# 1

No, solving each game after the random dice rolls using alpha-beta pruning will take significant time, and doing it 50 times per possible move is a lot of processing. What would be recommended instead is to use a playout policy after the random moves to generate feasible endgames after the 50 random moves (much like Monte Carlo Tree Search) or use a heuristic to judge the gamestate.

# 2

## Constraints

- $\text{Alldiff}(F, T, U, W, R, O)$
- $F, T, U, W, R, O \in [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]$
- $C_1, C_2, C_3 \in [0, 1]$
- $2O \mod 10 = R$
- $C_1 = 2O//10$
- $(2W + C_1) \mod 10 = U$
- $C_2 = (2W + C_1)//10$
- $(2T + C_2) \mod 10 = O$
- $C_3 = (2T + C_2)//10$
- $F = C_3$

## Breaking Down Constraints into Binary Constraints

- $F, T, U, W, R, O \in [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]$
- $C_1, C_2, C_3 \in [0, 1]$
- None of $F, T, U, W, R, O$ equal each other
- $2O \mod 10 = R$
- $C_1 = 2O//10$
- $2W \mod 10 \in [U, U - 1]$
- $U \mod 2 = C_1$
- $C_2 = 2W//10$
- $2T \mod 10 \in [O, O - 1]$
- $O \mod 2 = C_2$
- $C_3 = 2T//10$
- $F = C_3$

## Solving

We pick the first variable as $O$ as it has 4 constraints related to it following the MRV heuristic.

### 1 $O$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $U$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $R$ | [0,1,2,3,4,5,6,7,8,9] | 1 |
| $O$ | [0,1,2,3,4,5,6,7,8,9] | 4 |
| $C_1$ | [0,1] | 2 |
| $C_2$ | [0,1] | 2 |
| $C_3$ | [0,1] | 2 |

### Value Selection

$0$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [5] | 1 |
| $U$ | [1,2,3,4,5,6,7,8,9] | 2 |
| $W$ | [1,2,3,4,5,6,7,8,9] | 2 |
| $R$ | [] | 0 |
| $O$ | 0 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Variable Selection

Fails, backtracks to previous conflicting assignment.

## 2 $O$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $U$ | [0,1,2,3,4,5,6,7,8,9] | 2 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $W$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $R$ | [0,1,2,3,4,5,6,7,8,9] | 1 |
| $O$ | [0,1,2,3,4,5,6,7,8,9] | 4 |
| $C_1$ | [0,1] | 2 |
| $C_2$ | [0,1] | 2 |
| $C_3$ | [0,1] | 2 |

### Value Selection

1 is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [] | 1 |
| $T$ | [0,5] | 1 |
| $U$ | [0,2,3,4,5,6,7,8,9] | 2 |
| $W$ | [0,2,3,4,5,6,7,8,9] | 2 |
| $R$ | [2] | 0 |
| $O$ | 1 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [1] | 1 |
| $C_3$ | [0,1] | 2 |

### Variable Selection

Fails, backtracks to previous conflicting assignment.

## 3 $O$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $U$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $R$ | [0,1,2,3,4,5,6,7,8,9] | 1 |
| $O$ | [0,1,2,3,4,5,6,7,8,9] | 4 |
| $C_1$ | [0,1] | 2 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $C_2$ | [0,1] | 2 |
| $C_3$ | [0,1] | 2 |

### Value Selection

$2$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1,6] | 1 |
| $U$ | [0,1,3,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,3,4,5,6,7,8,9] | 2 |
| $R$ | [4] | 0 |
| $O$ | 2 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Variable Selection

$R$ is chosen as it has the least remaining restraints

## 3-1 $R$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1,6] | 1 |
| $U$ | [0,1,3,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,3,4,5,6,7,8,9] | 2 |
| $R$ | [4] | 0 |
| $O$ | 2 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Value Selection

$4$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1,6] | 1 |
| $U$ | [0,1,3,5,6,7,8,9] | 2 |
| $W$ | [0,1,3,5,6,7,8,9] | 2 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Variable Selection

$F$ is chosen as it has the least remaining restraints

## 3-1-1 $F$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1,6] | 1 |
| $U$ | [0,1,3,5,6,7,8,9] | 2 |
| $W$ | [0,1,3,5,6,7,8,9] | 2 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Value Selection

$1$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $T$ | [1,6] | 1 |
| $U$ | [0,3,5,6,7,8,9] | 2 |
| $W$ | [0,3,5,6,7,8,9] | 2 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Variable Selection

