Assignment 11.

22. The Last Problem! Due 11/27/17

Generalize the algorithm for construction of strategies. Explain how we can (or cannot) apply it to solve the following problems.

a) 2D/4A serial Reti problem for an arbitrary start state (or a class of start states);
b) 3D/4A serial problem;
c) 2D/4A concurrent problem.
For b) and c) make assumptions about the start state or class of start states if necessary. Sketch solutions.

23. <u>The Last Project!</u>
Project V. Due 12/09/17

Implement algorithm for construction of strategies <u>for solving the Reti endgame</u> (serial 2D/4A problem). In particular, implement State Space Chart, Quick Test of Strategies. Use your Grammar of Reduced Searches G_{rs}, CUT, grammar of Zones (or a simplified version of this grammar), the notion of gateways, board and state space distances. Zones must be either translated or regenerated in every state.

Input:

Start State, Winning and Draw conditions.

Output:

<u>A Solution Tree</u>.

In addition to the solution tree your output should demonstrate a number of intermediate snapshots of the tree (and the final one). These snapshots include the graphical networks of Zones in the current state showing the basis for choosing the next move (with respect to a certain strategy) and the termination of branches. Also, your output should demonstrate the snapshots of the State Space Chart with the strategies being pursued in the corresponding states of the tree.

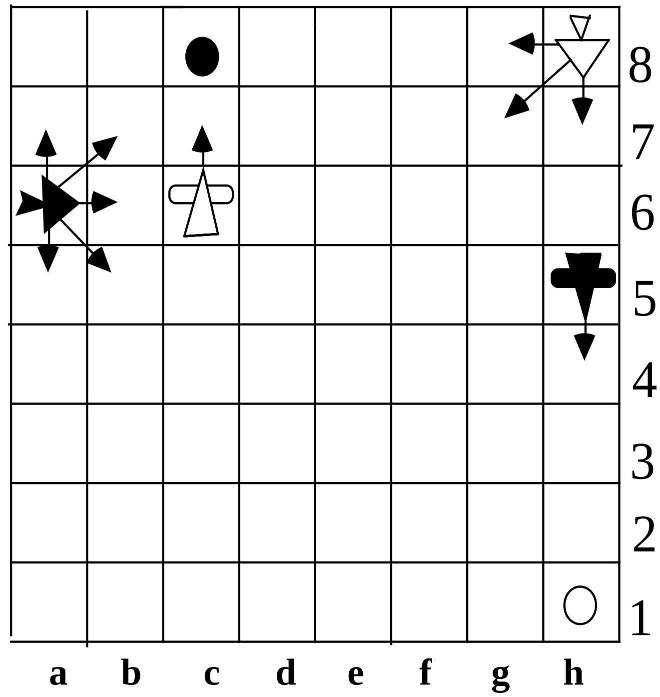
From Search to Construction

Part I
State Space Chart

(more details can be found in Chapter 13 of the book on LG)

Optimization problem for autonomous Aerospace robotic vehicles with serial alternating motions

2D/4A Problem



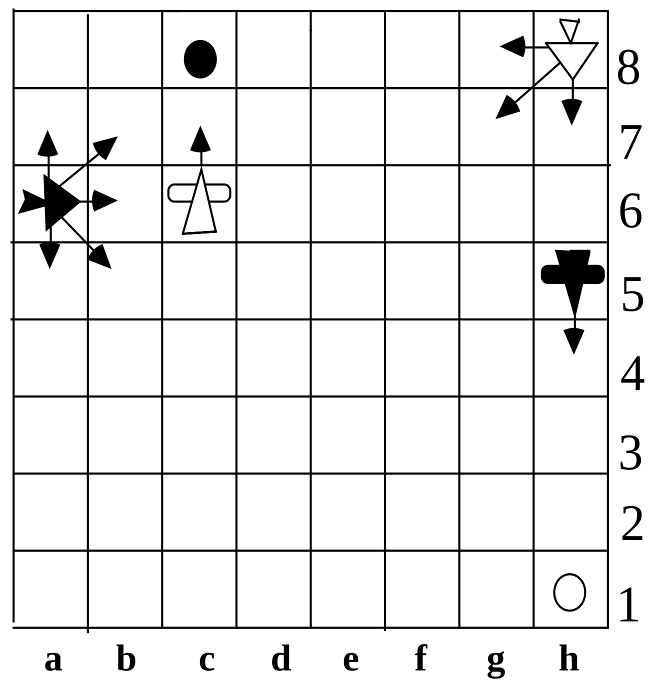
***Is there a strategy for the White to make a draw*?**

The specific question is as follows.
Is there an optimal strategy that provides one of the following?

