Class 16: Phonology-lexicon and phonology-processing interfaces

To do
☐ last homework, phrasal phonology, due Friday

Overview: We’ll look at a bunch of phonological phenomena that show frequency effects—including a case from my own research—and consider where in our model of language those effects could reside.

1 Classic frequency effect: English irregular past tense
   • There are only about 200 of them, but they are disproportionately likely to be frequent (e.g., Bybee & Slobin 1982).
   • Top 25 most frequent verbs (Oxford English Corpus)—irregulars are in bold:

   1. be
   2. have
   3. do
   4. say
   5. get
   6. make
   7. go
   8. know
   9. take
   10. see
   11. come
   12. think
   13. look
   14. want
   15. give
   16. use
   17. find
   18. tell
   19. ask
   20. work
   21. seem
   22. feel
   23. try
   24. leave
   25. call

   • Locus of explanation?

Diachrony
   - In order to learn an irregular past tense form, you have to be exposed to it enough times → low-frequency verbs will tend to regularize from one generation to the next (bode > bided).
   - Kirby 2001: simulation study

Processing
   - Dual-route model (see Pinker 2000 for overview and application to this case)
   - When you want to say a past tense, there’s a race between retrieving a stored form (which might be irregular) and creating the form via the –ed rule.
   - The more frequent the stored form, the higher its resting activation → more likely to win the race.
   - low-frequency verbs may get pronounced as regular, even if speaker knows irregular form.

Grammar?
   - I don’t think anyone has proposed it for this case, but it’s a logical possibility:
     - Some constraints are sensitive to frequency.

<table>
<thead>
<tr>
<th>/bowd/, cf. [bajd]</th>
<th>I-O FAITH(hi freq)</th>
<th>O-O FAITH</th>
<th>I-O FAITH(lo freq)</th>
<th>or split O-OFAITH by frequency.</th>
</tr>
</thead>
<tbody>
<tr>
<td>bowd</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bajdid</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   - Or there’s just one I-O FAITH constraint, but its ranking is a function of frequency

With these three possibilities in mind, let’s look at some more phonological cases and how they’ve been analyzed.
2 Ng 2010: Singapore English prosodic boundaries

- Singapore English has strong glottalization at prefix-stem, stem-stem, but not stem-suffix boundary
  - *mis-understand* [misʔəndəstæn], *stop-over* [stɔpʔəvə], *magic-al* [mædʒikəl](p. 8)
  - Ng analyzes this in terms of p-word structure: let’s sketch it out

**tone rules: pp. 11-13**

- Stress is realized as tone: \( (L_0 M^* M_0)H \) or \( H \)
  - last syllable is \( H \), whether stressed or not: *see* \( {'H} \)
  - first (non-final) stressed syllable gets \( M \) tone: *apple* \( {'MH} \)
  - sylls from first stress to penult get \( M \): *elephant* \( {'MMH} \), *Indonesia* \( {'MM,MH} \)
  - syllables preceding first stress get \( L \): *hibiscus* \( L'MH\), *machine* \( L'H\), *America* \( L'MMH\)

- Domain of tone assignment \( \approx \) p-word
  - tone pattern generally re-starts in compounds: *century egg* \( ('MH)(H) \)
  - tone pattern may or may not restart at prefix-stem boundary: *un-install* \( (H)-(L'H) \sim (L-L'H) \)
  - tone doesn’t restart at stem-suffix boundary: *remove-able* \( (L'MMH) \)

- Much interesting analysis follows, but let’s focus on initialisms (e.g. *NUS* ‘National University of Singapore’)
  - Initialisms show varying degrees of prosodic merger:
    - *Society for the Prevention of Cruelty to Animals, Anglo-Chinese Junior College, National Registration Identity Card, National Trade Unions Congress (supermarket)*
      
      | Least merger | Most merger |
      |--------------|-------------|
      | a. SPCA      | ((((H),H),H),H) |
      | b. ACJC      | ((((H),H),H),H) (((H),H),MH) |
      | c. NRIC      | ((((H),H),H),H) (((H),H),MH) ((H),MMH) |
      | d. NTUC      | ((((H),H),H),H) (((H),H),MH) ((H),MMH) (MMMH) |

  (p. 23)

- Ng finds a correlation between which group an initialism belongs to and its number of Google hits.
**Why?**

- Ng notes that frequency determines speed of production, perhaps because of faster access (see Bell et al. 2009 for more about possible mechanisms):

![Figure 4: Frequency and duration](image)

- Constraints are then sensitive to speed, e.g. “Grammatical word accessed at speed $n$ allows only $n$ levels of stress”
  - Result is a prosodification of higher-frequency words that results in fewer stresses.
  - This is an interesting way of removing the need for the grammar to refer to frequency
    - Predicts that if we can manipulate speaking rate independent of word frequency, we’ll get similar effects.

