OFFICE OF THE DIRECTOR OF NATIONAL INTELLIGENCE

Data Resources to Support the Babel Program
Intelligence Advanced Research Projects Activity (IARPA)

LEADING INTELLIGENCE INTEGRATION

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Babel

- The Program
- Program Goals and Structure
- The Data

BABEL

The Challenge

- Thousands of hours of speech are acquired in a language of emerging importance to the IC with varied audio quality.
- Few IC analysts have the ability to understand the language.
- There is no existing speech technology for the language.
- We must be able to rapidly develop effective triage capabilities to assist those few analysts.

Babel – Addressing the Language Deluge

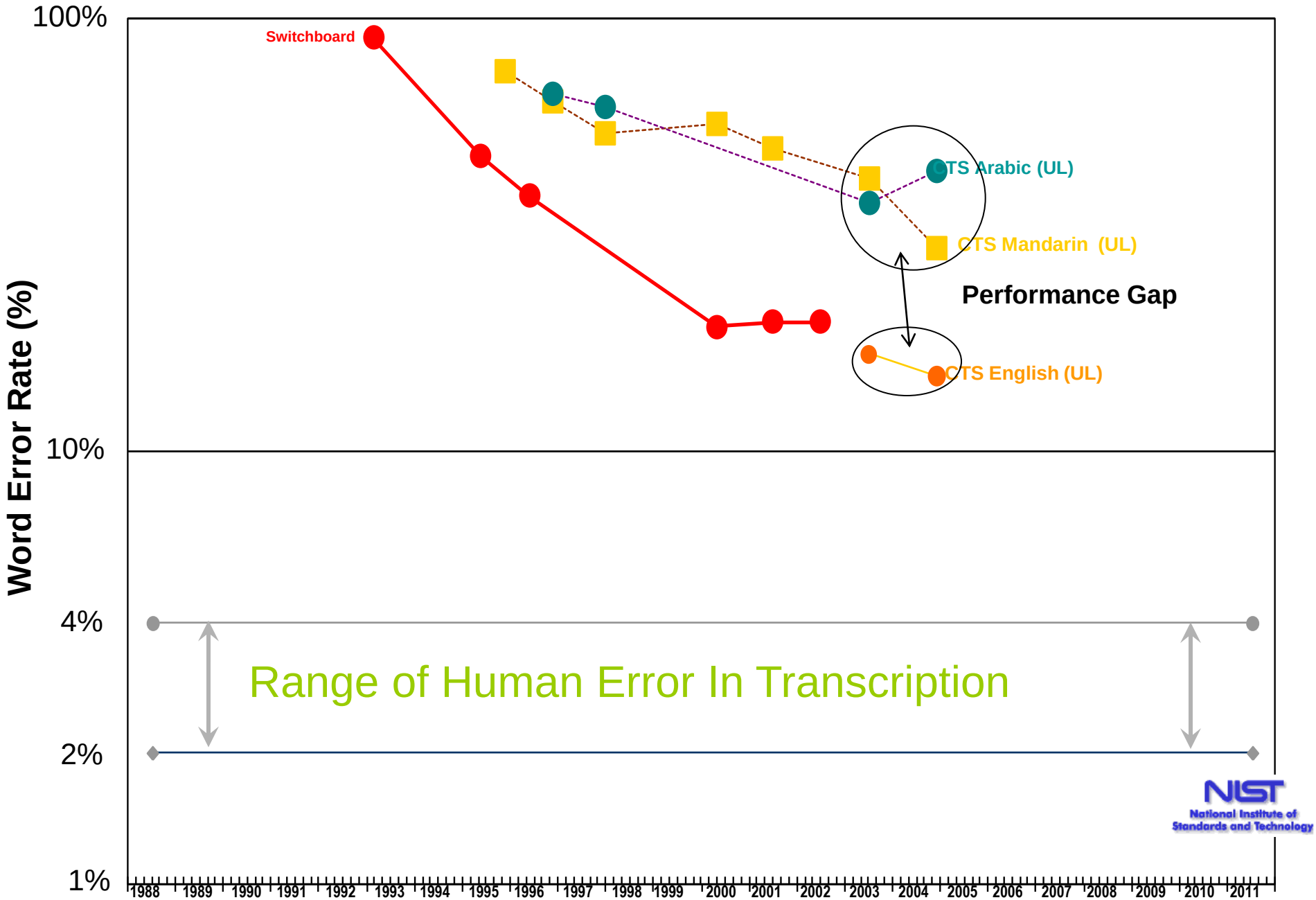
Goal:

