

Drawing trees with TikZ: Some tips and tricks

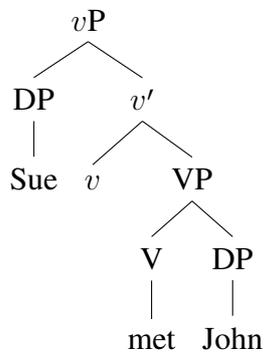
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January 22, 2021

1 Basic trees

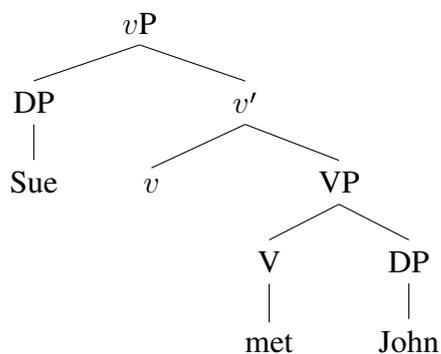
(1)



```
\ex.
\sameline
\begin{tikzpicture}
\Tree [.$v$P [.DP Sue ] [.$v'$ $v$ [.VP [.V met ] [.DP John ] ]]]
\end{tikzpicture}
```

Changing sibling distance:

(2)

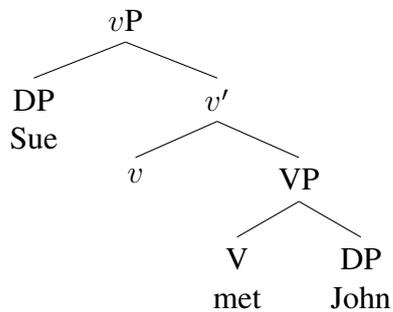


```
\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=2em}
\Tree [.$v$P [.DP Sue ] [.$v'$ $v$ [.VP [.V met ] [.DP John ] ]]]
\end{tikzpicture}
```

Other options: `level distance`. Any `\tikzset` can also be placed in the preamble, which will affect all trees in the document. For adjusting just one level (in one tree or globally), see the subsection on semantic denotations below.

Line breaks in nodes

(3)



```

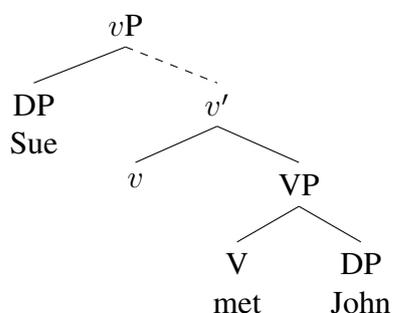
\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.$v$P DP\\{Sue} [.$v'$ $v$ [.VP V\\{met} DP\\{John} ]]]
\end{tikzpicture}

```

1.1 Edges

Dashed edge:

(4)



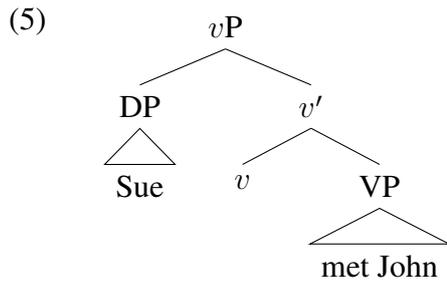
```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.$v$P DP\\{Sue} \edge[dashed]; [.$v'$ $v$ [.VP V\\{met}
DP\\{John} ]]]
\end{tikzpicture}

```

- Other options: `thick`, `semithick`, `very thick`, `white`
- This can be set for all levels:
e.g. `\tikzset{edge from parent/.append style={very thick}}`

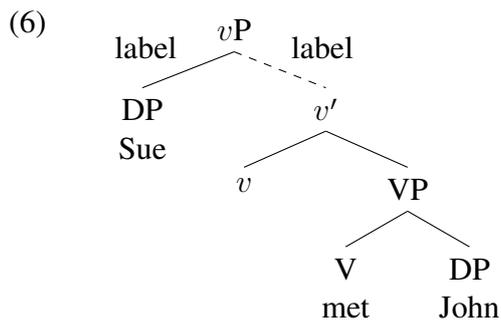
Roofs:



```
\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\Tree [.$v$P [.$v'$ $v$
[.VP \edge[roof]; {met John} ] ]]
\end{tikzpicture}
```

Note: Multiple words under a roof must be enclosed in {...}

Nodes on edges:

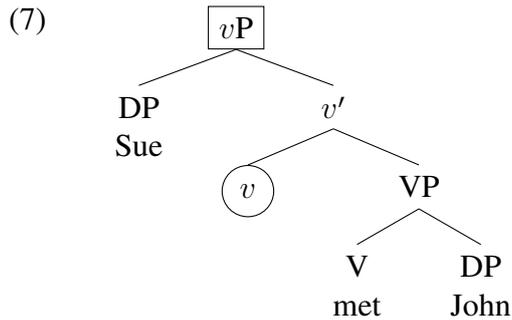


```
\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.$v$P \edge node[auto=right] {label} ; DP\\{Sue}
\edge[dashed] node[auto=left] {label} ;
[.$v'$ $v$ [.VP V\\{met} DP\\{John} ]]]
\end{tikzpicture}
```

1.2 Nodes

```
\node(node label){node text};
```

Boxed node:



```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.\node[draw](vp){$v$P}; DP\\{Sue}
[.\$v'$ \node[draw,circle](v){$v$}; [.\VP V\\{met} DP\\{John} ]]]
\end{tikzpicture}

```

Additional options: red, thick, dashed, rounded corners, etc.

