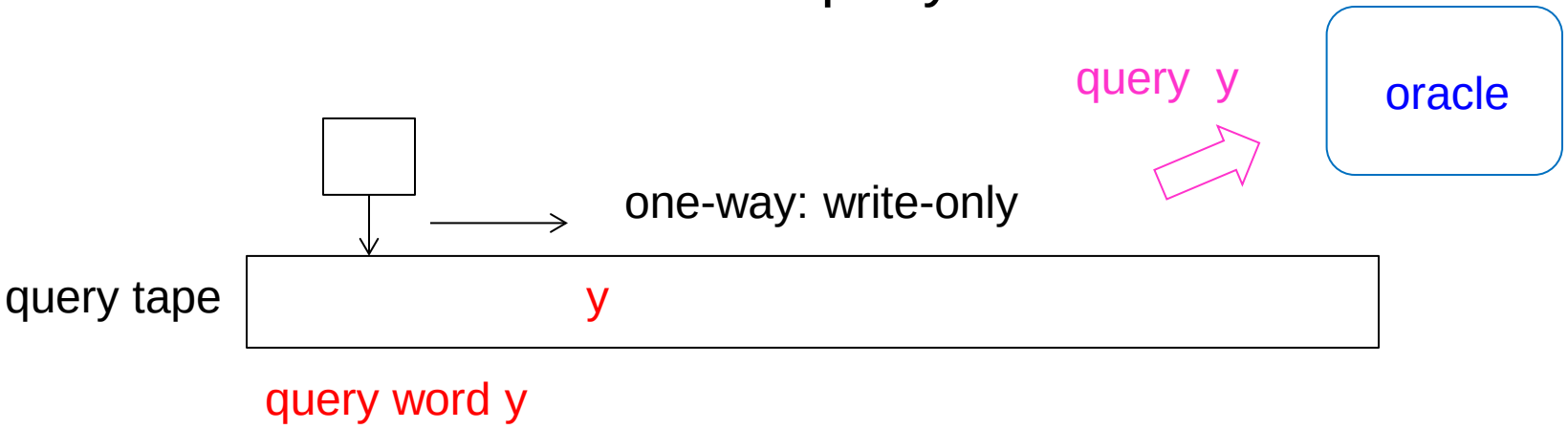
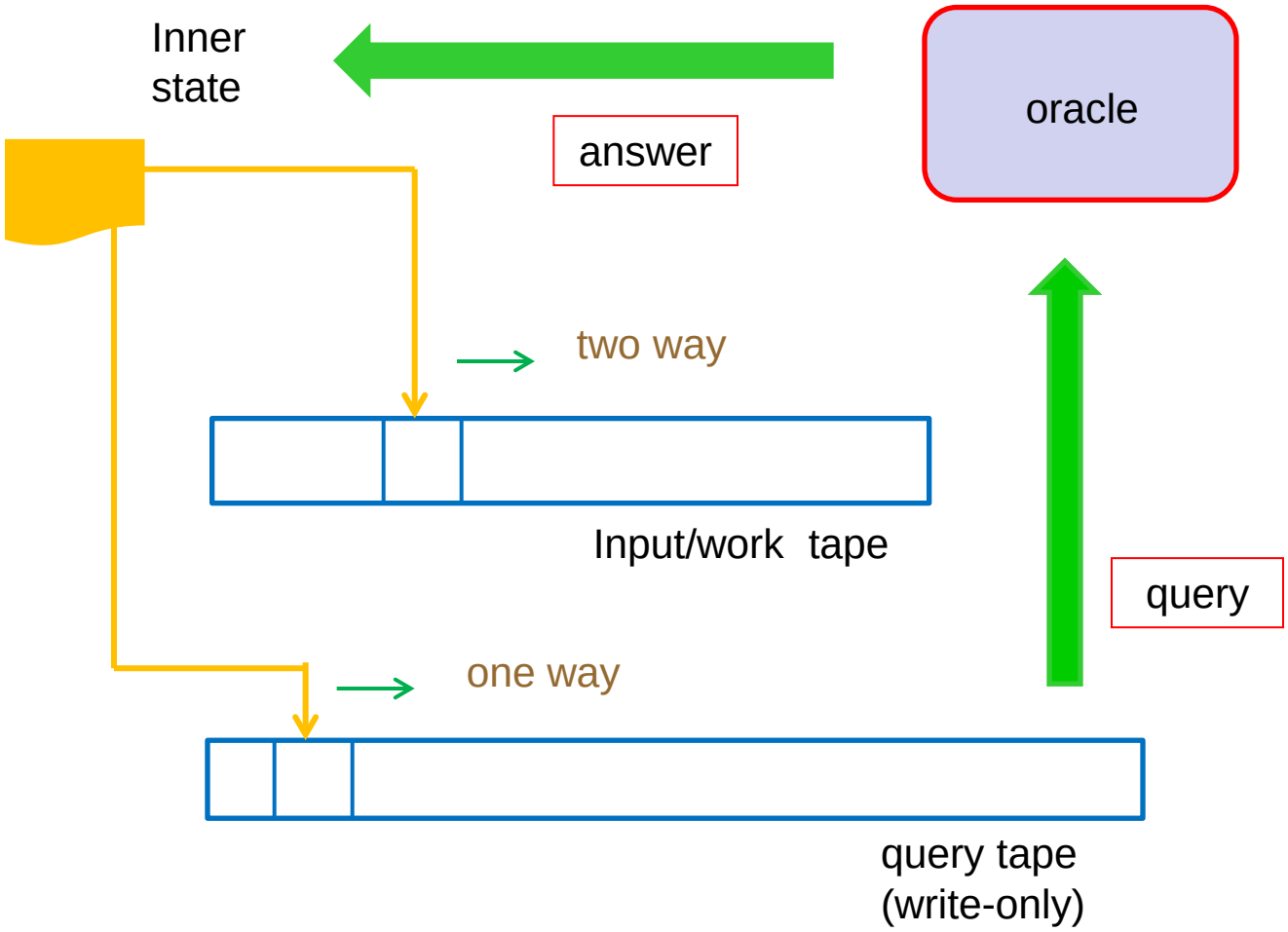
Oracle Turing Machines I (revisited)

- An oracle is an external information source, which can provide an underlying machine with necessary information via a process of query and answer.

