## A English Link Types

Recall that http://www.abisource.com/projects/link-grammar/dict/ summarize-links.html documents the 122 link types in the English link grammar lexicon. Below is the result of our largest English run, whose corpus uses 113 of these types.

Other researchers could postprocess link grammar parses by using the first two columns. These indicate whether a given link label $L$ tended to be oriented rightward or leftward by our ILP.

The labels that do not have a consistent direction are mainly those that connect a conjunction to its conjuncts. ${ }^{9}$ Our coarsening of the labels (see section 5.1) discarded the characters that distinguish left from right conjuncts.

The third column indicates where multi-headedness happens, by showing how often the child of an $L$ link had additional parents as well.

The remaining columns compare to the CoNLL parses. They show the fraction of $L$-labeled link tokens that were also present in the CoNLL reference parse-and on that fraction, whether the orientation matches CoNLL's and what the dominant CoNLL label was.

| Label | Rightward | Multiheaded | CoNLL Match | CoNLL Dir Match | CoNLL Label |
| :---: | :---: | :---: | :---: | :---: | :---: |
| A | 0\% (0/8501) | 0\% (0/8501) | 84\% (7148/8501) | 98\% (7002/7148) | NMOD 98\% (7000/7148) |
| AA | 0\% (0/4) | 0\% (0/4) | - | - | - |
| AF | 84\% (16/19) | $37 \%$ (7/19) | 32\% (6/19) | 0\% (0/6) | VMOD 83\% (5/6) |
| AJ | 50\% (131/262) | 0\% (0/262) | 86\% (225/262) | 99\% (223/225) | COORD 97\% (218/225) |
| AL | 100\% (71/71) | 99\% (70/71) | - | - | - |
| AM | 0\% (0/45) | 0\% (0/45) | 51\% (23/45) | 65\% (15/23) | AMOD 65\% (15/23) |
| AN | 0\% (0/9401) | 0\% (0/9401) | 83\% (7825/9401) | 98\% (7639/7825) | NMOD 96\% (7523/7825) |
| AZ | 100\% (2/2) | 0\% (0/2) | 100\% (2/2) | 100\% (2/2) | ADV 100\% (2/2) |
| B | 100\% (1514/1515) | 61\% (919/1515) | 53\% (806/1515) | 84\% (678/806) | NMOD 75\% (603/806) |
| BI | 100\% (34/34) | 0\% (0/34) | 38\% (13/34) | 100\% (13/13) | VMOD 77\% (10/13) |
| BW | 100\% (1/1) | 100\% (1/1) | 100\% (1/1) | 0\% (0/1) | OBJ 100\% (1/1) |
| C | 100\% (3272/3272) | 0\% (0/3272) | $3 \%(85 / 3272)$ | 53\% (45/85) | NMOD 27\% (23/85) |
| CC | 100\% (176/176) | 4\% (7/176) | 9\% (16/176) | 0\% (0/16) | PRN 56\% (9/16) |
| CO | 0\% (0/2478) | $1 \%(32 / 2478)$ | 5\% (114/2478) | 68\% (78/114) | NMOD 39\% (44/114) |
| CP | 100\% (283/283) | 13\% (36/283) | 88\% (249/283) | 100\% (249/249) | ROOT 100\% (249/249) |
| CQ | 100\% (7/7) | 0\% (0/7) | 100\% (7/7) | 0\% (0/7) | VMOD 57\% (4/7) |
| CV | 100\% (3237/3237) | 100\% (3237/3237) | 56\% (1827/3237) | 28\% (512/1827) | VMOD 52\% (956/1827) |
| CX | 100\% (6/6) | 0\% (0/6) | 83\% (5/6) | 20\% (1/5) | VMOD 60\% (3/5) |
| D | 0\% (56/19535) | 0\% (71/19535) | 85\% (16656/19535) | 100\% (16608/16656) | NMOD 100\% (16629/16656) |
| DD | 0\% (0/629) | 0\% (3/629) | 26\% (165/629) | 99\% (164/165) | NMOD 99\% (163/165) |
| DG | 0\% (0/1051) | 0\% (0/1051) | 90\% (950/1051) | 100\% (950/950) | NMOD 100\% (948/950) |
| DP | 0\% (0/13) | 0\% (0/13) | 23\% (3/13) | 100\% (3/3) | SBJ 100\% (3/3) |
| DT | 0\% (0/509) | 0\% (0/509) | 100\% (508/509) | 99\% (505/508) | NMOD 99\% (505/508) |
| E | 0\% (0/1897) | 0\% (2/1897) | 67\% (1279/1897) | 99\% (1263/1279) | ADV 84\% (1079/1279) |
| EA | 1\% (6/473) | 2\% (11/473) | 83\% (394/473) | 96\% (377/394) | AMOD 95\% (376/394) |
| EB | 100\% (509/511) | 1\% (7/511) | 63\% (321/511) | 95\% (305/321) | VMOD 54\% (174/321) |
| EC | 0\% (0/96) | 0\% (0/96) | 85\% (82/96) | 61\% (50/82) | AMOD 88\% (72/82) |
| EE | 9\% (11/126) | 0\% (0/126) | 87\% (110/126) | 44\% (48/110) | AMOD 87\% (96/110) |
| EF | 100\% (12/12) | 0\% (0/12) | 100\% (12/12) | 75\% (9/12) | AMOD 100\% (12/12) |
| EI | 0\% (0/7) | 0\% (0/7) | 57\% (4/7) | 100\% (4/4) | PMOD 50\% (2/4) |
| EL | 100\% (11/11) | 0\% (0/11) | 91\% (10/11) | 90\% (9/10) | NMOD 90\% (9/10) |
| EN | 0\% (0/490) | 0\% (0/490) | 85\% (415/490) | 40\% (167/415) | AMOD 90\% (374/415) |
| ER | 100\% (1/1) | 0\% (0/1) | - | - | - |
| EW | 0\% (0/3) | 0\% (0/3) | 33\% (1/3) | 100\% (1/1) | AMOD 100\% (1/1) |
| EZ | 0\% (0/12) | 0\% (0/12) | 33\% (4/12) | 50\% (2/4) | AMOD 100\% (4/4) |
| FM | 100\% (9/9) | 0\% (0/9) | 89\% (8/9) | 100\% (8/8) | PMOD 100\% (8/8) |
| G | 0\% (0/6061) | 0\% (0/6061) | 70\% (4258/6061) | 96\% (4070/4258) | NMOD 91\% (3868/4258) |
| GN | 0\% (0/273) | 0\% (0/273) | 92\% (250/273) | 98\% (245/250) | NMOD 99\% (248/250) |
| H | 100\% (4/4) | 0\% (0/4) | 100\% (4/4) | 50\% (2/4) | NMOD 50\% (2/4) |