2 Arrows

2.1 Basic arrows

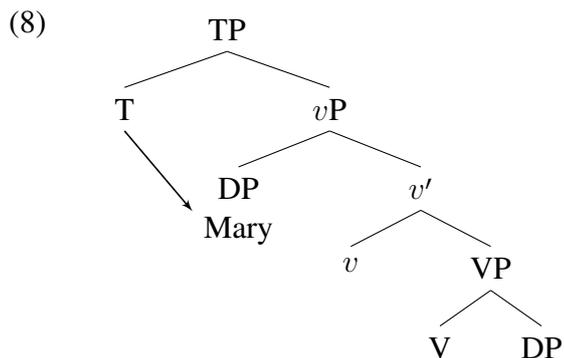
```

\draw[options] (node.directions) to (node.direction);

```

Directions: north, south, east, west, north west, south east, ...

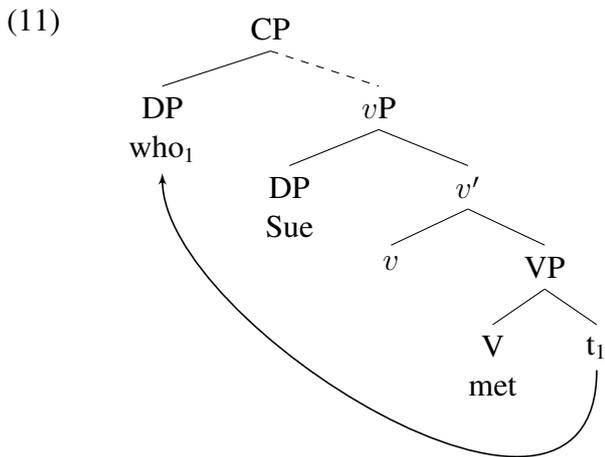
Straight line:



```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.\TP \node(t){T}; [.\$v$P \node(dp){DP\\{Mary}}];
[.\$v'$ $v$ [.\VP V DP ]]]]
\draw[->,semithick] (t.south) to (dp.west);
\end{tikzpicture}

```

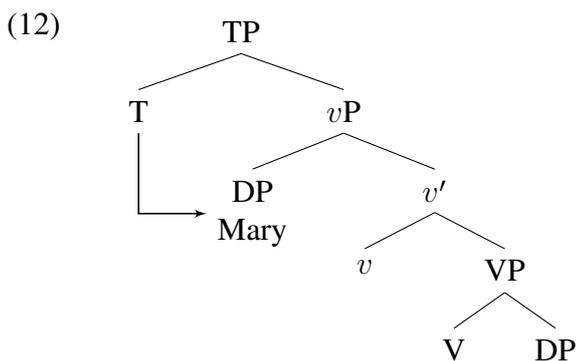
```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [ .CP \node{wh}{DP\{\{who\sub{1}\}\}}; \edge[dashed];
[ .\$v\$P DP\{\{Sue\} [ .\$v'\$ \$v\$
[ .VP V\{\{met\} \node{tr}{t\sub{1}\}}; ] ] ] ]
\draw[->,semithick] (tr.south) ..controls +(south:3)
and +(south:2)..(wh.south);
\end{tikzpicture}

```

Note: controls are difficult to understand, but basically act as ‘magnets’.

Right angles:

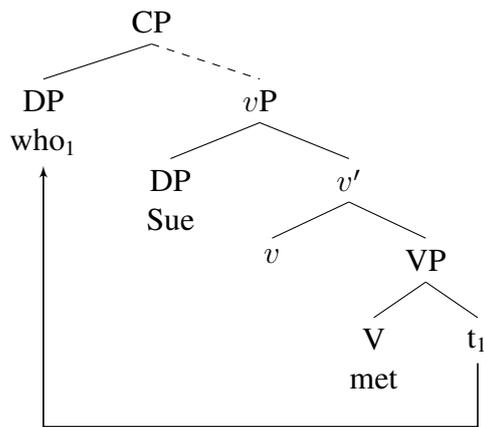


```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [ .TP \node{t}{T}; [ .\$v\$P \node{dp}{DP\{\{Mary\}\}};
[ .\$v'\$ \$v\$ [ .VP V DP ] ] ] ]
\draw[->,semithick] (t.south) |- (dp.west);
\end{tikzpicture}

```

(13)



\ex.

