Programming Proverbs

- 6. “Use procedures (methods or functions).”

- Henry F. Ledgard, “Programming Proverbs: Principles of Good Programming with Numerous Examples to Improve Programming Style and Proficiency”, (Hayden Computer Programming Series), Hayden Book Company, 1st edition, ISBN-13: 978-0810455221, December 1975.

Visportals and BSP trees

- consider this map
  - the walls are in red

- **chisel/maps/spiral.txt**

```
define 1 room 1
define 2 room 2
define 3 room 3
define 4 room 4
define O monster monster_demon_imp
define H monster monster_demon_hellknight
define S worldspawn
```

Visportals and BSP trees

chisel/maps/spiral.txt

```
##########################
#1        #2              #
#         .               #
#         .               #
#         .               #
#         #               #
#....###############...####
#3              #4         #
#               #  O O O   #
#       S       #          #
#               #  O O O   #
#               #          #
##########################
```

Visportals and BSP trees

- we can see that we are spawned in room 3
  - the imps are in room 4

- let us build this map with chisel

-
```
$ cd
$ cd Sandpit/chisel/python
$ ./developer-txt2map ../maps/spiral.txt
txt2pen: pass
Total rooms = 4
Total cuboids = 769
Total cuboids expanded (optimised) = 0
Total entities used = 89 entities unused = 4007
Total brushes used  = 769
pen2map: pass
```

Visportals and BSP trees

- now compile the map within dhewm3
  - and play it!

- notice when you are spawned at the beginning of the game
  - turn and if you face room 4
  - watch the fps drop !
  - why is this the case?

Visportals and BSP trees

- now we can implement visportals for open doors
  - compile the map and play the game

- notice after the player is spawned you can face room 4
  - and what happens?
  - why?

Algorithm for splitting an area into a BSP tree

```
PROCEDURE makeTree (polyList: polygon) : tree;
VAR
   root: polygon ;
   backList, frontList: polygonP ;
   p, backPart, frontPart: polygon ;
BEGIN
   IF polyList = NIL
   THEN
      RETURN NIL
   ELSE
```

Algorithm for splitting an area into a BSP tree

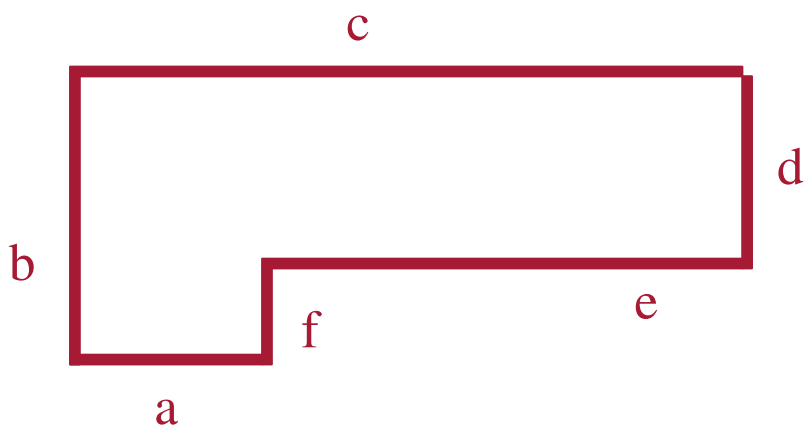
```
      root := selectAndRemovePolygon (polyList) ;
      backList := NIL ;
      frontList := NIL ;
      FOR p in polyList DO
         IF p is in front of root
         THEN
            frontList := addToList (frontList, p)
         ELSIF p is behind root
         THEN
            backList := addToList (backList, p)
         ELSE
            (* polygon, p, must be split as it spans across, root.  *)
            splitPolygon (p, root, frontPart, backPart) ;
            frontList := addToList (frontList, frontPart) ;
            backList := addToList (backList, backPart) ;
         END
      END ;
      RETURN combineTree (makeTree (frontList),
                          root,
                          makeTree (backList))
   END
END makeTree;
```