<table>
<thead>
<tr>
<th>$\text{Initials}$</th>
<th>$\text{WRAP}$</th>
<th>$\text{*SCLASHES}$</th>
<th>$\text{Stress}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$([M][O][E])_{S_2}$</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>a. $((M),OE)$</td>
<td></td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>b. $((M),OE)$</td>
<td></td>
<td></td>
<td>W*</td>
</tr>
<tr>
<td>c. $((M)(O)(E))$</td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>d. $(M)(O)(E)$</td>
<td>W*</td>
<td></td>
<td>L</td>
</tr>
</tbody>
</table>

(accessed at “speed 2” ($S_2$), so allows only two levels of stress (b and c have tertiary stresses))
3 Hammond 1999: English rhythm rule

- *thirteen mén* or *thirtèen mén*?
  - In survey, shift is more likely if adjective is more frequent: *nàive friend* vs. *obèse child*
  - Hammond proposes morpheme-specific faithfulness constraints, whose ranking depends on the word’s frequency.

4 (Löfstedt 2010): frequency-specific constraints

- We saw these earlier: Famous paradigm gaps in Swedish result when vowel shortening produces too much of a quality change.

<table>
<thead>
<tr>
<th>STEM</th>
<th>NEUTER</th>
<th>GLOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>b[[ɔː]]</td>
<td>b[[ɑː]]+t:</td>
<td>‘blue’</td>
</tr>
<tr>
<td>v[[iː]]t</td>
<td>v[[ɪ]]+t:</td>
<td>‘white’</td>
</tr>
<tr>
<td>v[[iː]]d</td>
<td>v[[ɪ]]+t:</td>
<td>‘wide’</td>
</tr>
</tbody>
</table>

- But! Sufficiently frequent words don’t have a gap

<table>
<thead>
<tr>
<th>STEM</th>
<th>NEUTER</th>
<th>GLOSS</th>
<th>ALLÉN (PL)</th>
<th>GOOGLE (-A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>gr[[ɑː]]d</td>
<td>INEFFABLE</td>
<td>‘straight’</td>
<td>0</td>
<td>7,140</td>
</tr>
<tr>
<td>l[[ɑː]]t</td>
<td>INEFFABLE</td>
<td>‘lazy’</td>
<td>0</td>
<td>581,000</td>
</tr>
<tr>
<td>gl[[ɑː]]d</td>
<td>gl[[ɑ]]+t:</td>
<td>‘happy’</td>
<td>29</td>
<td>2,110,000</td>
</tr>
</tbody>
</table>

- For each of the vowels that can show a gap, there seems to be a frequency cut-off above which there’s no gap. (Löfstedt shows this for some phenomena in other languages too) E.g.,

<table>
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<tr>
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<th>GLOSS</th>
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<td>gl[[ɑː]]d</td>
<td>gl[[ɑ]]+t:</td>
<td>‘happy’</td>
<td>29</td>
<td>2,110,000</td>
</tr>
</tbody>
</table>
Löfstedt’s solution: faithfulness constraints penalizing vowel changes are indexed to frequency:

\[
\begin{array}{|c|c|}
\hline
\text{Input} & \text{Output} \\
\hline
\text{/glad + t/} & \text{[glat]} \\
\text{\textit{‘happy’ neut.}} & \text{\textit{rad}} \\
\text{Cf. [glad]} & \text{\textit{‘wheel’}} \\
\text{Freq /glad /} & \text{\textit{‘rat’}} \\
\text{= 2,110,000)} & \text{\textit{‘wheel’}} \\
\hline
\end{array}
\]

5 Boersma 1999: lexical-access constraints

- The problem: in Dutch, you want to be able to recognize [rat] as either /rat/ or /rad/.
- If you try to use a standard grammar to map perceived form to underlying form, you’ll always pick the faithful one:

\[
\begin{array}{|c|c|}
\hline
\text{Input} & \text{Output} \\
\hline
\text{[rat]} & \text{\textit{‘rat’}} \\
\text{\textit{\textit{‘wheel’}}} & \text{\textit{‘rad’}} \\
\hline
\end{array}
\]

- So, Boersma proposes a family of constraints *LEX(x) “don’t recognize any utterance as lexical item x” (one for each lexical item).
- Ranking depends on word’s frequency:

\[
\begin{array}{|c|c|c|}
\hline
\text{Input} & \text{LEX} & \text{MAXVOI} \\
\hline
\text{[rat]} & \text{\textit{‘rat’}} & \text{\textit{‘wheel’}} \\
\hline
\end{array}
\]

- Actually, it’s a bit more complex: *LEX(x/context=\gamma) to allow for semantic context to matter
6 (Zuraw 2009): Tagalog tapping

- This is work that Kevin Ryan and I got started on—he did all the phonetic work.