- Develop agile and robust speech methods
  - Rapid application to any human language
  - Effective keyword search capability over massive amounts of real-world recorded speech

State-of-the-Art/Practice:

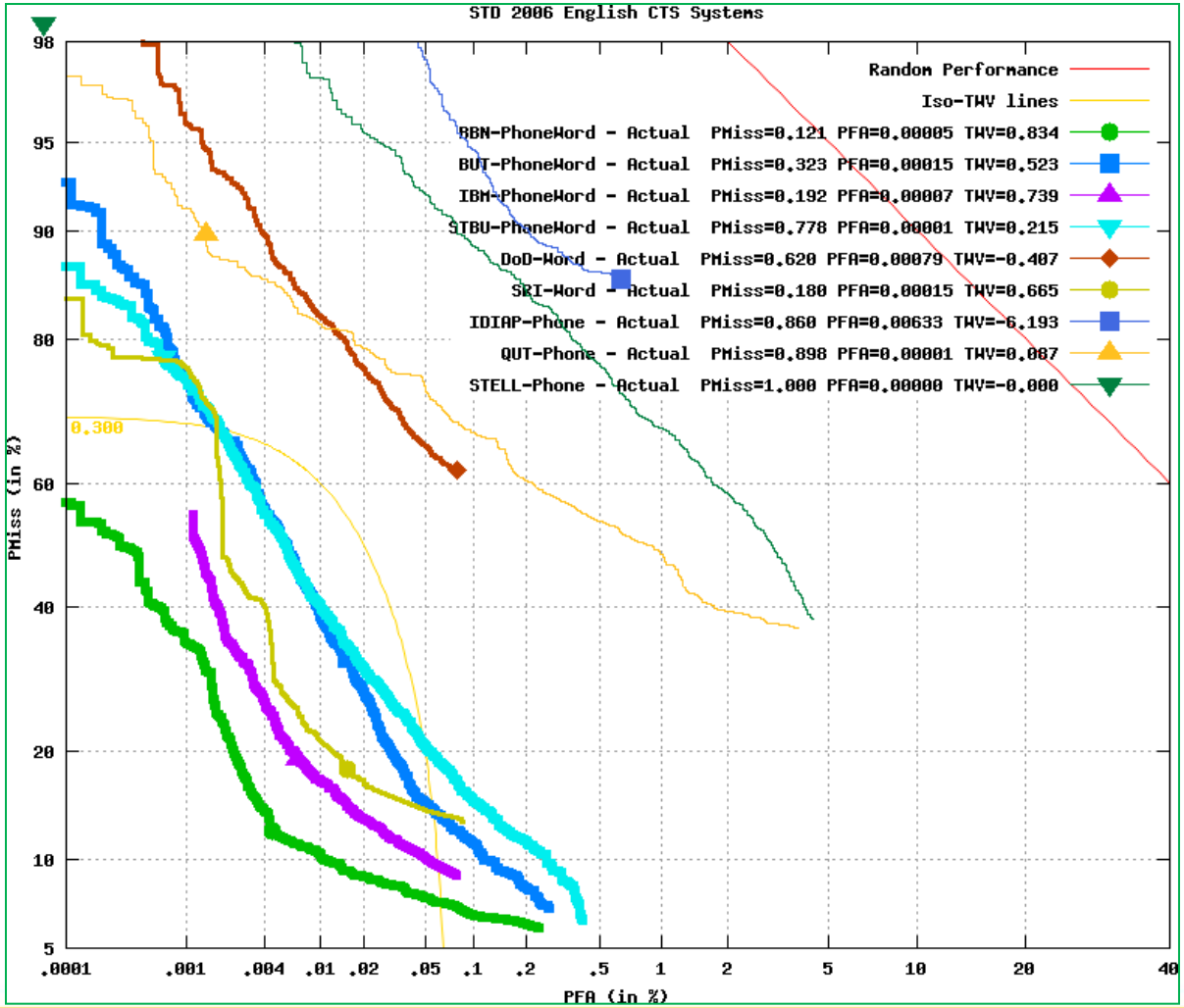
- 7,000+ languages, 330 have 1M+ speakers, but **only a few studied**
- Today's systems were originally developed for English on fairly clean speech with **significantly lower performance**:
  - On other languages
  - On speech collected in real-world conditions
- System development for a new language takes **months to years.**

