ĐẠI HỌC KHOA HỌC TỰ NHIÊN, ĐẠI HỌC QUỐC GIA TP.HCM
KHOA CÔNG NGHỆ THÔNG TIN
BỘ MÔN KHOA HỌC MÁY TÍNH

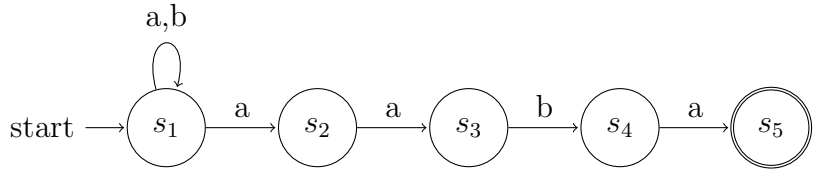
AUTOMATA VÀ NGÔN NGỮ HÌNH THỨC

BÀI TẬP CHƯƠNG 2 - PHẦN 2

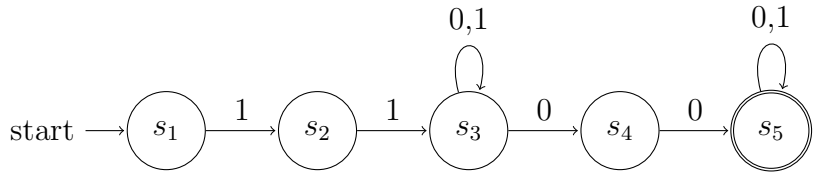
Sinh viên thực hiện: Nguyễn Thế Hoàng (MSSV: 2012 0090)
Giáo viên phụ trách: Nguyễn Thanh Phương - Lê Ngọc Thành

BÀI TẬP MÔN HỌC - AUTOMATA VÀ NGÔN NGỮ HÌNH THỨC
HỌC KỲ II - NĂM HỌC 2022 - 2023

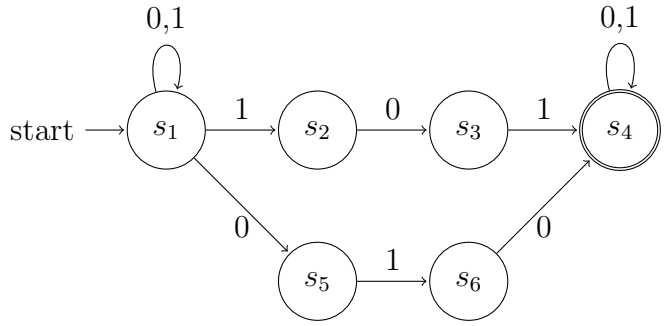
Bài 2 a. $\mathcal{L} = \{xaaba : x \in \{a, b\}^*\}$