**Tapping in prefixed Tagalog words: variable**

\[ d \rightarrow r \] (spelled \( r \)) / \( \_V \_V \)  
\( \text{dumi} \) ‘dirt’  
\( \text{ma-rumi} \) ‘dirty’

- Each word seems to have a consistent behavior (using spelling data in corpus):

\[ d \rightarrow r \] (spelled \( r \)) / \( \_V \_V \)  
\( \text{dumi} \) ‘dirt’  
\( \text{ma-rumi} \) ‘dirty’

\[ \text{dahon} \) ‘leaf’  
\( \text{ma-dahon} \) ‘leafy’

**Tapping in suffixed words: obligatory**

\( \text{lakad} \) ‘walk’  
\( \text{lakar-an} \) ‘to be walked on’

The grammar probably has to enforce the change here, since even low-frequency words undergo.

**Tapping in p-word reduplication: nearly forbidden**

\( \text{dala} \) ‘carry’  
\( \text{dala-dala} \) ‘load carried’

Even high-frequency words (D and E) rarely show tapping. (only 84 word types, though)

\[ d \rightarrow r \] (spelled \( r \)) / \( \_V \_V \)  
\( \text{dumi} \) ‘dirt’  
\( \text{ma-rumi} \) ‘dirty’

\[ \text{dahon} \) ‘leaf’  
\( \text{ma-dahon} \) ‘leafy’

\[ \text{dahon} \) ‘leaf’  
\( \text{ma-dahon} \) ‘leafy’

Not shown in this graph: The more frequent the word, the more likely tapping is.
2009 analysis: grammar refers to outcome of lexical access
- ALIGN(AccU,L; PWd,L): L edge of any accessed lexical unit must coincide with L edge of some p-word.
  → outcome for prefixed word depends on access mode:\(^1\)

<table>
<thead>
<tr>
<th>accessed:</th>
<th>*(......VdV....)</th>
<th>MINIMALITY</th>
<th>STEMISHED</th>
<th>ALIGN(AccU,L; PWd,L)</th>
<th>NORECURSION</th>
<th>* I</th>
</tr>
</thead>
<tbody>
<tr>
<td>maDami</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ma(dami)_ω)</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ma(rami)_ω)</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>madami_ω</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>marami_ω</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ma)_ω(dami)</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>((ma)_ω dami)_ω</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

more-frequent word: whole-word retrieval route should tend to win.

- Outcome for suffixed words is fixed, because constraint that refers to access mode is low-ranked:

<table>
<thead>
<tr>
<th>accessed:</th>
<th>*(......VdV....)</th>
<th>MINIMALITY</th>
<th>STEMISHED</th>
<th>ALIGN(AccU,L; PWd,L)</th>
<th>NORECURSION</th>
<th>* I</th>
</tr>
</thead>
<tbody>
<tr>
<td>lakaD, an, (and maybe lakaDan)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(lakad(an)_ω)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(lakadan)_ω</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| (lakaran)\_ω | | | | | *
| (lakad)\_ω(an)\_ω | | | | | *
| ((lakad)\_ω an)\_ω | | | | | *

\(^1\) Access route should depend on more than just word frequency. See (Hay 2003).

Ling 201A, Phonology II, Kie Zuraw, Winter 2018
- Similarly, outcome for 2-syll reduplicated words is fixed:

<table>
<thead>
<tr>
<th></th>
<th>accessed: DalaDala</th>
<th>*(...VdV...)</th>
<th>MINIMALITY</th>
<th>STEMISHED</th>
<th>ALIGN (ACC, L, Pwd, L)</th>
<th>NORECursion</th>
<th>*r</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>h [(dala)(dala)ω]φ</td>
<td><img src="image1.png" alt="image" /></td>
<td><img src="image2.png" alt="image" /></td>
<td><img src="image3.png" alt="image" /></td>
<td><img src="image4.png" alt="image" /></td>
<td><img src="image5.png" alt="image" /></td>
<td><img src="image6.png" alt="image" /></td>
</tr>
<tr>
<td></td>
<td>i [(dalarala)ω]φ</td>
<td><img src="image7.png" alt="image" /></td>
<td><img src="image8.png" alt="image" /></td>
<td><img src="image9.png" alt="image" /></td>
<td><img src="image10.png" alt="image" /></td>
<td><img src="image11.png" alt="image" /></td>
<td><img src="image12.png" alt="image" /></td>
</tr>
<tr>
<td></td>
<td>j [(dala)ω(dala)ω]φ</td>
<td><img src="image13.png" alt="image" /></td>
<td><img src="image14.png" alt="image" /></td>
<td><img src="image15.png" alt="image" /></td>
<td><img src="image16.png" alt="image" /></td>
<td><img src="image17.png" alt="image" /></td>
<td><img src="image18.png" alt="image" /></td>
</tr>
<tr>
<td></td>
<td>k [(dala)ω(rala)ω]φ</td>
<td><img src="image19.png" alt="image" /></td>
<td><img src="image20.png" alt="image" /></td>
<td><img src="image21.png" alt="image" /></td>
<td><img src="image22.png" alt="image" /></td>
<td><img src="image23.png" alt="image" /></td>
<td><img src="image24.png" alt="image" /></td>
</tr>
<tr>
<td></td>
<td>l [(dala)ω[(dala)ω]φ</td>
<td><img src="image25.png" alt="image" /></td>
<td><img src="image26.png" alt="image" /></td>
<td><img src="image27.png" alt="image" /></td>
<td><img src="image28.png" alt="image" /></td>
<td><img src="image29.png" alt="image" /></td>
<td><img src="image30.png" alt="image" /></td>
</tr>
<tr>
<td></td>
<td>m [(dala)ω[(rala)ω]φ</td>
<td><img src="image31.png" alt="image" /></td>
<td><img src="image32.png" alt="image" /></td>
<td><img src="image33.png" alt="image" /></td>
<td><img src="image34.png" alt="image" /></td>
<td><img src="image35.png" alt="image" /></td>
<td><img src="image36.png" alt="image" /></td>
</tr>
<tr>
<td></td>
<td>n [(dala)ω dala)ω]φ</td>
<td><img src="image37.png" alt="image" /></td>
<td><img src="image38.png" alt="image" /></td>
<td><img src="image39.png" alt="image" /></td>
<td><img src="image40.png" alt="image" /></td>
<td><img src="image41.png" alt="image" /></td>
<td><img src="image42.png" alt="image" /></td>
</tr>
</tbody>
</table>

(same outcome if Dala accessed)

Is any of this really online? Or is it all lexicalized (reflecting diachronic effects)?

- Clitics show real variation:  
  - daw ‘reportedly’  
  - ako raw ~ ako daw ‘me, reportedly’  
  - din ‘also’  
  - ako din ~ ako rin ‘me too’.

- Weak, non-linear frequency effects:  
  - all word+clitic combinations  
  - just the clitic+clitic combinations

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_Ling 201A, Phonology II, Kie Zuraw, Winter 2018_
Similar results vowel-height alternation
halo ‘mixture’ halo-halo ~ halu-halo ‘(a dessert)’
(final-syllable [o] alternates with non-final syllable [u])

- ‘o’ forms are mostly in lowest-frequency reduplicated words:

- Grammar matters too: strong reduplicative identity effect
  - if second copy is forced to be [u] by suffixation, first copy is usually [u] too (ka-tapus-tapus-an ‘very last’)

[Diagrams showing frequency distribution]
Similar results for nasal substitution
(see (Zuraw 2010) for more on this rule)

- Prefix-final nasal can fuse (or not) with following obstruent:
  
  /paŋ+pasko/ ‘for Christmas’
  
  a. non-assimilation  paŋ-pasko  <pang-pasko>
  b. assimilation  pam-pasko  <pam-pasko>
  c. nasal substitution  pamasko  <pamasko>

- Which obstruent it is matters a lot:

  ![Graph showing the fusion of nasal and obstruent]

- But within the /b/s, where there are plenty of both types, frequency matters:

  ![Graph showing the frequency of different outcomes]

So where is this effect, really?

