WORDS AND RULES
- Steven Pinker

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The Background

- Two basic principles underlying language
  - word-meaning pairing
  - grammar or rules

- Two theories which try to combine these two aspects
  - Generative Phonology
  - Connectionism

- Present a different viewpoint which maintains the word/rule distinction
  - with an enriched lexical memory which has some attributes of a pattern associator

Trick behind our speaking ability

- First trick articulated by Ferdinand de Saussure in 1960

  N
  |
  |

  webcam

  /'w bkam/

  (A video camera which is connected to a computer so that its output may be viewed on a network, especially the Internet)

- The second trick was articulated by William von Humboldt

  S → NP VP

  NP → (det) (adj.) N

- Finite algorithm for infinite sentences (approximated to be around a hundred million trillion sentences in practice)

- Recursive rules – infinite size sentences

Basic Design of Language

- Words and rules handled by distinct psychological systems
- A kind of memory – to handle the lexicon of words
- Symbolic computation to handle combinatorial rules
- To test this design we need to find a case in which words and rules express the same contents

Regular and Irregular Inflection

- Regular inflection
  - open-ended: thousands of words
  - completely predictable: children overgeneralize it to irregular verbs and nouns

- Suggests that there are rules similar to the rules of grammar

$$V_{past} \rightarrow V_{stem} + d$$
$$N_{plural} \rightarrow N_{singular} + s$$

- Irregular inflection
  - closed class: 180 verbs in present day English
  - unpredictable
  - monosyllables as opposed to phonologically unwieldy forms for some regulars

- Example: verbs

sink – sank

slink – slunk (not slank)
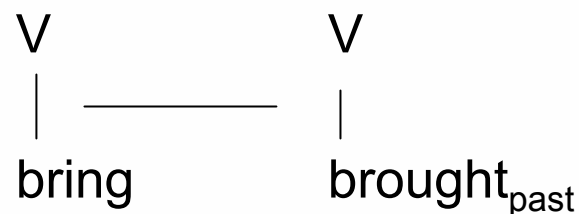
think – thought (not thank or thunk)

blink – blinked (not blank, blunk or blought)

- Example: nouns

tooth – teeth

foot – feet

- This suggests that irregulars are memorized as pairs of lexical items

V   V

| ————— |

bring   brought$_{past}$

- Interaction of memory and rule components takes place
- This hypothesis seems to confirm the rule-word theory

Point of contention

- Existence of patterns among the irregular verbs

  keep-kept, sleep-slept, feel-felt

  wear-wore, bear-bore, tear-tore

  string-strung, swing-swung, sting-stung

- Even these are generalized by humans sometimes (bring-brang, wipe-wope)

- Sometimes find a hold in the language and change its composition
  - American and British dialects have help-holp, drag-drug, climb-clumb

Generative Phonology

- Chomsky and Halle (1968)
- Explicit inaccessible rules for regulars as well as irregulars
- Minor rules for irregular patterns
- Problem
  - If the rule applies to a list in memory then it does not account for similarities among the verbs in the list
  - If the phonological pattern is a condition with the rule, then wrong verbs get picked up

Connectionism

- Rumelhart and McClelland (1986)
- Rules might provide a characterization of the performance of the speakers
- PDP models provide a mechanism sufficient to capture lawful behaviour without explicit rules
- Memory is more powerful
  - rather than linking items, we link features of items

The connectionist model

- The input string is encoded as a pattern of activation over the input units
- The input units are phonemes categorized on four dimensions – place, manner, interruption and vowel
- An identical bank of output units represents the past tense form
- For each output node, the net input to it from all weighted connections is computed
- Past tense form is the word which best fits the active output nodes

What Pinker has to say ….

- Pinker contests the first theory
- Points out places where the second theory fails and says it is also uncalled for
- According to him
  - Irregular forms are stored in memory which is partially associative
  - This accounts for easy store/recall of similar irregular verbs and generalizing irregular forms to new similar verbs
  - Regular verbs are generated by a standard symbol-concatenation rule

Weak Memory Entry

- If a word is rare, its entry in the mental lexicon is weaker

- In such cases, the irregular inflection will suffer but regular inflection will not

- The ten most spoken verbs in English are irregular whereas the first ten least spoken verbs are regular (Francis and Kucera, 1982)

- This shows that irregular forms have to be memorized to survive in a language

- If a irregular verb declines in popularity then the children will fail to remember its past tense and it will eventually become regular

Frequency in a million-word corpus

1. be	39175	abate	1
2. have	12458	abbreviate	1
3. do	4367	abhor	1
4. say	2765	ablate	1
5. make	2312	abridge	1
6. go	1844	abrogate	1
7. take	1575	acclimatize	1
8. come	1561	acculturate	1
9. see	1513	admix	1
10. get	1486	adsorb	1

- Old English has twice as many irregular forms as Modern English. Some obsolete forms:

  cleave-clove, crow-crew, abide-abode

- Low frequency irregular verbs sound strange

  slay-slew, bid-bade, tread-trod

- Low frequency regular verbs sound perfectly natural

  abated, abrogated

- Example from clichés, idioms
  – Use of the past tense of the verb may sound strange

- For example:

  You will excuse me if I forgo the pleasure …
  Last night I forwent the pleasure of …

  That dress really becomes her

  But her old dress became her even more

- This does not happen with expressions containing less frequent regular verbs
- Example:

We can't afford it.

