

# Computation, learning, and typology

## *Class 4: Converging grammars and typological frequency*



Adam Albright and Eric Baković  
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# Converging grammars



# Predicting typological frequency

- Over the last few sessions, we have introduced some intuitive ideas about how formal properties of grammars may correlate with typological frequency
  - Simplicity: scored more highly by evaluation metric = preferred by learners  $\Rightarrow$  more common typologically?
  - Learning trajectory: fewer learning “updates”  $\Rightarrow$  quicker to learn  $\Rightarrow$  more common typologically?
- Another question that has arisen: if more grammars can generate a pattern, is it more frequent?



The R-volume hypothesis Bane & Riggle (2008); Riggle (2010)

- Given a constraint set  $\mathbb{C}$  with size  $|\mathbb{C}|$ , and a set of tableaux for various UR's,
  - The number of distinct languages (sets of winners) is typically less than the number of total rankings ( $|\mathbb{C}|!$ )
- Reason: not all constraints are able to conflict with each other, so some distinct total rankings converge on the same language
- Hypothesis: more rankings that generate a language  $\Rightarrow$  greater typological frequency



# Illustration: Bane & Riggle (2008)

- Set of 12 constraints for quantity-insensitive (QI) stress, from Gordon (2002)

ALIGN(ó/ò)-Edge	Assign one * for each unstressed $\sigma$ at the edge of a
ALIGN(ó)-L, ALIGN(ó)-R	Assign one * for each $\sigma$ separating stress from the edge of the word
ALIGN(ó/ò)-L, ALIGN(ó/ò)-R	Assign one * for each $\sigma$ separating stress from the edge of the word
NONFINALITY	Assign one * for stress on the final $\sigma$
*CLASH	Assign one * for each sequence of two stressed $\sigma$ 's
*LAPSE	Assign one * for each sequence of two stressless $\sigma$ 's
*LAPSE-L/R	Assign one * if neither of the initial/final two $\sigma$ 's is stressed
*EXTENDLAPSE	Assign one * for each sequence of three stressless $\sigma$ 's
*EXTLAPSE-R	Assign one * if none of the final three $\sigma$ 's is stressed



# The predicted typology

- Gordon also assumes one meta-ranking
  - Either  $\text{ALIGN}(\acute{o})\text{-L}$  or  $\text{ALIGN}(\acute{o})\text{-R}$  must be ranked lowest (or 'inactive'/absent)
- Two sets of  $11!$  total rankings = 79,833,600
- Reduce to 152 distinct patterns
- Predicts 24 attested patterns, 128 unattested patterns<sup>1</sup>
- Every predicted pattern can be derived by multiple total rankings
  - Smallest by 23,760; largest by 11,880,000

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<sup>1</sup>Bane and Riggle note two attested patterns that were not known to Gordon, and are not generated by his constraint set.



# Relative frequencies

- The “largest” ranking: 11,880,000
  - Fixed initial stress, no secondary stress
  - Example: Koromfé (Gur; Rennison, 1997)
- The smallest: unattested



## Comparing to typological frequency

- Bane and Riggle compare r-volumes to empirical counts from the STRESSTYP database
- 306 QI stress systems
- Examples

Pattern	Rankings	r-vol	Lgs	Emp. prob.
Fixed initial	11,880,000	14.9%	69	22.5%
Penultimate	228,0960	2.9%	60	19.6%
Antepenultimate	285,120	0.4%	8	2.6%
Peninitial	31,6800	0.4%	12	3.9%
(Unattested)	23,760	0.3%	0	0%

- What is the relation between r-volume and empirical frequency?



# Bane and Riggle's result

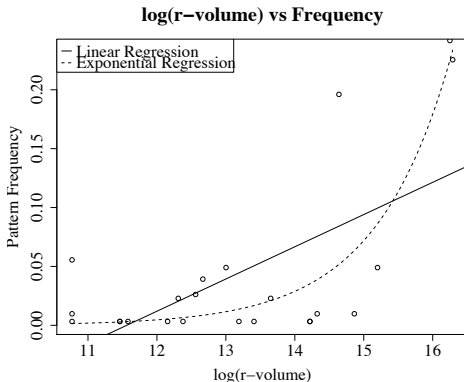


Figure 7: Linear and exponential regressions of typological frequency as a function of the natural logarithm of the pattern's  $r$ -volume.