NIST Conversational Speech

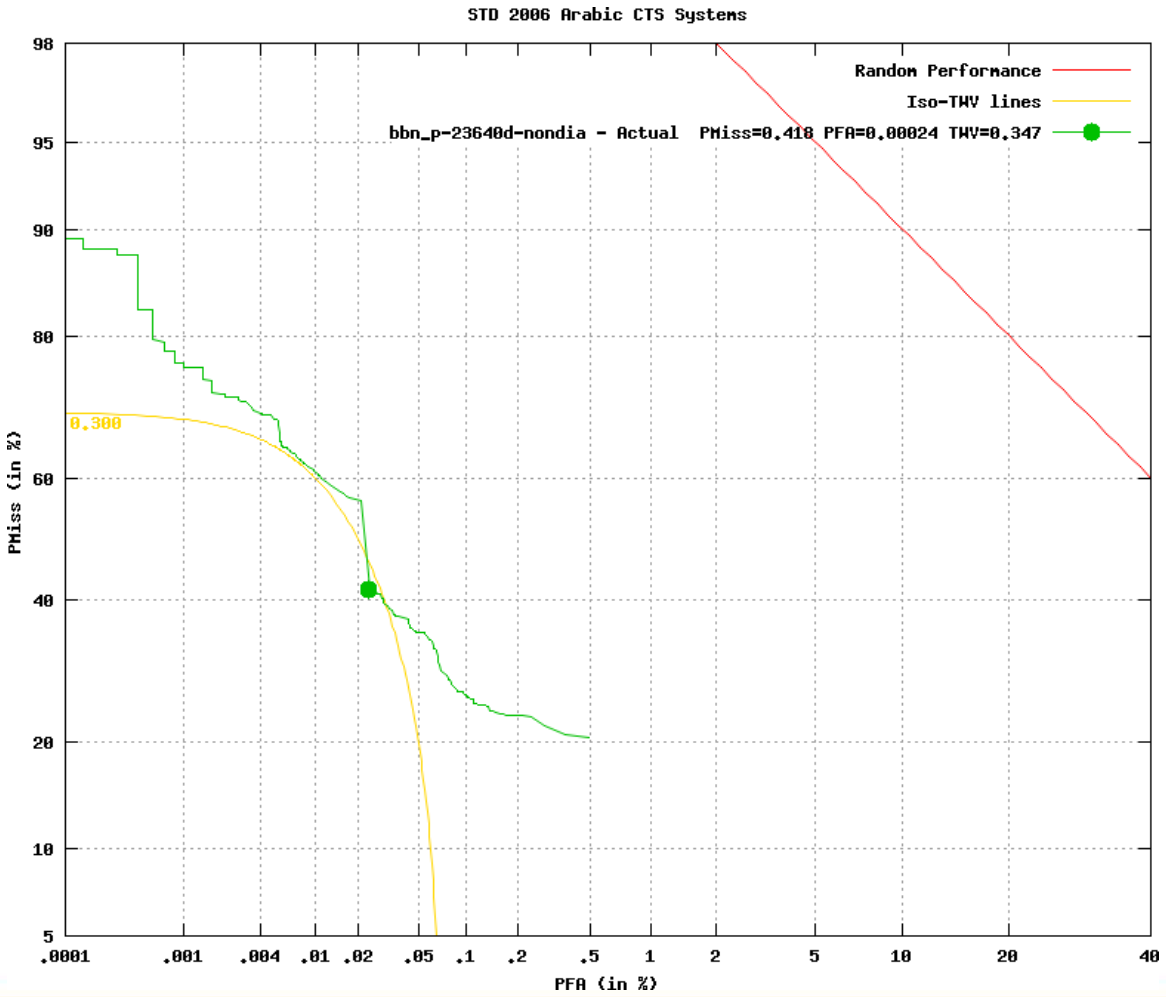


NIST National Institute of Standards and Technology

STD06: English Conversational Telephone Speech



STD06: Non-Diacritized Arabic Conversational Telephone Speech



Babel's Approach

- **Work with diverse languages from the outset**
  - Acquire speech data in-country for languages from a broad set of language families (e.g., Afro-Asiatic, Niger-Congo, Sino-Tibetan, Austronesian, Dravidian, Altaic), chosen for coverage of language types
  - *Study multiple languages each program period*
- **Handle real recording conditions from the outset**
  - Acquire data in a variety of conditions (e.g., in a moving car, in a café, on the street) and use different recording devices (e.g., cell phone, hands free, table top microphone)
  - *Evaluate using diverse conditions each period*
- **Constrain resources and system development time each period**
  - *Reduce the amount of transcribed speech for use in system development*
  - *Reduce system development time*
- **Rigorous evaluation**
  - *Use a "surprise" language for system evaluation each program period*

Babel's Approach

- Researchers will:
  - work with development languages to create new methods
  - be evaluated annually on a surprise language with development time and training size constraints
- Annual evaluation:
  - On the set of development languages and the surprise language
  - Progress will be measured using:
    - NIST Spoken Term Detection Evaluation (see http://www.itl.nist.gov/iad/mig//tests/std/2006/index.html)
    - Word Error Rate (WER) when appropriate for the technology

Snapshot of a Babel Program Period

Develop New Methods for N New Languages (~9 months)	Keyword Search Evaluation on the N languages (1 month)	Create Speech System for a Surprise Language (X weeks)	Keyword Search Evaluation on the Surprise (1 week)