$C_1$ is chosen as it has the least remaining restraints

## 3-1-1-1 $C_1$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [1,6] | 1 |
| $U$ | [0,3,5,6,7,8,9] | 2 |
| $W$ | [0,3,5,6,7,8,9] | 2 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Value Selection

$0$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [1,6] | 1 |
| $U$ | [6,8] | 1 |
| $W$ | [0,3,5,6,7,8,9] | 2 |
| $R$ | 4 | 0 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Variable Selection

$C_2$ is chosen as it has the least remaining restraints

## 3-1-1-1-1-1 $C_2$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [1,6] | 1 |
| $U$ | [6,8] | 1 |
| $W$ | [0,3,5,6,7,8,9] | 2 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Value Selection

$0$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [1,6] | 1 |
| $U$ | [6,8] | 1 |
| $W$ | [0,3] | 1 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | [1] | 1 |

### Variable Selection

$C_3$ is chosen as it has the least remaining restraints

## 3-1-1-1-1-1 $C_3$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [1,6] | 1 |
| $U$ | [6,8] | 1 |
| $W$ | [0,3] | 1 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | [1] | 1 |

### Value Selection

1 is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [6] | 0 |
| $U$ | [6,8] | 1 |
| $W$ | [0,3] | 1 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Variable Selection

$T$ is chosen as it has the least remaining restraints

## 3-1-1-1-1-1-1 $T$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [6] | 0 |
| $U$ | [6,8] | 1 |
| $W$ | [0,3] | 1 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Value Selection

1 is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 6 | 0 |
| $U$ | [8] | 1 |
| $W$ | [0,3] | 1 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Variable Selection

$U$ is chosen as it has the least remaining restraints

## 3-1-1-1-1-1-1-1 $U$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 6 | 0 |
| $U$ | [8] | 1 |
| $W$ | [0,3] | 1 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Value Selection

$8$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 6 | 0 |
| $U$ | 8 | 0 |
| $W$ | [] | 0 |
| $R$ | 4 | 0 |
| $O$ | 2 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Variable Selection

Fails, backtracks to previous conflicting assignment.

## 4 $O$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $U$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $R$ | [0,1,2,3,4,5,6,7,8,9] | 1 |
| $O$ | [0,1,2,3,4,5,6,7,8,9] | 4 |
| $C_1$ | [0,1] | 2 |
| $C_2$ | [0,1] | 2 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $C_3$ | [0,1] | 2 |

### Value Selection

$3$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1,6] | 1 |
| $U$ | [0,1,2,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,4,5,6,7,8,9] | 2 |
| $R$ | [6] | 0 |
| $O$ | 3 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [1] | 1 |
| $C_3$ | [0,1] | 2 |

### Variable Selection

$R$ is chosen as it has the least remaining restraints

## 4-1 $R$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1,6] | 1 |
| $U$ | [0,1,2,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,4,5,6,7,8,9] | 2 |
| $R$ | [6] | 0 |
| $O$ | 3 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [1] | 1 |
| $C_3$ | [0,1] | 2 |

### Value Selection

$6$ is selected.

## Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1,6] | 1 |
| $U$ | [0,1,2,4,5,7,8,9] | 2 |
| $W$ | [0,1,2,4,5,7,8,9] | 2 |
| $R$ | 6 | 0 |
| $O$ | 3 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [1] | 1 |
| $C_3$ | [0,1] | 2 |

## Variable Selection

$F$ is chosen as it has the least remaining restraints

# 4-1-1 $F$

## Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [1] | 1 |
| $U$ | [0,1,2,4,5,7,8,9] | 2 |
| $W$ | [0,1,2,4,5,7,8,9] | 2 |
| $R$ | 6 | 0 |
| $O$ | 3 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [1] | 1 |
| $C_3$ | [0,1] | 2 |

## Value Selection

1 is selected.

## Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [] | 1 |
| $U$ | [0,2,4,5,7,8,9] | 2 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $W$ | [0,2,4,5,7,8,9] | 2 |
| $R$ | 6 | 0 |
| $O$ | 3 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [1] | 1 |
| $C_3$ | [1] | 1 |

### Variable Selection

Fails, backtracks to previous conflicting assignment.

