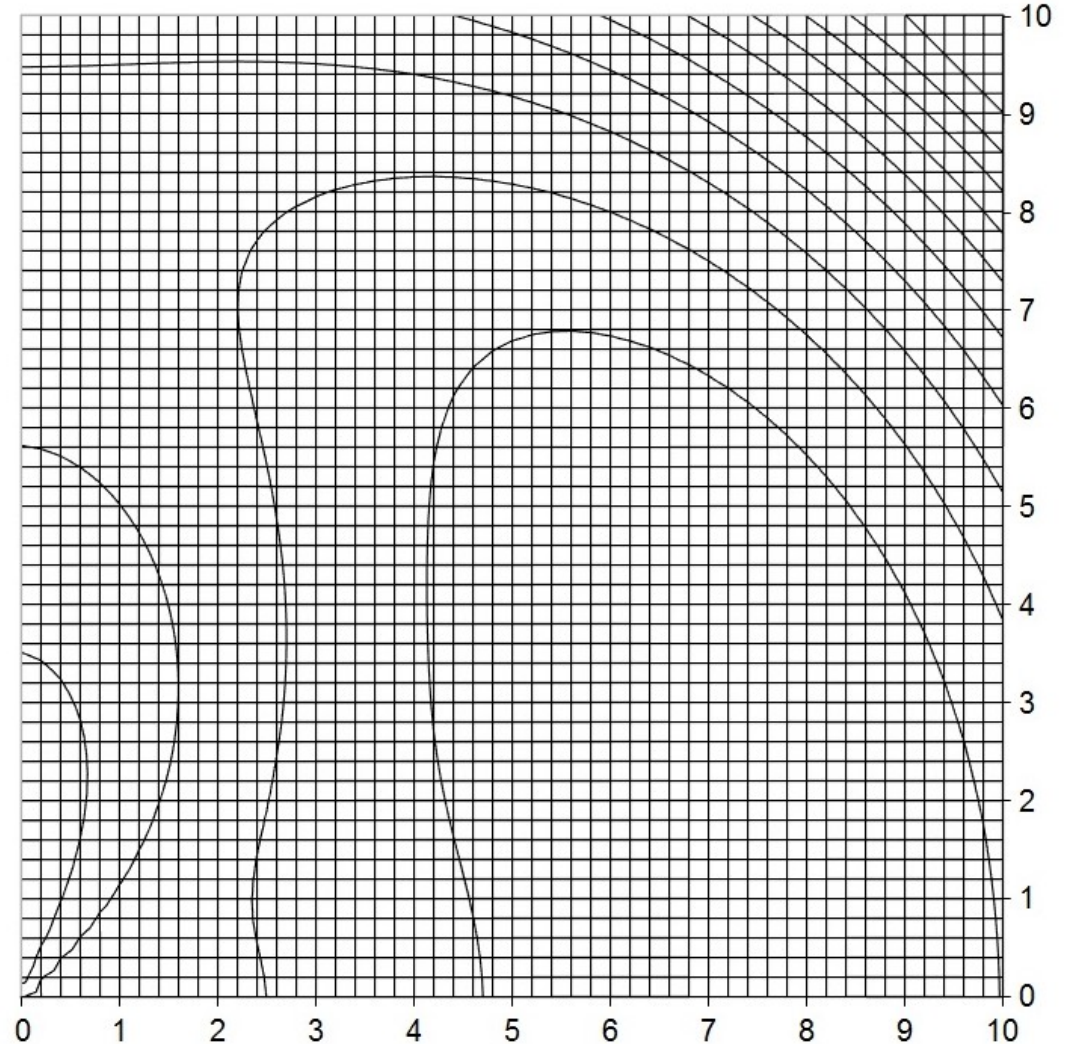


Leapfrogging Optimization

R. Russell Rhinehart

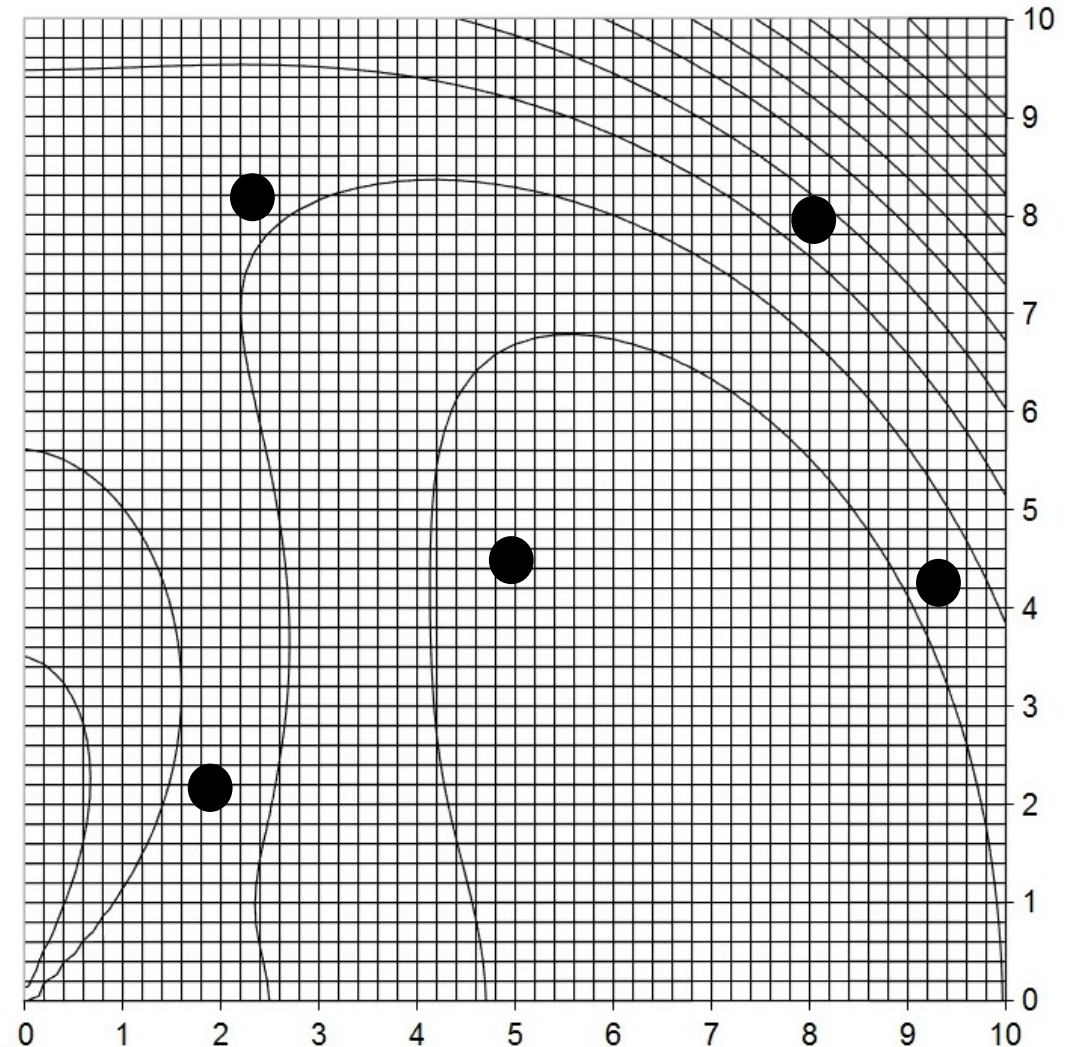
Contour Map of a 2-D Function

- The Objective Function (OF) is a function of two Decision Variables (DVs)
- The $f(x,y)$ contour plot is illustrated.
- The minimum is about at $x=7.5$, $y=2$.