1. **Both BOMBERs hit their targets on subsequent time increments and stay safe for at least one time increment.**

2. **Both BOMBERs are destroyed before they hit their targets or immediately after that.**

2D/4A Problem: Terminal Sets



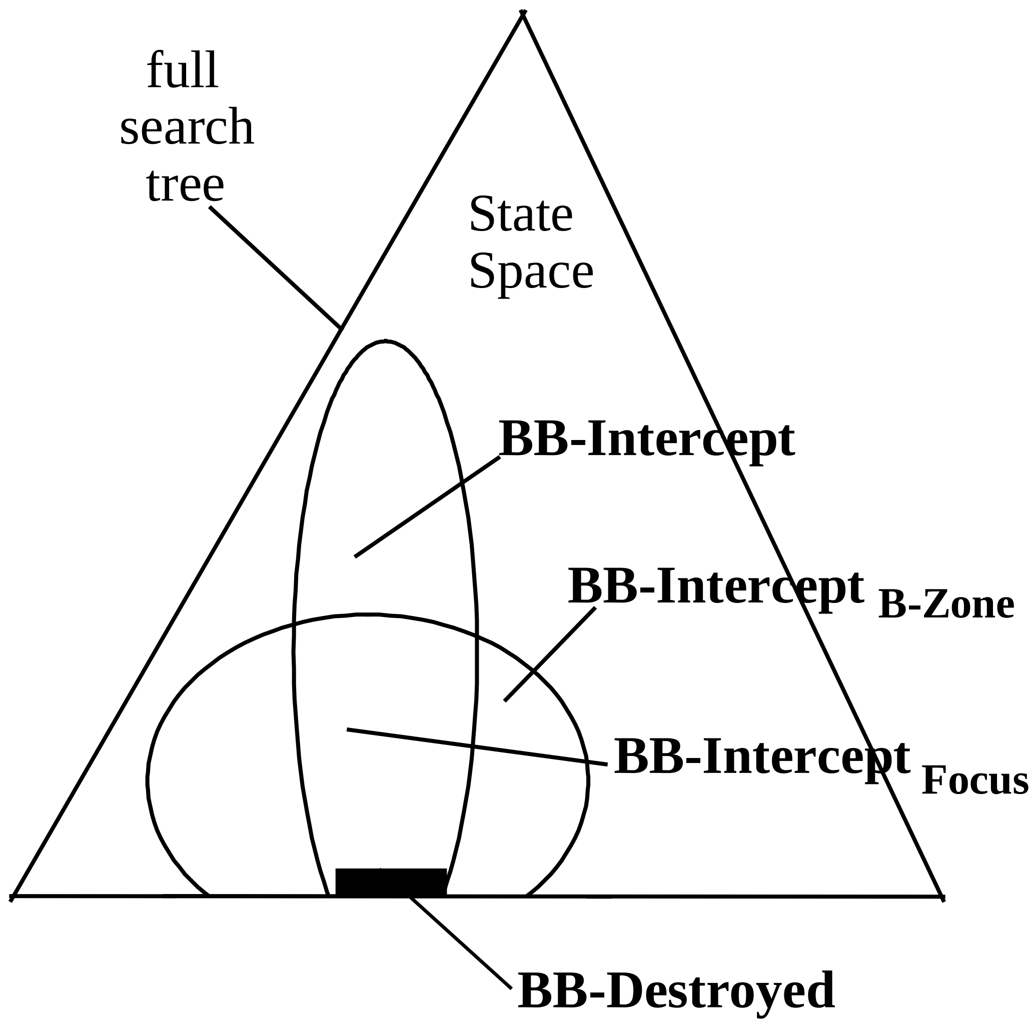
1. **W-Win** = **BB-Destroyed** ∩ **WB-Safe**

2. **B-Win** = **WB-Destroyed** ∩ **BB-Safe**

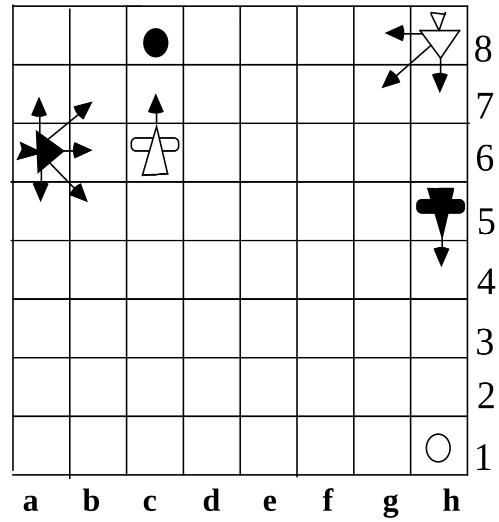
3. **Draw** = **Safe** ∪ **Destroyed**, where
Destroyed = **BB-Destroyed** ∩ **WB-Destroyed**,
Safe = **BB-Safe** ∩ **WB-Safe**

Let A be a set of states.
The strategy is called an A strategy if it is represented by the optimal subtree with the terminal nodes which represent states from A, only.