- An oracle Turing machine (OTM) is equipped with an extra one-way write-only tape, called a query tape, by which the machine make a query to an oracle.



Oracle Turing Machines II (revisited)



Oracle Computation I

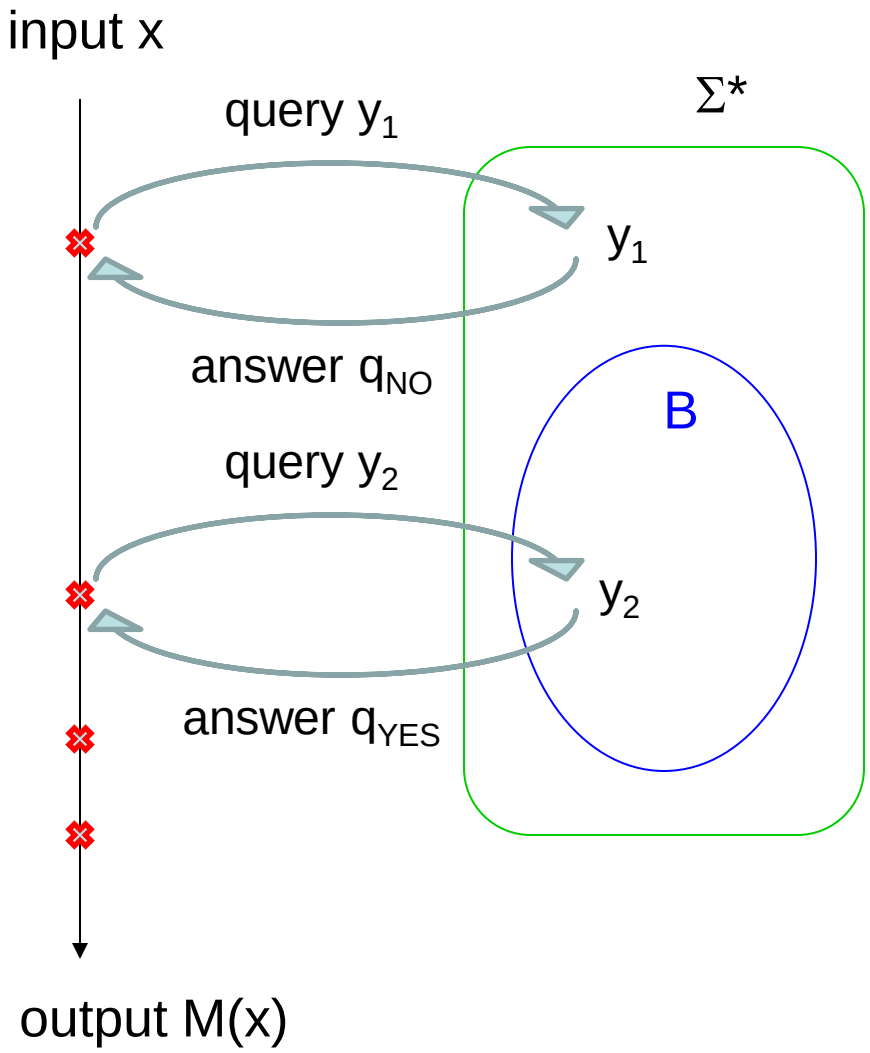
- Let M be an oracle Turing machine (OTM).
- Let x be any string in Σ^*.
- Let B be an oracle (which is now a language).

1. M starts with input x.
2. Whenever M writes a query word y on its query tape and enters a query state q_{query}, y is automatically sent to oracle B.
3. The oracle B returns its answer (YES/NO) by changing M's inner state from q_{query} to either q_{yes} or q_{no}, depending on whether $y \in B$ or $y \notin B$, respectively.
4. M resumes its computation, starting with q_{yes} or q_{no}.
5. If M halts, output M(x). Otherwise, go to Step 2.

Oracle Computation II (revisited)

- M: OTM, B: oracle

1. M starts with input x.
2. Whenever M writes a query word y on its query tape and enters a query state q_{query}, y is automatically sent to B.
3. The oracle B returns its answer (YES/NO) by changing M's inner state from q_{query}, to either q_{yes} or q_{no}.
4. M resumes its computation, starting with q_{yes} or q_{no}.
5. If M halts, output M(x). Otherwise, go to Step 2.



Languages Recognized by OTMs

- Let M be an OTM.
- Let B be an oracle (which is a language).

- We define a language recognized by M relative to B.

  $L(M,B) = \{ x \in \Sigma^* \mid M^B \text{ accepts } x \text{ with oracle } B \}$.

- Note that L(M,B) is depending on the choice of oracle B.
- If we choose a different oracle, say, C, then L(M,C) may be different from L(M,B).