[^0]| Label | Rightward | Multiheaded | CoNLL Match | CoNLL Dir Match | CoNLL Label |
| :---: | :---: | :---: | :---: | :---: | :---: |
| HA | 0\% (0/4) | 100\% (4/4) | - | - | - |
| I | 100\% (5405/5424) | 60\% (3247/5424) | 95\% (5168/5424) | 47\% (2408/5168) | VMOD 53\% (2756/5168) |
| ID | 0\% (0/1409) | 0\% (0/1409) | 76\% (1077/1409) | 35\% (380/1077) | PMOD 32\% (344/1077) |
| IN | 100\% (244/244) | 0\% (0/244) | 99\% (242/244) | 100\% (242/242) | PMOD 100\% (242/242) |
| IV | 100\% (1626/1627) | 100\% (1626/1627) | 85\% (1389/1627) | 97\% (1353/1389) | OBJ 70\% (972/1389) |
| J | 98\% (16400/16673) | 2\% (280/16673) | 87\% (14522/16673) | 97\% (14069/14522) | PMOD 98\% (14240/14522) |
| JG | 100\% (58/58) | 0\% (0/58) | 81\% (47/58) | 100\% (47/47) | PMOD 100\% (47/47) |
| JQ | 100\% (3/3) | 100\% (3/3) | 100\% (3/3) | 100\% (3/3) | PMOD 100\% (3/3) |
| JT | 100\% (83/83) | 0\% (0/83) | 94\% (78/83) | 100\% (78/78) | PMOD 97\% (76/78) |
| K | 100\% (565/565) | 0\% (0/565) | 97\% (547/565) | 100\% (545/547) | PRT 70\% (384/547) |
| L | 100\% (546/546) | 0\% (0/546) | 1\% (3/546) | 0\% (0/3) | AMOD 67\% (2/3) |
| LE | 100\% (2/2) | 0\% (0/2) | - | - | - |
| LI | 100\% (8/8) | 0\% (0/8) | 88\% (7/8) | 100\% (7/7) | ADV 100\% (7/7) |
| M | 100\% (9594/9596) | 0\% (16/9596) | 74\% (7124/9596) | 92\% (6583/7124) | NMOD 82\% (5873/7124) |
| MG | 100\% (58/58) | 0\% (0/58) | 86\% (50/58) | 100\% (50/50) | NMOD 100\% (50/50) |
| MJ | 50\% (100/200) | 0\% (0/200) | 68\% (136/200) | 96\% (131/136) | COORD 88\% (120/136) |
| MV | 100\% (13375/13376) | 0\% (61/13376) | 51\% (6797/13376) | 98\% (6681/6797) | ADV 75\% (5105/6797) |
| MX | 100\% (1999/1999) | $4 \%(83 / 1999)$ | 42\% (836/1999) | 91\% (763/836) | NMOD 89\% (741/836) |
| N | 100\% (546/546) | 0\% (0/546) | 100\% (545/546) | 100\% (545/545) | VMOD 100\% (544/545) |
| NA | 0\% (0/2) | 0\% (0/2) | 100\% (2/2) | 50\% (1/2) | COORD 100\% (2/2) |
| ND | 0\% (0/617) | 0\% (0/617) | 68\% (419/617) | 98\% (411/419) | NMOD 72\% (302/419) |
| NI | 32\% (103/324) | $2 \%$ (5/324) | 64\% (206/324) | 76\% (157/206) | COORD 31\% (64/206) |
| NJ | 0\% (0/1) | 0\% (0/1) | - | - | - |
| NM | 100\% (899/899) | 0\% (0/899) | 88\% (790/899) | 82\% (646/790) | AMOD 75\% (589/790) |
| NN | 0\% (0/658) | 0\% (0/658) | 11\% (75/658) | 95\% (71/75) | AMOD 87\% (65/75) |
| NR | 0\% (0/5) | 0\% (0/5) | 100\% (5/5) | 60\% (3/5) | AMOD 60\% (3/5) |
| NS | 0\% (0/157) | 0\% (0/157) | 92\% (145/157) | 100\% (145/145) | NMOD 98\% (142/145) |
| NT | 0\% (0/21) | $0 \%(0 / 21)$ | 5\% (1/21) | 0\% (0/1) | AMOD 100\% (1/1) |
