

Discrete Optimization

Local Search: Part V

Goal of the Lecture

- ▶ **Local search**
 - sports scheduling
 - complex neighborhood

Sports Scheduling

- ▶ Practical applications
 - baseball, basketball, football, hockey
 - radio and television networks: \$\$\$
- ▶ The traveling tournament problem (TTP)
 - abstraction of major league baseball
 - proposed by Easton, Nemhauser, and Trick
- ▶ The TTP is complex
 - Feasibility constraints: home/away patterns
 - Objective function: total travel distance

The Traveling Tournament

► Input

- n teams
- a matrix d of distances between teams

► Output: a double round-robin schedule

- atmost constraint: no more than three consecutive games at home or away
- no repeat constraint: a game $a @ b$ cannot be followed by a game $b @ a$
- minimize travel distance

The Traveling Tournament

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

The Traveling Tournament

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| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

$$d_{12} + d_{21} + d_{15} + d_{54} + d_{43} + d_{31} + d_{16} + d_{61}$$

The Traveling Tournament

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|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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The Traveling Tournament

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| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

$d_{12} + d_{21} + d_{15} + d_{54} + d_{43} + d_{31} + d_{16} + d_{61}$
+ ... +

The Traveling Tournament

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| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

$$d_{12} + d_{21} + d_{15} + d_{54} + d_{43} + d_{31} + d_{16} + d_{61}$$

+ ... +

$$d_{61} + d_{14} + d_{45} + d_{56} + d_{63} + d_{36} + d_{62} + d_{26}$$

The Neighborhood

- ▶ A number of moves
 - swap homes
 - swap rounds
 - swap teams
 - partial swap rounds
 - partial swap teams

Swap Homes

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Homes

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Homes

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Homes

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
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| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Rounds

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
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| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
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| 5 | @2 | @3 | 1 | 4 | 6 | @6 | @4 | @1 | 3 | 2 |
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Swap Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
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| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
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| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @5 | 4 | 3 | @2 | @4 | @3 | 2 | 5 | @6 |
| 2 | 5 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | @5 |
| 3 | @4 | 2 | 5 | @1 | 6 | @5 | 1 | @6 | @2 | 4 |
| 4 | 3 | 6 | @1 | @2 | @5 | 1 | 2 | 5 | @6 | @3 |
| 5 | @2 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | 2 |
| 6 | @1 | @4 | @2 | 5 | @3 | 2 | @5 | 3 | 4 | 1 |

Swap Partial Rounds

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 2 | 3 | @5 | @4 | @3 | 5 | 4 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 4 | @1 | 6 | @2 | 1 | @6 | @5 | 2 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 2 | 1 | @6 | @4 | @1 | 3 | 4 |
| 6 | @1 | @4 | @5 | 4 | @3 | 5 | @2 | 3 | 2 | 1 |

Swap Partial Rounds

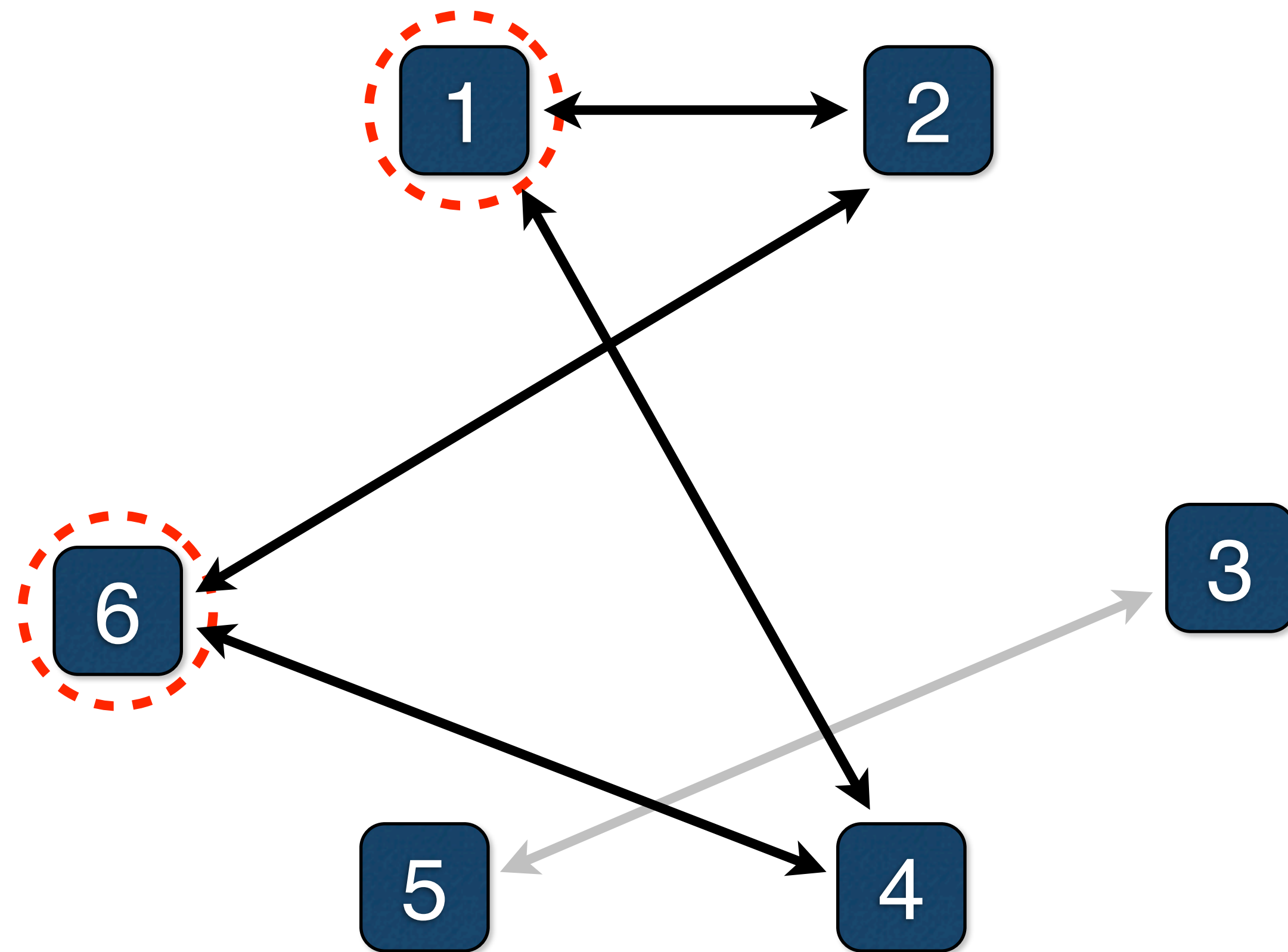
| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 2 | 3 | @5 | @4 | @3 | 5 | 4 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 4 | @1 | 6 | @2 | 1 | @6 | @5 | 2 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 2 | 1 | @6 | @4 | @1 | 3 | 4 |
| 6 | @1 | @4 | @5 | 4 | @3 | 5 | @2 | 3 | 2 | 1 |