b. $\mathcal{L} = \{11x00y : x, y \in \{0, 1\}^*\}$



c. $\mathcal{L} = \{w \in \{0, 1\}^* : 101 \in w \wedge 010 \in w\}$



Bài 3 a. Ban đầu DFA chỉ chứa trạng thái bắt đầu s_1

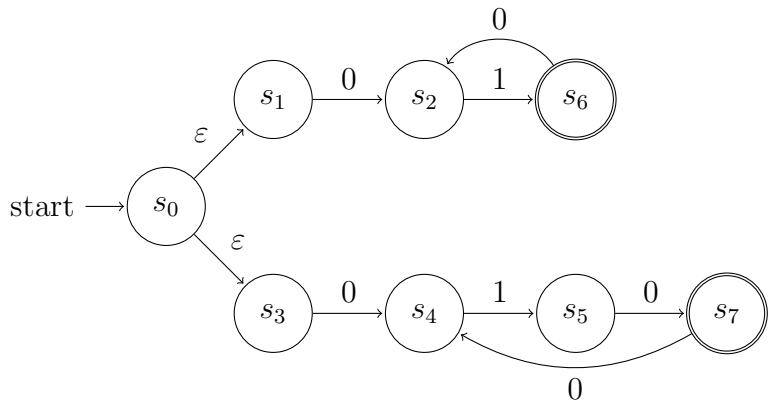
* $\delta_D(\{s_1\}, a) = \delta_N(s_1, a) = \{s_1, s_2\}$ -
* $\delta_D(\{s_1\}, b) = \delta_N(s_1, b) = \{s_1\}$
* $\delta_D(\{s_1, s_2\}, a) = \delta_N(s_1, a) \cup \delta_N(s_2, a) = \{s_1, s_2, s_3\}$ -
* $\delta_D(\{s_1, s_2\}, b) = \delta_N(s_1, b) \cup \delta_N(s_2, b) = \{s_1\}$
* $\delta_D(\{s_1, s_2, s_3\}, a) = \delta_N(s_1, a) \cup \delta_N(s_2, a) \cup \delta_N(s_3, a) = \{s_1, s_2, s_3\}$
* $\delta_D(\{s_1, s_2, s_3\}, b) = \delta_N(s_1, b) \cup \delta_N(s_2, b) \cup \delta_N(s_3, b) = \{s_1, s_4\}$ -
* $\delta_D(\{s_1, s_4\}, a) = \delta_N(s_1, a) \cup \delta_N(s_4, a) = \{s_1, s_2, s_5\}$ *
* $\delta_D(\{s_1, s_4\}, b) = \delta_N(s_1, b) \cup \delta_N(s_4, b) = \{s_1\}$
* $\delta_D(\{s_1, s_2, s_5\}, a) = \delta_N(s_1, a) \cup \delta_N(s_2, a) \cup \delta_N(s_5, a) = \{s_1, s_2, s_3\}$
* $\delta_D(\{s_1, s_2, s_5\}, b) = \delta_N(s_1, b) \cup \delta_N(s_2, b) \cup \delta_N(s_5, b) = \{s_1\}$

b. Ban đầu DFA chỉ chứa trạng thái bắt đầu s_1

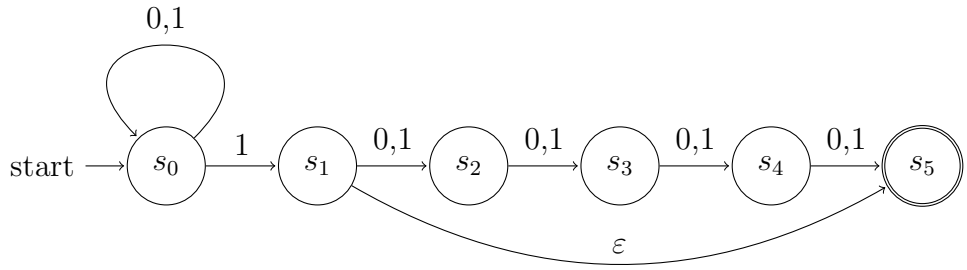
* $\delta_D(\{s_1\}, 1) = \delta_N(s_1, 1) = \{s_2\}$ -
* $\delta_D(\{s_1\}, 0) = \delta_N(s_1, 0) = \{\}$
* $\delta_D(\{s_2\}, 0) = \delta_N(s_2, 0) = \{\}$
* $\delta_D(\{s_2\}, 1) = \delta_N(s_2, 1) = \{s_3\}$ -
* $\delta_D(\{s_3\}, 0) = \delta_N(s_3, 0) = \{s_3, s_4\}$ -
* $\delta_D(\{s_3\}, 1) = \delta_N(s_3, 1) = \{s_3\}$
* $\delta_D(\{s_3, s_4\}, 0) = \delta_N(s_3, 0) \cup \delta_N(s_4, 0) = \{s_3, s_4, s_5\}$ *
* $\delta_D(\{s_3, s_4\}, 1) = \delta_N(s_3, 1) \cup \delta_N(s_4, 1) = \{s_3\}$
* $\delta_D(\{s_3, s_4, s_5\}, 0) = \delta_N(s_3, 0) \cup \delta_N(s_4, 0) \cup \delta_N(s_5, 0) = \{s_3, s_4, s_5\}$ *

* $\delta_D(\{s_3, s_4, s_5\}, 1) = \delta_N(s_3, 1) \cup \delta_N(s_4, 1) \cup \delta_N(s_5, 1) = \{s_3, s_5\}$ *
* $\delta_D(\{s_3, s_5\}, 0) = \delta_N(s_3, 0) \cup \delta_N(s_5, 0) = \{s_3, s_4, s_5\}$ *
* $\delta_D(\{s_3, s_5\}, 1) = \delta_N(s_3, 1) \cup \delta_N(s_5, 1) = \{s_3, s_5\}$ *