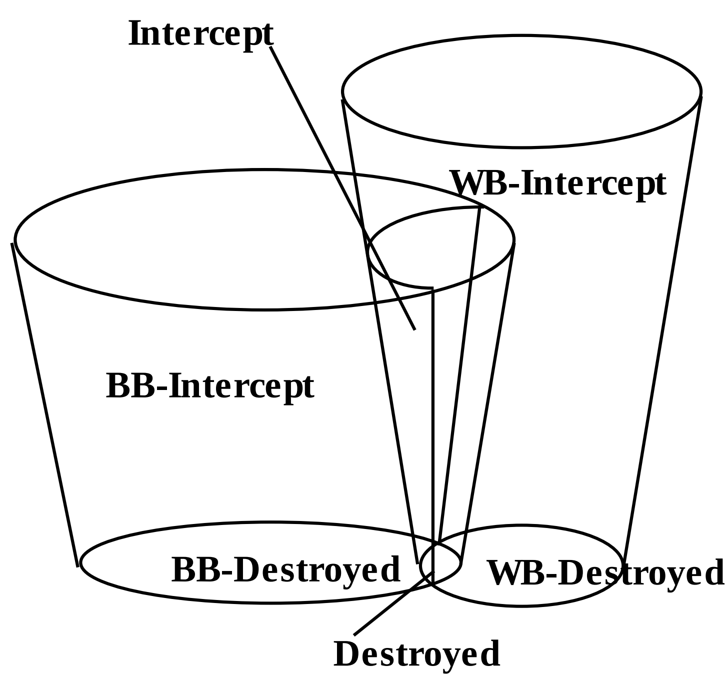
Why do we need the Terminal States Expansion?



Terminal Sets Expansion

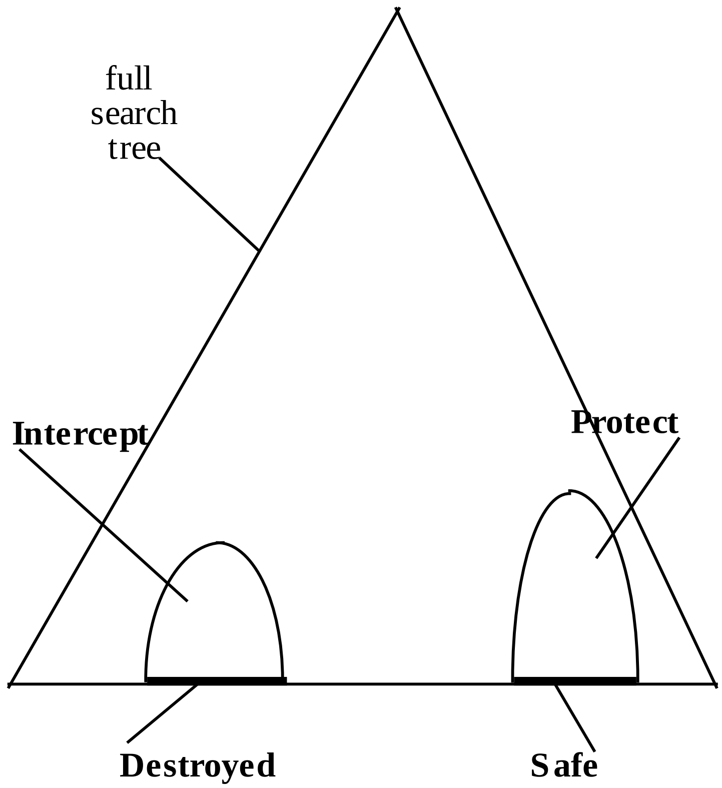


BB-Intercept is the set of states where BB-Destroyed strategy exists



Intercept = BB-Intercept $\cap$ WB-Intercept
Destroyed = BB-Destroyed $\cap$ WB-Destroyed.
Destroyed $\subset$ DrawExpand.

Expanded Terminal States



Terminal Sets Expansion

Intercept = **BB-Intercept** ∩ **WB-Intercept**

is the set of states where the **Destroyed strategy** exists
Destroyed = **BB-Destroyed** ∩ **WB-Destroyed**.
Intercept ⊂ **DrawExpand**.