| NW | 0\% (0/1) | 0\% (0/1) | 100\% (1/1) | 100\% (1/1) | NMOD 100\% (1/1) |
| O | 100\% (11027/11028) | 0\% (0/11028) | 81\% (8932/11028) | 96\% (8535/8932) | OBJ 73\% (6495/8932) |
| OD | 100\% (39/39) | 0\% (0/39) | 87\% (34/39) | 100\% (34/34) | OBJ 74\% (25/34) |
| OF | 100\% (549/549) | 50\% (274/549) | 96\% (528/549) | 98\% (518/528) | NMOD 70\% (367/528) |
| ON | 100\% (18/18) | 0\% (0/18) | 89\% (16/18) | 100\% (16/16) | PMOD 100\% (16/16) |
| OT | 100\% (6/6) | 0\% (0/6) | 100\% (6/6) | 100\% (6/6) | OBJ 50\% (3/6) |
| OX | 100\% (5/5) | 0\% (0/5) | - | - | - |
| P | 100\% (3755/3756) | $31 \%(1167 / 3756)$ | 94\% (3528/3756) | 100\% (3523/3528) | VC 60\% (2104/3528) |
| PF | 100\% (25/25) | 0\% (0/25) | 80\% (20/25) | 0\% (0/20) | ADV 60\% (12/20) |
| PP | 100\% (1292/1294) | 67\% (862/1294) | 98\% (1265/1294) | 99\% (1254/1265) | VC 99\% (1250/1265) |
| Q | 100\% (53/53) | 49\% (26/53) | 66\% (35/53) | 63\% (22/35) | ROOT 37\% (13/35) |
| QI | 100\% (163/163) | 0\% (0/163) | 8\% (13/163) | 100\% (13/13) | PMOD 85\% (11/13) |
| QJ | 50\% (2/4) | 0\% (0/4) | 50\% (2/4) | 100\% (2/2) | COORD 100\% (2/2) |
| R | 100\% (1404/1404) | $38 \%$ (538/1404) | 13\% (179/1404) | 16\% (29/179) | NMOD 78\% (140/179) |
| RJ | 50\% (23/46) | 0\% (0/46) | $7 \%$ (3/46) | 100\% (3/3) | COORD 100\% (3/3) |
| RS | 0\% (0/565) | 99\% (561/565) | 95\% (537/565) | 97\% (522/537) | SBJ 97\% (521/537) |
| S | 97\% (13138/13520) | 57\% (7662/13520) | 92\% (12476/13520) | 5\% (586/12476) | SBJ 97\% (12150/12476) |
| SF | 99\% (200/203) | 76\% (154/203) | 92\% (187/203) | 2\% (3/187) | SBJ 98\% (183/187) |
| SFI | 100\% (1/1) | 0\% (0/1) | 100\% (1/1) | 100\% (1/1) | SBJ 100\% (1/1) |
| SI | 100\% (129/129) | 0\% (0/129) | 80\% (103/129) | 99\% (102/103) | SBJ 86\% (89/103) |
| SJ | 50\% (2736/5468) | 0\% (0/5468) | 69\% (3778/5468) | 93\% (3502/3778) | COORD 86\% (3240/3778) |
| SX | 100\% (17/17) | 88\% (15/17) | 100\% (17/17) | 0\% (0/17) | SBJ 100\% (17/17) |
| SXI | 100\% (1/1) | 0\% (0/1) | 100\% (1/1) | 100\% (1/1) | SBJ 100\% (1/1) |
| TA | 0\% (0/31) | 0\% (0/31) | 100\% (31/31) | 100\% (31/31) | NMOD 100\% (31/31) |
| TD | 100\% (5/5) | 0\% (0/5) | 100\% (5/5) | 0\% (0/5) | NMOD 100\% (5/5) |
| TH | 100\% (660/660) | 0\% (0/660) | 1\% (9/660) | 100\% (9/9) | OBJ 89\% (8/9) |
| TI | 100\% (38/38) | 0\% (0/38) | 82\% (31/38) | 100\% (31/31) | PMOD 81\% (25/31) |
| TM | 100\% (26/26) | 0\% (0/26) | 100\% (26/26) | 100\% (26/26) | NMOD 100\% (26/26) |
| TO | 100\% (1733/1734) | 0\% (1/1734) | 0\% (5/1734) | 100\% (5/5) | ADV 40\% (2/5) |