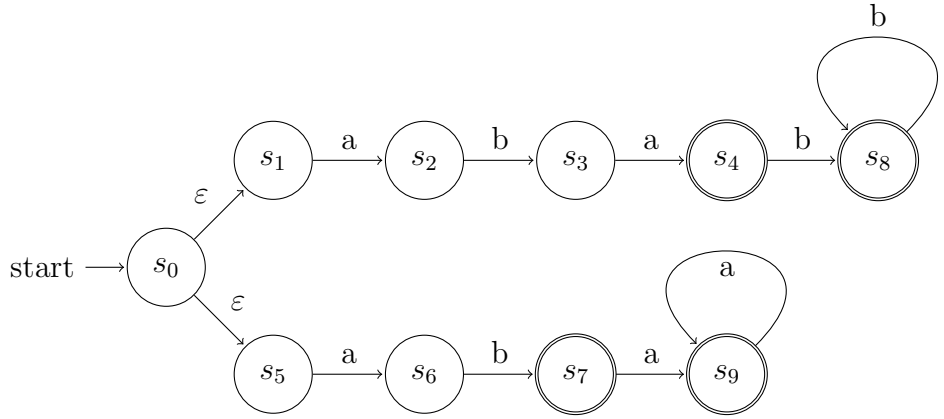
Bài 4 a. $\mathcal{L} = \{(01)^n \vee (010)^m : n, m \in \mathbb{Z}^+\}$



d. $\mathcal{L} = \{x1y : x, y \in \{0, 1\}^* \wedge |y| = 4\}$



f. $\mathcal{L} = \{abab^n \vee aba^n : n \in \mathbb{N}\}$



Bài 5 a. Ban đầu εCLOSE(s_0) $= \{s_0, s_1, s_3\}$. Các hàm chuyển từ trạng thái DFA chỉ chứa một trạng thái từ NFA mà có kết quả là rỗng sẽ được lược bỏ trong các bước dưới đây.

* $\delta_D(\{s_0, s_1, s_3\}, 0) =$
  εCLOSE($\delta_N(s_0, 0) \cup \delta_N(s_1, 0) \cup \delta_N(s_3, 0)$) $= \varepsilon$CLOSE($\{s_2, s_4\}$) $= \{s_2, s_4\}$
  -
* $\delta_D(\{s_0, s_1, s_3\}, 1) =$
  εCLOSE($\delta_N(s_0, 1) \cup \delta_N(s_1, 1) \cup \delta_N(s_3, 1)$) $= \varepsilon$CLOSE($\{\}$) $= \{\}$

* $\delta_D(\{s_2, s_4\}, 0) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_2, 0) \cup \delta_N(s_4, 0)\ ) = \varepsilon\text{CLOSE}\,(\ \{\}\ ) = \{\}$
* $\delta_D(\{s_2, s_4\}, 1) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_2, 1) \cup \delta_N(s_4, 1)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_6, s_5\}\ ) = \{s_6, s_5\}$ *
* $\delta_D(\{s_5, s_6\}, 0) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_5, 0) \cup \delta_N(s_6, 0)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_7, s_2\}\ ) = \{s_2, s_7\}$ *
* $\delta_D(\{s_5, s_6\}, 1) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_5, 1) \cup \delta_N(s_6, 1)\ ) = \varepsilon\text{CLOSE}\,(\ \{\}\ ) = \{\}$
* $\delta_D(\{s_2, s_7\}, 0) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_2, 0) \cup \delta_N(s_7, 0)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_4\}\ ) = \{s_4\}$ -
* $\delta_D(\{s_2, s_7\}, 1) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_2, 1) \cup \delta_N(s_7, 1)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_6\}\ ) = \{s_6\}$ *
* $\delta_D(\{s_4\}, 1) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_4, 1)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_5\}\ ) = \{s_5\}$ -
* $\delta_D(\{s_6\}, 0) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_6, 0)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_2\}\ ) = \{s_2\}$ -
* $\delta_D(\{s_5\}, 0) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_5, 0)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_7\}\ ) = \{s_7\}$ *
* $\delta_D(\{s_2\}, 1) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_2, 1)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_6\}\ ) = \{s_6\}$ *
* $\delta_D(\{s_7\}, 0) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_7, 0)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_4\}\ ) = \{s_4\}$