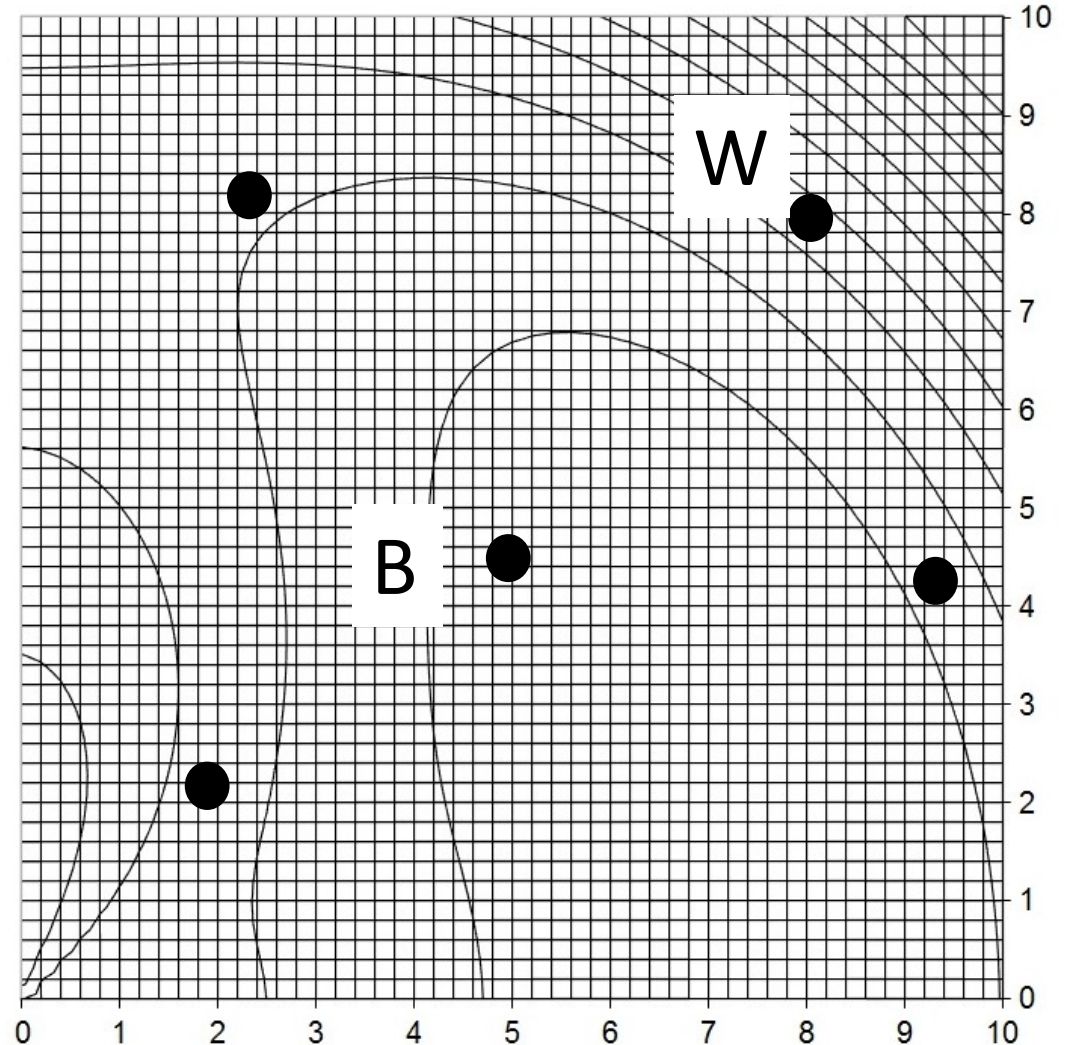
Step 0 Initialize Players

- 5 trial solutions are illustrated with markers.
- Trial Solutions are called Players.
- Players are placed randomly in feasible DV space.
- Calculate the OF for each player.
- Note: 10 players per dimension is recommended. Here, only 5 are shown for simplicity of the presentation.



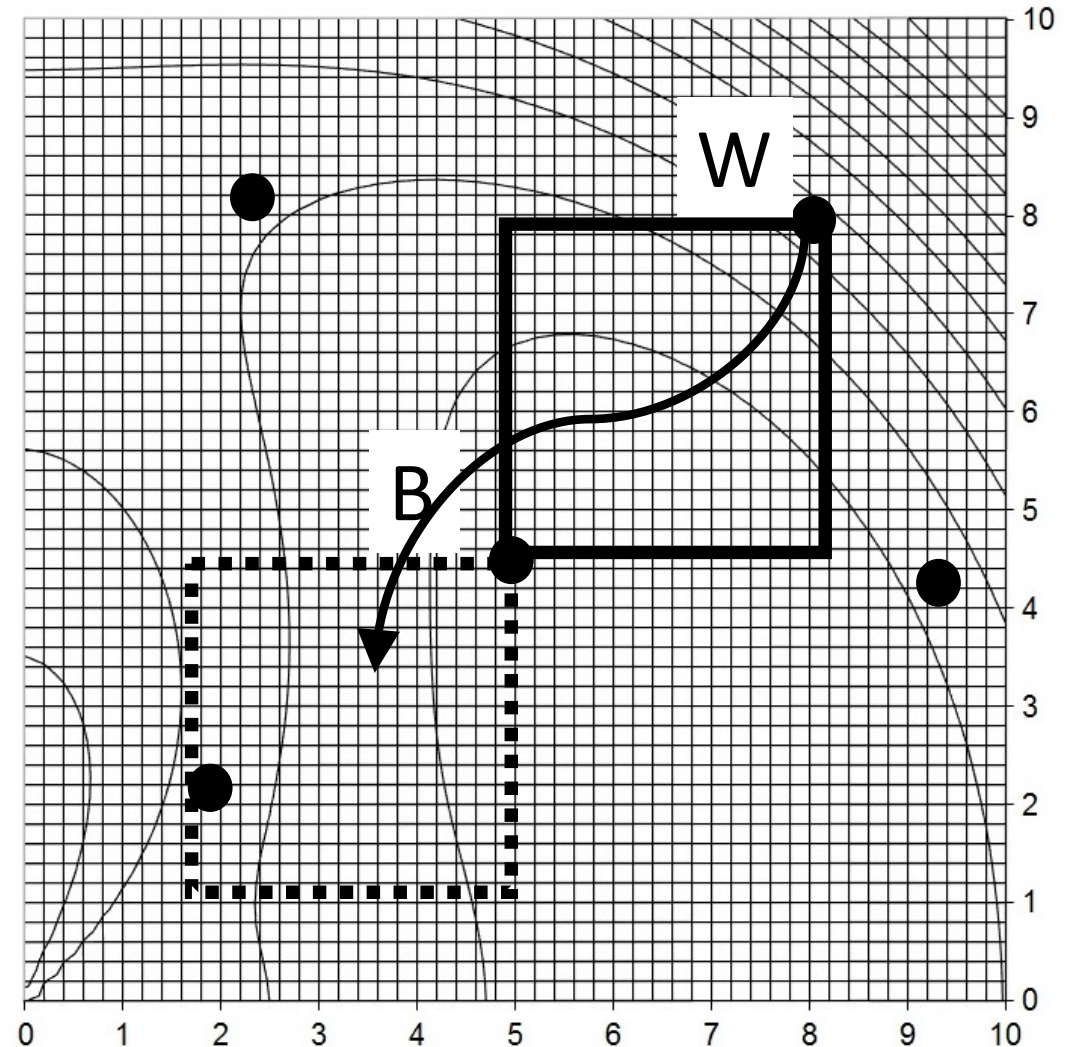
Step 1 Identify Players

- Use the OF-value for each player to:
 1. Identify the best - B
 2. And worst - W.



