In [1]:
```
# Import and initiate
from project_02.forest import Tree
from tic_tac_toe import TicTacToe
from connect_four import ConnectFour

ttt = TicTacToe()
c4 = ConnectFour()
```

GameAI

Project 02 - Game trees and path planning

ToDo

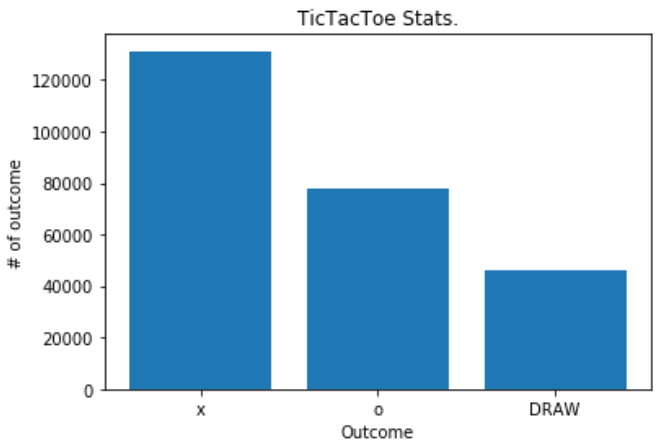
- 2.1 - The tic tac toe game tree
  - 2.1.1 - Use a graph instead of tree
- 2.2 - MinMax computations
- 2.3 - MinMax search for Connect4
- 2.4 - Breakout
- 2.5 - Path planning

2.1 - The tic tac toe game tree

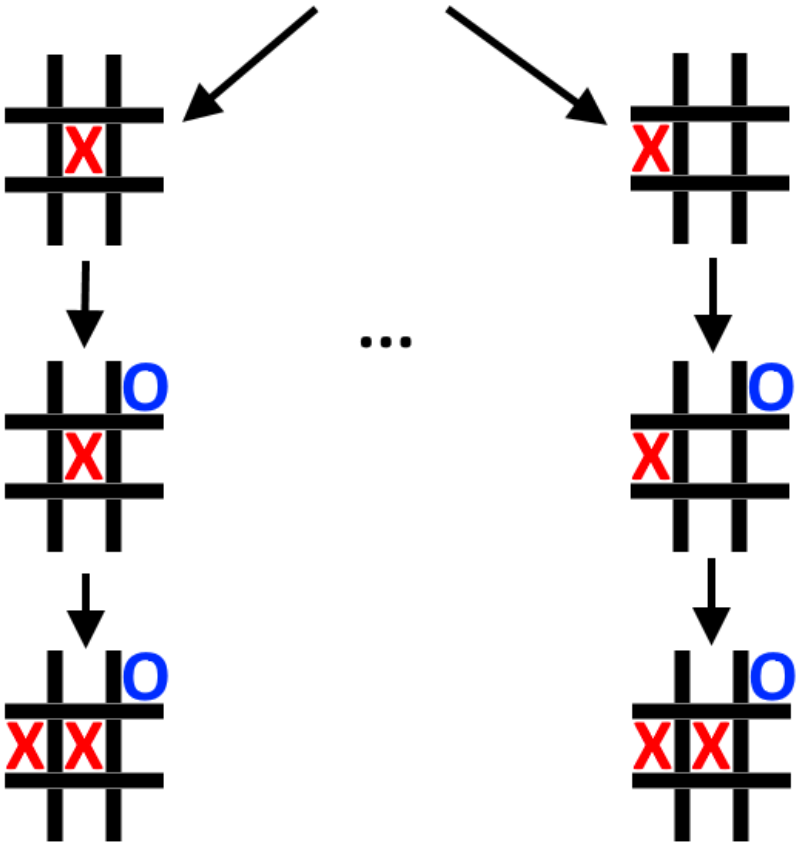
In [2]:
```
%%time
# Get the game tree data
data = ttt.build_game_tree(ttt.S, ttt.p)
print(data)
```

```
({1: 131184, -1: 77904}, 46080, 549945, 294778)
CPU times: user 1min 2s, sys: 1.48 s, total: 1min 4s
Wall time: 1min 2s
```