I don't know how he afforded it.

- Michael Ullman (1993) has confirmed these claims quantitatively
  – Subjects asked to rate the naturalness of verbs in the frequencies of their stems and past tense forms
  – Regular pasts correlate significantly with their stems but not with their frequencies
  – Irregular pasts correlate less significantly with their stems and more with their frequencies

Difficult-to-analogize verbs

- Unusual-sounding verbs: difference in regular and irregular verbs

- Pattern-associator memories can generalize to rare or new verbs based on their similarity to existing well-learned verbs and strength of connections

- People do the same for irregular verbs if it is similar to an existing family

- But for regular verbs, they apply the suffix to any new verb with ease regardless of its sound

Bybee's Experiment

Similarity to existing verbs	Irregular Verbs	Regular Verbs
Prototypical Verbs	spling 80%	plip
Intermediate Verbs	krink 50%	smaig
Unfamiliar Verbs	vin 20%	ploamph

- For the irregular verbs the pattern associator acts like human beings
- But for regular verbs, humans provided forms for unusual-sounding verbs like ploamph as easily as for familiar sounding verbs like plip
- The pattern associator is unable to generate forms like ploamphed
- This shows that pattern associators unlike symbolic-computational architectures do not have the mechanism of a general variable 'Verb'

Where is the irregular form?

- Let us see some examples which show that the irregular form is trapped in memory

- This happens because of the word's grammatical structure

Systematic Regularization

- Where irregular forms mysteriously take regular inflections:

  All my daughter's friends are low-lifes.
  Boggs has flied out in the game.

- Sound alone cannot be the input to the inflectional system – semantics is one possible input

- Fails to account for cases like:
  Prefixing: overshot, overdid
  Compounding: workmen, muskoxen
  Metaphor: sawteeth, snowmen
 Idiom: cut a deal, caught a cold

- An explanation that works!
  - *headless* words become regular
- Right-hand head rule: new complex word inherits its properties from the memory entry of the rightmost morpheme – the 'head'

```
         ___ V ___
       /           \
    prefix          V
      |             |
    over-          eat
```
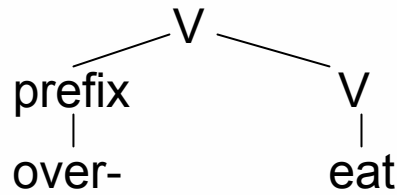
- Some complex words are headless – they don't get their properties from the rightmost morpheme
- The normal right hand rule is turned-off and the irregular form gets trapped in memory (unable to be passed upward to apply to the whole word) – the regular rule thus comes into action!

Compounds

- Let us see how this rule can be applied to different classes of regularizations
- Low-life does not refer to a kind of life but refers to a kind of person

```
              N
           ╱     ╫
         A         N
         │         │
        low       life
```
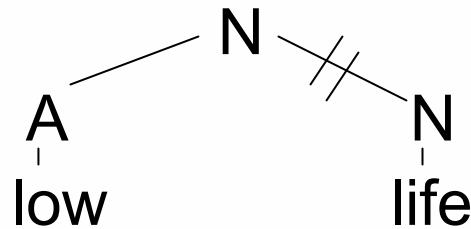
- The information about life cannot be passed upwards
- Other examples: saber-tooths, flatfoots, bigmouths

Eponyms

- When ordinary nouns are converted to names and then converted back into common nouns

$$
\begin{array}{c}
N \\
| \\
name \\
\diagup \quad \diagdown \\
name \qquad N \\
| \qquad\quad | \\
Mickey \quad mouse
\end{array}
$$
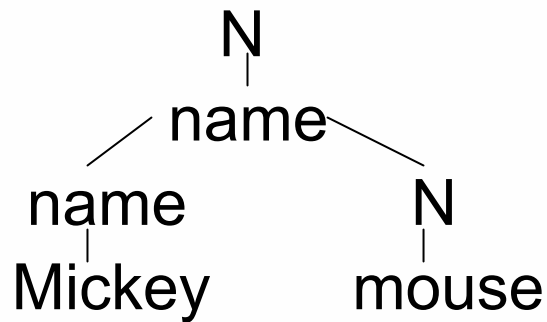
- The right hand-rule has been turned-off twice. Hence the word Mickey mouses!