\sameline

\begin{tikzpicture}

\tikzset{sibling distance=1.5em}

\tikzset{every tree node/.style={align=center,anchor=north}}

\Tree [.CP \node{wh}{DP\{\{who\}_1\}}; \edge[dashed];

[\$v\$P DP\{\{Sue\} [\$v'\$ \$ \$v\$

[\$VP V\{\{met\} \node{tr}{t\}_1\};]]]

\draw[->,semithick] (tr.south) |- +(0,-2em) -| (wh.south);

\end{tikzpicture}

2.2 Line styles

Some options:

dashed, dotted, rounded corners, thick, semithick, very thick, <colors>

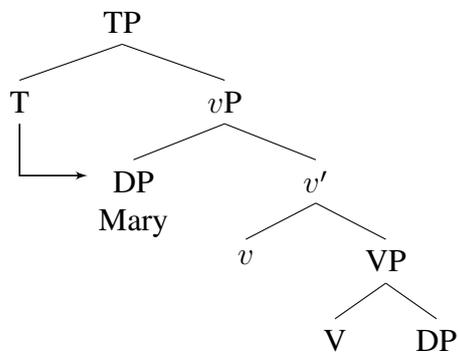
Arrow head styles: <-, ->, <->, o-o and **many** more

2.3 Offsets

([offset]node.direction) to ([offset]node.direction)

Right angle with y-offset:

(14)

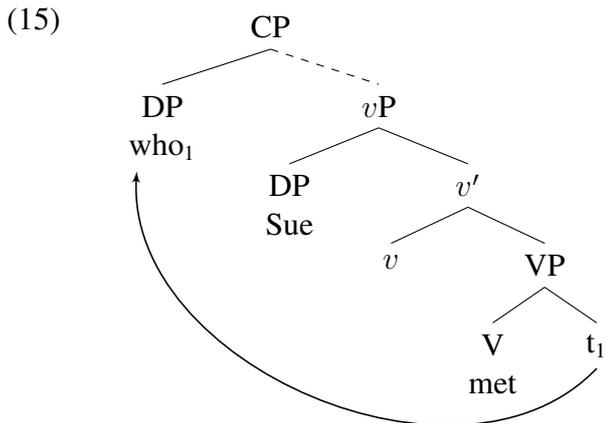


```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.\TP \node(t){T}; [.\$v\$P \node(dp){DP\\{Mary}}];
[.\$v'\$ \$v\$ [.\VP V DP ]]]
\draw[->,semithick] (t.south) |- ([yshift=0.8em]dp.west);
\end{tikzpicture}

```

Curved arrow with x-offset:



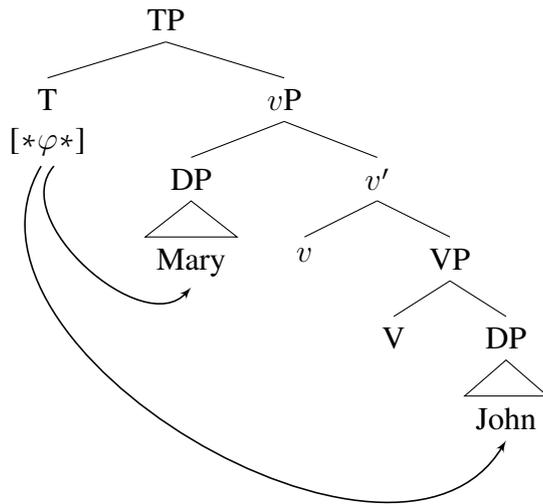
```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.\CP \node(wh){DP\\{who\sub{1}}}; \edge[dashed];
[.\$v\$P DP\\{Sue} [.\$v'\$ \$v\$
[.\VP V\\{met} \node(tr){t\sub{1}}]; ]]]
\draw[->,semithick] (tr.south) to [bend left=70]
([xshift=-0.8em]wh.south);
\end{tikzpicture}

```

Multiple offsets:

(16)



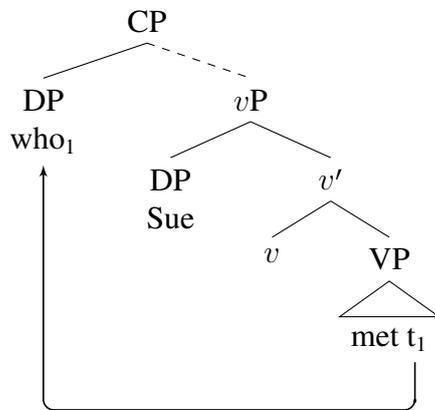
```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.TP \node(t){T\{\{[*\varphi*]\}}};
[.$v$P [.DP \edge[roof]; \node(dp){Mary}; ] [.$v'$ $v$
[.VP V [.DP \edge[roof]; \node(dp2){John}; ] ]]]
\draw[->,semithick] ([xshift=0.2em]t.south) to
[bend right=90] (dp.south);
\draw[->,semithick] ([xshift=-0.2em]t.south) to
[bend right=90] (dp2.south);
\end{tikzpicture}

```

Offset under roof:

(17)



