The Thirteenth Annual North American Computational Linguistics Olympiad 2019

Invitational Round March 7, 2019

Serious language puzzles that are surprisingly fun!

-Will Shortz, Crossword editor of The New York Times and Puzzlemaster for NPR
Welcome to the thirteenth annual North American Computational Linguistics Olympiad! You are among the few, the brave, and the brilliant to participate in this unique event. In order to be completely fair to all participants across North America, we need you to read, understand, and follow these rules completely.

**Rules**

1. The contest is four hours long and includes ten problems, labeled I to R.
2. Follow the facilitators’ instructions carefully.
3. If you want clarification on any of the problems, talk to a facilitator. The facilitator will consult with the jury before answering.
4. You may not discuss the problems with anyone except as described in items 3 & 11.
5. Each problem is worth a specified number of points, with a total of 100 points. **In the Invitational Round, some questions require explanations.** Please read the wording of the questions carefully.
6. All your answers should be in the Answer Sheets at the end of this booklet. ONLY THE ANSWER SHEETS WILL BE GRADED.
7. Write your name and registration number on each page of the Answer Sheets’
   Here is an example: Jessica Sawyer #850
8. The top students from each country (USA and Canada) will be invited to the next round, which involves team practices before the international competition in South Korea.
9. Each problem has been thoroughly checked by linguists and computer scientists as well as students like you for clarity, accuracy, and solvability. Some problems are more difficult than others, but all can be solved using ordinary reasoning and some basic analytic skills. You don’t need to know anything about linguistics or about these languages in order to solve them.
10. If we have done our job well, very few people will solve all these problems completely in the time allotted. So, don’t be discouraged if you don’t finish everything.
11. **DO NOT DISCUSS THE PROBLEMS UNTIL THEY HAVE BEEN POSTED ONLINE! THIS MAY BE A COUPLE OF MONTHS AFTER THE END OF THE CONTEST.**

Oh, and have fun!
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Problem I: The Afrihili Word Machine - Michael Salter and Aleka Blackwell
   Problem J: Polish These Nouns! - Milena Venena
   Problem K: Two Róngs Don't Make a Right - Ethan Chi
   Problem L: We Were Born to Solve This Problem - Daniel Lovsted
   Problem M: Colorless Green Concepts Scripting Furiously - Daniel Lovsted
   Problem N: Fun With Witsuwit’en - Daniel Lovsted
   Problem O: Infer a Surprise - Tom McCoy
   Problem P: Do You Hear the Master’s Moon? - Sam Ahmed
   Problem Q: A Tale of Kieu-plets - Ethan Chi
   Problem R: Disambiguate This! - Ethan Chi

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Union College

University of Kentucky

University of Maryland

University of Washington

Princeton University

Penn

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University of Southern California

uOttawa

Yale University

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(I) The Afrihili Word Machine (1/2) [5 Points]

In 1970, a Ghanaian historian named Kumi Attobrah designed a Pan-African auxiliary language which he named Afrihili. As was the case with Esperanto (the most widely spoken constructed international auxiliary language devised in 1887 by L. L. Zamenhof), Attobrah decided to solve the problem of having to create a large number of unique words by developing an elaborate system of inflections and derivations for making new words.

Below are some words in Afrihili with their English translations:

<table>
<thead>
<tr>
<th>Afrihili</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>adu</td>
<td>tooth</td>
</tr>
<tr>
<td>ajamuri</td>
<td>republic</td>
</tr>
<tr>
<td>akalini</td>
<td>pen</td>
</tr>
<tr>
<td>amadu</td>
<td>dentist</td>
</tr>
<tr>
<td>amkate</td>
<td>bread</td>
</tr>
<tr>
<td>amola</td>
<td>children</td>
</tr>
<tr>
<td>amukamo</td>
<td>kingdom</td>
</tr>
<tr>
<td>aturesine</td>
<td>bouquet</td>
</tr>
<tr>
<td>afidi</td>
<td>machine</td>
</tr>
<tr>
<td>emeli</td>
<td>ship</td>
</tr>
<tr>
<td>uruzindi</td>
<td>stream</td>
</tr>
<tr>
<td>eshuli</td>
<td>principal</td>
</tr>
<tr>
<td>eture</td>
<td>flowers</td>
</tr>
<tr>
<td>enti</td>
<td>date tree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Afrihili</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>ikalini</td>
<td>pens</td>
</tr>
<tr>
<td>ijamura</td>
<td>president</td>
</tr>
<tr>
<td>ilengi</td>
<td>horses</td>
</tr>
<tr>
<td>imukazi</td>
<td>girls</td>
</tr>
<tr>
<td>isabamatu</td>
<td>cobbler/shoemaker</td>
</tr>
<tr>
<td>ishule</td>
<td>school</td>
</tr>
<tr>
<td>omuntu</td>
<td>man</td>
</tr>
<tr>
<td>olengi</td>
<td>horse</td>
</tr>
<tr>
<td>uruzi</td>
<td>river</td>
</tr>
<tr>
<td>omola</td>
<td>child</td>
</tr>
<tr>
<td>omukazi</td>
<td>girl</td>
</tr>
<tr>
<td>emelisini</td>
<td>fleet</td>
</tr>
<tr>
<td>oluganda</td>
<td>dialect</td>
</tr>
<tr>
<td>omuntundu</td>
<td>dwarf</td>
</tr>
</tbody>
</table>

11. Fill in the gaps in the table below, marking your answers on the answer sheets:
(I) The Afrihili Word Machine (2/2)

I2. Below are three more Afrihili words and three options for a likely translation of the word. Pick the most likely translation to be correct, and explain your choice—make sure to mark these in your answer sheets.

