CCDSTRU Project Specifications
Term 2, AY 2025–2026
Due: Mar 30, 2026 (M) before 0800

Implement a computer program (either in C or Java) following the specifications of the system given below.

Applicable Sets

$\mathbf{C} : \{x \in \mathbf{Z}^+ \mid x < 4\}$ $\mathbf{M} : \mathbf{C} \times \mathbf{C}$

$\mathbf{N} : \{x \in \mathbf{Z}^+ \cup \{0\} \mid x <= 16\}$ $\mathbf{V} : \{\text{true}, \text{false}\}$

System Variables

$good \in \mathbf{V}$ $over \in \mathbf{V}$ $R, B, S, T, F \subseteq \mathbf{M}$

$go \in \mathbf{V}$ $found \in \mathbf{V}$

$start \in \mathbf{V}$ $val \in \mathbf{N}$

System Facts

$F = \mathbf{M} - (R \cup B)$

$over \leftrightarrow (|F| = 3 \vee val \geq 20 \vee \neg start \wedge (|R| > 0 \wedge |B| = 0 \vee |R| = 0 \wedge |B| > 0))$

System Initialization

$good = \text{false}$ $found = \text{false}$ $B = \varnothing$

$go = \text{true}$ $val = 0$ $S = \varnothing$

$start = \text{true}$ $R = \varnothing$ $T = \varnothing$

System States and Behavior

`Remove`$(pos \in \mathbf{M})$

$go \rightarrow (R = R - \{pos\})$

$\neg go \rightarrow (B = B - \{pos\})$

$S = S - \{pos\}$

$T = T - \{pos\}$

`Replace`$(pos \in \mathbf{M})$

$found = \text{false}$

$(go \wedge pos \in B) \rightarrow (B = B - \{pos\} \wedge found = \text{true})$

$(go \wedge pos \in R) \rightarrow found = \text{true}$

$(go \wedge pos \notin R) \rightarrow (R = R \cup \{pos\})$

$(\neg go \wedge pos \in R) \rightarrow (R = R - \{pos\} \wedge found = \text{true})$

$(\neg go \wedge pos \in B) \rightarrow found = \text{true}$

$(\neg go \wedge pos \notin B) \rightarrow (B = B \cup \{pos\})$

$(found \wedge pos \notin S) \rightarrow (S = S \cup \{pos\} \wedge found = \text{false})$

$(found \wedge pos \in S \wedge pos \notin T) \rightarrow (T = T \cup \{pos\} \wedge \texttt{Expand}(pos))$

$\texttt{Expand}(pos \in \mathbf{M})$

    $(a, b) = pos$

    $u, d, k, r \in \mathbf{M}$

    $u = (a - 1, b)$

    $d = (a + 1, b)$

    $k = (a, b - 1)$

    $r = (a, b + 1)$

    $\texttt{Remove}(pos)$

    $(go) \rightarrow \texttt{Replace}(u)$

    $(\neg go) \rightarrow \texttt{Replace}(d)$

    $\texttt{Replace}(k)$

    $\texttt{Replace}(r)$

$\texttt{Update}(pos \in \mathbf{M})$

    $good = \text{false}$

    $(pos \notin S) \rightarrow (S = S \cup \{pos\} \wedge good = \neg good)$

    $(\neg good \wedge pos \in S \wedge pos \notin T) \rightarrow (T = T \cup \{pos\} \wedge \texttt{Expand}(pos))$

$\texttt{NextPlayerMove}(pos \in \mathbf{M})$

    $(\neg over \wedge start \wedge go) \rightarrow (R = R \cup \{pos\} \wedge S = S \cup \{pos\} \wedge good = \text{true})$

    $(\neg over \wedge start \wedge \neg go) \rightarrow (B = B \cup \{pos\} \wedge S = S \cup \{pos\} \wedge good = \text{true})$

    $(\neg over \wedge \neg start \wedge (go \wedge pos \in R \vee \neg go \wedge pos \in B)) \rightarrow (\texttt{Update}(pos) \wedge good = \text{true})$

    $(start \wedge |R| = 1 \wedge |B| = 1) \rightarrow start = \text{false}$

    $(\neg over \wedge good) \rightarrow (good = \neg good \wedge go = \neg go \wedge val = val + 1)$

$\texttt{GameOver}()$

    $result \in \{\text{"R wins"}, \text{"B wins"}, \text{"draw"}\}$

    $(over \wedge |R| > |B|) \rightarrow result = \text{"R wins"}$

    $(over \wedge |R| < |B|) \rightarrow result = \text{"B wins"}$

    $(over \wedge |R| = |B|) \rightarrow result = \text{"draw"}$