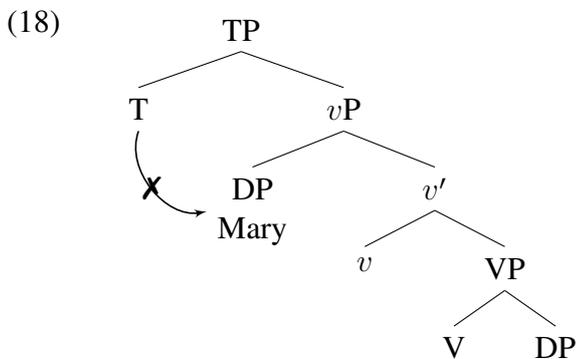
```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.CP \node(wh){DP\{\who\sub{1}\}}; \edge[dashed];
[. $v$P DP\{\Sue} [. $v'$ $ $v$
[.VP \edge[roof]; \node(tr){met t\sub{1}\}; ]]]
\draw[->,semithick,rounded corners] ([xshift=0.8em]tr.south)
|- +(0,-1.5em) -| (wh.south);
\end{tikzpicture}

```

2.4 Labels

(x) to node[options]{label} (y)



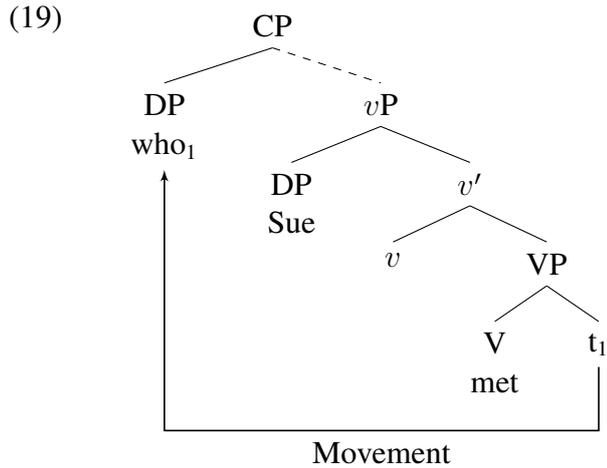
```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.TP \node(t){T}; [. $v$P \node(dp){DP\{\Mary}\};
[. $v'$ $ $v$ [.VP V DP ]]]]
\draw[->,semithick] (t.south)
to [bend right=60] node[midway] {\ding{55}} (dp.west);
\end{tikzpicture}

```

Options: above, below, midway, fill=white

Label on right angle

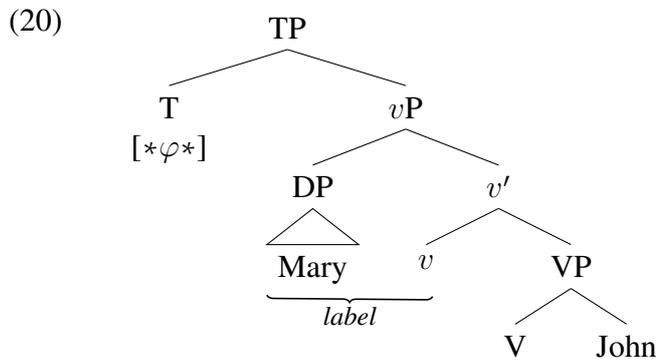


```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.CP \node(wh){DP\{\{who\sub{1}\}}}; \edge[dashed];
[. $v$P DP\{\{Sue\}} [.$v'$ $ $v$
[.VP V\{\{met\}} \node(tr){t\sub{1}}; ]]]
\draw[->,semithick] (tr.south) |- +(0,-2em) -|
node[pos=0.25,below] {Movement} (wh.south);
\end{tikzpicture}

```

Braces:



```

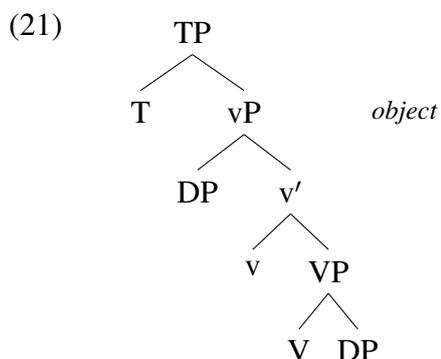
\ex.
\sameline
\begin{tikzpicture}
\tikzset{sibling distance=1.5em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.TP \node(t){T\{\{[*\varphi*]\}}}; [.$v$P
[.DP \edge[roof]; \node(dp){Mary}; ]
[.$v'$ $ \node(v){$v$}; [.VP V \node(dp2){John}; ]]]
\draw[semithick,decoration={brace},decorate]
([yshift=-0.5em,xshift=0.2em]v.south)
to node[below,font=\footnotesize\it] {\textit{label}} (dp.south west);
\end{tikzpicture}

```

3 Ornaments

3.1 Defining nodes outside the tree

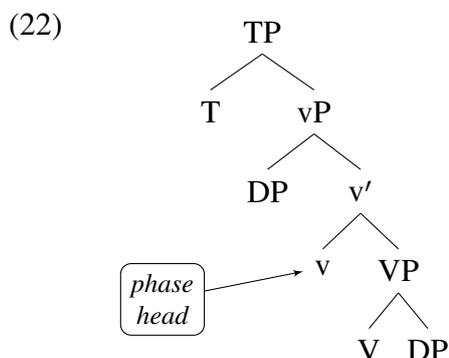
A random object outside the tree:



```
\ex.\sameline
\begin{tikzpicture}
  \Tree [.TP T
    [. \node(vp) {vP}; DP
      [.v'$ $ v [.VP V DP ] ] ] ]
  \node[font=\footnotesize\it] at ([xshift=5em]vp) {object};
\end{tikzpicture}
```

The positioning of the object is relative to some node in the tree, so that their positions will change together.