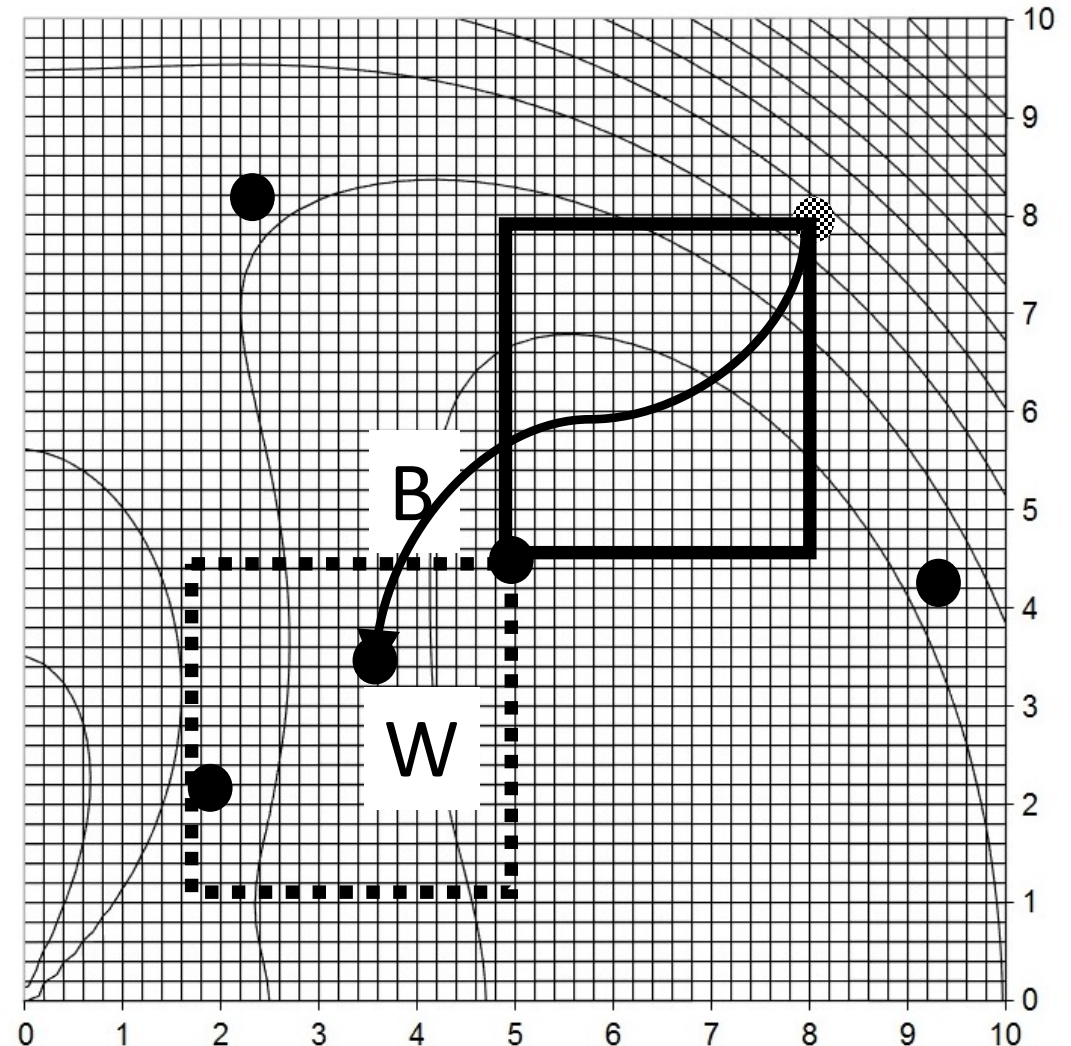
Step 2 Leap Worst Over Best

- W leaps into a random spot inside of the reflected DV-space window on the other side of the best.
- The “from” area is the solid line representing the DV boundaries between B and W players.
- The “into” window is the dashed line of identical size.