A. imulenzi  (a) fruit (b) boys (c) bridge
   Explain your choice in your answer sheets:

B. aposino   (a) baggage (b) classroom (c) parent
   Explain your choice in your answer sheets:

C. iwelemase (a) book (b) library (c) librarian
   Explain your choice in your answer sheets:

I3. Describe what you have learned about the structure of words in Afrihili in your answer sheets.
(J) Polish These Nouns! (1/3) [10 points]

The Polish language is a West Slavic language spoken by approximately 50 million people in Poland and around the world. Here are some phrases in Polish in the singular and plural and their translations in English.

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>adwokat</td>
<td>adwokaci</td>
<td>advocate (a person who supports a cause)</td>
</tr>
<tr>
<td>ambaras</td>
<td>ambarasy</td>
<td>problem</td>
</tr>
<tr>
<td>autor</td>
<td>autorzy</td>
<td>author</td>
</tr>
<tr>
<td>biedny napis</td>
<td>biedne napy</td>
<td>poor subtitle</td>
</tr>
<tr>
<td>blady indyk</td>
<td>blade indyki</td>
<td>pale turkey</td>
</tr>
<tr>
<td>blady optymista</td>
<td>bladzi optymisci</td>
<td>pale optimist (someone with a positive outlook)</td>
</tr>
<tr>
<td>błotnisty artysta</td>
<td>błotniści artyści</td>
<td>muddy artist</td>
</tr>
<tr>
<td>chiński antropolog</td>
<td>chińscy antropodzy</td>
<td>Chinese anthropologist</td>
</tr>
<tr>
<td>cienki gnat</td>
<td>cienkie gnaty</td>
<td>weak bone</td>
</tr>
<tr>
<td>dochód</td>
<td>dochody</td>
<td>income</td>
</tr>
<tr>
<td>drobniuski granat</td>
<td>drobniuskie granaty</td>
<td>tiny pomegranate</td>
</tr>
<tr>
<td>dystrybutor</td>
<td>dystrybutorzy</td>
<td>distributor</td>
</tr>
<tr>
<td>egipski adwersarz</td>
<td>egipscy adwersarze</td>
<td>Egyptian adversary</td>
</tr>
<tr>
<td>kacyk</td>
<td>kacykowie</td>
<td>cacique (the chief of an indigenous tribe)</td>
</tr>
<tr>
<td>kardynal</td>
<td>kardynalowie</td>
<td>cardinal (an official in the Church)</td>
</tr>
<tr>
<td>kolejna</td>
<td>kardynaly</td>
<td>cardinal (the bird)</td>
</tr>
<tr>
<td>kolega</td>
<td>koledzy</td>
<td>colleague</td>
</tr>
<tr>
<td>emir</td>
<td>emirowie</td>
<td>emir (a title for the ruler of a Muslim country)</td>
</tr>
<tr>
<td>nijaki zasób</td>
<td>nijakie zasoby</td>
<td>unremarkable resource</td>
</tr>
<tr>
<td>notariusz</td>
<td>notariusze</td>
<td>notary (someone who certifies legal documents)</td>
</tr>
</tbody>
</table>
(J) Polish These Nouns! (2/3)

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>objazd</td>
<td>objazdy</td>
<td>detour</td>
</tr>
<tr>
<td>obojczyk</td>
<td>obojczyki</td>
<td>collarbone</td>
</tr>
<tr>
<td>odcinek</td>
<td>odcinki</td>
<td>episode (of a TV show)</td>
</tr>
<tr>
<td>pancerz</td>
<td>pancerze</td>
<td>armor</td>
</tr>
<tr>
<td>Polak</td>
<td>Polacy</td>
<td>Pole (someone from Poland)</td>
</tr>
<tr>
<td>szacunek</td>
<td>szacunki</td>
<td>respect</td>
</tr>
</tbody>
</table>

Note that sz, rz, cz, dz, ń, and ł are consonants and that q, ó, and y are vowels.

J1. The Polish word **darmozjad** means "a loafer," or a person who lives on others' expense. You might expect the plural of **darmozjad** to be **darmozjadzi**. However, the plural is actually **darmozjady**. Explain why this is the case in your answer sheets.

J2. **wielkoluď** ('giant') has two plurals. What are they, and when would each be used? Mark your answers in your answer sheets.

J3. Give the plural forms of the following phrases in your answer sheets.