Bài 6 a. Ban đầu $\varepsilon\text{CLOSE}\,(\ s_0\ ) = \{s_0, s_1, s_2\}$. Các hàm chuyển từ trạng thái DFA chỉ chứa một trạng thái từ NFA mà có kết quả là rỗng sẽ được lược bỏ trong các bước dưới đây. Do sự đồng bộ các kí hiệu trạng thái trong suốt văn bản này và việc điều chỉnh lại kí hiệu trong hàm định nghĩa mới của Latex sẽ rất cồng kềnh nên mọi trạng thái trong Bài 6 này sẽ được chuyển từ q_i thành s_i, mà không mất tính tổng quát.

* $\delta_D(\{s_0, s_1, s_2\}, a) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, a) \cup \delta_N(s_1, a) \cup \delta_N(s_2, a)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_0, s_1\}\ ) = \{s_0, s_1, s_2\}$
* $\delta_D(\{s_0, s_1, s_2\}, b) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, b) \cup \delta_N(s_1, b) \cup \delta_N(s_2, b)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_0, s_2, s_3\}\ ) =$
  $\{s_0, s_1, s_2, s_3\}$ -
* $\delta_D(\{s_0, s_1, s_2, s_3\}, a) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, a) \cup \delta_N(s_1, a) \cup \delta_N(s_2, a) \cup \delta_N(s_3, a)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_0, s_1, s_4\}\ ) =$
  $\{s_0, s_1, s_2, s_4\}$ *
* $\delta_D(\{s_0, s_1, s_2, s_3\}, b) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, b) \cup \delta_N(s_1, b) \cup \delta_N(s_2, b) \cup \delta_N(s_3, b)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_0, s_2, s_3\}\ ) =$
  $\{s_0, s_1, s_2, s_3\}$
* $\delta_D(\{s_0, s_1, s_2, s_4\}, a) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, a) \cup \delta_N(s_1, a) \cup \delta_N(s_2, a) \cup \delta_N(s_4, a)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_0, s_1\}\ ) =$
  $\{s_0, s_1, s_2\}$
* $\delta_D(\{s_0, s_1, s_2, s_4\}, b) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, b) \cup \delta_N(s_1, b) \cup \delta_N(s_2, b) \cup \delta_N(s_4, b)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_0, s_2, s_3\}\ ) =$
  $\{s_0, s_1, s_2, s_3\}$

b. Ban đầu $\varepsilon\text{CLOSE}(\ s_0\ ) = \{s_0\}$.

* $\delta_D(\{s_0\}, 0) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 0)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_1\}\ ) = \{s_0, s_1, s_2\}$ *
* $\delta_D(\{s_0\}, 1) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 1)\ ) = \varepsilon\text{CLOSE}(\ \{s_0\}\ ) = \{s_0\}$
* $\delta_D(\{s_0, s_1, s_2\}, 0) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 0) \cup \delta_N(s_1, 0) \cup \delta_N(s_2, 0)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_1, s_3\}\ ) =$
  $\{s_0, s_1, s_2, s_3\}$ *
* $\delta_D(\{s_0, s_1, s_2\}, 1) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 1) \cup \delta_N(s_1, 1) \cup \delta_N(s_2, 1)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_2\}\ ) = \{s_0, s_2\}$
  *
* $\delta_D(\{s_0, s_1, s_2, s_3\}, 0) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 0) \cup \delta_N(s_1, 0) \cup \delta_N(s_2, 0) \cup \delta_N(s_3, 0)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_1, s_3\}\ ) =$
  $\{s_0, s_1, s_2, s_3\}$ *
* $\delta_D(\{s_0, s_1, s_2, s_3\}, 1) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 1) \cup \delta_N(s_1, 1) \cup \delta_N(s_2, 1) \cup \delta_N(s_3, 1)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_2\}\ ) =$
  $\{s_0, s_2\}$ *
* $\delta_D(\{s_0, s_2\}, 0) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 0) \cup \delta_N(s_2, 0)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_1, s_3\}\ ) = \{s_0, s_1, s_2, s_3\}$
  *
* $\delta_D(\{s_0, s_2\}, 1) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, 1) \cup \delta_N(s_2, 1)\ ) = \varepsilon\text{CLOSE}(\ \{s_0\}\ ) = \{s_0\}$

c. Ban đầu $\varepsilon\text{CLOSE}(\ s_0\ ) = \{s_0\}$.

