# Formal Languages and Compilers
# Lab IV: Top-Down and Bottom-Up Parsers

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Formal Languages and Compilers — BSc course

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# Top-Down Parser

Given the following grammar with terminals $VT = \{\textbf{type}, \textbf{ID}, :, \textbf{INT}, \textbf{REAL}, (, )\}$ and TL is the scope of the language:

PROG

$$
\begin{aligned}
\texttt{Prog} &\rightarrow \texttt{TL} \\
\texttt{TL} &\rightarrow \texttt{T TL} \mid \epsilon \\
\texttt{T} &\rightarrow \textbf{type ID} : \texttt{D} \\
\texttt{D} &\rightarrow \textbf{REAL} \mid \textbf{INT} \mid (\texttt{DL}) \\
\texttt{DL} &\rightarrow \texttt{D DL} \mid \epsilon
\end{aligned}
$$

Construct the Top-Down Parser.

FIRST (Prog) = {ε, type}
FIRST (TL) = {ε, type}
FIRST (T) = {type}
FIRST (D) = {REAL, INT, (}
FIRST (DL) = {ε, REAL, INT, (}

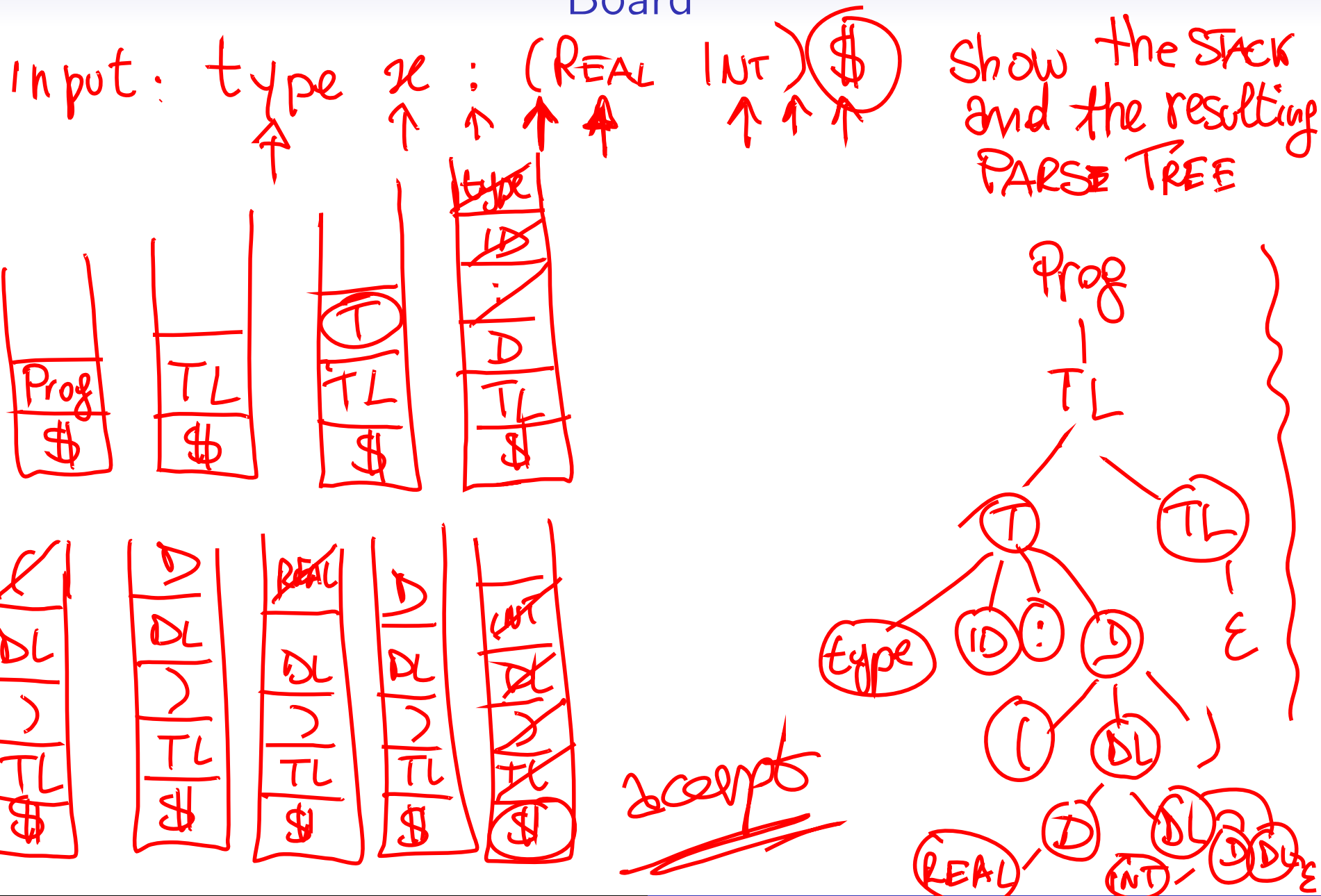
FOLLOW (Prog) = {$}
FOLLOW (TL) = {$}
FOLLOW (T) = {type, $}
FOLLOW (D) = {type, $, REAL, INT, (, )}
FOLLOW (DL) = {)}