| Label | Rightward | Multiheaded | CoNLL Match | CoNLL Dir Match | CoNLL Label |
| :--- | :--- | :--- | :--- | :--- | :--- |
| TS | $100 \%(7 / 7)$ | $0 \%(0 / 7)$ | - | - | - |
| TY | $100 \%(57 / 57)$ | $0 \%(0 / 57)$ | $100 \%(57 / 57)$ | $77 \%(44 / 57)$ | NMOD 96\% (55/57) |
| U | $100 \%(43 / 43)$ | $0 \%(0 / 43)$ | $86 \%(37 / 43)$ | $92 \%(34 / 37)$ | PMOD 92\% (34/37) |
| UN | $100 \%(4 / 4)$ | $0 \%(0 / 4)$ | $100 \%(4 / 4)$ | $100 \%(4 / 4)$ | PMOD 100\% (4/4) |
| V | $100 \%(8 / 8)$ | $0 \%(0 / 8)$ | $100 \%(8 / 8)$ | $100 \%(8 / 8)$ | OBJ 38\%(3/8) |
| VJ | $51 \%(765 / 1500)$ | $1 \%(8 / 1500)$ | $71 \%(1059 / 1500)$ | $89 \%(939 / 1059)$ | COORD 86\% (916/1059) |
| W | $100 \%(10528 / 10528)$ | $0 \%(5 / 10528)$ | $5 \%(504 / 10528)$ | $46 \%(232 / 504)$ | P 52\% (262/504) |
| WN | $100 \%(6 / 6)$ | $0 \%(0 / 6)$ | - | - | - |
| WV | $100 \%(7563 / 7563)$ | $100 \%(7557 / 7563)$ | $57 \%(4345 / 7563)$ | $97 \%(4214 / 4345)$ | ROOT 97\% (4214/4345) |
| WY | $100 \%(1 / 1)$ | $0 \%(0 / 1)$ | - | - | - |
| X | $80 \%(13132 / 16406)$ | $5 \%(806 / 16406)$ | $8 \%(1364 / 16406)$ | $95 \%(1300 / 1364)$ | P 100\% (1358/1364) |
| Y | $2 \%(4 / 172)$ | $0 \%(0 / 172)$ | $86 \%(148 / 172)$ | $93 \%(137 / 148)$ | AMOD 80\% (118/148) |
| YP | $0 \%(0 / 120)$ | $0 \%(0 / 120)$ | $100 \%(120 / 120)$ | $0 \%(0 / 120)$ | NMOD 100\% (120/120) |
| YS | $0 \%(0 / 1645)$ | $0 \%(0 / 1645)$ | $98 \%(1619 / 1645)$ | $0 \%(0 / 1619)$ | NMOD 100\% (1619/1619) |
| Z | $100 \%(9 / 9)$ | $0 \%(0 / 9)$ | $56 \%(5 / 9)$ | $0 \%(0 / 5)$ | VMOD 100\% (5/5) |

