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1. $\overline{S_1} = \{1, \cancel{4}, 6, \cancel{8}, \cancel{9}, 10\}$

$S_2 = \{2, 4, 5, 8, 9\}$

$\overline{S_1} \cup S_2 = \{1, 2, 4, 5, 8, 9, 10\}$

2. $S_1 = \{2, 3, 5, 7\}$

$S_2 = \{2, 4, 5, 8, 9\}$

$S_1 \times S_2 =$

$\{(2,2)(2,4)(2,5)(2,8)(2,9),$
$(3,2)(3,4)(3,5)(3,8)(3,9),$
$(5,2)(5,4)(5,5)(5,8)(5,9),$
$(7,2)(7,4)(7,5)(7,8)(7,9)\}$

3. $S_1 = \{1, 2\}$ $S_2 = \{2, 1\}$
$U = \{1; 4\}$

$S_1 \subseteq S_2$

$\overline{S_1} = \{3, 4\}$ $\overline{S_2} = \{3, 4\}$

$\overline{S_2} \subseteq \overline{S_1}$

4. ww^Rw, $w = aabbab$
$w^R = babbaa$

$ww^Rw = aabbabbabbaaaabbab$

There are two substrings of 'aab' in the above. underlined with ___

Notes: $|\Sigma|$ = Number of symbols in an alphabet
n = length of string
$|\Sigma|^n$ = number of strings @ length 'n' possible w/ alphabet Σ

$L^* = \varepsilon L^+$
$\Sigma = \{g\}$ g^*
$\{\varepsilon, g, gg, ggg, gggg \dots\}$

g^+
$\{g, gg, ggg, gggg \dots\}$

Σ^* = power set. Every possible string.
$L \subset \Sigma^*$
$*$ includes ε (empty set)

5. $\overline{L^*}$ → L^* includes ε
so its complement would not include ε.
$(\overline{L})$ → L may or may not include ε
so its complement may or may not include ε. But when you add the $*$ on the outside → $(\overline{L})^*$, this will now definitely include ε.

Therefore:
$\overline{L^*} \neq (\overline{L})^*$ in any scenario.

Notes: Grammars = G
$G = (V, T, S, P)$

V = Finite set of objects called variables (uppercase letters)
T = Finite set of objects called terminal symbols (lowercase) Σ
S = Start Symbol ($S \in V$)
P = Production rules; specify how the grammar transforms one string to another.

Disjoint sets = no elements in common. Intersection of 2 disjoint sets is ε

sets V & T are non-empty and disjoint.

$\lambda = \varepsilon$ = empty string

$S \to aSb$ $S \to aSb \to ab$
$S \to \lambda$ $S \to aSb \to aaSbb \to$
$aaaSbbb$

All strings that start with a and end with b.

$\Sigma = \{a, b\}$ $S \to aAb$
$S \to aaAb \to aabAb$
$\downarrow$
$aabbAb$

$S \to aAb$
$A \to aA \mid bA \mid \lambda$

All strings with at least 3 a's.
$\Sigma \{a, b\}$

$S \to AaAaAaA$
$A \to aA \mid Ab \mid \lambda$

6. $\Sigma = \{a, b\}$

$G = (\{S, A\}, (a, b), S, P\}$

(a) P =
$S \to AaAaA$
$A \to bA \mid \lambda$

(b) P =
$S = AaAaA$
$A = aA \mid bA \mid \lambda$

(c) P =
$S \to bS \mid aA \mid \lambda$
$A \to bA \mid aB \mid \lambda$
$B \to bB \mid aC \mid \lambda$
$C \to bC \mid \lambda$

7. $S \to aaA \mid \lambda$
$A \to bS$

$aaA \to aabS \to aabaaA \to aabaabS$
$\to \cancel{aabaab}$

Every string in the language will be 2 a's followed by a b of various different lengths, or it could go on forever.

$L = \{\lambda,$
$aab,$
$aabaab,$
$aabaabaab,$
$aabaabaabaab \dots\}$