Connect the object to the tree, e.g. for labeling purposes:

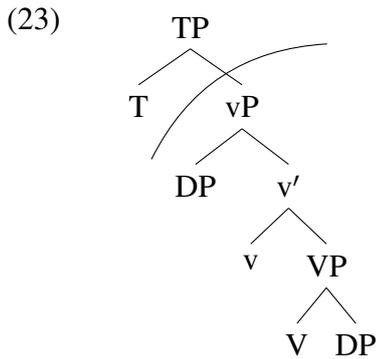


```
\ex.\sameline
\begin{tikzpicture}
  \Tree [.TP T [.vP DP
    [.v'$ $ \node(v) {v};
      [.VP V DP ] ] ] ]
  \node[draw,rounded corners,font=\footnotesize\it]
  at ([xshift=-5em,yshift=-1em]v) (ph) {phase head};
  \draw[->] (ph) to (v);
\end{tikzpicture}
```

The `\align=...` bit allows the node to have more than one line.

3.2 Phase boundaries

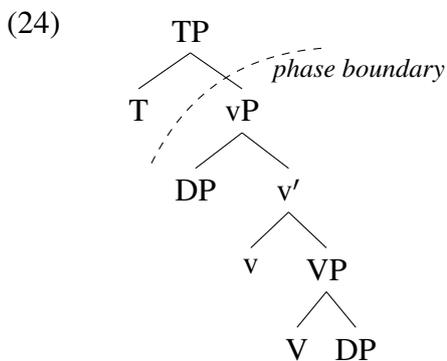
A simple curved line:



```
\ex.\sameline
\begin{tikzpicture}
  \Tree [.TP T [.\node(vp){vP}; DP [.v$'$ v [.VP V DP ] ] ] ]
  \node[] at ([xshift=-3em,yshift=-2em]vp) (ph1) {};
  \node[] at ([xshift=3em,yshift=2em]vp) (ph2) {};
  \draw (ph1) to [bend left=30] (ph2);
\end{tikzpicture}
```

It's just a curved line connecting two nodes that have no content.

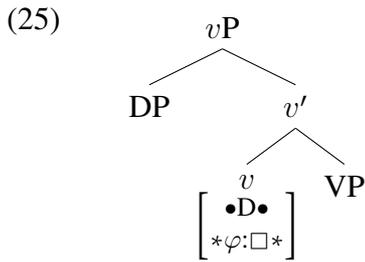
Something fancier:



```
\ex.\sameline
\begin{tikzpicture}
  \Tree [.TP T [.\node(vp){vP}; DP [.v$'$ v [.VP V DP ] ] ] ]
  \node[] at ([xshift=-3em,yshift=-2em]vp) (ph1) {};
  \node[] at ([xshift=3em,yshift=2em]vp) (ph2) {};
  \draw[dashed] (ph1) to [bend left=30]
node[xshift=1em,below,pos=1,font=\footnotesize\it]{phase boundary} (ph2);
\end{tikzpicture}
```

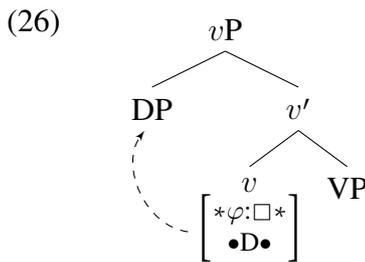
3.3 Stacks

Feature stack in a node:



```
\ex.
\sameline
\begin{tikzpicture}[>=latex']
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.$v$P DP [.$v'$ $v$\\{\footnotesize $\begin{bmatrix}
\text{\bullet}$D$\text{\bullet}$} \\
*\varphi:$\boxempty$$*}$} \\
\end{bmatrix}$} VP ]]
\end{tikzpicture}
```

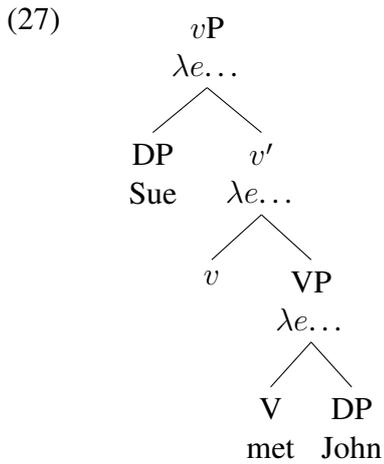
Arrow from complex node:



```
\ex.
\sameline
\begin{tikzpicture}[>=latex']
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.$v$P \node(dp){DP};
[.$v'$ \node(v){$v$\\{\footnotesize $\begin{bmatrix}
\text{\bullet}$D$\text{\bullet}$} \\
*\varphi:$\boxempty$$*}$} \\
\text{\bullet}$D$\text{\bullet}$} \\
\end{bmatrix}$}; VP ]]
\draw[->,dashed] (v) to [bend left=60] (dp);
\end{tikzpicture}
```