Time

N= 4, 5, 6, and 7 Languages over the Program Periods
X = 4, 3, 2, and 1 Weeks over the Program Periods

Performance Goals

	Phase 1		Phase 2	
Year	Base	Option 1	Option 2	Option 3
Transcribed %	100%	≤ 75%	≤ 50%	≤ 50%
Pronunciation Lexicon (transcription coverage)	100%	≤ 75%	≤ 50%	≤ 50%
Channels	telephone	telephone and non-telephone	telephone and non-telephone	telephone and non-telephone
Languages Investigated Development+Surprise	4+1	5+1	6+1	7+1
Build Time for Surprise	4 weeks	3 weeks	2 weeks	1 week
Minimum NIST Actual Term Weighted Value (ATWV)	0.3	0.3	0.3	0.3

NOTE: All evaluations will include data from challenging environments.
There will also be alternative evaluations with different amounts of transcribed audio.

Data and Evaluation

- The Data
- The T&E Team

Test & Evaluation

MITRE

NIST National Institute of Standards and Technology

UNIVERSITY OF MARYLAND CASL CENTER FOR ADVANCED STUDY OF LANGUAGE

MIT Lincoln Laboratory

Data Design

- Languages are chosen:
  - From a variety of language families (e.g., Afro-Asiatic, Niger-Congo, Sino-Tibetan, Austronesian, Dravidian, Altaic)
  - With a variety of different features (i.e., with different phonotactic, morphological, syntactic characteristics)
- Audio data is collected in-country:
  - Dialectal variation
  - Wide variety of environments: home office (landline or mobile), public place, street, in vehicle, car kit, and others
  - Network and handset diversity
  - Non-telephone channels after the BP
  - Metadata balance (gender, age, dialect)

The Data

- We anticipate collecting a total of 26 languages for the Program.
- Languages of Base Period
  - Cantonese
  - Turkish
  - Pashto
  - Tagalog
  - And the Surprise!