# Summary

- The very most popular patterns generally have higher r-volumes
  - Final .242, initial .225, penultimate .196, initial/alternating/non-fin .056, initial/alternating .049, penultimate alternating .049, peninitial .039, antepenultimate .026
- Significant, but also not especially great predictor



# Rankings or parses



101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000

# Rankings, or parses?

- Recall Kager (2012): modeled stress windows at word edges, using various foot-based constraint sets
- Feet introduce “hidden” (silent) structure: determine a phonetic property (position of stress), but are not themselves present phonetically
- Multiple footings can yield the same output
  - $\sigma(\acute{\sigma}\sigma)$  vs.  $(\sigma\acute{\sigma})<\sigma>$
  - These correspond to different rankings, each with their own r-volume
- Kager’s hypothesis: stress patterns with **more parses** are more frequent typologically



# Kager's observation: parses and attestation

N	Ex.
16	Modern Greek
16	Spanish
11	Kobon
10	—
9	Comanche
9	—
8	Aguaruna
8	Kashaya
8	Azkoitia Basque
8	—
6	Gidabal
6	Korafe
6	Hopi
6	—
6	Terêna
6	—
6	Pirahã
5	—
5	—
5	—
5	Latin

N	Ex.
5	Ctr, W. Macedonian
4	—
4	—
4	—
4	—
4	—
3	Ossetic
3	—
3	Choguita Rarámuri
3	—
3	—
3	—
3	—
3	—
3	Kunjen
3	Yapese
3	—
3	—
3	—
2	—

N	Ex.
2	—
2	—
2	—
2	—
2	—
2	—
2	—
2	—
2	—
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2	—
2	—
2	—
2	—
2	—
1	—
1	—
1	—
1	—

N	Ex.
1	—
1	—
1	—
1	—
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## Kager's observation: parses and attestation

- Patterns are more likely to be attested if they can be produced in multiple ways (more parses)
- Kager does *not* consider the relation between number of parses and number of rankings
  - If a pattern can be produced with multiple parses, by necessity it can be produced by multiple rankings
  - However, it is also possible for a pattern to correspond to exactly one parse, but supported by many rankings
- Question: is Kager's observation really about r-volume, and not the number of parses?



# A toy example to test this

## Peninitial vs. penultimate stress

- Penultimate stress: two parses
  - Final trochee:  $\sigma\sigma(\acute{\sigma}\sigma)$
  - Final iamb + final  $\sigma$  extrametricality:  $\sigma(\sigma\acute{\sigma})\langle\sigma\rangle$
- Peninitial: just one parse
  - Initial iamb:  $(\sigma\acute{\sigma})\sigma\sigma$
  - Assumption: no such thing as initial syllable extrametricality
- Empirically: penultimate  $\approx 5$  times more frequent
  - 60 vs. 12 lgs in STRESSTYP



# Rankings for penultimate vs. peninitial stress

- Peninitial
  - lambs:  
ALL-Ft-L  $\gg$  ALL-Ft-R  
IAMB  $\gg$  TROCHEE
- Penultimate
  - lambs:  
ALL-Ft-R  $\gg$  ALL-Ft-L  
IAMB  $\gg$  TROCHEE  
NONFIN  $\gg$  ALL-Ft-R
  - Trochees:  
ALL-Ft-R  $\gg$  ALL-Ft-L  
TROCHEE  $\gg$  IAMB  
ALL-Ft-R  $\gg$  NONFIN
- Although there are two parses for penultimate stress, both involve more crucial rankings (smaller r-volume?)
- Question: does frequency of penultimate stress





# The r-volume of Kager's parses

- Constraint set
  - ALL-FT-L, ALL-FT-R
  - IAMB, TROCHEE
  - NONFIN
- Candidate set
  - Syllables parsed or unparsed into feet
  - Feet: iamb ( $\sigma\acute{\sigma}$ ), trochee ( $\acute{\sigma}\sigma$ ), degenerate ( $\acute{\sigma}$ )
- Introduces one additional parse for penultimate stress:  $\langle\sigma\sigma\rangle(\acute{\sigma})\langle\sigma\rangle$  (non-final degenerate trochees)
- Also one additional mostly-peninitial language: initial in disyllables, peninitial otherwise



# The typology

- Out of 120 (=5!) logically possible languages, only 11 distinct languages/patterns
- Focus here on “penultimate” and “peninitial” patterns
- R-vol of penultimate = .225, peninitial = .058/.125

	Parse	r-Vol
Penultimate	$\langle\sigma\sigma\rangle(\acute{\sigma}\sigma)$	0.092
	$\langle\sigma\rangle(\sigma\acute{\sigma})\langle\sigma\rangle$	0.033
	$\langle\sigma\sigma\rangle(\acute{\sigma})\langle\sigma\rangle$	0.100
Peninitial	$(\sigma\acute{\sigma})\langle\sigma\sigma\rangle$	0.058
	$(\sigma\acute{\sigma})\langle\sigma\sigma\rangle + \text{nonfin}$	0.067



## More generally...

Pattern	Parses	R-Vol	STRESSTyp2
initial	3	0.3750	101
final	2	0.2417	104
penult	3	0.2250	75
peninit	1	0.0583	16
peninit+nonfin	1	0.0667	1
antepenult	1	0.0333	11



## Summary of this demonstration

- Turns out that r-volume and number of parses are correlated
- Other cases may yet show inverse predictions for r-vol and number of parses
- Both favor the typologically more common pattern, to some extent
  - Strength of preference less than observed asymmetry



## References

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