3.4 Semantic denotations

Denotations below the label of a tree node:

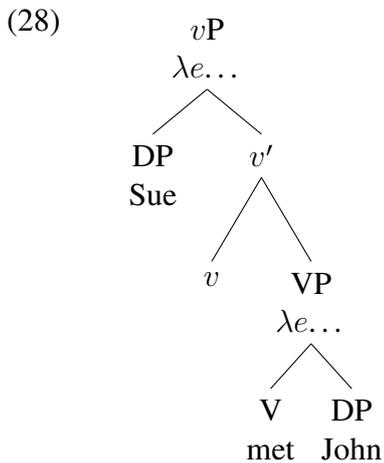


```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{level distance=4em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.$v$P\{\$\lambda\}e$\ldots$ DP\{Sue}
[.$v'$\{\$\lambda\}e$\ldots$ $v$
[.VP\{\$\lambda\}e$\ldots$ V\{met} DP\{John} ]]]
\end{tikzpicture}

```

Note that an adjustment is needed to level distance. However, this creates an asymmetry:



```

\ex.
\sameline
\begin{tikzpicture}
\tikzset{level distance=4em}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.$v$P\{\$\lambda\}e$\ldots$ DP\{Sue} [.$v'$ $v$
[.VP\{\$\lambda\}e$\ldots$ V\{met} DP\{John} ]]]
\end{tikzpicture}

```

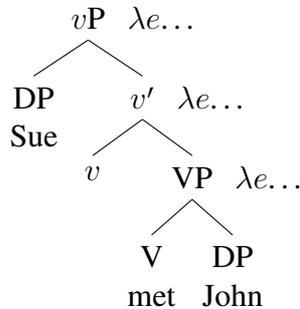
- This can be fixed by adjusting the level distance manually for the second level:

```
\tikzset{level 2/.style={level distance=2.5em}}
```

- A better approach is to use *labels* for semantic denotations:

```
[.\node[label={right:Text to go next to your node}]{DP};
```

(29)



\ex.

\sameline

\begin{tikzpicture}

\tikzset{every tree node/.style={align=center,anchor=north}}

\Tree [.\node[label={right:\$\lambda e\ldots\$}]{vP}; DP\{\Sue}

[.\node[label={right:\$\lambda e\ldots\$}]{v'}; v

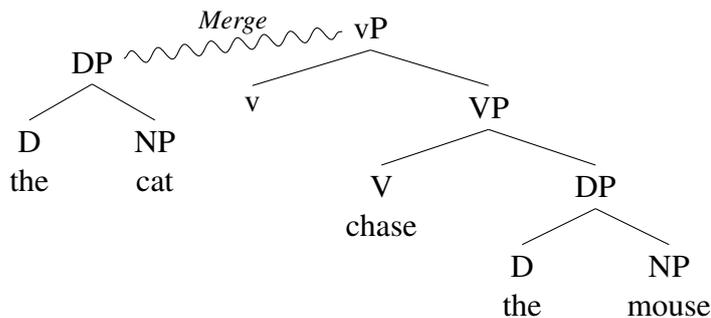
[.\node[label={right:\$\lambda e\ldots\$}]{VP}; V\{met} DP\{\John}]]

\end{tikzpicture}

3.5 Several trees in a single picture

A small tree next to the main tree, and some relation between them:

(30)



\ex.\sameline

\begin{tikzpicture}

\tikzset{sibling distance=2em}

\Tree [.\node(vP){vP}; \node(v){v};

[.VP V\{chase} [.DP D\{the} NP\{mouse}]]]]

\begin{scope}[shift={([xshift=-5em,yshift=2em]v)}]

\Tree [.\node(DP){DP}; D\{the} NP\{cat}]

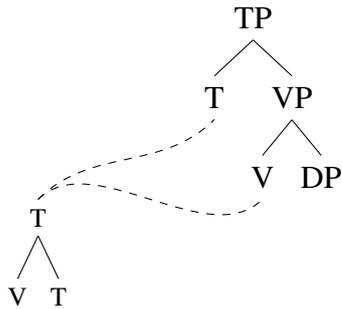
\end{scope}

\draw[decorate,decoration=snake] (DP) to node[above,font=\footnotesize\it]{Merge} (vP);

\end{tikzpicture}

A treelet shared by two nodes in a tree:

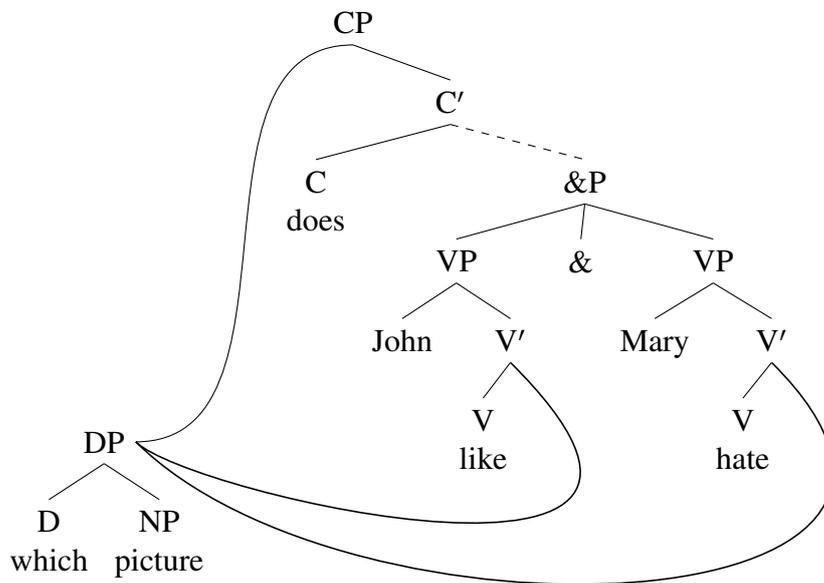
(31)



```
\ex.\sameline
\begin{tikzpicture}
\Tree [.\TP \node(T){T}; [.\VP
\node(V){V}; DP ] ]
\begin{scope}[shift={([xshift=-7em]V.south)}]
\footnotesize\Tree [.\node(t){T}; V T ]
\end{scope}
\draw[dashed] (t.north) .. controls +(north east:1) and +(south west:1) ..
\draw[dashed] (t.north) .. controls +(north east:1) and +(south west:1) ..
\end{tikzpicture}
```

Multidominance:

(32)



```
\ex.\sameline
\begin{tikzpicture}
\tikzset{every tree node/.style={align=center,anchor=north}}
\Tree [.\node(c){CP}; \edge[white]; ~ [.\node(cprime){C'}; C\{\does\} \edge[dashed];
[.\node(w){&P}; [.\node(vp){VP}; John
[.\node(wprime){V'}; V\{\like\} \edge[white]; ~ ] ] \&
[.\node(z){VP}; Mary [.\node(zprime){V'}; V\{\hate\} \edge[white]; ~ ] ] ] ]
\begin{scope}[shift={([xshift=-10em,yshift=-5em]vp.west)}]
\end{scope}
```

```

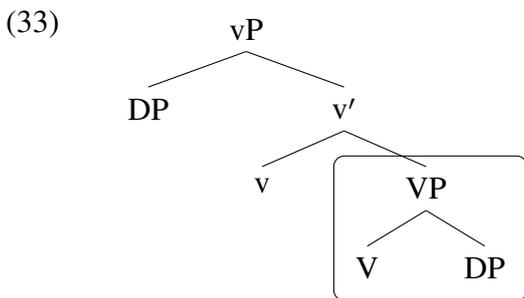
\Tree [ . \node(y){DP}; D\\which NP\\picture ]
\end{scope}
\draw (y.east) to [out=0, in=180](c.south);
\draw[semithick,overlay] (y.east)..controls +(south east:1)
and +(south east:5)..(w.south);
\draw[semithick,overlay] (y.east)..controls +(south east:4)
and +(south east:5)..(z.south);
\end{tikzpicture}

```

An important aspect of this: It requires adding empty nodes; that's what the ~ is for.

3.6 Treating subtrees as simple nodes

Draw a box around a subtree:

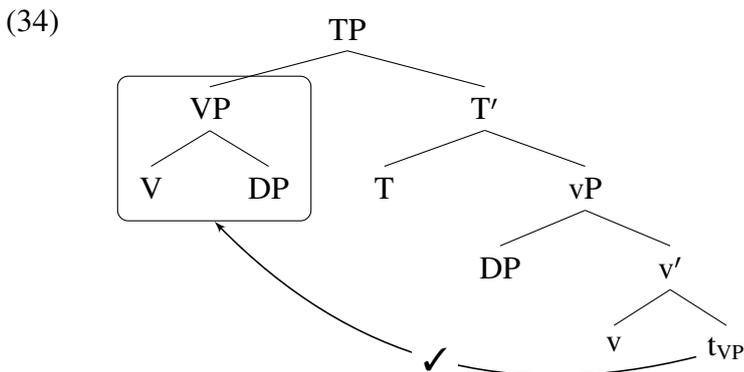


```

\ex.\sameline
\begin{tikzpicture}
\tikzset{sibling distance=2em}
\Tree [ .vP DP
[ .v$'$ v [ .\node(VP){VP}; \node(V){V}; \node(DP){DP}; ] ] ]
\node[draw,rounded corners,fit=(VP) (V) (DP)] {};
\end{tikzpicture}

```

Representing movement of a subtree:



```

\ex.\sameline
\begin{tikzpicture}
  \tikzset{sibling distance=2em}
  \Tree [ .TP [ .\node(VP){VP}; \node(V){V}; \node(DP){DP}; ]
  [.T$'$ T [.vP DP [.v$'$ v \node(tr){t\sub{VP}}]; ] ] ] ]
\node[draw,rounded corners,fit=(VP) (V) (DP)] (vp) {};
\draw[->,semithick] (tr) to [bend left=30]
  node[fill=white] {\ding{51}} (vp.south);
\end{tikzpicture}

```

Note the fill white part: it breaks the line around the label.