Protect = **BB-Protect** ∩ **WB-Protect**

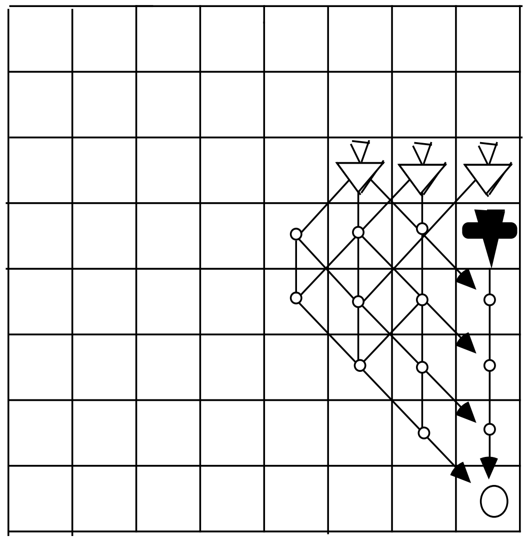
is the set of states where the **Safe strategy** exists
Safe = **BB-Safe** ∩ **WB-Safe**.
Protect ⊂ **DrawExpand**

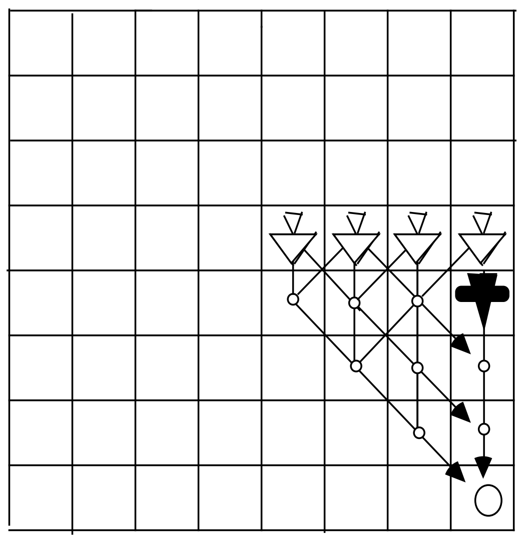
Intercept ∪ **Protect** ⊂ **DrawExpand**.

Intercept ∪ **Protect** ≠ **DrawExpand**.

Structure of Expanded Terminal Sets

BB-Intercept$_{\text{B-Zone}}$

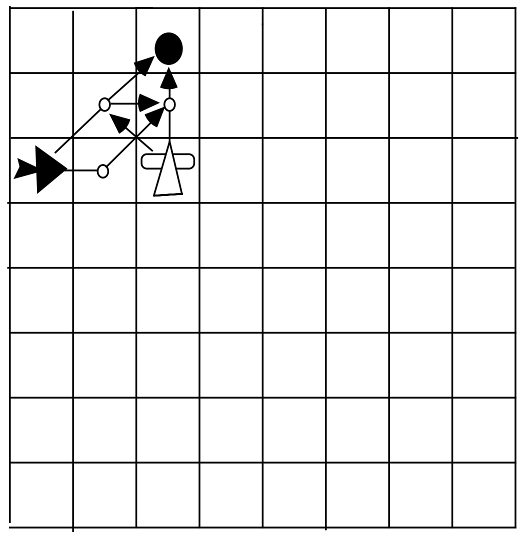


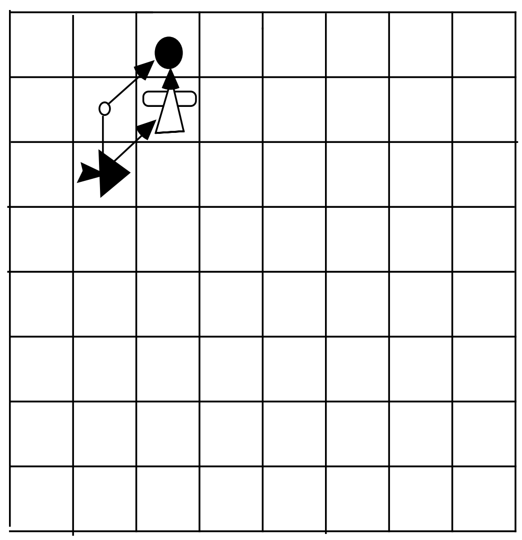


$$\mathbf{Z_{BB} = \mathit{t}(BB, t_{BB}, \mathit{l}_1)\mathit{t}(WF, t_{WF}, \mathit{l}_2)}$$