# Predictive Parsing Table

Board

| | type | ID | : | INT | REAL | ( | ) | $ |
|---|---|---|---|---|---|---|---|---|
| Prog | Prog → TL | | | | | | | Prog → TL |
| TL | TL → T TL | | | | | | | TL → ε |
| T | T → type ... | | | | | | | |
| D | | | | D → INT | D → REAL | D → (DL) | | |
| DL | | | | DL → D DL | DL → D DL | DL → D DL | DL → ε | |

# Board


input: type x : (REAL INT) $
Show the STACK and the resulting PARSE TREE
Prog
TL
T
TL
$
type
ID
:
D
TL
ε
(
DL
)
REAL
INT
accepts

# Board

$V_T = \{NUM, +, *, (, ), ,\}$

Scope: E
input: (+6,9)$

E → LE RE
RE → *E | ε
LE → NUM | (+ LS)
LS → NUM LSR
LSR → ,LS | ε

FIRST

FOLLOW

# Board

# Board

# Bottom-Up Parser

input: (num, id)$

Consider now the following grammar with terminals $VT = \{\mathbf{num}, \mathbf{id}, (, ), ,\}$:

$$
\begin{array}{rcl}
\texttt{S} & \rightarrow & \texttt{A} \mid \texttt{L} \\
\texttt{A} & \rightarrow & \mathbf{num} \mid \mathbf{id} \\
\texttt{L} & \rightarrow & (\ \texttt{LS}\ ) \\
\texttt{LS} & \rightarrow & \texttt{LS}\ ,\ \texttt{S} \mid \texttt{S}
\end{array}
$$

Construct the Bottom-Up Parser.

FIRST(S) = {num, id, (}
FIRST(A) = {num, id}
FIRST(L) = {(}
FIRST(LS) = {num, id, (}

FOLLOW(S) = {$, ), ,}
FOLLOW(A) = {$, ), ,}
FOLLOW(L) = {$, ), ,}
FOLLOW(LS) = {), ,}

# Canonical Collection Board

$I_0$ = $S' \to \cdot S$
$S \to \cdot A$
$S \to \cdot L$
$A \to \cdot num$
$A \to \cdot ID$
$L \to \cdot (LS)$

$I_2 = goto(I_0, A)$

FOLLOW(S) = {$, ), ,}
FOLLOW(A) = FOLLOW(S)

$I_1$ = $S' \to S \cdot$
$I_2$ = $S \to A \cdot$ (r1)
$I_3$ = $S \to L \cdot$ (r2)
$I_4$ = $A \to num \cdot$ (r3)
$I_5$ = $A \to ID \cdot$ (r4)

$I_6$
$L \to (\cdot LS)$
$LS \to \cdot LS, S$
$LS \to \cdot S$
$S \to \cdot A$
$S \to \cdot L$
$A \to \cdot num$
$A \to \cdot ID$
$L \to \cdot (LS)$

# Board

$I_7 = L \to (LS\bullet)$

$LS \to LS\bullet , S$

$I_8 = LS \to S\bullet$ (r7)

$I_9 = L \to (LS)\bullet$ (r5)