4 Arrows in examples

This uses `overlay`, which allows one to (i) define tikz nodes outside a tikz environment with `\tikz\node`, and then (ii) overlay a tikz picture on top of that text.

Example with movement lines:

(35) Who₁ did Sue see t₁



```

\ex.
\tikzexsetup
\tikz\node(wh){Who\sub{1}}; did Sue see \tikz\node(tr){t\sub{1}};
  \begin{tikzpicture}[overlay,remember picture]
\draw[rounded corners,->] (tr.south) |- +(0,-1em) -| (wh.south) ;
\end{tikzpicture}
\vspace*{1em}

```

Unfortunately, a manual space after (or before) the overlaid picture is needed.

Arrow above example, e.g. with glossed sentences:

(36) Nor₁ ikusi zuen Olatzek t₁



who.ABS see.PRF AUX.PST Olatz.ERG

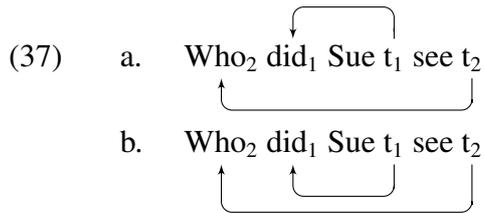
```

\vspace*{1em}
\ex.
\tikzexsetup
\gll\tikz\node(wh){Nor\sub{1}}; ikusi zuen Olatzek
\tikz\node(tr){t\sub{1}};\
who.\sc abs see.\sc prf \sc aux.pst Olatz.\sc erg\
  \begin{tikzpicture}[overlay,remember picture]
\draw[rounded corners,->] (tr.north) -| +(0,1em) -| (wh.north) ;
\end{tikzpicture}

```

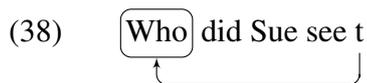
This doesn't work well with `\exg`. instead of `\ex`. ... `\gll`.

Multiple movements:



```
\vspace*{1em}
\ex.
\begin{tikzpicture}
\draw[rounded corners,->] (tr2.south) |- +(0,-1em) -| (wh.south) ;
\draw[rounded corners,->] (tr2.north) -| +(0,1em) -| (did.north) ;
\end{tikzpicture}
\vspace*{1.5em}
\begin{tikzpicture}
\draw[rounded corners,->] (tr2.south) |- +(0,-1.5em) -| (wh.south) ;
\draw[rounded corners,->] (tr2.south) |- +(0,-1em) -| (did.south) ;
\end{tikzpicture}
\vspace*{2em}
```

Highlighting moved element with a box:



```
\ex.
\begin{tikzpicture}
\draw[rounded corners,->] (tr.south) |- +(0,-1em) -| (wh.south) ;
\end{tikzpicture}
\vspace*{1em}
```

Grouping moved elements with braces:

- (39) a. $\overbrace{\text{Which picture}_1 \text{ did Sue buy } t_1}^{\text{wh-phrase}} ?$
 b. $\underbrace{\text{Which picture}_1 \text{ did Sue buy } t_1}_{\text{wh-phrase}} ?$

```
\vspace*{1em}
\ex.
\ a. \tikzexsetup
\tikz\node (wh) {Which}; \tikz\node (p) {picture\sub{1}}; did
Sue buy t\sub{1} ?
\begin{tikzpicture}[overlay,remember picture]
\draw[semithick,decoration={brace}, decorate] (wh.north west) to
node[above]{\small \textit{wh-phrase}} (p.north east);
\end{tikzpicture}
\ b. \tikzexsetup
\tikz\node (wh) {Which}; \tikz\node (p) {picture\sub{1}}; did
Sue buy t\sub{1} ?
\begin{tikzpicture}[overlay,remember picture]
\draw[semithick,decoration={brace}, decorate] (p.south east) to
node[below]{\small \textit{wh-phrase}} (wh.south west);
\end{tikzpicture}
\vspace*{1.5em}
```

Adding labels to movement arrows:

- (40) $\underbrace{\text{Which picture}_1 \text{ did Sue buy } t_2}_x ?$

```
\ex. \tikzexsetup
\tikz\node (wh) {Which}; \tikz\node (p) {picture\sub{1}}; did
\tikz\node (s) {Sue}; buy \tikz\node (tr) {t\sub{2}}; ?
\begin{tikzpicture}[overlay,remember picture]
\draw[semithick,decoration={brace}, decorate] (p.south east) to
node (brace) [below]{} (wh.south west);
\draw[rounded corners,->] (tr.south) |- +(0,-1.5em) -|
node[pos=0.25,yshift=-0.3em,fill=white]{\ding{55}}
([yshift=0.3em]brace.center);
\end{tikzpicture}
\vspace*{1.5em}
```