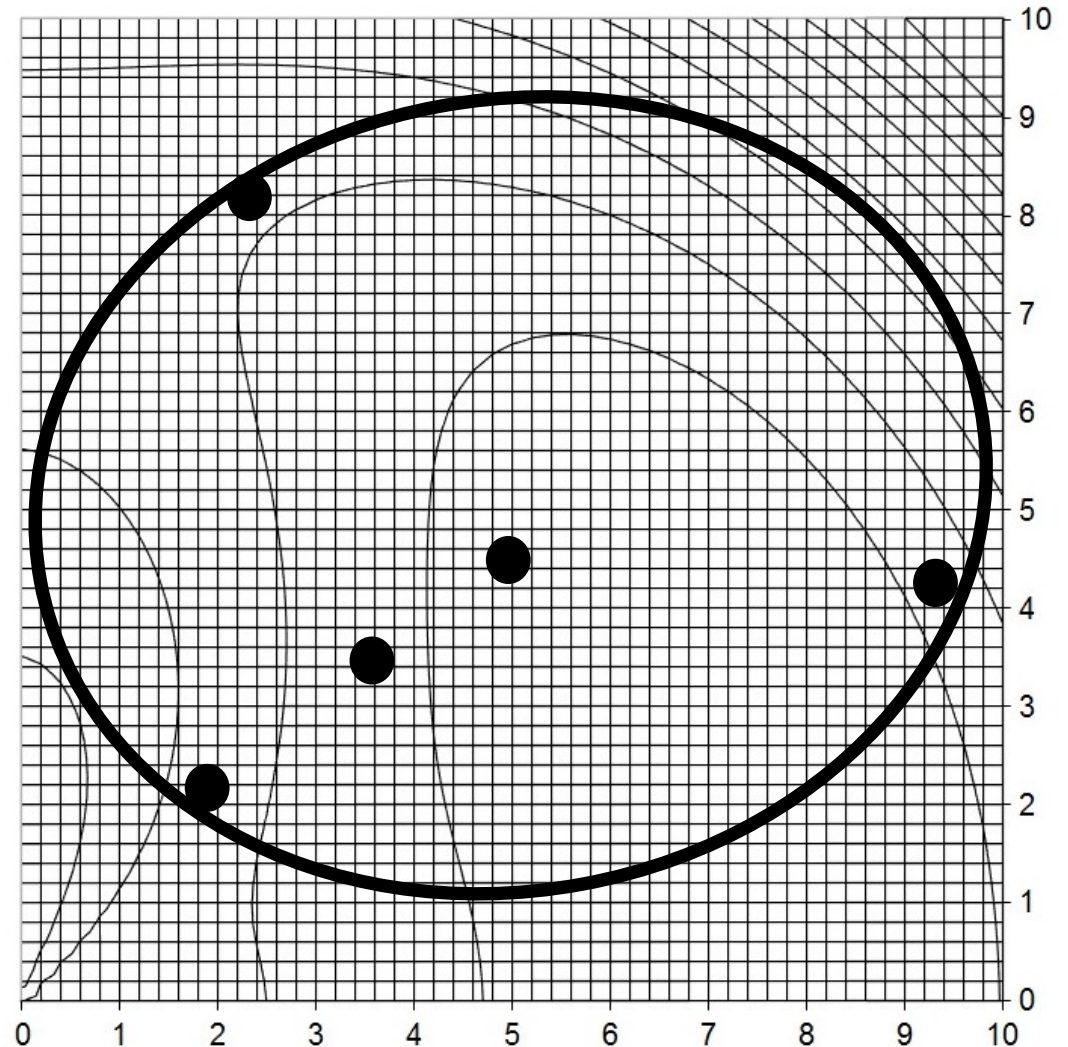
Step 2 Continued

- W moved to new position.
- Its prior location is vacated.
- Determine the OF value at the new player position
- Notes:
 - The new position is not in the center of the leap-into window.
 - There are still 5 players.
 - There is one function evaluation per leap-over.