Structure of Expanded Terminal Sets

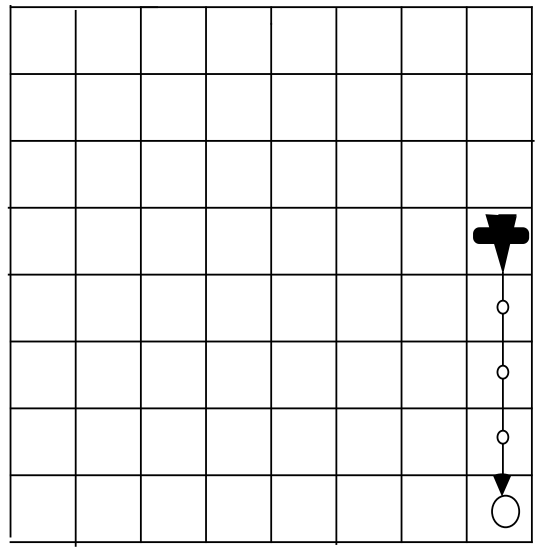
WB-Intercept$_{\text{W-Zone}}$

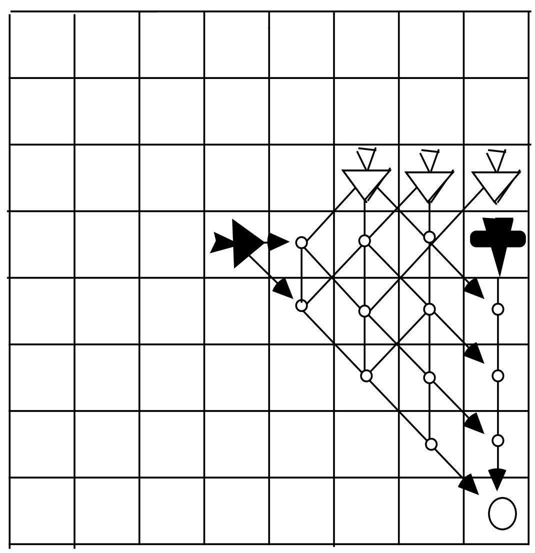




Structure of Expanded Terminal Sets

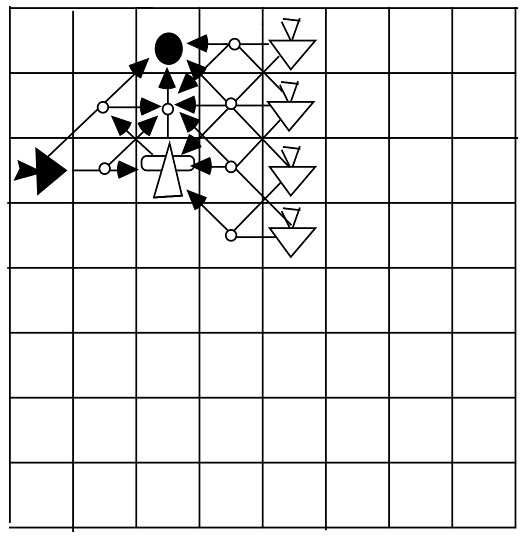
BB-Protect$_{\text{B-Zone}}$

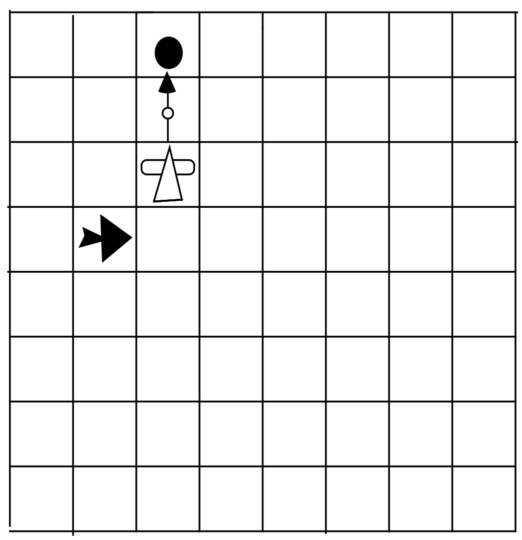




A Structure of Expanded Terminal Sets

WB-Protect$_{\text{W-Zone}}$

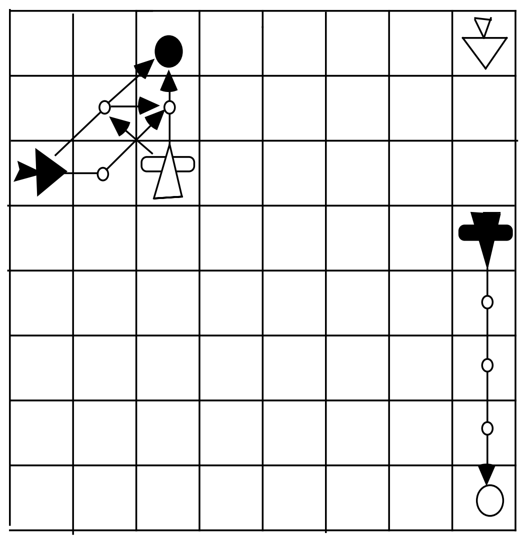


