



## Final Exam

In submitting this exam you declare that you did not give or receive unpermitted aid. This includes discussing the exam with your peers or seeking advice from third parties, including searching for help on the Internet.

### 1 Morphology (50%)

In this problem you will define an XFST expression that relates (phonological representations of) Hebrew singular nouns with their plural forms.

Hebrew nouns are represented *phonetically*. We use five vowels ( $[a, e, i, o, u]$ ) and a designated symbol preceding the vowel ( $'$ ) to denote the location of the main stress. As for consonants, we use  $v$  for fricative  $\text{ב}$ ,  $x$  for both  $\text{פ}$  and fricative  $\text{כ}$ ,  $f$  for fricative  $\text{פ}$ ,  $\$$  for  $\text{ש}$ ,  $t$  for both  $\text{ט}$  and  $\text{ת}$ ,  $c$  for  $\text{צ}$ .

Example pairs include:

singular:	s'us	c'uk	'ec	x'ov	k'oc	x'of	m'ot	'or
plural:	sus'im	cuk'im	ec'im	xov'ot	koc'im	xof'im	mot'ot	or'ot
singular:	k'elev	d'erec	d'elet	t'oxen	b'oker	g'odel	g'oren	b'oxan
plural:	klav'im	drax'im	dlat'ot	txan'im	bkar'im	gdal'im	gran'ot	bxan'im
singular:	siml'a	pirc'a	\\$ixv'a	kder'a	\\$an'a	man'a	dak'a	cur'a
plural:	smal'ot	prac'ot	\\$xav'ot	kder'ot	\\$an'im	man'ot	dak'ot	cur'ot
singular:	masm'er	\\$om'er	max'ol	mal'on	pitr'on	arg'az	miflag'a	haxlat'a
plural:	masmr'im	\\$omr'im	mxol'ot	mlon'ot	pitron'ot	argaz'im	miflag'ot	haxlat'ot
singular:	\\$t'ut	xan'ut	\\$ab'at	xav'it	zav'it	xaz'it	xaziy'a	tal'it
plural:	\\$tuy'ot	xanuy'ot	\\$abat'ot	xaviy'ot	zaviy'ot	xazit'ot	xaziy'ot	talit'ot

Define a lexicon of the singular nouns you work on. Decide which information must be encoded in the lexicon in order to derive the correct plural forms. Define a set of rules that map the singular forms to their plural counterparts. The smaller the set, the better your solution is. Test your grammar on all the examples above, as well as similar examples of your choice.

Submit an XFST script called `nouns.txt` with your XFST code; please make sure the singular nouns are in the upper language and the plural forms are in the lower one.

Some questions for thought, which you do not have to account for: try to understand the difference between  $\text{דָּבָר}$  ( $\text{dav'ar-dvar'im}$ ) and  $\text{דְּבָרִים}$  ( $\text{dav'ar-davar'im}$ ); and between  $\text{גַּמֵּל}$  ( $\text{gam'ad-gamad'im}$ ) and  $\text{גַּמְלִים}$  ( $\text{gam'al-gmal'im}$ ). How do you think children acquire them? Don't forget that children do not have access to the written form or the the history of the language they acquire, they are only exposed to the phonological forms.

Other challenging examples, which you may or may not want to try to account for, follow:

singular:	t'of	d'ov	d'af	z'ayit	t'ayi\\$	b'ayit	x'ec	'ez	c'el
plural:	tup'im	dub'im	dap'im	zeyt'im	tya\\$'im	bat'im	xic'im	iz'im	clal'im



## 2 Syntax (50%)

In this problem you will design and implement a PATR grammar for a small fragment of Hindi. Hindi is an Indo-European language spoken by over 500 Million people, mostly in India. The standard word order in Hindi is Subject Object Verb, but this order is relatively flexible.

Hindi verb structure is focused on aspect; we will focus on two aspects, *perfect* and *imperfect*. Distinctions in tense (*present* vs. *past*) are expressed through the use of an auxiliary (the verb *ho* “be”), which follows the main verb. The auxiliary inflects for person, number and (for past tense) gender; the main verb inflects for aspect, person, number and gender. Nouns are sometimes marked for *case* (which can be nominative, ergative or accusative). Case is expressed as a suffix on nouns; we will only focus on ergative case here. The default, unmarked case is nominative.