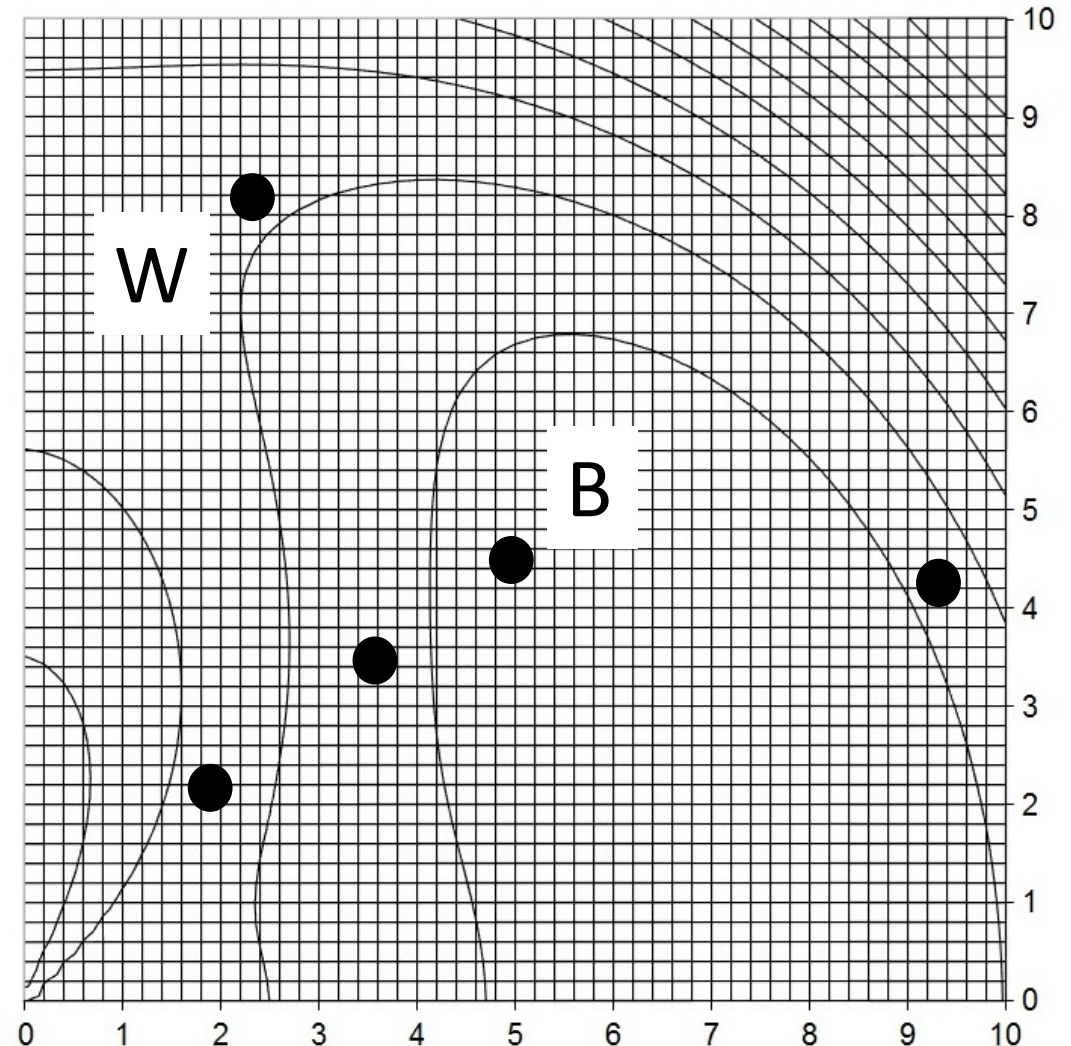
Step 3 Test For Convergence

- The players are still far apart, as indicated by the size of the ellipse that contains them.
- Not converged yet.
- Many metrics can be used to determine when the players are all close to the optimum.
- For simplicity, I often use average deviation of all players from the best.