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A kalendar</td>
<td></td>
<td>calendar</td>
</tr>
<tr>
<td>B jarski kapelusz</td>
<td></td>
<td>vegetarian hat</td>
</tr>
<tr>
<td>C łotr</td>
<td></td>
<td>villain</td>
</tr>
<tr>
<td>D robotnik</td>
<td></td>
<td>worker</td>
</tr>
<tr>
<td>E chorowity chirurg</td>
<td></td>
<td>sickly surgeon</td>
</tr>
<tr>
<td>F partner</td>
<td></td>
<td>partner</td>
</tr>
<tr>
<td>G zwalisty golfista</td>
<td></td>
<td>stocky golfer</td>
</tr>
<tr>
<td>H zachodnioeuropejski akordeonista</td>
<td></td>
<td>Western European accordionist</td>
</tr>
<tr>
<td>I chybki pilot</td>
<td></td>
<td>swift pilot</td>
</tr>
<tr>
<td>J czepek</td>
<td></td>
<td>bonnet</td>
</tr>
</tbody>
</table>
(J) Polish These Nouns! (3/3)

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>grzejnik</td>
<td>heater</td>
</tr>
<tr>
<td>L</td>
<td>rudy grób</td>
<td>red tomb</td>
</tr>
<tr>
<td>M</td>
<td>szympants</td>
<td>chimpanzee</td>
</tr>
<tr>
<td>N</td>
<td>pan</td>
<td>lord</td>
</tr>
<tr>
<td>O</td>
<td>zalążek</td>
<td>seed</td>
</tr>
</tbody>
</table>

J4. Explain how Polish plurals are formed in your answer sheets.
(K) Two Róngs Don’t Make a Right (1/1) [10 Points]

According to legend, the Lepcha script was devised in the early 18th century by Prince Chakdor Namgyal of Tibet. Today, it is still used to write the Róng (རོང) language, which is spoken by around 50,000 people in Sikkim, India. Róng is distantly related to Tibetan, Burmese, and Chinese. Below are some words written in Lepcha script, with their transcriptions in a different order. Note that ó and ú are distinct vowels (unrelated to o and u).

1. ཞ ས ཨ A. bakto 'grain'
2. ག ས ཨ B. bi 'vegetable'
3. ཐ ས ཨ C. bik 'cow'
4. ས ས ཨ D. chik 'to weigh'
5. ཨ ཨ ཨ E. chung 'little'
6. ཨ ཨ ཨ F. dú 'umbrella'
7. ཨ ཨ ཨ G. ka 'overseer'
8. ཨ ཨ ཨ H. kajú 'dog'
9. ཨ ཨ ཨ I. khek 'freeze'
10. ཨ ཨ ཨ J. lali 'a kind of laurel tree'
11. ཨ ཨ ཨ K. món 'pig'
12. ཨ ཨ ཨ L. radi 'blanket'
13. ཨ ཨ ཨ M. thúk 'season'
14. ཨ ཨ ཨ N. tsung kóng 'a kind of sorghum'
15. ཨ ཨ ཨ O. tsúk 'to bite'
16. ཨ ཨ ཨ P. ót 'to pick fruit'
17. ཨ ཨ ཨ Q. úng 'water'
18. ཨ ཨ ཨ R. út 'otter'

K1. Determine the correct correspondences in your answer sheets.
K2. Write chông ‘hand’, jik ‘native land’ and, thikûng ‘great-grandfather’ in Lepcha in your answer sheets.
K3. Transcribe the following Róng words in your answer sheets: ང ‘to crack’, མ ‘to read’, མ ལ ‘elephant.'
(L) We Were Born to Solve This Problem (1/1) [15 Points]

Here are some words in Cupeño¹ and their translations in English:

1. pulinchemyax  
   We were born. (we were given birth to)

2. pinehamanin  
   I embarrassed him.

3. empulinwen  
   You (pl.) used to bear children.

4. chimichungpenqal  
   He used to kiss us.

5. ewel  
   You (sg.) grew.

6. wixpemyax  
   They were stepped on.

7. pemhamawen  
   They used to feel ashamed.

8. piwixeminwen  
   You (pl.) used to step on him.

9. nepuyqal  
   I used to dine

10. pichempuynin  
    We fed him

11. chakweyax  
    You (sg.) were caught.

12. nichakwpeminwen  
    They used to catch me

13. imichakwnen  
    I caught you (pl.)

L1. Translate into English on your answer sheets:

   chungpemyax

L2. Translate into Cupeño on your answer sheets:

   We used to raise you (sg.)

L3. Explain how verbs are formed in Cupeño in your answer sheets

¹ Cupeño is an extinct language of the Uto-Aztecan family, formerly spoken in Southern California. The last native speaker, Roscinda Nolasquez, died in 1987.
(M) Colorless Green Concepts Scripting Furiously (1/2)

[10 Points]

Modern logicians represent the logical relationships between statements with a straightforward notation. For example, if we represent the statement “Canada is beautiful” with p, then we can represent the statement “Canada isn’t beautiful” with ¬p (read as “not p”). If we have two statements represented by p and q, then we can represent “if p, then q” as p→q, and similarly we can represent “p and q” and “p or q” as p∧q and p∨q, respectively. Pretty easy, right?

But things weren’t always this clear! In 1879, German logician Gottlob Frege published a seminal work on logic called Begriffsschrift, which literally translates to “concept script”. The notation he used, also called Begriffsschrift, confused many readers with its two-dimensional format and use of few symbols. That being said, the Begriffsschrift notation is a carefully thought-out system that adheres to formal rules. Here are some examples of Begriffsschrift formulas, with their translations into modern logical notation.