BSP trees

- consider the following walls in a map

BSP trees

- we will label each line



BSP trees

- we initialise our `polyList` to the labeled lines

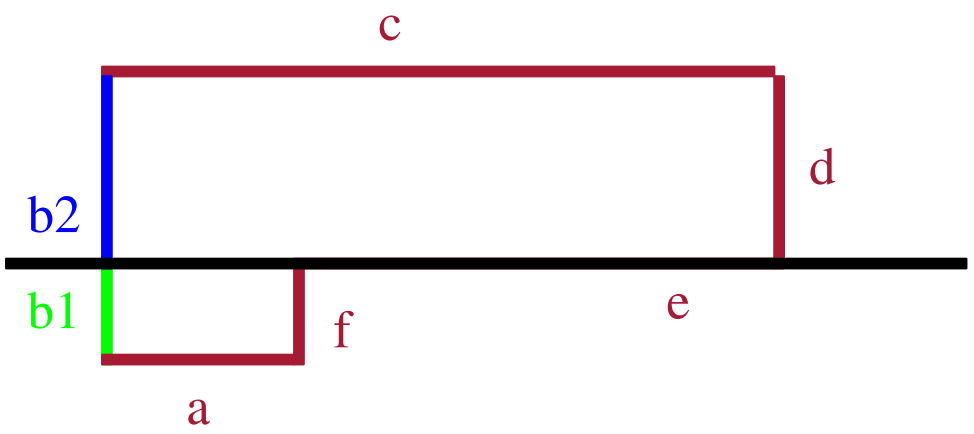
- and the tree to empty
  - the tree will be a binary tree, built by a number of 3 item lists
    - in the list, element 0, is the left, which represents behind,
    - middle, element 1, is the node label
    - right, element 2, means forward
    - forward means right for a vertical line
    - forward means above a horizontal line
  - the algorithm will create a binary tree of ordered lines
  - the algorithm keeps recursing until each node is a label (rather than a list)
  - and each leaf contains a label (rather than a list)

BSP trees

```
polyList = [a, b, c, d, e, f]
tree     = []
```

BSP trees

- we will choose an existing line to perform the split (marked in black)

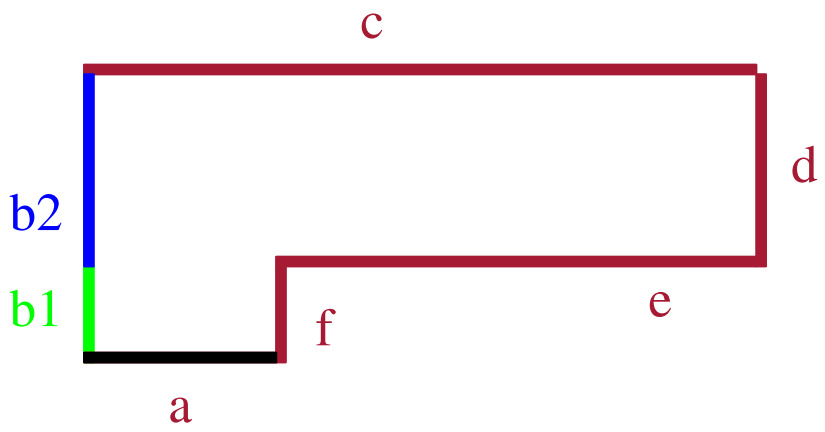


BSP trees

```
polyList = [a, b1, b2, c, d, e, f]
tree = [makeTree ([b1, a, f]),  # left node, below
        e,                      # pivot node
        makeTree ([b2, c, d])]  # right node, above
```

- we will call `makeTree ([b1, a, f])`

makeTree ([b1, a, f])

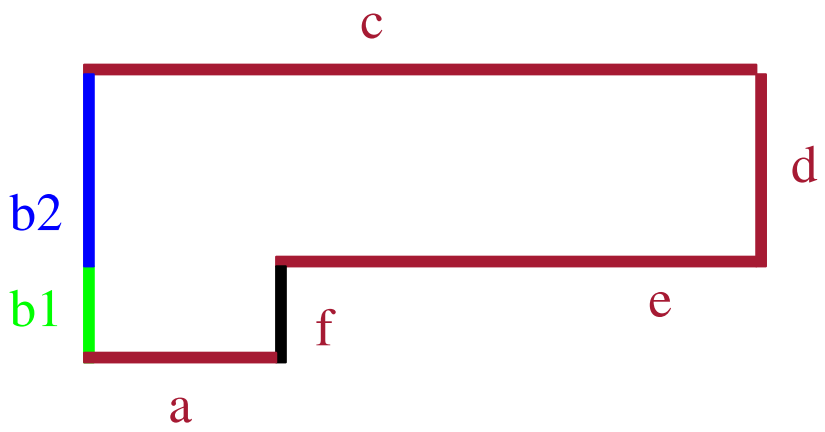


makeTree ([b1, a, f])

```
polyList = [b1, a, f]

tree = [combineTree ([],    # left, below
                     a,
                     makeTree ([b1, f])]  # right, above
```

makeTree ([b1, f])



makeTree ([b1, f])

```
tree = [b1, f, []]
```

- therefore the caller to `makeTree` now creates the tree as:

```
tree = [combineTree ([],  # left, below
                     a,   # pivot node
                     makeTree ([b1, f])]  # right, above
tree = [a, b1, f]
```