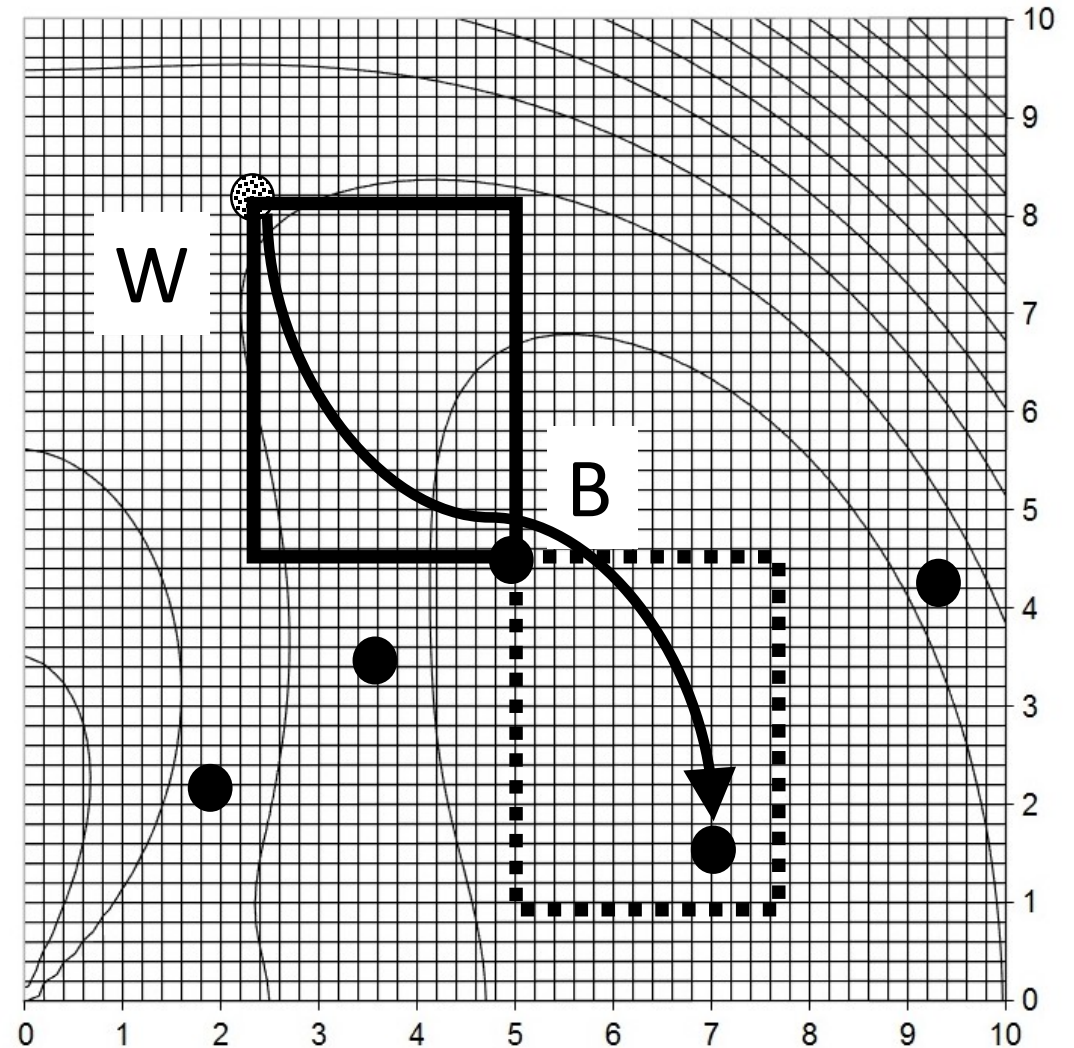
Repeat Step 1 Identify Best and Worst

- The best is still the best.
- The former worst now has a mid-contour value.
- The new worst is identified.
- Notes:
- Don't have to search for the best. If the new player is better than former best, it is the new best; else, the old best remains the lead.
- If the leap-to spot was infeasible, that player remains as worst.