<table>
<thead>
<tr>
<th>Begriffsschrift</th>
<th>Modern notation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Begriffsschrift Diagram 1" /></td>
<td>B ∨ A</td>
</tr>
<tr>
<td><img src="image2.png" alt="Begriffsschrift Diagram 2" /></td>
<td>(C → B) → ¬A</td>
</tr>
<tr>
<td><img src="image3.png" alt="Begriffsschrift Diagram 3" /></td>
<td>C ∧ ¬(B → A)</td>
</tr>
<tr>
<td><img src="image4.png" alt="Begriffsschrift Diagram 4" /></td>
<td>(C → ¬B) ∨ A</td>
</tr>
<tr>
<td><img src="image5.png" alt="Begriffsschrift Diagram 5" /></td>
<td>(D ∨ C) ∨ (B ∧ A)</td>
</tr>
</tbody>
</table>
(M) Colorless Green Concepts Scripting Furiously (2/2)

M1. Translate from Begriffsschritt into modern notation:

Begriffsschritt ain’t just pretty to look at! It’s also a meaningful logical language. As an example, consider the following facts which you may not have known about astrophysics:

All quaxors are galactions. Most of those pulsoids with a sateotrope are galactions, too. A pulsoid with a sateotrope is only not a galaction when it is dingly. (Of course, all this only holds true if the polyverse is Groop-normal.)

M2. Match these sentences to letters A to F to correctly complete the Begriffsschritt formula below (note that there are two possible correct answers) in your answer sheets:

i. x is a galaction
ii. the polyverse is Groop-normal
iii. x is dingly
iv. x has a sateotrope
v. x is a quaxor
vi. x is a pulsoid

M3. Explain how the Begriffsschritt notation works in your answer sheets
(N) Fun With Witsuwit’en (1/1) [15 Points]

Here are some words and phrases in Witsuwit’en and their English translations:

1. bat  a. abdomen
2. batdeč  b. bat
3. cas  c. blanket
4. deč  d. broadleaf plantain
5. dečyas  e. cold
6. dalk”ač  f. dog
7. dalk”ačbat  g. dog harness
8. dalk”ačdatay  h. face
9. dalk”ačnetdac  i. feather
10. dani  j. female dog
11. daninanin  k. fine powder snow
12. lac  l. frog
13. lac’tl’ol  m. icicle
14. lacyas  n. light blue
15. ladaní  o. male dog
16. lãnani  p. man
17. netdac  q. penny
18. nin  r. snow
19. waq’az  s. snowflake
20. waq’az yas  t. snow on branches or rooftops
21. waq’az yu  u. tooth
22. yas  v. top
23. yascas  w. upper part of stomach
24. yu  x. wolf

N1. Match the English translations to the Witsuwit’en words in your answer sheets.

N2. Translate to English in your answer sheets: datay, tl’ol.

Note 1: The Witsuwit’en language is spoken by about 130 people in British Columbia, Canada.

Note 2: The broadleaf plantain (Plantago major) grows throughout British Columbia. Its broad leaves act as shelter for many small reptiles, insects, and amphibians.

Note 3: Many species of frog are found in British Columbia, varying in shape, size, and colour.
(O) Infer a Surprise (1/4) [5 Points]

A popular task in natural language processing is called natural language inference (NLI). This task involves training a model to take two sentences and label whether the first sentence entails the second sentence. (Sentence 1 is said to entail Sentence 2 if Sentence 2 is guaranteed to be true whenever Sentence 1 is true). Here are some examples of entailment and non-entailment:

<table>
<thead>
<tr>
<th>Sentence 1</th>
<th>Sentence 2</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>The judge is 6 feet tall and the lawyer is 5 feet tall.</td>
<td>The judge is taller than the lawyer.</td>
<td>entailment</td>
</tr>
<tr>
<td>Lichen grows on every continent.</td>
<td>Lichen grows on Antarctica.</td>
<td>entailment</td>
</tr>
<tr>
<td>The dentist was born in Illinois.</td>
<td>The dentist was born in Chicago.</td>
<td>non-entailment</td>
</tr>
<tr>
<td>Lichen grows on every continent.</td>
<td>The judge is taller than the lawyer.</td>
<td>non-entailment</td>
</tr>
<tr>
<td>Lichen grows on every continent.</td>
<td>Lichen does not grow on every continent.</td>
<td>non-entailment</td>
</tr>
</tbody>
</table>

To get a computer to solve this task, the standard approach is to train the computer on many examples like the ones above. Ideally, the computer will solve the task by learning to understand the sentences and therefore figure out which sentences have meanings that entail the meanings of other sentences. However, sometimes a computational model will place too much weight on certain coincidences in the training data, and this tendency will cause it to make incorrect predictions. Suppose a model is trained on these examples:

<table>
<thead>
<tr>
<th>Sentence 1</th>
<th>Sentence 2</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhode island is the smallest US state.</td>
<td>Rhode Island is smaller than Connecticut.</td>
<td>entailment</td>
</tr>
<tr>
<td>Rice is a type of grass.</td>
<td>Rice is a plant.</td>
<td>entailment</td>
</tr>
<tr>
<td>Ottawa is the capital city of Canada.</td>
<td>Ottawa is in Alberta.</td>
<td>non-entailment</td>
</tr>
<tr>
<td>No human has ever set foot on Mars.</td>
<td>Several animals have been to Mars.</td>
<td>non-entailment</td>
</tr>
</tbody>
</table>

A model trained on these examples might learn the following generalization:

*If both sentences start with R, the sentence pair should be labeled entailment. Else, label non-entailment.*