In [3]:
```
# Plot the tree info
ttt.plot_bar(statistics={1:data[0][1], -1:data[0][-1], 0:data[1]})
```



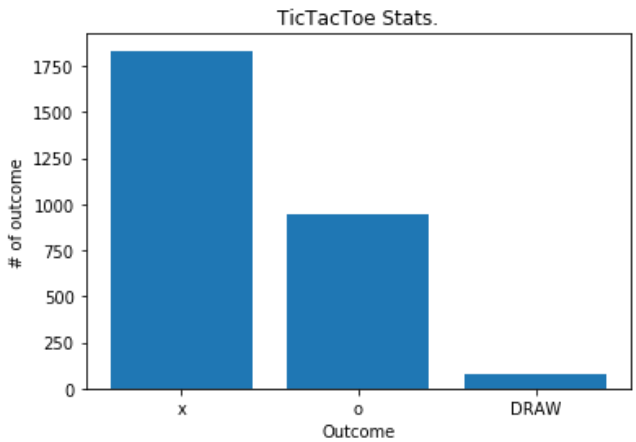
- Branching factor: 1.8656 (549945 / 294779)



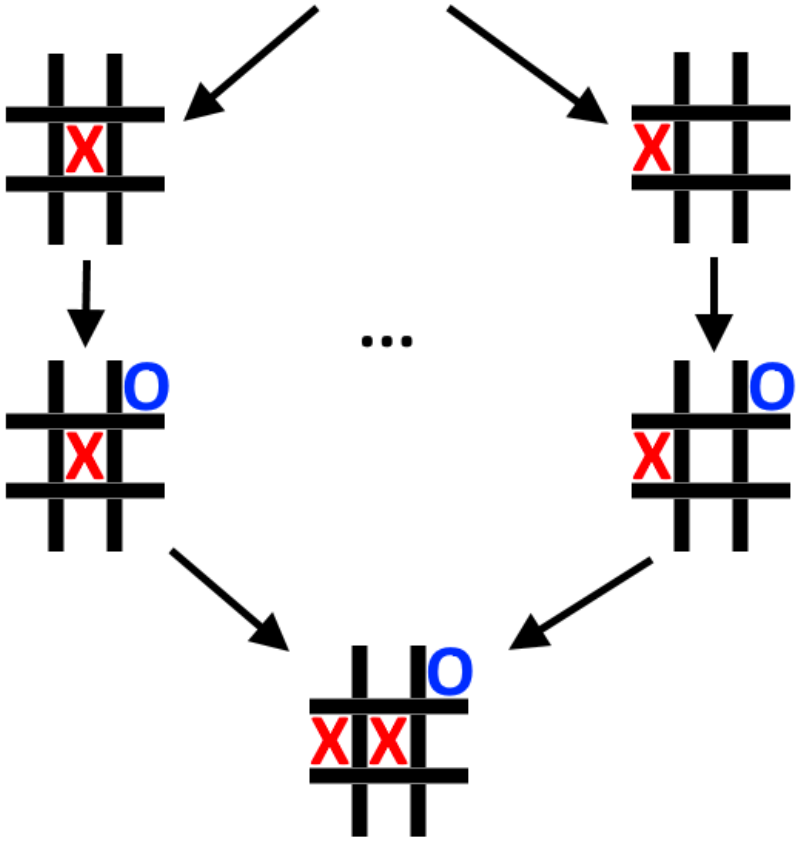
In [4]:
```
%%time
# Get game graph data
gdata = ttt.build_game_graph(ttt.S, ttt.p)
print(gdata)
```

```
({1: 1834, -1: 948}, 80, 16167, 4520, <networkx.classes.graph.Graph objec
t at 0x7f58633a61d0>)
CPU times: user 2.26 s, sys: 207 ms, total: 2.46 s
Wall time: 2.25 s
```