## B Sample English Parses

Below we display the first 100 English sentences whose widths do not exceed the width of this page. The blue upper half shows the CoNLL tagging and dependency parse. The red lower half shows the link grammar's tagging and our orientation of the link parse. A vertical edge to word token $v$ denotes an edge $0 \rightarrow v$. Words that were unknown to the link parser are flagged with [!].

Edges are shown as solid lines if they appear in both parses. They are drawn more thickly if the directions do not match.

Edges are shown as dotted lines if they appear only in one parse and not in the other.
Edges are highlighted in orange if the child has multiple parents.

they chance alienating the customers they hope to woo by looking like opportunistic sharks .


the companies reached an agreement in principle for the sale in August .


of the almost $3,000[!]$ athletes surveyed, $1,240[!]$ took the time to respond.



 the two shared results from this route swap, and followed rules on ticket pricing




2 . provide better incentives .

the Japanese want us to accept their culture, but they refuse to accept the American culture


the two companies each produce market pulp, containerboard and white paper .

first Executive[!] and troubled Valley[!] National[!] Corp. of Arizona were next in line .



BROKERAGE[!] HIRING[!] languishes amid market turmoil .

(W)

X


Censorship[!] is n't a Marxist invention.


X
NN
Esselte[!] Business[!] Systems[!] rose 1 to 4312 .


the machine is essentially a mainframe computer, he said .

in 1987[!], prosecutors filed against 35 defendants for every 100,000[!] adults .


the index uses a base of $100[!]$ in 1982[!]






the reason is simple .


among the economic effects of the hurricane was a sharp drop in rental income


the first models will ship in the spring, with the largest following in the fall


but the apple industry is ripe for change .

fuel costs were up $10 \%$ in the third quarter .

the number of workers in production sectors will be cut by $488[!]$, to $5,200[!]$ by September .

(W)

S.


WV


MX

(M)




Mr. Freeman is an executive vice president of American Express[!] .


so what does consensus mean?
 the local American Legion[!] color guard led the way .



TW Services[!]
1

the three units contributed about a third of Emhart[!] 's total sales .


still , Radio[!] Shack[!] is aware that some of its products are controversial


Outokumpu[!] is a mining, trading and construction concern .


now, the personal-computer revolution is finally reaching Japan.

the judge, they say, was fiercely proud of his abilities and accomplishments.


at the time the plan was announced, there were 135[!] lawyers.

rising operating expenses are another problem .

W) WV

(W) WV
X

the Fed[!] 's stock market role ought not to be very ambitious.


many middle-class people would love free food, Medicaid[!] insurance, utilities and rent .

(P)
 the account had previously been handled by Saatchi[!] Saatchi[!] Wegener[!] , New York[!] .



Gen-Probe[!] was another active takeover stock .


Madison 's noble and unifying vision of the representative still can guide us .



compare the Bush[!] request to what the Senators gave themselves :

these people have different agendas .


mortgage securities ended 232 to 432 higher in light trading .



P.

the bank says it 's interested in purchasing banks in Morocco, Portugal and Puerto[!] Rico .


speculation about a takeover fight has sent Jaguar[!] shares soaring in the past six weeks



Ortega[!] had threatened to end a 19-month-old ceasefire .


（⿶）


the result is that the unthinkable and illogical are happening .



Geraldo or Phil would probably pull up another camera and interview the chained protesters .

(O)

区



Mr. Volk[!], 55 years old, succeeds Duncan Dwight, who retired in September .


X



Petroleos[!] will supply $135,000[!]$ barrels of oil a day for the refinery, Unocal[!] said



how can we turn this situation around?



(⿶)


Government[!] Contractors[!]


imports of goods and services soared, while exports were flat .

but he said Dentsu[!] has n't looked seriously at Saatchi[!] .



but he said this does n't mean he is satisfied with the market 's big swings .




[^0]:    ${ }^{9}$ See http://www. abisource.com/projects/link-grammar/dict/coordination.html.