However, this conclusion is incorrect. It makes the wrong predictions for the following sentences:

<table>
<thead>
<tr>
<th>Sentence 1</th>
<th>Sentence 2</th>
<th>Correct label</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regularization is useful.</td>
<td>Regularization is not useful.</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>No amphibians can echolocate.</td>
<td>Frogs cannot echolocate.</td>
<td>entailment</td>
<td>non-entailment</td>
</tr>
</tbody>
</table>
(O) Infer a Surprise (2/4)

A natural language inference model has been trained on the sentences in the following table (in practice, such a model would use a much larger training set, but we are displaying a small set to keep it manageable):

<table>
<thead>
<tr>
<th>#</th>
<th>Sentence 1</th>
<th>Sentence 2</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>the happiest walrus lives in Paris</td>
<td>the happiest walrus lives in Berlin</td>
<td>non-entailment</td>
</tr>
<tr>
<td>2</td>
<td>all dogs are mammals</td>
<td>all mammals are dogs</td>
<td>non-entailment</td>
</tr>
<tr>
<td>3</td>
<td>all dogs are mammals</td>
<td>no dog is not a mammal</td>
<td>entailment</td>
</tr>
<tr>
<td>4</td>
<td>we have stopped eating at Loretta's Diner</td>
<td>we once ate at Loretta's Diner</td>
<td>entailment</td>
</tr>
<tr>
<td>5</td>
<td>ice cream contains sugar</td>
<td>Chile is a narrow country</td>
<td>non-entailment</td>
</tr>
<tr>
<td>6</td>
<td>apples are red, and oranges are orange</td>
<td>oranges are orange</td>
<td>entailment</td>
</tr>
<tr>
<td>7</td>
<td>I love chocolate milk</td>
<td>I enjoy strawberry milk</td>
<td>non-entailment</td>
</tr>
<tr>
<td>8</td>
<td>the building is seventy feet tall</td>
<td>the building is over sixty-three feet in height</td>
<td>entailment</td>
</tr>
<tr>
<td>9</td>
<td>Charles Dickens was born in Portsmouth</td>
<td>the author of <em>A Tale of Two Cities</em> was born in a coastal city in the south of England</td>
<td>entailment</td>
</tr>
<tr>
<td>10</td>
<td>ice cream contains sugar</td>
<td>ice cream has sugar in it</td>
<td>entailment</td>
</tr>
<tr>
<td>11</td>
<td>Mary knows that the vase broke</td>
<td>the vase broke</td>
<td>entailment</td>
</tr>
<tr>
<td>12</td>
<td>all mammals are welcome here</td>
<td>Paul the walrus is welcome here</td>
<td>entailment</td>
</tr>
<tr>
<td>13</td>
<td>the editor read the submission</td>
<td>the submission was read by the editor</td>
<td>entailment</td>
</tr>
<tr>
<td>14</td>
<td>the squirrel chased the chipmunk</td>
<td>the chipmunk chased the squirrel</td>
<td>non-entailment</td>
</tr>
<tr>
<td>15</td>
<td>the folder containing my passport is in the filing cabinet</td>
<td>my passport is in the filing cabinet</td>
<td>entailment</td>
</tr>
<tr>
<td>16</td>
<td>I have never seen a walrus</td>
<td>I have never seen a manatee</td>
<td>non-entailment</td>
</tr>
<tr>
<td>17</td>
<td>Augustus was the first emperor</td>
<td>Augustus was an emperor</td>
<td>entailment</td>
</tr>
<tr>
<td>18</td>
<td>every walrus enjoys swimming</td>
<td>most walruses enjoy yoga</td>
<td>non-entailment</td>
</tr>
<tr>
<td>19</td>
<td>etiquette demands that one display a certain degree of respect toward one's elders</td>
<td>nothing in life is ever free</td>
<td>non-entailment</td>
</tr>
<tr>
<td>20</td>
<td>I like Baltimore very much</td>
<td>I like Baltimore</td>
<td>entailment</td>
</tr>
<tr>
<td>21</td>
<td>Wilhelmina has a cousin</td>
<td>Wilhelmina has at least one aunt or uncle</td>
<td>entailment</td>
</tr>
</tbody>
</table>
(O) Infer a Surprise (3/4)

The model was then tested on many examples, and it got the following examples wrong:

<table>
<thead>
<tr>
<th>#</th>
<th>Sentence 1</th>
<th>Sentence 2</th>
<th>Correct Label</th>
<th>Model Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>while the painter painted the furniture was covered with a plastic sheet</td>
<td>the painter painted the furniture</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>23</td>
<td>I have never, ever seen a walrus</td>
<td>I have never seen a walrus</td>
<td>entailment</td>
<td>non-entailment</td>
</tr>
<tr>
<td>24</td>
<td>the book on the table is blue</td>
<td>the table is blue</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>25</td>
<td>fish swim</td>
<td>this is an example of a dummy sentence that is being used for demonstration purposes</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>26</td>
<td>the only animals in the aviary are birds</td>
<td>the aviary does not have a heron living in it</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>27</td>
<td>I have never seen a walrus</td>
<td>I have without a doubt seen a walrus</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>28</td>
<td>I like Baltimore very much</td>
<td>the moon shone like a burnished medallion</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>29</td>
<td>Alice believes Mary is lying</td>
<td>Alice believes Mary</td>
<td>non-entailment</td>
<td>entailment</td>
</tr>
<tr>
<td>30</td>
<td>every walrus loves oysters</td>
<td>Paul the walrus loves oysters</td>
<td>entailment</td>
<td>non-entailment</td>
</tr>
<tr>
<td>31</td>
<td>my aunt lives in Lagos with her pet walrus</td>
<td>my aunt lives in Lagos</td>
<td>entailment</td>
<td>non-entailment</td>
</tr>
</tbody>
</table>
(O) Infer a Surprise (4/4)

