CKY Parsing

A worked example

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 $S \rightarrow NP VP$

 $NP \rightarrow N$

 $PP \rightarrow P NP$

The grammar: Binary, no epsilons,

0.9

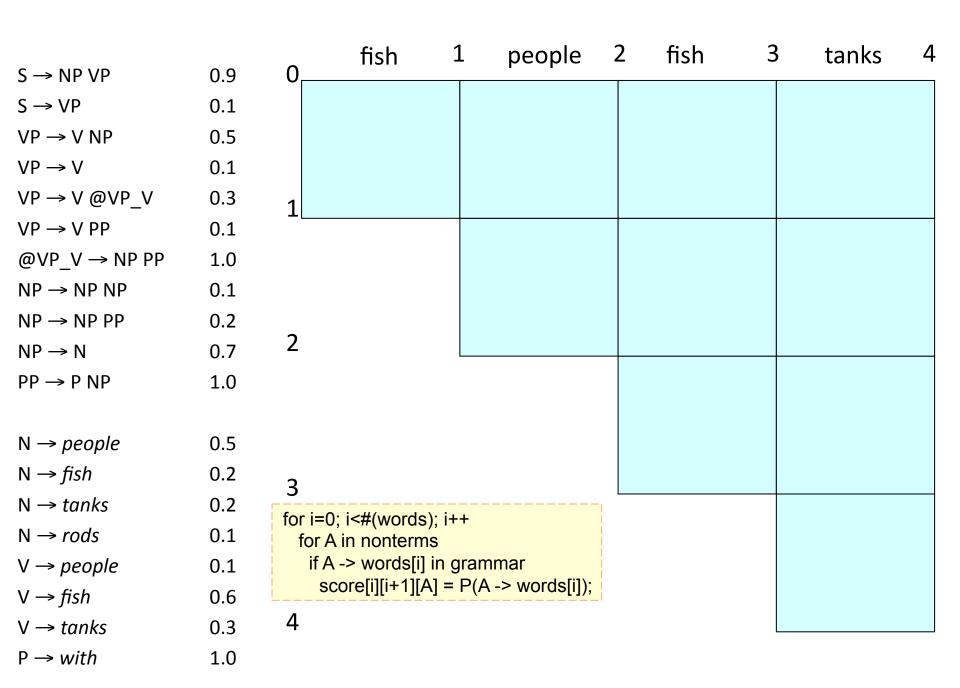
0.7

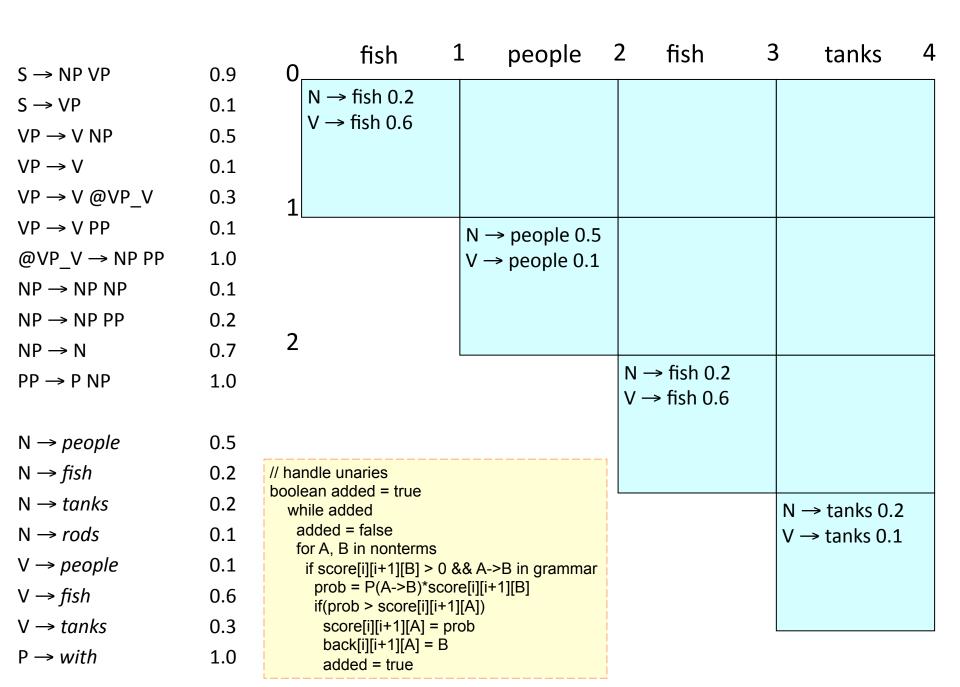
1.0

J FINI VI	0.5
$S \rightarrow VP$	0.1
$VP \rightarrow V NP$	0.5
$VP \rightarrow V$	0.1
$VP \rightarrow V @VP_V$	0.3
$VP \rightarrow VPP$	0.1
$@VP_V \rightarrow NPPP$	1.0
$NP \rightarrow NP NP$	0.1
$NP \rightarrow NP PP$	0.2

$$N \rightarrow people$$
 0.5
 $N \rightarrow fish$ 0.2
 $N \rightarrow tanks$ 0.2
 $N \rightarrow rods$ 0.1
 $V \rightarrow people$ 0.1
 $V \rightarrow fish$ 0.6
 $V \rightarrow tanks$ 0.3
 $P \rightarrow with$ 1.0

0_	fish 1	L people	2 fish	3 tanks 4
1	score[0][1]	score[0][2]	score[0][3]	score[0][4]
2		score[1][2]	score[1][3]	score[1][4]
3			score[2][3]	score[2][4]
4				score[3][4]





C NDVD	0.0	fish 1 people 2 fish 3	tanks 4
$S \rightarrow NP VP$	0.9	$0 \longrightarrow \text{fish } 0.2$	
$S \rightarrow VP$	0.1	$V \rightarrow \text{fish } 0.6$	