Civil Liberties, Privacy Protections, and Human Subjects

- The ODNI Civil Liberties and Privacy Office has reviewed the data collection process and the Babel program was found to have no CLPO issues.

- For each language, approximately 2000 subjects will sign consent forms and participate by speaking into a telephone, first to an automated system then with a friend of their choosing. The speech will be collected in a non-US country where the language is widely spoken. The government will not receive any PII (personally identifiable information). Additionally, the PII and the collected speech data are not at any point stored in the same computer system.

- The collection delivered to the government will contain audio recordings and transcription. Speech will be annotated with coarse-grained metadata, including speaker characteristics (gender, age, dialect spoken), channel (e.g., landline telephone, cell telephone, table top microphone at a distance), and environment (e.g., in a bar, at a restaurant, in a shopping mall, on the street/roadside, in an office, at home, in a moving vehicle).

- The data collection company has registered with the U.S. Department of Health and Human Services, Office for Human Research Protections, and has received Federal Wide Assurance (FWA) for the Protection of Human Subjects (Reference Number FWA00015539 with expiration date March 24, 2013). They have also registered with an approved Institutional Review Board (IRB) for review of the proposed collection method using human subjects.

Cantonese

- Sino-Tibetan, related to but not mutually intelligible with Modern Standard Chinese (*Putonghua* or *Guoyu*)
- Spoken in southern China from China's Guangdong & Guangxi Provinces (not Hong Kong or Macao)
- Written in simplified characters
  - Vernacular writing not highly conventionalized, so morphemes that have no equivalent in Modern Standard Chinese may be represented with:
    - (Roughly) homophonous characters from the Modern Standard Chinese canon
    - (More or less) idiosyncratic vernacular characters
- Phonology: intermediate complexity.
  - Eight vowels, ten diphthongs
  - 19 consonants
  - Seven tones (some descriptions six to nine), limited tone *sandhi*
- Limited derivational morphology, *very* limited inflectional morphology

Environment Audio Issues

- Background speech

  有 啊 <int> 有 啊 (()) 工夫 (()) 冻烂 啦 (()) 啊 吓 系 咪

  [*Yes <int> yes (()) effort (()) ??? (()) huh huh yes*]

- In vehicle recording

  听唔听到 哦 听到 啊 系 嘛 有 啊 我 问 你 系 咪 去 香港 买- 买 佳能 相机

  [*Can you hear me? I can hear you. I want to ask you if you went to Hong Kong to buy the camera.*]

- In vehicle recording (hands free)

  唔 系 买 部 通风 三 零 六 定 三 零 七 咩

  [*Don't buy 3 6 3 7.*]

Cell Phone Audio Issues

- Cell phone coding errors

  啊 有时 **睇 埋 有** 冇 **睇 埋** 嘸 啲 **咩 新**闻 **啊** 啲

  [*Sometimes I watch some news.*]

- Cell phone drop outs

  哦 (()) **哦 而家 系** <hes> **打包 系 嘛**

  [*Oh. (()) Right now, yes. <hes> Pack it to go.*]

- Clipping

  <sta> **你 你 等等 先** 妈咪 **等等 先** 妈咪 倾 紧 电话 倾 紧 电话 **你 放** 喺 **果度 先 放 系 碗 果** 头 **先 咯 哦 咁**样 **系 咪 好 啊**

  [*Wait. Wait for mommy to speak on the phone. Put it where the bowl is. Yes.*]