The model’s behavior can be explained by a set of generalizations it could have learned from the training examples. On the answer sheet, fill in the blanks to describe these rules. For each rule, also write the numbers of 2 training example sentences (i.e. in the range 1-21) from which it might have learned the rule (there may be more than 2 training examples that could apply):

Rule 1: If ____(a)____ is more than ____(b)____ words long, label the sentences ____(c)______. (Evidence: example ____(d)____ and example ____(e)______)

Rule 2: If ____(f)____, label the sentences ____(g)_______. (Evidence: example ____(h)____ and example ____(i)______)

Rule 3: If ____(j)____ contains the word ____(k)____, label the sentences ____(l)_______. (Evidence: example ____(m)____ and example ____(n)______)

From the examples, it seems that the model has given different priorities to these three rules. Rank the rules in order of priority:

TOP PRIORITY: ____(o)______

MIDDLE PRIORITY: ____(p)______

BOTTOM PRIORITY: ____(q)______

Which test example(s) allow you to determine this ranking? ____(r)______
(P) Do You Hear the Master’s Moon? (1/1) [15 Points]

Mayangna is a Misumalpan language spoken in Nicaragua and Honduras by about 8700 people. Here are some sentences in Mayangna along with their English translations. Note that in the English, ‘you’ refers to the singular; ‘you (pl)’ refers to the plural.

<table>
<thead>
<tr>
<th>Mayangna Sentence</th>
<th>English Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>kuring man yaihmat yak yamtasyang</td>
<td>I do not make a pipante next to you.</td>
</tr>
<tr>
<td>yang dakiwan ulamak balna kaswi yang mikit yak</td>
<td>My master eats clams above me.</td>
</tr>
<tr>
<td>kubamhni balna mukuks balna yamamwaski witeninga yalinamak taanit yak</td>
<td>The owls do not make clouds in front of their farm.</td>
</tr>
<tr>
<td>yanga dikitna yak witning palani dakaasman</td>
<td>You do not hear his raft under us.</td>
</tr>
<tr>
<td>man kammapani wainiku man mamat yak buiwi</td>
<td>Your company shakes the moon above you.</td>
</tr>
<tr>
<td>yang kuringk yiainnit yak wakurusni balna buknina kurahtayang</td>
<td>I open the scorpions’ book next to my pipante.</td>
</tr>
<tr>
<td>man walamabis yang pinkisil talwaski witning daniwan balna yaihnta yak</td>
<td>Your son does not see my pencil next to his masters.</td>
</tr>
<tr>
<td>mukusni balna witning sunipai balna dakakaawi palani dinit yak</td>
<td>The clouds hear her spiders under the raft.</td>
</tr>
<tr>
<td>man sumalu balna kisauri kakaswi yang dangkit yak</td>
<td>Your dogs eat coriander behind me.</td>
</tr>
<tr>
<td>man mumalalah yang yaihkit yak kastasman</td>
<td>You do not eat your guapote next to me.</td>
</tr>
<tr>
<td>was supai balna taanitna yak daakaman</td>
<td>You hear water in front of spiders.</td>
</tr>
<tr>
<td>yamak yak yang titinghki wakisa talwi</td>
<td>My grandmother sees a banana at a farm.</td>
</tr>
</tbody>
</table>

P1. Translate these sentences into English on your answer sheets:
   1. waiku dakaayang man damat yak
   2. ulamakni man kubamhna yaihnti yak buitaman
   3. man wakimasa talasyangna yang walakabis balna taanitna yak

P2. Translate these sentences into Mayangna on your answer sheets:
   4. Our masters do not open the clouds in front of us.
   5. You make the dog’s raft next to the water.
   6. I shake pencils above your (pl) grandmother.
   7. You (pl) do not eat our bananas at a raft.

P3. Explain your solution in the answer sheets.

A pipante is a small wooden boat rowed with shovels and a guapote is a type of edible freshwater fish, sometimes called a wolf cichlid.)
(Q) A Tale of Kieu-plets (1/2) [10 Points]

*The Tale of Kieu* is an epic poem written in Vietnamese by author Nguyễn Du in 1820, which details the life of the talented young woman Thúy Kiều. The poem is composed of 1,627 couplets, or groups of two lines. Here are some couplets from *The Tale of Kieu* in no particular order:

1. Trăm năm trong côi người ta,
   Chữ tài chữ mình khéo là ghét nhau.
2. Đâu lòng hai â tò nga,
   Thúy Kiều là chỉ, em là Thúy Văn.
3. Nửa năm hoi tiếng vưa quen,
   Sân ngôi cảnh biệt đã chen là vàng.
4. Vạn ràng: Chỉ cùng nước cười,
   Khéo đuổi nước mắt khóc người đồi xưa.
5. Người đâu gặp gỡ làm chi?
   Trăm năm biệt có duyên gì hay không?