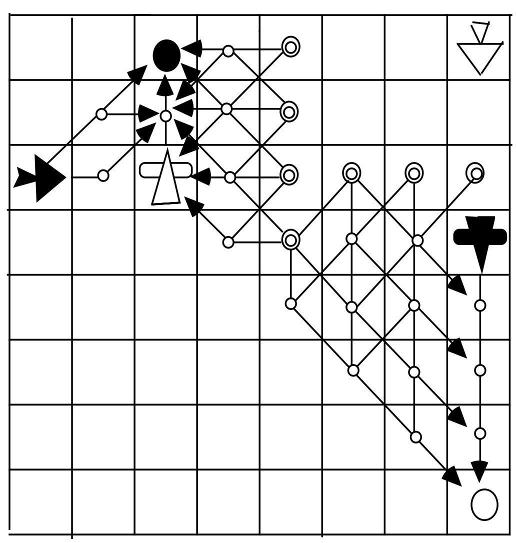


State Space Decomposition

$$\mathbf{SPACE} = \mathbf{BB\text{-}Intercept}_{\mathbf{B\text{-}Zone}} \cup \mathbf{BB\text{-}Protect}_{\mathbf{B\text{-}Zone}}$$

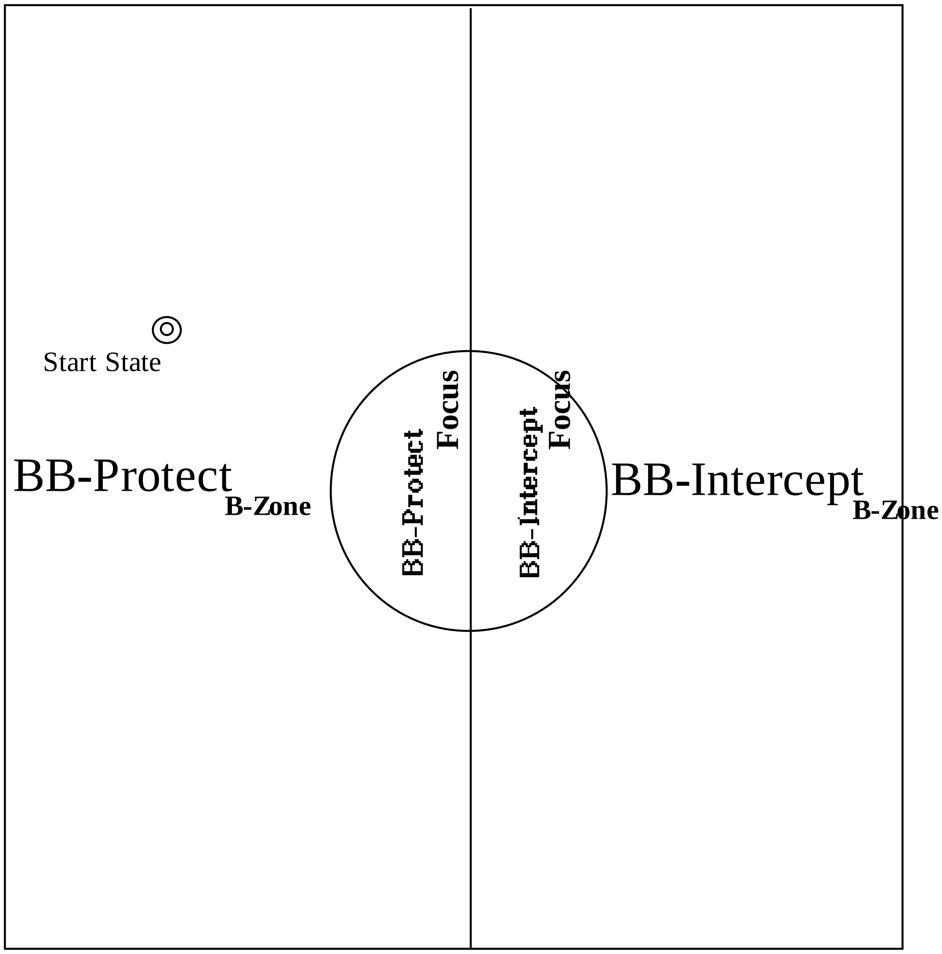
$$\mathbf{SPACE} = \mathbf{WB\text{-}Intercept}_{\mathbf{W\text{-}Zone}} \cup \mathbf{WB\text{-}Protect}_{\mathbf{W\text{-}Zone}}$$