$VP \rightarrow V NP$	0.5	$NP \rightarrow N \ 0.14$	
$VP \rightarrow V$	0.1	$VP \rightarrow V 0.06$	
$VP \rightarrow V @VP_V$	0.3	$\begin{array}{c} 1 \\ S \rightarrow VP \ 0.006 \end{array}$	
$VP \rightarrow VPP$	0.1	N → people 0.5	
$@VP_V \rightarrow NPPP$	1.0	V → people 0.1	
$NP \rightarrow NP NP$	0.1	NP → N 0.35	
$NP \rightarrow NP PP$	0.2	$VP \rightarrow V 0.01$	
$NP \rightarrow N$	0.7	$2 \qquad \qquad S \rightarrow VP \ 0.001$	
$PP \rightarrow P NP$	1.0	$N \rightarrow \text{fish } 0.2$	
		$V \rightarrow \text{fish } 0.6$	
$N \rightarrow people$	0.5	$\begin{array}{c} NP \rightarrow N \ 0.14 \\ VP \rightarrow V \ 0.06 \end{array}$	
$N \rightarrow fish$	0.2	3 S → VP 0.006	
$N \rightarrow tanks$	0.2		→ tanks 0.2
$N \rightarrow rods$	0.1	prob=score[begin][split][B]*score[split][end][C]*P(A->BC) if (prob > score[begin][end][A])	→ tanks 0.1
$V \rightarrow people$	0.1	score[begin]end][A] = prob	P → N 0.14
$V \rightarrow fish$	0.6		$P \rightarrow V 0.03$
$V \rightarrow tanks$	0.3	4	→ VP 0.003
$P \rightarrow with$	1.0		