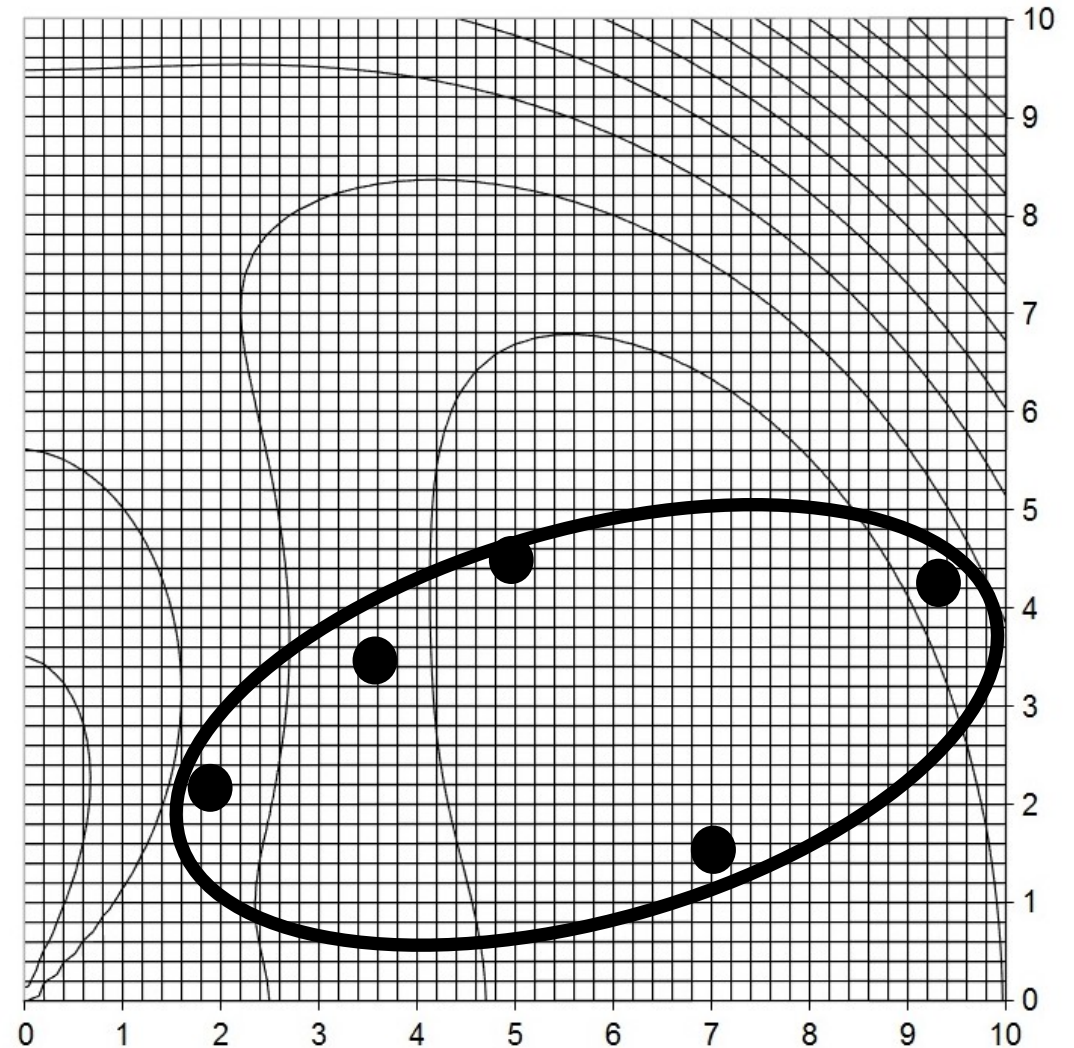
Repeat Step 2 Leap Worst Over Best

- W leaps over B and moves into a random spot in the reflected DV space.
- Determine the new OF-value.