In [5]:
```
# Plot the graph info
ttt.plot_bar(statistics={1:gdata[0][1], -1:gdata[0][-1], 0:gdata[1]})
```



- Branching factor: 3.576 (16167 / 4521)



2.2 - MinMax computations

In [6]:
```
# Setup the tree
tree = Tree(root_label='n0')

for i in range(1,6):
    tree.root.add_child(label='n{}'.format(i))

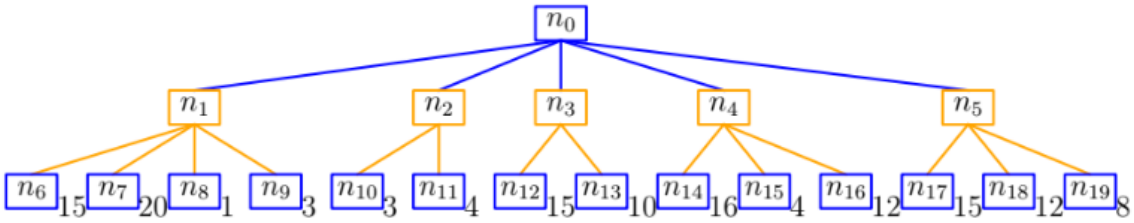
for i,v in enumerate([15,20,1,3]):
    tree.root.children[0].add_child(label='n{}'.format(i+6), value=v)

for i,v in enumerate([3,4]):
    tree.root.children[1].add_child(label='n{}'.format(i+10), value=v)

for i,v in enumerate([15,10]):
    tree.root.children[2].add_child(label='n{}'.format(i+12), value=v)

for i,v in enumerate([16,4,12]):
    tree.root.children[3].add_child(label='n{}'.format(i+14), value=v)

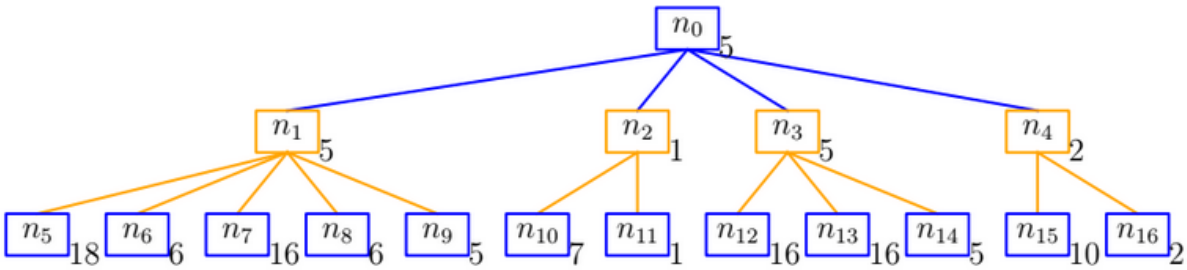
for i,v in enumerate([15,12,8]):
    tree.root.children[4].add_child(label='n{}'.format(i+17), value=v)
```




```
In [7]: tree.calculate_mmv(print_info=True)
```

```
[INFO] Used '-1' and picked '1' of node 'n8'.
[INFO] Used '-1' and picked '3' of node 'n10'.
[INFO] Used '-1' and picked '10' of node 'n13'.
[INFO] Used '-1' and picked '4' of node 'n15'.
[INFO] Used '-1' and picked '8' of node 'n19'.
[INFO] Used '1' and picked '10' of node 'n3'.
```

```
Out[7]: (10, 'n3')
```