C - ND VD	0.0	0_	fish í	l people	2 fish	3 tanks 4
$S \rightarrow NP VP$	0.9	_	N → fish 0.2	NP → NP NP		
$S \rightarrow VP$	0.1		$V \rightarrow fish 0.6$	0.0049		
$VP \rightarrow V NP$	0.5		$NP \rightarrow N \ 0.14$	VP → V NP		
$VP \rightarrow V$	0.1		$VP \rightarrow V 0.06$	0.105		
$VP \rightarrow V @VP_V$	0.3	1	$S \rightarrow VP 0.006$	$S \rightarrow NP VP$ 0.00126		
$VP \rightarrow VPP$	0.1			$N \rightarrow \text{people } 0.5$	NP → NP NP	
$@VP_V \rightarrow NPPP$	1.0			$V \rightarrow \text{people 0.1}$	0.0049	
$NP \rightarrow NP NP$	0.1			NP → N 0.35	$VP \rightarrow V NP$ 0.007	
$NP \rightarrow NP PP$	0.2	_		$VP \rightarrow V 0.01$ S \rightarrow VP 0.001	$S \rightarrow NP VP$	
$NP \rightarrow N$	0.7	2		3 → VP 0.001	0.0189	
$PP \rightarrow P NP$	1.0				$N \rightarrow \text{fish } 0.2$	$\begin{array}{c} NP \rightarrow NP NP \\ 0.00196 \end{array}$
					$V \rightarrow \text{fish } 0.6$ NP \rightarrow N 0.14	VP → V NP
$N \rightarrow people$	0.5		//handle unaries		$VP \rightarrow V 0.06$	0.042
$N \rightarrow fish$	0.2	3	boolean added = tru	ıe	$S \rightarrow VP 0.006$	$S \rightarrow NP VP$ 0.00378
$N \rightarrow tanks$	0.2	3	while added added = false			N → tanks 0.2
$N \rightarrow rods$	0.1		for A, B in nonterms			V → tanks 0.1
V → people	0.1		if prob > score[be	core[begin][end][B]; egin][end][A]		NP → N 0.14
V → fish	0.6		score[begin][end][A] = prob back[begin][end][A] = B			$VP \rightarrow V 0.03$
$V \rightarrow tanks$	0.3	4	added = true	 		$S \rightarrow VP 0.003$
$P \rightarrow with$	1.0					

C - ND VD	0.0	fish 1 people 2 fish 3	3 tanks 4
$S \rightarrow NP VP$	0.9	$N \rightarrow \text{fish } 0.2$ NP \rightarrow NP NP	
$S \rightarrow VP$	0.1	$V \rightarrow \text{fish } 0.6$ 0.0049	
$VP \rightarrow V NP$	0.5	$NP \rightarrow N \ 0.14$ $VP \rightarrow V \ NP$	
$VP \rightarrow V$	0.1	$VP \rightarrow V \ 0.06 \qquad \begin{array}{c} 0.105 \\ S \rightarrow VP \end{array}$	
$VP \rightarrow V @VP_V$	0.3	1 S \rightarrow VP 0.006 0.0105	
$VP \rightarrow VPP$	0.1	$N \rightarrow \text{people } 0.5 NP \rightarrow NP NP$	
$@VP_V \rightarrow NPPP$	1.0	$V \rightarrow \text{people } 0.1$ 0.0049	
$NP \rightarrow NP NP$	0.1	$NP \rightarrow N \ 0.35$ $VP \rightarrow V \ NP$ 0.007	
$NP \rightarrow NP PP$	0.2	$ VP \rightarrow V 0.01 $ $ S \rightarrow NP VP$	
$NP \rightarrow N$	0.7	2 $S \rightarrow VP 0.001$ 0.0189	
$PP \rightarrow P NP$	1.0	$N \rightarrow \text{fish } 0.2$	$NP \rightarrow NP NP$
		$V \rightarrow \text{fish } 0.6$	$\begin{array}{c} 0.00196 \\ VP \rightarrow V NP \end{array}$
$N \rightarrow people$	0.5	$NP \rightarrow N \ 0.14$ $VP \rightarrow V \ 0.06$	0.042
$N \rightarrow fish$	0.2	$S \rightarrow VP \cap OOG$	$S \rightarrow VP$
N → tanks	0.2	3	0.0042
$N \rightarrow rods$	0.1	for split = begin+1 to end-1	N → tanks 0.2 V → tanks 0.1
		for A,B,C in nonterms	$V \rightarrow talks 0.1$ NP $\rightarrow N 0.14$
$V \rightarrow people$	0.1	prob=score[begin][split][B]*score[split][end][C]*P(A->BC) if prob > score[begin][end][A]	$VP \rightarrow V 0.03$
$V \rightarrow fish$	0.6	score[begin]end][A] = prob	$S \rightarrow VP 0.003$
V → tanks	0.3	back[begin][end][A] = new Triple(split,B,C)	
$P \rightarrow with$	1.0		

