Today

- Parts of vocal tract used in producing vowels
- Articulatory description of vowels
- IPA symbols for English vowels
- Speech Synthesis: brief intro

Readings: 3.4, 14.4-14.5
Review of Consonants

Three-part Articulatory description of consonants:
1) Voicing
2) Place of articulation
3) Manner of articulation

[d] = voiced alveolar stop
Vowel articulation

- Chambers in mouth
- (above the glottis):
  - Oral cavity
  - Pharynx (behind tongue)
  - Area between lips
  - (Nasal cavity)

- Length and shape of each chamber affect the ‘resonance’ (or the properties of the vibration) of vowel sound
Tongue body position

Saggital view of tongue positions in vowels

Your turn... study aids!

Listen & then practice front --> back, high --> low
Cut and paste the following link into your web browser to hear the online demo:

http://www.exploratorium.edu/exhibits/vocal_vowels/vocal_vowels.html

Duck call demo
Articulatory Description

4-part classification system for vowels:
1) Tongue height
2) Frontness vs. backness of tongue
[3) Tenseness ** don’t need to know]
4) Lip rounding

[ also (5) Nasality (in many languages)]
Vowel height

- **High vowels**: tongue body is raised
  - [i]  [ɪ]  [u]  [ʊ]  
    - ‘beat’  ‘bit’  ‘boot’  ‘put’

- **Mid vowels**: tongue body is intermediate
  - [eɪ]  [ɛ]  [ɔu]  [ɔ]  [ʌ]
  - [e]  [o]
    - ‘bait’  ‘bet’  ‘boat’  ‘bought’  ‘butt’  ‘bore’*

- **Low vowels**: tongue body is lowered
  - [æ]  [a]
    - ‘bat’  ‘bomb’  ‘bar’
  - [e]
    - [espesijal]
  - [eɪ]
    - *[eispeisijal]
Vowel height
Vowel Backness*

- **Front** vowels: tongue body is pushed forward
  - [i] [ɪ] [ɛ] [ɛ] [æ]
- **Back** vowels: tongue body is pulled back
  - [u] [ʊ] [o] [ɔ] [ɑ]
- **Central** vowels: tongue body is neutral
  - [ɔ] [ʌ]

*book calls this “retraction”
Vowel Backness

- Front
  - [i]
  - [e]
  - [æ]
  - [ʌ]
- Central
  - [ɛ]
  - [ɔ]
- Back
  - [ʊ]
  - [ø]
  - [ɔ]
  - [a]
Vowel Roundedness

- **Rounded**: produced with rounded lips
  - [u] [o] [ɔ] [ʊ]
- **Unrounded**: produced with unrounded lips
  - [i] [e] [ɛ] [æ] [a] [ə] [ʌ]
- Many languages also have front rounded vowels (e.g., French)
  - lit “bed”  lu “read”  loup “wolf”
  - [li]  [ly]  [lu]
## Vowel Roundedness

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<thead>
<tr>
<th></th>
<th>high</th>
<th>mid</th>
<th>low</th>
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<tbody>
<tr>
<td>front</td>
<td>[i]</td>
<td>[e]</td>
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<td></td>
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</tbody>
</table>

- **Roundness:**
  - [i] (High, Front)
  - [u] (Mid, Back)

### Vowel Position
- **Front:** [i], [ɛ], [æ]
- **Central:** [ɛ], [ɔ]
- **Back:** [u], [ɜ], [ə]

### Vowel Height
- **High:** [i], [u]
- **Mid:** [ɛ], [ɔ]
- **Low:** [æ], [ə], [a]
Practice: Articulatory descriptions

[i] = High front unrounded
[o] = Mid back rounded
[a] = Low back unrounded
Diphthongs

- Two-part vowel sounds consisting of transition from one vowel to another in same syllable
  - [baɪ] ‘buy’
  - [beɪ] ‘bay’
  - [bɔːɪ] ‘bow (and arrow)’
  - [bɔɪ] ‘boy’
  - [baʊ] ‘bow (down)’
Application: Speech Synthesis

- Producing “human-like sounds”

- Two basic approaches: mimic the sound or mimic the vocal tract shape
  - sound: splice recorded sounds
  - vocal tract shape: duck call (use ‘source-filter theory’: 1--generate a source, 2--generate a filter)

- Text-to-speech (TTS)
  - grapheme > phoneme > speech (sound)