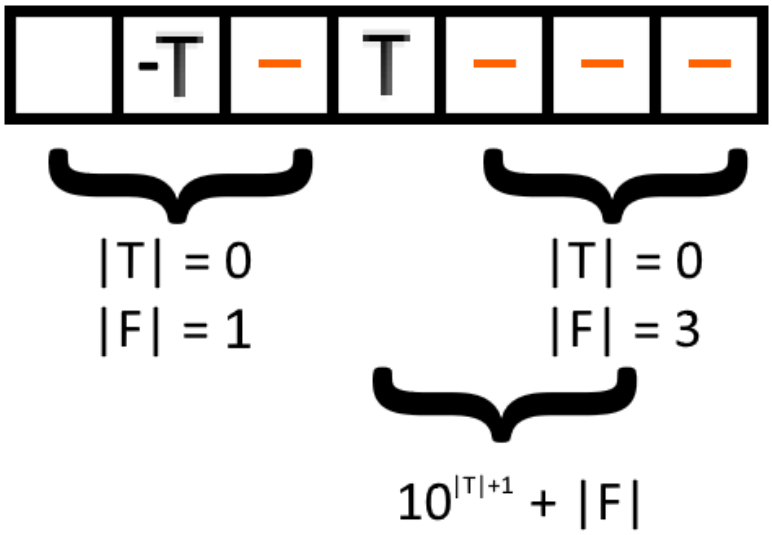


- Update n1 and n3 value
  - Iterate over sub-nodes
- Do the same on sub-nodes
- Increases everything

2.3 - MinMax search for Connect4

Get some value

- $value(Token) = \begin{cases} 10^{|tokens|} + |free|, & \text{if } |token + free| \geq 3 \\ 0, & \text{otherwise} \end{cases}$
  - For each direction
- $value(State) = value(Yellow) - value(Red)$

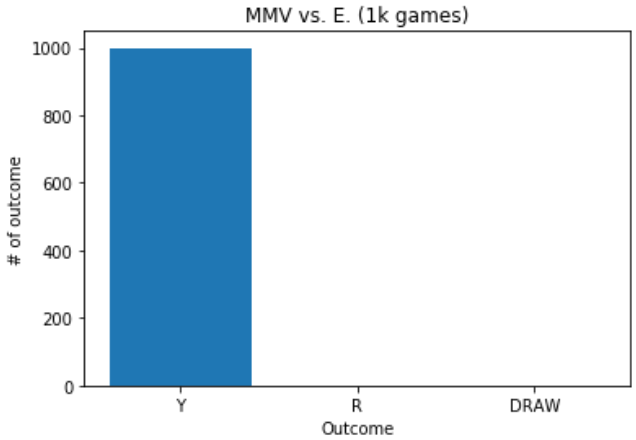


Tournament (1k games)

In [10]:
```
%%time
c4.reset_game()
tournament_results = c4.play_a_tournament(use_mmv=True)
```

```
=== Lap: 0 ===
'Y'     1
'R'     0
DRAW    0
=== Lap: 100 ===
'Y'     101
'R'     0
DRAW    0
=== Lap: 200 ===
'Y'     201
'R'     0
DRAW    0
=== Lap: 300 ===
'Y'     301
'R'     0
DRAW    0
=== Lap: 400 ===
'Y'     401
'R'     0
DRAW    0
=== Lap: 500 ===
'Y'     501
'R'     0
DRAW    0
=== Lap: 600 ===
'Y'     601
'R'     0
DRAW    0
=== Lap: 700 ===
'Y'     701
'R'     0
DRAW    0
=== Lap: 800 ===
'Y'     801
'R'     0
DRAW    0
=== Lap: 900 ===
'Y'     901
'R'     0
DRAW    0
Tournament results in:
'Y'     999
'R'     1
DRAW    0
CPU times: user 24min 12s, sys: 355 ms, total: 24min 12s
Wall time: 24min 12s
```

In [11]:
```
c4.plot_bar(label="MMV vs. E. (1k games)", statistics=tournament_results
)
```