C - NDVD	0.0	fish 1 people 2 fish 3	tanks 4
$S \rightarrow NP VP$	0.9	$N \rightarrow \text{fish } 0.2$ $NP \rightarrow NP NP$ $NP \rightarrow NP NP$	
$S \rightarrow VP$	0.1	$V \rightarrow \text{fish } 0.6$ 0.0049 0.0000686	
$VP \rightarrow V NP$	0.5	$NP \rightarrow N \ 0.14$ $VP \rightarrow V \ NP$ $VP \rightarrow V \ NP$ 0.105 0.00147	
$VP \rightarrow V$	0.1	$VP \rightarrow V \ 0.06$ $\begin{array}{c c} 0.105 & 0.00147 \\ S \rightarrow VP & S \rightarrow NP \ VP \end{array}$	
$VP \rightarrow V @VP_V$	0.3	1 $S \rightarrow VP \ 0.006$ 0.0105 0.000882	
$VP \rightarrow VPP$	0.1	$N \rightarrow \text{people } 0.5 NP \rightarrow NP NP$	
$@VP_V \rightarrow NPPP$	1.0	$V \rightarrow \text{people } 0.1$ $VP \rightarrow VNP$	
$NP \rightarrow NP NP$	0.1	$ NP \rightarrow N 0.35 $ 0.007	
$NP \rightarrow NP PP$	0.2	$VP \rightarrow V 0.01$ $S \rightarrow NP VP$	
$NP \rightarrow N$	0.7	2 $S \rightarrow VP \ 0.001$ 0.0189	
$PP \rightarrow P NP$	1.0	1.0.1.0.1	→ NP NP 0.00196
		$V \rightarrow \text{fish } 0.6$ $NP \rightarrow N \ 0.14$	→ V NP
$N \rightarrow people$	0.5	$VP \rightarrow V \cap 06$	0.042
$N \rightarrow fish$	0.2	$S \rightarrow VP \ 0.006$	→ VP 0.0042
$N \rightarrow tanks$	0.2		→ tanks 0.2
$N \rightarrow rods$	0.1	for split = begin+1 to end-1	→ tanks 0.1
$V \rightarrow people$	0.1	for A,B,C in nonterms prob=score[begin][split][B]*score[split][end][C]*P(A->BC)	P → N 0.14
V → fish	0.6		$V \rightarrow V 0.03$
V → tanks	0.3	4 back[begin][end][A] = new Triple(split,B,C)	→ VP 0.003
$P \rightarrow with$	1.0		

S → NP VP	0.9	fish 1 people 2 fish 3	tanks 4
$S \rightarrow VP$	0.9	$N \rightarrow \text{fish } 0.2$ $NP \rightarrow NP NP$ $NP \rightarrow NP NP$	
VP → V NP	0.5	$V \rightarrow \text{fish } 0.6$ $VP \rightarrow V NP$ $VP \rightarrow V NP$ $VP \rightarrow V NP$ $VP \rightarrow V NP$	
$VP \rightarrow V$	0.1	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	
$VP \rightarrow V @VP_V$	0.3	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	
$VP \rightarrow VPP$	0.1		IP → NP NP
$@VP_V \rightarrow NP PP$	1.0	$V \rightarrow \text{people } 0.1$	0.0000686
$NP \rightarrow NP NP$	0.1	$ NP \rightarrow N 0.35 $ 0.007	$P \rightarrow V NP$ 0.000098
$NP \rightarrow NP PP$	0.2	$VP \rightarrow V 0.01$ $S \rightarrow NP VP$ S	→ NP VP
$NP \rightarrow N$	0.7	0.0189	0.01323
$PP \rightarrow P NP$	1.0	17 11511 512	IP → NP NP 0.00196
		$V \rightarrow \text{fish } 0.6$ $NP \rightarrow N \ 0.14$	'P → V NP
$N \rightarrow people$	0.5	$VP \rightarrow V \cap 06$	0.042
$N \rightarrow fish$	0.2	$S \rightarrow VP \ 0.006$	→ VP 0.0042
$N \rightarrow tanks$	0.2	_	I → tanks 0.2
$N \rightarrow rods$	0.1	for split = begin+1 to end-1	′ → tanks 0.1
$V \rightarrow people$	0.1	prob-score[begin][spin][b] score[spin][end][c] r (A->bc)	IP → N 0.14
$V \rightarrow fish$	0.6		$VP \rightarrow V 0.03$
V → tanks	0.3	back[begin][end][A] = new Triple(split,B,C)	→ VP 0.003
$P \rightarrow with$	1.0		