- Giving grammar a role seems to work well.
- But what if the grammatical effects be achieved by a diachronic model? Maybe this is all just information stored in lexical entries, perhaps reflecting lexical-access events from long ago.
- If lexical access really is involved, it should be possible to affect a word’s pronunciation through priming (temporarily perturbs the item’s activation).
  - We think it does! Zuraw, Lin, Yang & Peperkamp (in preparation)
7 More proposals in which grammar refers (at least somewhat) directly to frequency

- Can we think of ways to determine whether grammar makes direct reference to frequency, or sees only to the outcome of lexical access?
  - Coetzee 2008: a lexical item’s frequency determines how likely it is to be assigned to a given lexical class on any production occasion
  - Myers 2005: how can lenition be both postlexical and sensitive to lexical frequency?
    - proposes a diachronic solution, where high frequency results in a more lenited lexical entry over time, but plays no synchronic role
    - diachronic and synchronic explanations should make different predictions about effects of priming on production...
  - Alcantara 1998 (English): high-frequency exceptions can be protected by high-ranking idiosyncratic constraints
  - Carlson & Gerfen 2011 (not a proposal about grammar, but a cool case): when a Spanish diphthong loses stress (say, because of suffixation), it should monophthongize. But it’s variable:

![Diagram](p. 512)

The more productive the suffix (by corpus measures), the more likely to keep the diphthong.

- Gouskova & Roon 2008: in Russian compounds, the constraint requiring each stem to bear a prominence is ranked low, but there’s a higher-ranked version of the constraint for low-frequency stems, forcing a secondary stress:

![Diagram](p. 56)
8 Bermúdez-Otero 2012 forthcoming: two types of listing

- **Non-analytic listing**: output of stem level goes into the lexicon (fully prosodified)
  - blocks application of stem-level phonology, e.g. stress assignment, if faithfulness ranked high
  - → allows exceptional stress to survive (*Arabic*)
  - listed form blocks morphosyntactic synthesis (you can’t just compose *Arab+ic* or *drive+d*)

- **Analytic listing**: output of word level may go into the lexicon, but is listed as a concatenation of inputs to the word level
  - example: `<LOAD, PAST> = [WORD_LEVEL [p-word (ləʊd)] – d]` (p. 23)
  - unable to block application of word-level phonology, e.g. [-d][-t][-id] allomorphy
  - → no exceptions to word-level phonology allowed

- vs. plain old computation

**Illustrated with a classic example**

- `-al` is a stem-level suffix
  - so *orignal* is listed non-analytically
  - if you then want to derive *originality* (if you’d never heard it), you have to start with *orignal/
  - can’t start with *origin+all/

- faithfulness is ranked high: *orignal+ity* → *originality*, not *origináity* (cf. *àbracadábra*)

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**Chung’s generalization (from Chung 1983)**

- A stem-level process can “cyclically misapply” iff it can have lexical exceptions in monomorphemes
- Bermúdez-Otero’s OT interpretation:
  - High-ranking faithfulness are needed to ensure *orignal+ity* → *originality* (= cyclic misapp.)
  - This means you could have monomorphemic exceptions to the ‘abracadabra rule’ too: *Epâminónadas*, apparently (ancient Greek statesman)
Blocking can break down, though, because it happens in processing

- Nonanalytic entry \[p\text{-word} \left((ˈæ^\text{m}ˌæ^\text{b}̂)ɪk\right)\] (Arabic) races against synthesis, \[\text{[STEM.LEVEL. ææb - ɪk]}\]
- If the whole word isn’t frequent enough, the entry isn’t accessible enough, so it can lose out to synthesis, resulting in a regularized production.
- And if the exceptional form isn’t produced often enough, the next generation won’t learn it.

Frequency effects

- Classic cyclicity:

```
| a. cómp[ə]nsâte | cómp[ə]nsât-ion |
| comp[ə]nâte | comp[ə]nât-ion |
| b. cond[ɛ]mn | cond[ɛ]mn-átion |
```

- but:

```
| a. cons[ʒ]rv | cons[ʒ]rv-átion |
| trâsp[ʒ]rt | trâsp[ʒ]rt-átion |
```

- The reason is frequency:

```
(33) \(\times\) per 10^6 words in spoken section of COCA

<table>
<thead>
<tr>
<th>base</th>
<th>derivative</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. cyclic stress</td>
<td></td>
</tr>
<tr>
<td>cond[ɛ]mn</td>
<td>cond[ɛ]mn-átion</td>
</tr>
<tr>
<td>b. variable stress</td>
<td></td>
</tr>
<tr>
<td>cond[ɛ]nse</td>
<td>cond[ɛ-ə]ns-átion</td>
</tr>
<tr>
<td>c. noncyclic stress</td>
<td></td>
</tr>
<tr>
<td>cons[ʒ]rv</td>
<td>cons[ʒ]rv-átion</td>
</tr>
<tr>
<td>trâsp[ʒ]rt</td>
<td>trâsp[ʒ]rt-átion</td>
</tr>
</tbody>
</table>
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See Collie 2008 for a full study

To sum up today

- We looked at several cases of lexical frequency’s influencing phonology.
- We considered putting the explanation in diachrony, processing, and/or grammar.

Next week

- More about phonology and processing
- Getting phonological evidence
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