2.4 - Breakout

Controler

- Observe 'Ball'
  - ```
    If ball.center < paddle.x and ball.center > paddle.x + paddle.widt
    h:
        paddle.move(key_left or key_right)
    ```

- Ball outruns paddle
  - paddle.speed is fixed

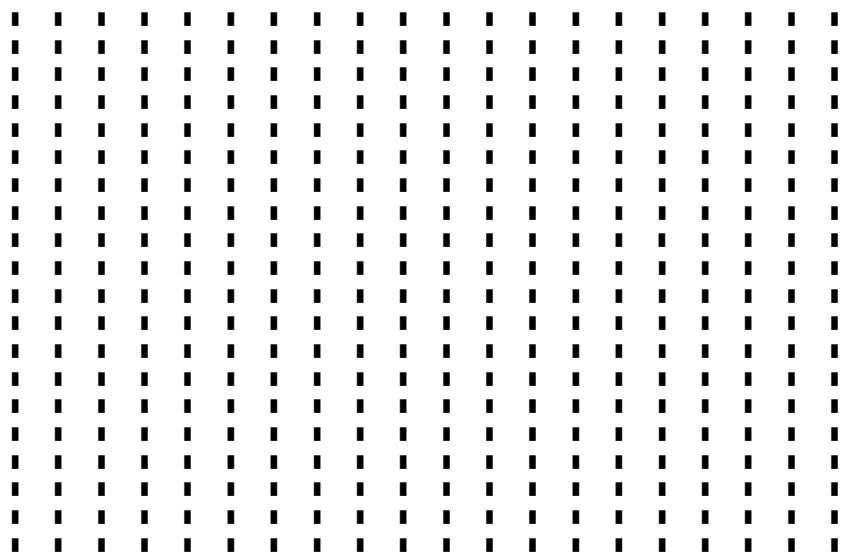
- Colision checking malfunctions at a to high speed
  - paddle.speed increases

2.5 - Path planning

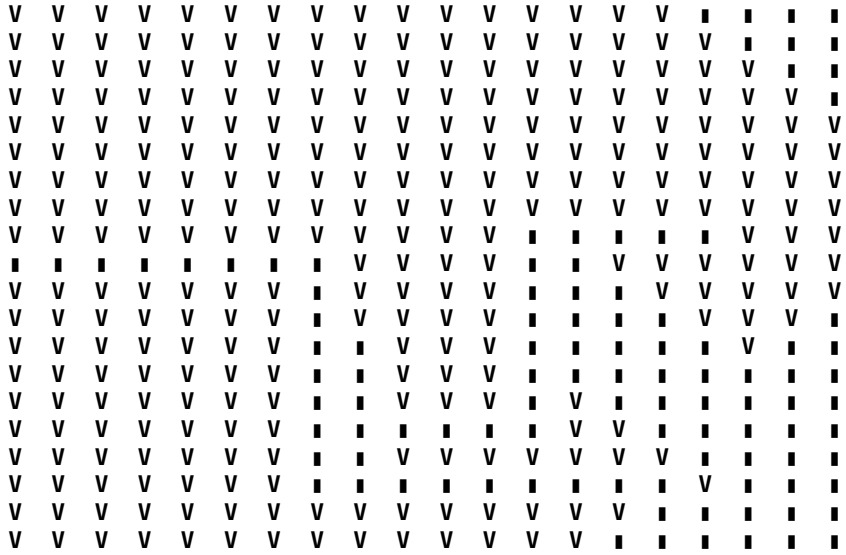
In [1]:
```
from project_02.mapper import Map

m = Map("project_02/simpleMap-1-20x20.txt")
```
```

In [2]:
```
m.print_map()
```



In [4]:
```
path = m.get_dijkstra_path((0,10), (15,1), use_nx=False, symbol_print=False)
```



In [5]:
```
path_a = m.get_astar_path((0,10), (15,1), use_nx=False, symbol_print=False)
```