In [1]:
```
from grammar import *
from parser import *
from util2 import *
```

The given PCFG:

In [2]:
```
print str(timeFliesPCFG)
```

```
Noun => flies    | 0.4
Noun => arrow    | 0.4
Noun => time     | 0.2
TOP => S         | 1.0
Det => an        | 1.0
VP => Verb NP    | 0.6
VP => Verb PP    | 0.2
VP => Verb       | 0.1
VP => Verb NP_PP         | 0.1
S => VP | 0.2
S => NP VP       | 0.5
S => VP PP       | 0.1
S => NP VP_PP    | 0.2
VP_PP => VP PP   | 1.0
NP_PP => NP PP   | 1.0
Prep => like     | 1.0
PP => Prep NP    | 1.0
Verb => flies    | 0.5
Verb => like     | 0.2
Verb => time     | 0.3
NP => Det Noun   | 0.7
NP => Noun       | 0.3
```

The sentence we wish to parse:

In [3]:
```
print timeFliesSent
```

```
['time', 'flies', 'like', 'an', 'arrow']
```

Expected output:

```
(TOP:
    (S:
        (NP: (Noun: 'time'))
        (VP:
            (Verb: 'flies')
            (PP: (Prep: 'like') (NP: (Det: 'an') (Noun: 'arrow'))))))
```

Actual output:

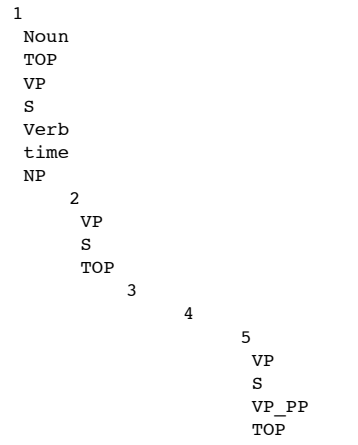
In [4]:
```
print parse(timeFliesPCFG, timeFliesSent)
```

```
(TOP:
  (S:
    (NP: (Noun: 'time'))
    (VP:
      (Verb: 'flies')
      (PP: (Prep: 'like') (NP: (Det: 'an') (Noun: 'arrow'))))))
```

The chart produced:

In [5]:
```
chart = cky(timeFliesPCFG, timeFliesSent, pruningPercent=None)
printChart(chart,timeFliesSent, widths=(5,11,7,3,2), printBackPointers=False, printProbs=False)
```

```
row0_____________________________
```


1
Noun
TOP
VP
S
Verb
time
NP
2
VP
S
TOP
3
4
5
VP
S
VP_PP
TOP
row1_____
1
2
flies
Noun
TOP
VP
S
Verb
NP
3
S
TOP
4
5
VP
NP_PP
S
VP_PP
TOP
row2_____
1
2
3
like
TOP
VP
S
Verb
Prep
4
5
VP
PP
S
row3_____
1
2
3
4
Det
an
5
NP
row4_____
1
2
3

```
                    4
                         5
                          NP
                          Noun
                          arrow
______________________________
```

In [6]:
```python
printChart(chart,timeFliesSent, widths=(5,11,7,3,2), printBackPointers=True)
```

```
row0____________________________________________________________________________________________________

1
 Noun  time[0:1]  None    -1.61
 TOP   S[0:1]     None    -5.12
 VP    Verb[0:1]  None    -3.51
 S     VP[0:1]    None    -5.12
 Verb  time[0:1]  None    -1.20
 time  None       None    0.00
 NP    Noun[0:1]  None    -2.81
                            2
                             VP    Verb[0:1]  NP[1:2] -3.84
                             S     VP[0:2]    None    -5.44
                             TOP   S[0:2]     None    -6.50
                                                        3
                                                                                   4
                                                                                                            5
                                                                                                             VP    Verb[0:1]  NP_PP[1:5] -6.90
                                                                                                             S     NP[0:1]    VP[1:5] -7.08
                                                                                                             VP_PP VP[0:2]    PP[2:5] -5.11
                                                                                                             TOP   S[0:5]     None    -7.08
row1____________________________________________________________________________________________________

1
                            2
                             flies None       None    0.00
                             Noun  flies[1:2] None    -0.92
                             TOP   S[1:2]     None    -4.61
                             VP    Verb[1:2]  None    -3.00
                             S     VP[1:2]    None    -4.61
                             Verb  flies[1:2] None    -0.69
                             NP    Noun[1:2]  None    -2.12
                                                        3
                                                         S     NP[1:2]    VP[2:3] -6.73
                                                         TOP   S[1:3]     None    -6.73
                                                                                   4
                                                                                                            5
                                                                                                             VP    Verb[1:2]  PP[2:5] -3.58
                                                                                                             NP_PP NP[1:2]    PP[2:5] -3.39
                                                                                                             S     VP[1:5]    None    -5.18
                                                                                                             VP_PP VP[1:2]    PP[2:5] -4.27
                                                                                                             TOP   S[1:5]     None    -6.21
row2____________________________________________________________________________________________________

1
                            2
                                                        3
                                                         like  None       None    0.00
                                                         TOP   S[2:3]     None    -5.52
                                                         VP    Verb[2:3]  None    -3.91
                                                         S     VP[2:3]    None    -5.52
                                                         Verb  like[2:3]  None    -1.61
                                                         Prep  like[2:3]  None    0.00
                                                                                   4
                                                                                                            5
                                                                                                             VP    Verb[2:3]  NP[3:5] -3.39
                                                                                                             PP    Prep[2:3]  NP[3:5] -1.27
                                                                                                             S     VP[2:5]    None    -5.00
row3____________________________________________________________________________________________________
```

1
2
3
4
Det an[3:4] None 0.00
an None None 0.00
5
NP Det[3:4] Noun[4:5] -1.27

row4

1
2
3
4
5
NP Noun[4:5] None -2.12
Noun arrow[4:5] None -0.92
arrow None None 0.00