$S \rightarrow NP VP$	0.9	o fish 1 people 2 fish 3	3 tanks 4
$S \rightarrow VP$	0.9	$N \rightarrow \text{fish } 0.2$ $NP \rightarrow NP NP$ $NP \rightarrow NP NP$	$NP \rightarrow NP NP$
VP → V NP	0.5	$V \rightarrow \text{fish } 0.6$ $VP \rightarrow V NP$ $VP \rightarrow V NP$ $VP \rightarrow V NP$ $VP \rightarrow V NP$ $V \rightarrow V NP$	0.000009604 VP → V NP
$VP \rightarrow V$	0.1	$ \begin{array}{c ccccc} NP \rightarrow N & 0.14 \\ VP \rightarrow V & 0.06 \end{array} $ $ \begin{array}{c cccccc} VP \rightarrow V & NP \\ 0.105 & 0.00147 \end{array} $	0.00002058
VP → V @VP V	0.3	$ S \rightarrow VP \cap OOE$ $ S \rightarrow VP S \rightarrow NP VP$	$S \rightarrow NP VP$
$VP \rightarrow VPP$	0.1	$1 \longrightarrow VP 0.000 \qquad 0.0105 \qquad 0.000882$ $N \rightarrow \text{people } 0.5 \qquad NP \rightarrow NP NP$	0.00018522 $NP \rightarrow NP NP$
$@VP_V \rightarrow NPPP$	1.0	$V \rightarrow \text{people 0.1}$ 0.0049	0.0000686
$NP \rightarrow NP NP$	0.1	$NP \rightarrow N \ 0.35$ $VP \rightarrow V \ NP$ 0.007	$VP \rightarrow V NP$ 0.000098
$NP \rightarrow NP PP$	0.2	$VP \rightarrow V 0.01$ $S \rightarrow NP VP$	$S \rightarrow NP VP$
$NP \rightarrow N$	0.7	2 $S \rightarrow VP \ 0.001$ 0.0189	0.01323
$PP \rightarrow P NP$	1.0	$N \rightarrow \text{fish } 0.2$	$\begin{array}{c} NP \rightarrow NP NP \\ 0.00196 \end{array}$
		$V \rightarrow \text{fish } 0.6$ $NP \rightarrow N \ 0.14$	VP → V NP
$N \rightarrow people$	0.5	$VP \rightarrow V 0.06$	$\begin{array}{c} 0.042\\S \rightarrow VP \end{array}$
$N \rightarrow fish$	0.2	$S \rightarrow VP \ 0.006$	0.0042
$N \rightarrow tanks$	0.2	<u> </u>	N → tanks 0.2
$N \rightarrow rods$	0.1		V → tanks 0.1
$V \rightarrow people$	0.1		$NP \rightarrow N \ 0.14$
$V \rightarrow fish$	0.6		$VP \rightarrow V 0.03$
$V \rightarrow tanks$	0.3	4	$S \rightarrow VP 0.003$
$P \rightarrow with$	1.0	Call buildTree(score, back) to get the best parse	

CKY Parsing

A worked example