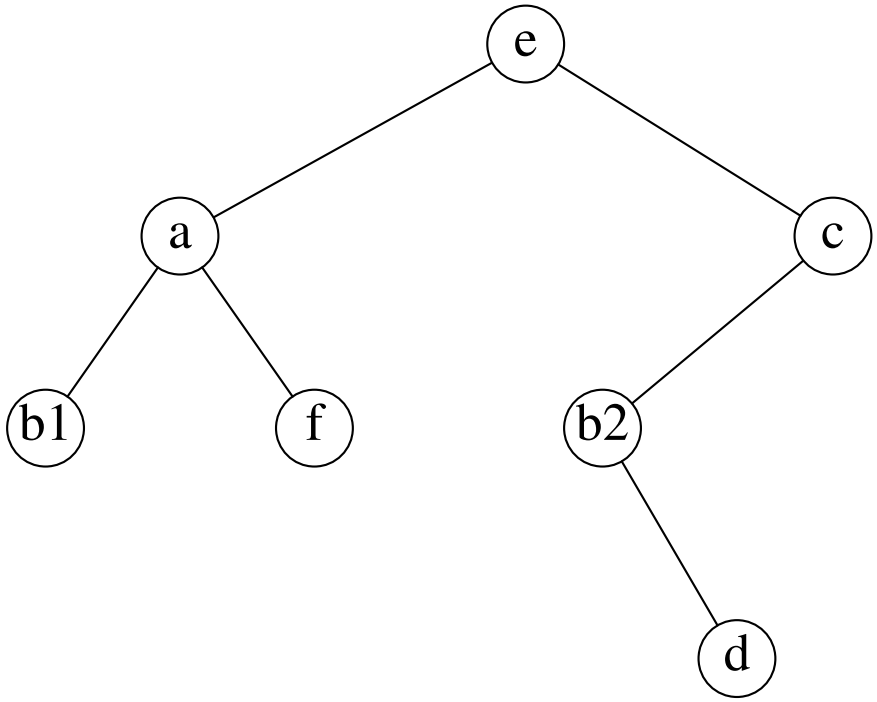
makeTree ([b1, f])

- and the caller to this `makeTree`

```
tree = [makeTree ([a, b1, f]),  # left, below
        e,
        makeTree ([b2, c, d])]  # right, above
```

```
tree = [[a, b1, f],     # left, below
        e,
        makeTree ([b2, c, d])] # right, above
```

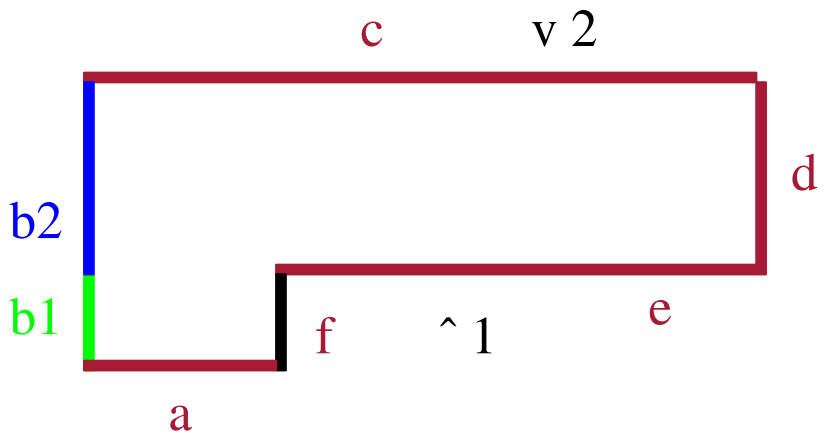
BSP tree



Display BSP Tree algorithm

```
PROCEDURE displayTree (tree)
BEGIN
   IF tree # NIL
   THEN
      IF Viewer is in front of tree->line
      THEN
         (* display back child, root, front child.  *)
         displayTree (tree->left) ;  (* back.  *)
         displayLine (tree->line) ;
         displayTree (tree->right)   (* front.  *)
      ELSE
         (* display front child, root and back child.  *)
         displayTree (tree->right) ;  (* front.  *)
         displayLine (tree->line) ;
         displayTree (tree->left)    (* back.  *)
      END
   END
END displayTree ;
```

Display BSP Tree algorithm



Line (polygon) display order using the bsp tree and display algorithm

- given position 1 (facing upwards)
  - c, b2, d, e, b1, a, f
- given position 2 (facing downwards)
  - b1, a, f, e, b2, d, c