Each couplet of the *Tale* is written in the poetic meter known as *lục bát*, which has several rules. Even if we don’t speak Vietnamese, we can still use these rules to identify whether a couplet has been corrupted. For example, here is a corrupted version of couplet #1:

1a. Trăm năm trong dài người ta,
   Chữ tài chữ mình khéo là ghét nhau.

This couplet does not follow the rules of *lục bát* and consequently must have been corrupted. However, this is not always the case. Consider this other corruption to couplet #1:

1b. Trăm năm trong cá người ta,
   Chữ tài chữ mình khéo là ghét nhau.

This corrupted version of couplet #1 still follows the rules of *lục bát*; we would need to know Vietnamese in order to determine that there was a mistake.

In Vietnamese, the diacritics (accent marks) á, à, â, ă, â indicate five of the six Vietnamese tones (known as sắc, huyền, hỏi, nặng, and ngã respectively); the absence of a diacritic indicates the sixth tone, *ngang*. Importantly, the diacritics â, ă, ē, ơ, ư do not represent tones; instead, they represent slight changes to the pronunciation of the vowels. Traditionally, Vietnamese tones are divided into two groups: *sharp* tones, of which there are four, and *flat* tones, of which there are two.

**Q1.** Which tones belong to which groups? Write your answer on the answer sheets.

1. From the Middle Chinese words *liuk-pat*, or ‘six-eight’.
(Q) A Tale of Kieu-plets (2/2)

While searching in your local library for linguistics papers, you find six more couplets from *The Tale of Kieu*. However, some have been damaged. Only two of them have remained uncorrupted—the other four have had **exactly two words changed or removed** so that they no longer follow the rules of *lục bát*. Fortunately, even if you don’t know Vietnamese, you can use the rules of *lục bát* to determine which couplets are original.

6. Vàng trình hội chùa xem tướng,
   Mà sao trong số đoạn sẵn có tên.

7. Æu đánh qua tồn nhân duyên,
   Cùng người một hối, một thuyên đâu ngại!

8. Thùa rạng: Chút phân ngày thơ,
   Dương sinh đối tiền tóc to chửa đen

9. Ngoài sống thơ thể oanh vàng,
   Nách tường bông liễu bay ngang trước mành.

10. Chàng Kim tự lại thu song,
    Nơi nàng cảnh cảnh bên lòng biếng khuây.

11. Mạnh Tương phất phát gió truyền,
    Hướng gây mùi nhỏ, trả khan giọng.

Q2. Determine which two couplets are authentic and which four have been corrupted. For each couplet, circle “corrupted” or “authentic”. For each corrupted couplet, write the two words which have been corrupted, or write REMOVED if a word has been removed.

Here is one more couplet from *The Tale of Kieu*. The couplet has been transmitted in damaged form: for some of the words, two choices are possible (marked in parentheses).

Q3. For each combination in parentheses, determine which of the two words is correct. If both of the two words could occur and still follow the rules, circle the word BOTH. Write your answers on the answer sheets.

12. Nhân (ở/tử) (quán/rap) (khách/tùơi) lần (la/khác),
   Tuấn trông thắm thoát nay (低下/ach) thêm hai.

Q4. Explain your observations about the structure of *lục bát* in your answer sheets.
(R) Disambiguate This! (1/3) [5 points]

One important (and often tricky) task in machine translation is disambiguation: identifying which sense of a word is being used in a sentence. Consider the following sentences:

1) The old sing.
2) The singers are old.

In 1), “old” is used as a noun, while in 2), “old” is used as an adjective. Computers must be able to deduce which meaning of the word is intended in order to properly label these sentences for translation. Here’s an example:

1) the old are singing
   the.DET old.N be.VRB sing.VRB
2) the singers are old
   the.DET singer.N be.VRB old.ADJ

Here’s a brief explanation of the above syntax:
- The lowercase word before the first period is the lemma—the base form of the word.
- The uppercase word after the period is a tag which marks the part of speech.
- The following tags are available: DET for determiners (broadly, words that come before a noun, like "this," "your," or "the"); N for nouns; PRN for pronouns (e.g. "I," "me," or "you"); VRB for verbs; ADJ for adjectives; ADV for adverbs; PREP for prepositions (words like "about").

Unlike us, computers are not automatically able to tell that the word old is a noun in the first sentence but an adjective in the second. Therefore, we must write rules to determine the correct tag for such words. Here’s an example rule, which is written in a syntax known as constraint grammar:

old: SELECT N if (+1 VRB)

This selects the noun (N) form of the word old if the next (+1) word is tagged as a verb (VRB), and does nothing otherwise. Note that negative numbers may be used to select previous words, as in this rule:

old: SELECT ADJ if (-1 DET)

Here’s one more rule, which selects the verb form of the word "desert" in every case.

desert: SELECT VRB

Before using the rules, our computer system first tags all words that only have one possible part of speech. It then handles the rules in top-down order, applying each rule in turn to every word (from left to right) in the sentence that still has more than one possible tag. Beware: if no rule makes a decision, the system will crash!
(R) Disambiguate This! (2/3)

Below are some sentences in English containing the ambiguous word “her”, which can either serve as a determiner (‘her dress’, represented as her.DET) or as a pronoun (‘I saw her’, represented as her.PRN).