We focus below on verb agreement patterns in Hindi. By default, the verb agrees with its subject. For example:

John so-t-a                      hai  
John sleep-imperf-sm    be-pres,3sg  
“John sleeps”

Notice that the present tense is carried by the auxiliary. The main verb inflects for the imperfect aspect, as well as for number and gender. Both the main verb and the auxiliary agree with the subject in number and gender.

Mary so-t-i                      hai  
Mary sleep-imperf-sgf    be-pres,3sg  
“Mary sleeps”

Replacing the imperfect aspect with the perfect aspect on the main verb in the examples above, gives us the present perfect form of the sentences:

John so-y-a                      hai  
John sleep-perf-sm    be-pres,3sg  
“John has slept”

Mary so-y-i                      hai  
Mary sleep-perf-sgf    be-pres,3sg  
“Mary has slept”

The simple past in Hindi does not have an overt auxiliary to carry tense. The perfect form of the verb without an auxiliary is used to denote the simple past:

John so-y-a  
John sleep-perf-sm  
“John slept”

Mary so-y-i  
Mary sleep-perf-sgf  
“Mary slept”



The past perfect tense is very similar to the present perfect tense, except for the fact that the present tense auxiliary is replaced by the past tense auxiliary. Unlike the present tense auxiliary, the past tense auxiliary also inflects for gender:

John so-y-a tha  
John sleep-perf-sgm be-past,3sg  
“John had slept”

Mary so-y-i thi  
Mary sleep-perf-sgf be-past,3sg  
“Mary had slept”

The same auxiliary form is also used for the habitual/generic past:

John so-t-a tha  
John sleep-imperf-sgm be-past,3sg  
“John used to slept”

Mary so-t-i thi  
Mary sleep-imperf-sgf be-past,3sg  
“Mary used to slept”

Let us now move on to *transitive* verbs, exemplified by *kha* “eat”. In the following simple cases, the verb still agrees with the subject:

John seb kha-t-a hai  
John apple-3sgm eat-imperf-sgm be-pres,3sg  
“John eats an apple”  
Mary seb kha-t-i hai  
Mary apple-3sgm eat-imperf-sgf be-pres,3sg  
“Mary eats an apple”

Replacing the present tense auxiliary with the past auxiliary yields the habitual/generic past:

John seb kha-t-a tha  
John apple-3sgm eat-imperf-sgm be-past,sgm  
“John used to eat an apple”  
Mary seb kha-t-i thi  
Mary apple-3sgm eat-imperf-sgf be-past,sgf  
“Mary used to eat an apple”

Transitive verbs that are marked with the perfect aspect agree with the *object* and not with the subject. In such a case, the subject is marked with the ergative case. The default (unmarked) case of NPs is nominative, unless they are overtly marked with ergative or accusative case:



John ne seb kha-y-a  
John ERG apple-3sgm eat-perf-sgm  
“John ate an apple”  
Mary ne seb kha-y-a  
Mary ERG apple-3sgm eat-perf-sgm  
“Mary ate an apple”

The present perfect and the past perfect tenses are generated similarly, where again the verb agrees with the object rather than the subject:

John ne seb kha-y-a hai  
John ERG apple-3sgm eat-perf-sgm be-pres,3sg  
“John has eaten an apple”  
Mary ne seb kha-y-a hai  
Mary ERG apple-3sgm eat-perf-sgm be-pres,3sg  
“Mary has eaten an apple”  
John ne roti kha-y-i hai  
John ERG bread-3sgf eat-perf-3sgf be-pres,3sg  
“John has eaten bread”  
John ne roti kha-y-i thi  
John ERG bread-3sgf eat-perf-3sgf be-past,sgf  
“John had eaten bread”  
Mary ne roti kha-y-i thi  
Mary ERG bread-3sgf eat-perf-3sgf be-past,sgf  
“Mary had eaten bread”

Your task is to define a PATR grammar that correctly recognizes and assigns an adequate structure to all the sentences listed above, and rejects similar obviously ungrammatical strings. Try to design the grammar according to the syntactic structure of the language; in particular, group together features that go together. Few, general rules are better than many specific ones!

Submit two files, `hindi.grm` and `hindi.lex`, with your solution. Submission is online at <http://csweb.haifa.ac.il/~shuly/submit.html>.

בהצלחה