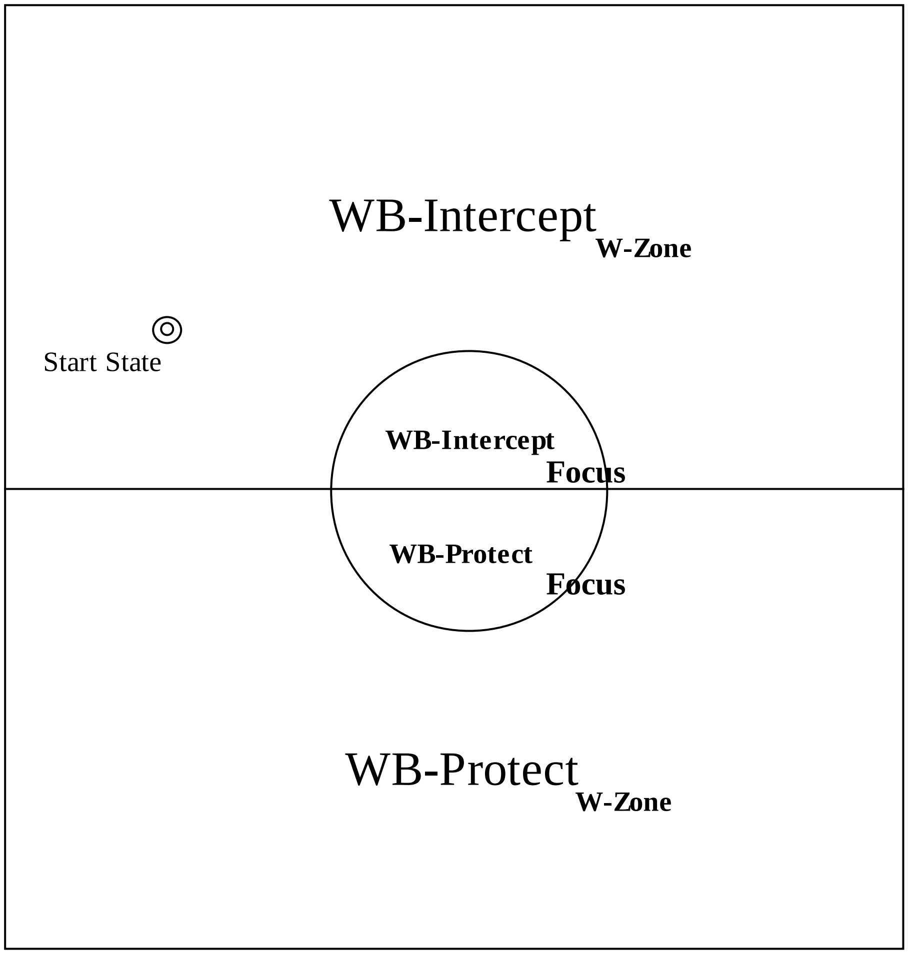
State Space Decomposition

$$\textbf{SPACE} = \textbf{BB-Protect}_{\textbf{B-Zone}} \cup \textbf{BB-Intercept}_{\textbf{B-Zone}}$$