1. I see her now.
   I.PRN see.VRB her.PRN now.ADV

2. Her son is tall.
   her.DET son.N be.VRB tall.ADJ

3. The girl hears her daughter today.
   the.DET girl.N hear.VRB her.DET daughter.N today.ADV

4. The dog looks at her.
5. The girl is her friend.
6. I am her daughter.
7. The cat saw her dog yesterday.
8. You walk with her.
9. The boy likes her.
10. A giraffe sees her now.
11. I give her flowers.
12. Her tall daughter is smart.
13. The cat examines her quizically.
14. I am her older sister.
15. Her orange cat likes me.

R1. For sentences 4-15, indicate, on your answer sheets, whether “her” is being used as a determiner or as a pronoun.

R2. All of the above sentences—except one—can be disambiguated using three rules. List these three rules in your answer sheets, remembering that rule order matters. Assume that all words other than “her” only have one possible tag.

R3. Which sentence is disambiguated incorrectly? Explain, in your answer sheets, why it would be difficult to create a rule that would successfully tag this sentence.
(R) Disambiguate This! (3/3)

Below are some sentences in Sranan Tongo (an English-based creole language with influences from Dutch, Javanese, Hindustani, and Chinese, which is the national language of Suriname) with their translations in English.

Mi lobi den singi.                      "I love the songs."
Den lobi yu singi.                     "They love your songs."
Den lobi mi.                           "They love me."
Mi singi abra yu lobi.                 "I sing about your love."
Den lobi dati mi singi.                "They love that I sing."
Yu lobi mi sisa.                       "You love my sister."
Mi lobi yu.                            "I love you."

Note that no Sranan Tongo words change from their lemma forms. For example, the lemma form of sisa is sisa.N. Most of the words in these examples have parts of speech that were also present in the English examples on the previous page, but there are also two additions: “abra” should be tagged PREP (preposition) and “dati” should be tagged COMP (complementizer).

As you can see, disambiguation is much harder in Sranan Tongo than in English, as many words have multiple meanings. For example, “lobi” can mean "love" (noun) or "to love" (verb).

To deal with this level of difficulty, we need more powerful rules. Here's a rule that uses some additional syntax available for Sranan Tongo:

PRN/DET: SELECT DET if (-1 [VRB]) and (+1 PRN)

This selects the determiner (DET) form of a word that could be either a pronoun (PRN) or a determiner (DET) if the previous (-1) word could possibly be a verb ([VRB]) and the next word has been confirmed to be a pronoun (PRN) and does nothing otherwise. Specifically, the notation we are adding is the slash / (which can only be used before the colon, not after it); the brackets [ ] (which can only be used after the colon, not before it); and the word “and” (but not “or”)

Of course, you can still use the syntax given in the previous section.

R4. Write a set of rules that would successfully disambiguate the above sentences in your answer sheets. Hint: you should need no more than 5 rules. Recall that, before the rules are applied, all words with only one possible part of speech are tagged with that part of speech.
Contest Booklet

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Contest Site: ____________________________________________

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SIGN YOUR NAME BELOW TO CONFIRM THAT YOU WILL NOT DISCUSS THESE PROBLEMS WITH ANYONE UNTIL THEY HAVE BEEN OFFICIALLY POSTED ON THE NACLO WEBSITE IN APRIL.

Signature: ____________________________________________
(I) The Afrihili Word Machine

<table>
<thead>
<tr>
<th>English</th>
<th>Afrihili</th>
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<tbody>
<tr>
<td>machinist</td>
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<tr>
<td>ships</td>
<td>ajamura</td>
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<td>flower</td>
<td>amkamate</td>
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<td>group of girls</td>
<td>oluga</td>
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<tr>
<td>date fruit</td>
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<td>shoe</td>
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12. A) 
   
   B) 
   
   C) 

![Image of n a c l o diagram]
Answer Sheet (2/8)

I3.

(J) Polish These Nouns!

J1.

J2.

J3. A
B
C
D
E
F
G
Answer Sheet (3/8)

J3. H

J4.

(K) Two Róns Don’t Make a Right

K1. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18.

K2. hand native land great-grandfather

K3.
(L) We Were Born to Solve This Problem

L1. 

L2. 

L3. 

(M) Colorless Green Concepts Scripting Furiously

1. 

2. i. ii. iii. iv. v. vi. 

3. 

n a c l o
(N) Fun With Witsuwit’en
1. 1  2  3  4  5  6  7  8
9. 10 11 12 13 14 15 16
17. 18 19 20 21 22 23 24
2. 

(O) Infer a Surprise
(a) sentence  
(b)  
(c) 
(d)  
(e) 
(f) 
(g)  
(h)  
(i) 
(j) sentence  
(k) 
(l)  
(m)  
(n) 
(o)  
(p)  
(q)  
(r)  

(P) Do You Hear the Master’s Moon?
P1. 1. 
2. 
3. 

n a c l o
(Q) A Tale of Kieu-Plets

Q1. sharp tones

flat tones

Q2. corrupted / authentic
Corrupted words: #1 __________________________ #2 __________________________

Q3. a. õ̌ tùr  BOTH
b. quán ráp  BOTH
c. khách tươí  BOTH
d. la khách  BOTH
e. ðà ách  BOTH
**Answer Sheet (8/8)**

Q4

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(R) Disambiguate This!

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Additional Space for Scrap Work