* $\delta_D(\{s_0\}, a) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, a)\ ) = \varepsilon\text{CLOSE}(\ \{s_0\}\ ) = \{s_0\}$
* $\delta_D(\{s_0\}, b) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, b)\ ) = \varepsilon\text{CLOSE}(\ \{s_1\}\ ) = \{s_0, s_1\}$ -
* $\delta_D(\{s_0\}, c) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, c)\ ) = \varepsilon\text{CLOSE}(\ \{s_2\}\ ) = \{s_2, s_1, s_0\}$ *
* $\delta_D(\{s_0, s_1\}, a) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, a) \cup \delta_N(s_1, a)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_1\}\ ) = \{s_0, s_1\}$
* $\delta_D(\{s_0, s_1\}, b) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, b) \cup \delta_N(s_1, b)\ ) = \varepsilon\text{CLOSE}(\ \{s_1, s_2\}\ ) = \{s_0, s_1, s_2\}$ *
* $\delta_D(\{s_0, s_1\}, c) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, c) \cup \delta_N(s_1, c)\ ) = \varepsilon\text{CLOSE}(\ \{s_2\}\ ) = \{s_2, s_1, s_0\}$ *
* $\delta_D(\{s_0, s_1, s_2\}, a) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, a) \cup \delta_N(s_1, a) \cup \delta_N(s_2, a)\ ) = \varepsilon\text{CLOSE}(\ \{s_0, s_1, s_2\}\ ) =$
  $\{s_0, s_1, s_2\}$ *
* $\delta_D(\{s_0, s_1, s_2\}, b) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, b) \cup \delta_N(s_1, b) \cup \delta_N(s_2, b)\ ) = \varepsilon\text{CLOSE}(\ \{s_1, s_2\}\ ) = \{s_0, s_1, s_2\}$
  *
* $\delta_D(\{s_0, s_1, s_2\}, c) =$
  $\varepsilon\text{CLOSE}(\ \delta_N(s_0, c) \cup \delta_N(s_1, c) \cup \delta_N(s_2, c)\ ) = \varepsilon\text{CLOSE}(\ \{s_2, s_0\}\ ) = \{s_0, s_1, s_2\}$
  *

d. Ban đầu $\varepsilon\text{CLOSE}(\ s_0\ ) = \{s_0, s_2\}^*$.

* $\delta_D(\{s_0, s_2\}, a) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, a) \cup \delta_N(s_2, a)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_1\}\ ) = \{s_1\}$ -
* $\delta_D(\{s_0, s_2\}, b) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_0, b) \cup \delta_N(s_2, b)\ ) = \varepsilon\text{CLOSE}\,(\ \{\}\ ) = \{\}$
* $\delta_D(\{s_1\}, a) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_1, a)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_2\}\ ) = \{s_2\}$ *
* $\delta_D(\{s_1\}, b) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_1, b)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_1, s_2\}\ ) = \{s_1, s_2\}$ *
* $\delta_D(\{s_2\}, a) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_2, a)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_0\}\ ) = \{s_0, s_2\}$ *
* $\delta_D(\{s_2\}, b) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_2, b)\ ) = \varepsilon\text{CLOSE}\,(\ \{\}\ ) = \{\}$
* $\delta_D(\{s_1, s_2\}, a) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_1, a) \cup \delta_N(s_2, a)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_2, s_0\}\ ) = \{s_0, s_2\}$ *
* $\delta_D(\{s_1, s_2\}, b) =$
  $\varepsilon\text{CLOSE}\,(\ \delta_N(s_1, b) \cup \delta_N(s_2, b)\ ) = \varepsilon\text{CLOSE}\,(\ \{s_2\}\ ) = \{s_2\}$ *