## 5 $O$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $U$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,3,4,5,6,7,8,9] | 2 |
| $R$ | [0,1,2,3,4,5,6,7,8,9] | 1 |
| $O$ | [0,1,2,3,4,5,6,7,8,9] | 4 |
| $C_1$ | [0,1] | 2 |
| $C_2$ | [0,1] | 2 |
| $C_3$ | [0,1] | 2 |

### Value Selection

$4$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [2,7] | 1 |
| $U$ | [0,1,2,3,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,3,5,6,7,8,9] | 2 |
| $R$ | [8] | 0 |
| $O$ | 4 | 0 |
| $C_1$ | [0] | 1 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Variable Selection

$R$ is chosen as it has the least remaining restraints

## 5-1 $R$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [2,7] | 1 |
| $U$ | [0,1,2,3,5,6,7,8,9] | 2 |
| $W$ | [0,1,2,3,5,6,7,8,9] | 2 |
| $R$ | [8] | 0 |
| $O$ | 4 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Value Selection

$8$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [2,7] | 1 |
| $U$ | [0,1,2,3,5,6,7,9] | 2 |
| $W$ | [0,1,2,3,5,6,7,9] | 2 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Variable Selection

$F$ is chosen as it has the least remaining restraints

## 5-1-1 $F$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | [1] | 1 |
| $T$ | [2,7] | 1 |
| $U$ | [0,1,2,3,5,6,7,9] | 2 |
| $W$ | [0,1,2,3,5,6,7,9] | 2 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [0,1] | 2 |

### Value Selection

1 is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [2,7] | 1 |
| $U$ | [0,2,3,5,6,7,9] | 2 |
| $W$ | [0,2,3,5,6,7,9] | 2 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Variable Selection

$C_1$ is chosen as it has the least remaining restraints

## 5-1-1-1 $C_1$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [2,7] | 1 |
| $U$ | [0,2,3,5,6,7,9] | 2 |
| $W$ | [0,2,3,5,6,7,9] | 2 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | [0] | 1 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Value Selection

$0$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [2,7] | 1 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3,5,6,7,9] | 2 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Variable Selection

$C_2$ is chosen as it has the least remaining restraints

## 5-1-1-1-1 $C_2$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [2,7] | 1 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3,5,6,7,9] | 2 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | [0] | 1 |
| $C_3$ | [1] | 1 |

### Value Selection

$0$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [2,7] | 1 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | [1] | 1 |

### Variable Selection

$C_3$ is chosen as it has the least remaining restraints

## 5-1-1-1-1-1 $C_3$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [2,7] | 1 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $C_3$ | [1] | 1 |

### Value Selection

$0$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [7] | 0 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Variable Selection

$T$ is chosen as it has the least remaining restraints

## 5-1-1-1-1-1 $T$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | [7] | 0 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Value Selection

$0$ is selected.

## Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

## Variable Selection

$U$ is chosen as it has the least remaining restraints

# 5-1-1-1-1-1-1 $U$

## Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | [0,2,6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

## Value Selection

$0$ is selected.

## Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | 0 | 0 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $W$ | [] | 0 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Variable Selection

Fails, backtracks to previous conflicting assignment.

## 5-1-1-1-1-1-2 $U$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | [2,6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Value Selection

$2$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | 2 | 0 |
| $W$ | [] | 0 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |

| Variable | Values | Remaining Restraints |
|---|---|---|
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Variable Selection

Fails, backtracks to previous conflicting assignment.

## 5-1-1-1-1-1-3 $U$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | [6] | 1 |
| $W$ | [0,2,3] | 1 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Value Selection

$2$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | 6 | 0 |
| $W$ | [3] | 0 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Variable Selection

$T$ is chosen as it has the least remaining restraints

## 5-1-1-1-1-1-3-1 $T$

### Possible Values

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | 6 | 0 |
| $W$ | [3] | 0 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

### Value Selection

$2$ is selected.

### Forward Checking

| Variable | Values | Remaining Restraints |
|---|---|---|
| $F$ | 1 | 0 |
| $T$ | 7 | 0 |
| $U$ | 6 | 0 |
| $W$ | 3 | 0 |
| $R$ | 8 | 0 |
| $O$ | 4 | 0 |
| $C_1$ | 0 | 0 |
| $C_2$ | 0 | 0 |
| $C_3$ | 1 | 0 |

# Solution

| Variable | Values |
|---|---|
| $F$ | 1 |
| $T$ | 7 |
| $U$ | 6 |
| $W$ | 3 |

| Variable | Values |
| --- | --- |
| $R$ | 8 |
| $O$ | 4 |

734+734=1468

# 3

If $WA = green$ and $V = red$, then according to AC-3,

- $SA = blue$
- $NT = red$
- $Q = green$
- $NSW = red$

$NSW$ and $V$ touch, which invalidates the partial assignment.