Swap Partial Rounds

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 2 | 3 | @5 | @4 | @3 | 5 | 4 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 4 | @1 | 6 | @2 | 1 | @6 | @5 | 2 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 2 | 1 | @6 | @4 | @1 | 3 | 4 |
| 6 | @1 | @4 | @5 | 4 | @3 | 5 | @2 | 3 | 2 | 1 |

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | 4 | 2 | 3 | @5 | @4 | @3 | 5 | @2 | @6 |
| 2 | 5 | @6 | @1 | @5 | 4 | 3 | 6 | @4 | 1 | @3 |
| 3 | @4 | 5 | 4 | @1 | 6 | @2 | 1 | @6 | @5 | 2 |
| 4 | 3 | @1 | @3 | @6 | @2 | 1 | 5 | 2 | 6 | @5 |
| 5 | @2 | @3 | 6 | 2 | 1 | @6 | @4 | @1 | 3 | 4 |
| 6 | @1 | 2 | @5 | 4 | @3 | 5 | @2 | 3 | @4 | 1 |

Swap Partial Rounds



Swap Partial Rounds

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 2 | 3 | @5 | @4 | @3 | 5 | 4 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 4 | @1 | 6 | @2 | 1 | @6 | @5 | 2 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
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| 4 | 3 | @1 | @3 | @6 | @2 | 1 | 5 | 2 | 6 | @5 |
| 5 | @2 | @3 | 6 | 2 | 1 | @6 | @4 | @1 | 3 | 4 |
| 6 | @1 | 2 | @5 | 4 | @3 | 5 | @2 | 3 | @4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @1 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @6 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

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|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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Swap Partial Teams

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|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

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|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

Swap Partial Teams

| T-R | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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Swap Partial Teams

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|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
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Swap Partial Teams

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| 2 | 5 | 1 | @3 | @6 | 4 | 3 | 6 | @4 | @6 | @5 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @1 | @5 | @2 | 1 | 5 | 2 | @1 | @3 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
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| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
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Swap Partial Teams

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|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 4 | 3 | @5 | @4 | @3 | 5 | 2 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 2 | @1 | 6 | @2 | 1 | @6 | @5 | 4 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 4 | 1 | @6 | @4 | @1 | 3 | 2 |
| 6 | @1 | @4 | @5 | 2 | @3 | 5 | @2 | 3 | 4 | 1 |

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|-----|----|----|----|----|----|----|----|----|----|----|
| 1 | 6 | @2 | 2 | 3 | @5 | @4 | @3 | 5 | 4 | @6 |
| 2 | 5 | 1 | @1 | @5 | 4 | 3 | 6 | @4 | @6 | @3 |
| 3 | @4 | 5 | 4 | @1 | 6 | @2 | 1 | @6 | @5 | 2 |
| 4 | 3 | 6 | @3 | @6 | @2 | 1 | 5 | 2 | @1 | @5 |
| 5 | @2 | @3 | 6 | 2 | 1 | @6 | @4 | @1 | 3 | 4 |
| 6 | @1 | @4 | @5 | 4 | @3 | 5 | @2 | 3 | 2 | 1 |

Until Next Time