- Other examples: Renault Elfs, Batmans

Denominal Verbs

- Verbs that have been formed out of nouns
- In baseball the verb *to fly* was converted to a noun, *a fly* and back to a verb, *to fly out*

  V – N – V – fly

- It is sealed off from the original verb by two layers and hence the past tense, *flied out*
- Other examples: high-sticked, rang the city, grandstanded

Other headless derivations

- Onomatopoeia: The engine pinged
- Quotations: While checking for sexist writing, I found three 'man's.
- Foreign Borrowing: succumbed, derided, chiefs
- Artificial Concoctions (truncations, acronyms): lip-synched, Ox's (containers of oxygen)

One Exception

- Inside compound words, irregular words take plurals whereas regulars do not

- Example: mice-infested vs. rat-infested, teethmarks vs. clawmarks, men-bashing vs. guy-bashing

- Simple explanation: the order of morphological processes is – memorized words (including irregulars), complex word formation and then regular inflection

Childhood

- A circumstance of impeded memory access and its effect on inflection
- We need to account for overregularizations done by children (comed, holded)
- If the child has not heard an irregular verb often, the corresponding memory entry will be weak
- Hence the child retrieves it less reliably and with less confidence. If the child has acquired the regular past tense rule, he will apply it instead.

Supporting evidence

- The more often the parent uses an irregular form, the less often the child overregularizes it

- U-shaped development:
  - For several months children use only the correct irregular form before producing their first error
  - Before the first error, children do not have the regular rule at all
  - Mastery over the –ed rule leads to overregularization and errors in the period

Disorders

- To show that memory impairment affects irregular inflection, we look at patients whose memory or grammatical systems are differentially disrupted

- Patients with anomic aphasia (have difficulty retrieving words)
  - Find it difficult to inflect irregular verbs (60% vs. 89%)
  - Made frequent overgeneralization errors (25% of the time)
  - Fairly good with novel verbs (84%)

- Patients with agrammatic aphasia (difficulty combining words)
  - Find it harder to inflect regular verbs (20% vs. 69%)
  - Made no overregularization errors
  - Poor at inflecting novel verbs (5%)

- This shows :
  - Patients who are more impaired on vocabulary (1) find irregular forms hard to produce, (2) produce overregularized forms and (3) easily produce past tense forms for novel verbs

- This double dissociation was also found in patients with neurodegenerative diseases

- Anomic Alzheimer's Disease:
  – impairment in memory
  – trouble producing irregular forms, made frequent overregularization errors but were successful with novel verbs

- Parkinson's Disease:
  – symptoms of agrammatism
  – more trouble with regular verbs and novel verbs but made no overregularization errors.

Crosslinguistic Validations

- One possible confound: We have chosen English which shows a very high frequency of regular verbs

- Pattern associators generalize the majority pattern most strongly

- Connectionist researchers might say that because of the type frequency, the regular pattern is strongly reinforced

- If we could find a language in which regular rule applies to a minority of the forms, then it would be wonderful

- Note that now regular would mean the default operation produced by a rule and not the most frequent inflectional form

Deutsch

- One language which displays this profile is German
- The past formed is expressed by participles which come in three forms:
  - Strong (vowel change and the suffix –en)
  - Mixed (vowel change and the suffix –t)
  - Weak (just the suffix –t)
- The weak forms are analogous to English regular verbs (45% of the verbs)
- Plurals come in eight forms (-e, -er, -en, -s, and no suffix) and they can come with an umlauted stem vowel
- The –s is the default rule analogous to English
  - Applied only to 7% of the nouns

Analogy with English

	English	German
Rare Verbs	ablated	geloetet (welded)
Unusual sounding verbs	ploamphed	geplaupft
Onomatopoeic forms	dinged	gebrummt (growled)
Denominal Verbs	flied out	gehaust (housed)
Overregularization	singed	gesingt

Plurals: A dramatic comparison

	English	German
Unusual sounding nouns	ploamphs	plaupfs
Name-nouns	the Childs	die Manns
Eponyms	Batmans	Fausts
Foreign words	chiefs	cafés
Truncations	lip-synched	Sozis
Overregularization	three mans	drei manns
Compound-effect	*rats-eater	*autos-fresser

Historical Reasons

- In proto-Germanic languages the majority of verbs were strong (irregular)
- There was also a precursor of the weak suffix which applied to borrowings and derived forms
- The major growth in English was in the areas of borrowing (60% of English verbs are from French or Latin) and derivations (20% of the verbs are denominals)
- German did not borrow too many verbs and also does not convert nouns to verbs as freely
- So, it is in English that we find majority of regular verbs for grammatical reasons.

Comparison with other languages

- Francais –
  - Overregularization in French:
    - Particip passé: prendre-prendu, dire-du, peindre-peindu
    - Plurals: journal-journals, cheval-chevals
  - Eponyms: Napoleons, Piafs
  - Names which become nouns: les Legrands
- Hindi
  - Difficult to find irregular verbs which are uncommon and can be regularized
  - Overregularization is seen in plurals

Conclusions

- Despite identical functions, the regular suffix is applied freely in a variety of circumstances
- Some connectionist models have tried to counter specifically the examples pointed out but human brain does not perform in this way
    - It is a more general phenomenon
- Actually regular inflection applies whenever memory retrieval fails
    - The disorder studies support this
- Comparison with German supports that the regular rule is not applied because it is the majority pattern
- Hence, we vote for the word/rule distinction!

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THANK YOU !