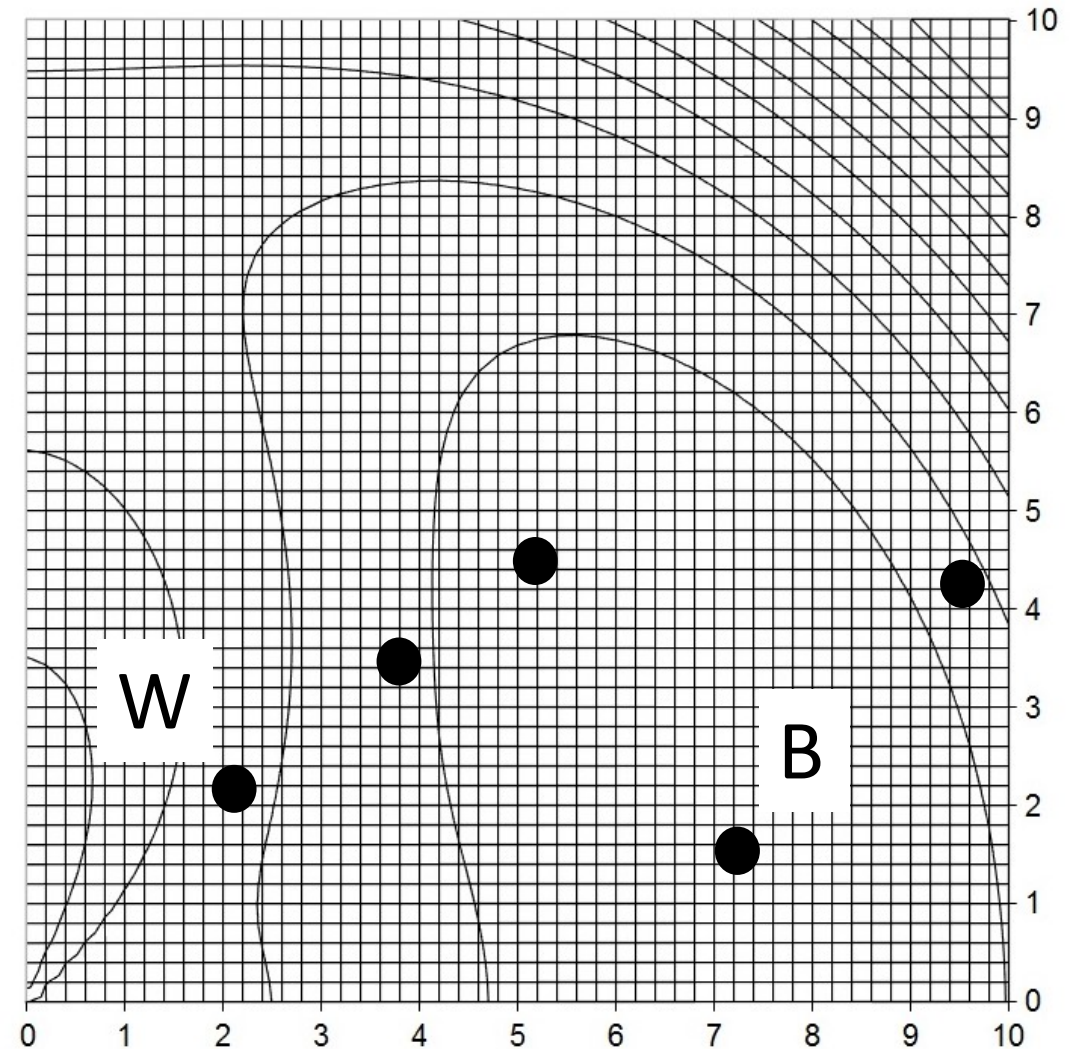
Repeat Step 3 Test for Convergence

- Not yet.
- But, the team of players is gathering.



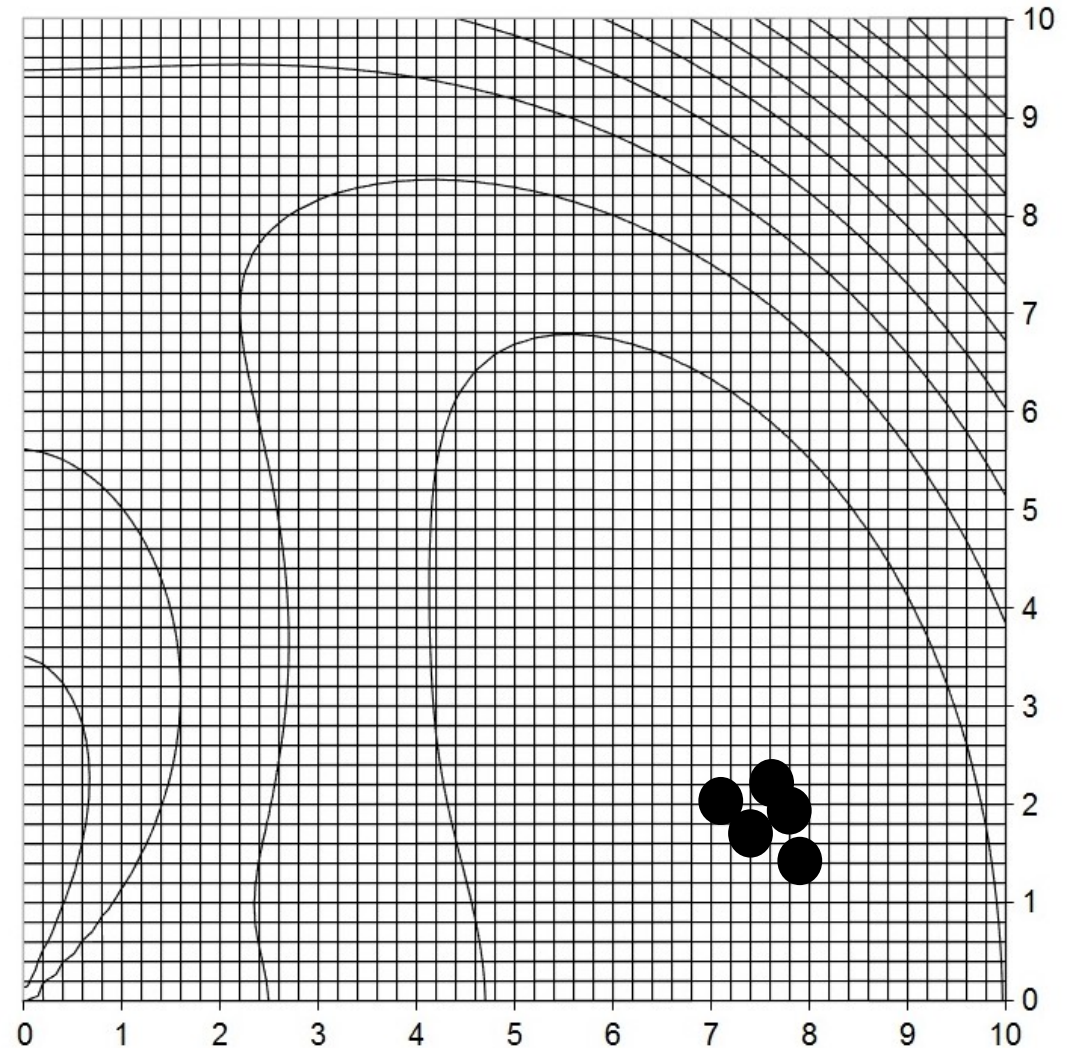
Repeat Step 1 Identify Best and Worst

- A new player has taken the lead.



Repeat Steps 1, 2, 3

- After several leap-overs the players:
 1. Cluster together.
 2. At the optimum.



Converged!

- When converged:
- End the procedure.
- Report the best player DV and OF values as DV^* and OF^*