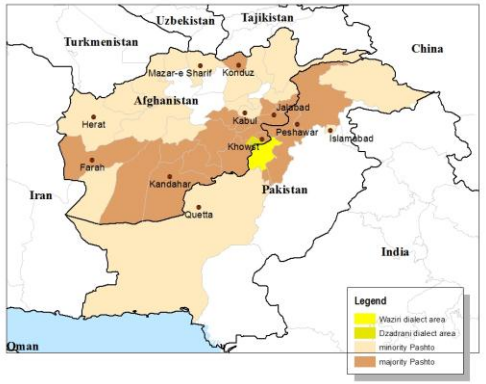
Pashto

- Indo-Iranian (related to Iranian languages, but influenced by Indo-Aryan languages)
- An official language in Afghanistan, also spoken in Pakistan
- Written in Perso-Arabic script
  - Some characters are not in Arabic, recommend a wide-coverage Arabic font (e.g. SIL's Scheherazade)
  - Not all vowels are written in Perso-Arabic script, some phonemes have > 1 representation (e.g. four letters with same /z/ sound). SAMPA transcriptions also to be provided.
- Phonology
  - Large number of consonant phonemes: 30
    (cf. English ~24)
  - Contrasts dental vs. retroflex (+ palato-alveolar fricatives and affricates)
  - Smaller number of vowel phonemes: 7
  - *Some* speakers *might* add "elegant" (= Arabic) consonants *sometimes*

Pashto

- Dialectal variation, esp. in phonology
- Morphology
  - Nouns and Adjectives
    - Multiple declension classes
    - Suffixes mark case, number, gender/animacy
    - Some stem allomorphy

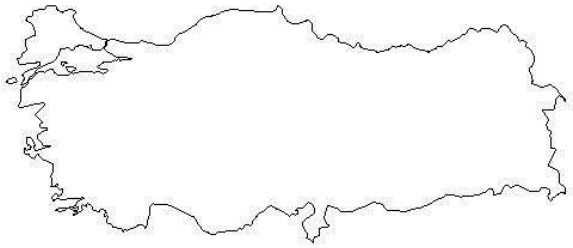
      ɣal ‘thief’ (direct case, singular)
      ɣlo ~ ɣlúno (oblique/ ablative plural)



  - Verbs
    - Prefixes and suffixes marking tense, aspect, mood, subject person/ number/ gender
    - Some stem allomorphy

      raség-əm ‘I arrive/am arriving’,
      wə-rased-əy ~ wə-rased-əl-əy ‘you-all arrived’

Turkish



- Turkic language family
- Official language of Turkey
- Written in Latin script
- Intermediate number of phonemes (8 vowels, 23 consonants)
  - Includes front rounded and back unrounded vowels
- Some dialectal variation; “standard” dialect is that of Istanbul

Turkish Morphology

- Agglutinating, strictly suffixal; very little irregularity
- Vowel harmony in suffixes
- Some phonological processes affect stem (devoicing)
- Nouns mark case, number, person of possessor (optional);
  ev-ler-in-izin ‘of your houses’
  ağaç-lar-ın-ızın ‘of your trees’
- Adjectives don’t decline (unless acting as noun)
- Verbs mark tense, aspect, mood/evidential, negation, and subject person
  gel-mez-se-ler ‘if they did not come’
  oku-maz-sa-lar ‘if they did not study’
- Abundant morphological resources available

Tagalog (aka Filipino)

- Central Philippine language (Austronesian family)
- An official language of the Philippines (with English)
- Written in Latin script
- Intermediate phonology (six vowels, nine diphthongs,19 consonants)
  - Word-final voiceless stops often unreleased
  - Vowel length can be contrastive, but not written in orthography (nor is word-final /h/)
    aso /a:soh/ ‘dog’
    aso /asoh/ ‘smoke’
- Some dialectal variation (loss of glottal, [r] ~ [d], some morphology and lexical differences)

Tagalog Morphology

- Nouns not inflected, but “case”-marked by preceding particles
- Verbs are complex: marked by prefixes, suffixes, infixes, reduplication for “focus”, aspect, mode, voice

nag-*sabi*	‘say’	(actor focus, completed)
mag-sa-*sabi*		(actor focus, “contemplated”)
sa-*sabi*-hin		(object focus, “contemplated”)
s-um-*ayaw*	‘dance’	(actor focus, completed)
sa-*sayaw*		(actor focus, “contemplated”)
sa-*sayaw*-in		(object focus, “contemplated”)

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