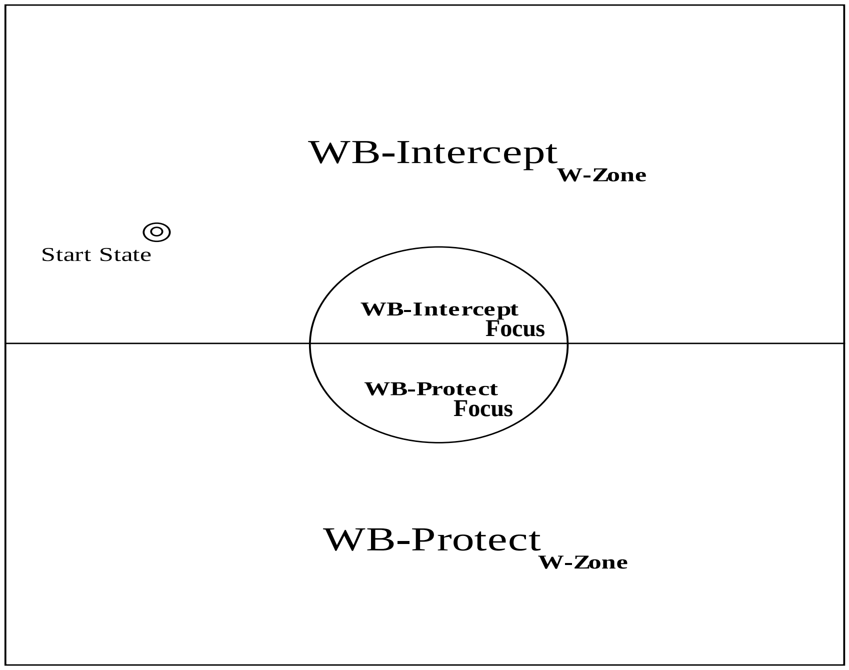


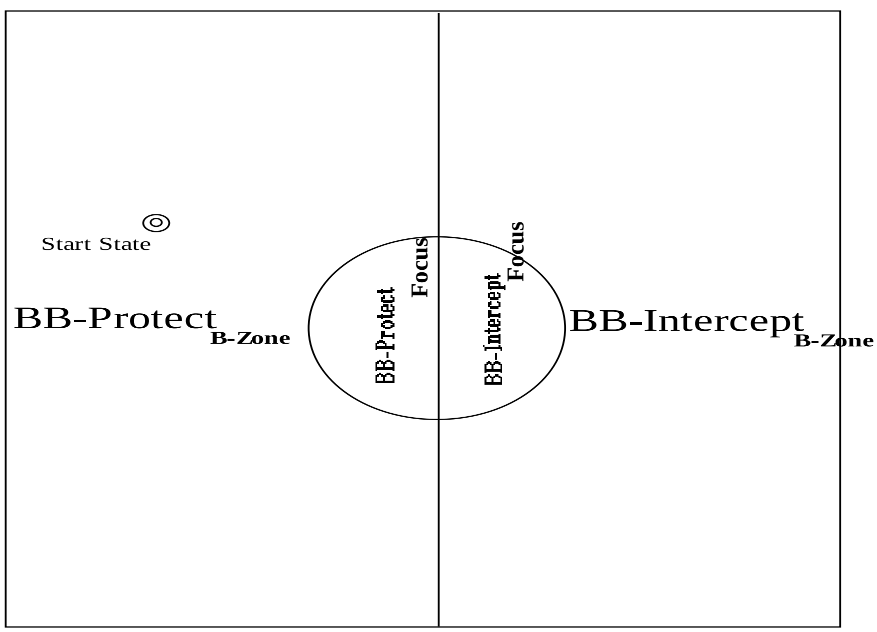
State Space Decomposition

$$\mathbf{SPACE} = \mathbf{WB\text{-}Protect}_{\mathbf{W\text{-}Zone}} \cup \mathbf{WB\text{-}Intercept}_{\mathbf{W\text{-}Zone}}$$

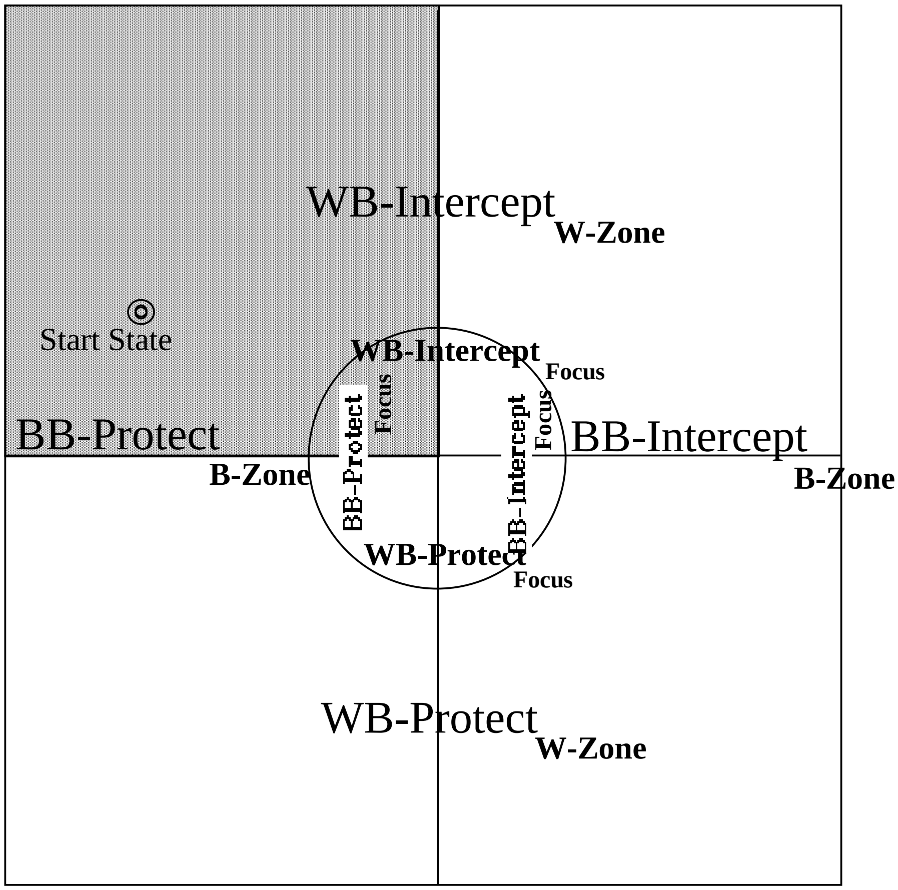


State Space Decomposition





State Space Decomposition
Apply both decompositions simultaneously



State Space Chart