$I_{10} = LS \to LS , \bullet S$

$S \to \bullet A$

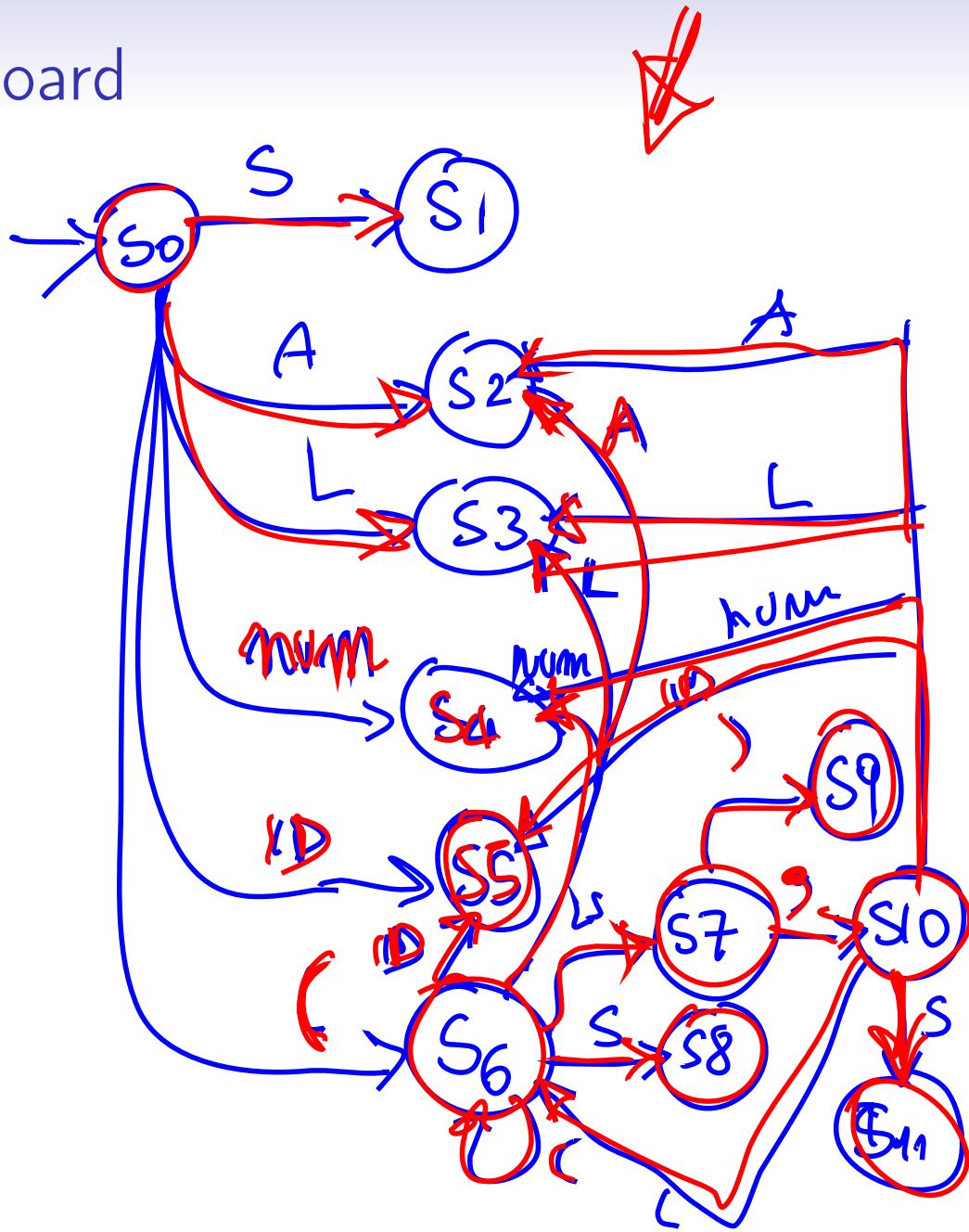
$S \to \bullet L$

$A \to \bullet num$

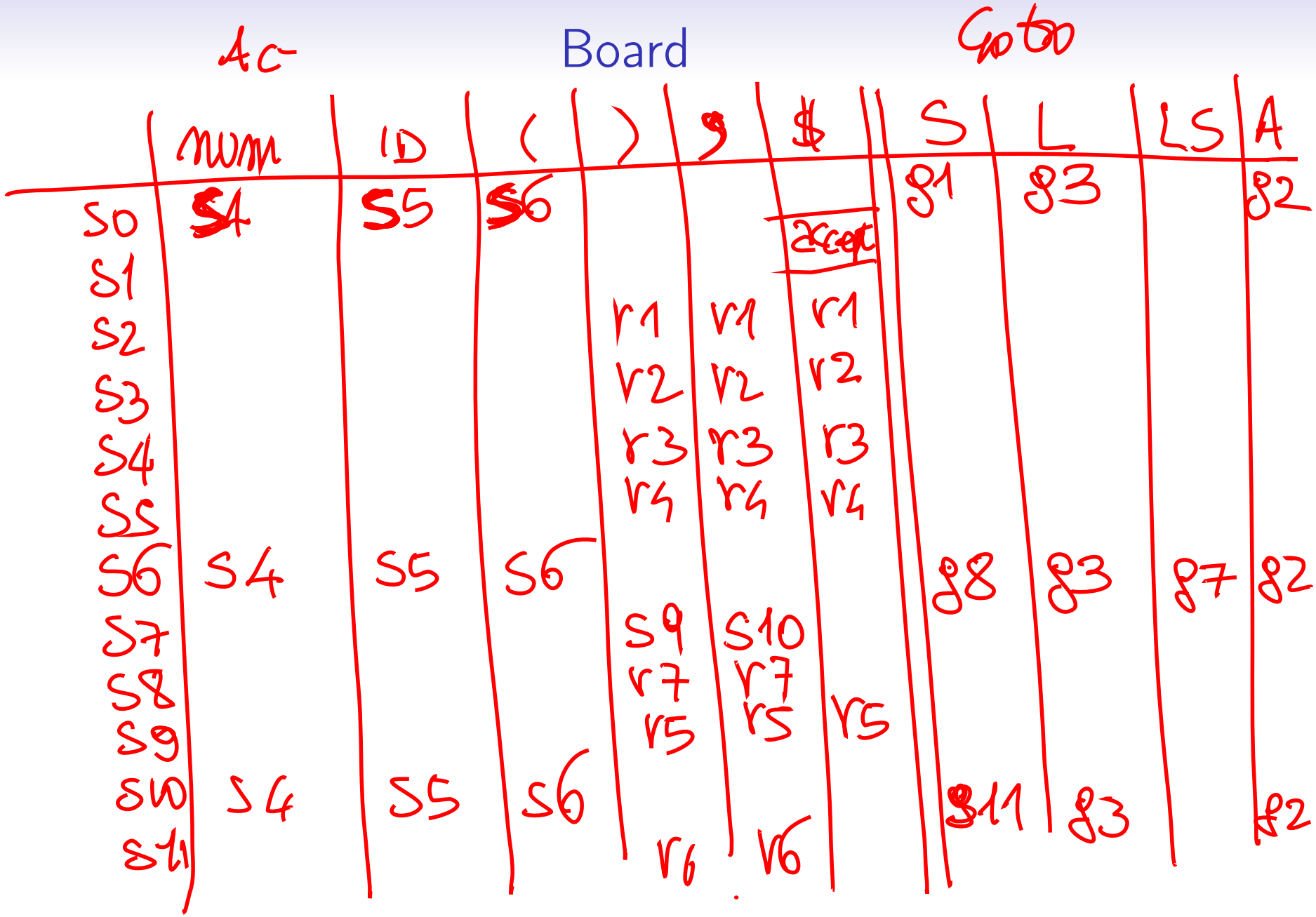
$A \to \bullet id$

$L \to \bullet (LS)$

$I_{11} = LS \to LS , S\bullet$



# Board


Ac-
Goto
num
ID
(
)
$
S
L
LS
A
S0
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S4
S5
S6
S4
S5
S6
S4
S5
S6
S1
S3
S2
S8
S3
S7
S2
S11
S3
S2
r1
r2
r3
r4
r7
r5
r6
S9
S10
r5
r6
r1
r2
r3
r4
r5
Accept

# Board

# Board

# Board