Foundations of Linguistics
WiSe 20/21
Take-home exam 1

Hand-out of exam: Friday the 12th of February 2021; 23.59
Hand-in of exam: Friday the 19th of February 2021; 23.59

Hand-in form: PDF. Attached to the exam is a .docx answer file which lists the questions numbers. Please use it to answer the questions, convert it to PDF, and upload it to MS Teams. You are not required to use Word, those of you that use Open Office, LaTeX, whatever, will know how to convert the .docx file. The final product, your exam, should have just your answers, appropriately numbered, in PDF form.

In case there are any technical problems you can reach Annemarie Verkerk at:
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You will receive a confirmation message from Annemarie Verkerk when the exam has been successfully received.

Note: this exam is intended to reflect your individual knowledge and skills. Working together and copying each other's work in any way is NOT ALLOWED. Using published work without citing it fully is plagiarism and is NOT ALLOWED. Reframing in your own words published or unpublished work without citing it fully is plagiarism and is NOT ALLOWED. Along with this document (the exam) you will find the "Erklärung über Eigenständigkeit" that relates these issues in more detail. Please hand in a signed version of this document along with your exam.

Part I: Morphology and Syntax

1.1.

a) 1 morpheme boundary => mice catch+er
b) 1 morpheme boundary => stick-on label+ing
c) 2 morpheme boundaries => over+sleep+t
d) 2 morpheme boundaries => un+abbreviate+able
e) 2 morpheme boundaries => back+transform+ation
f) 1 morpheme boundary => ping-pong table+s
g) 1 morpheme boundary => self-de+struct
h) 0 morpheme boundary => UNESCO phone
i) 2 morpheme boundaries => North America+n Sci-Fi Mini-convention
j) 2 morpheme boundaries => single+mind+ed+ness

1.2.

a) Root- mice, catch (verb)
   Derivation- catching (Adj)
   Inflection- caught (verb)

b) Root- stick (verb), label (noun)
   Derivation- sticky (adjective), unlabeled (verb)
   Inflection- stuck (verb), labels (noun)

c) Root- sleep (verb)
   Derivation- sleepy (Adj)
   Inflection- sleeping (verb)

d) Root- abbreviate (verb)
   Derivation- abbreviation (noun)
   Inflection- abbreviated (verb)

e) Root- transform (verb)
   Derivation- transformer (noun)
   Inflection- transformed (verb)

f) Root- ping-pong, table (noun)
   Derivation- tabular (Adj)
   Inflection- tablet (noun)

g) Root- struct (Latin) (noun)
   Derivation- destructive (Adj)
   Inflection-Instruct (noun)
   References: https://www.readingrockets.org/sites/default/files/Latin-Roots-Chart.pdf

h) Root- UNESCO, phone (verb)
   Derivation- telephone (noun)
   Inflection- phoned (verb)

i) Root- America (noun), Sci-Fi (noun), convention (noun)
   Derivation- conventional (adjective)
   Inflection- conventions (plural noun)

j) Root- mind (verb)
   Derivation- mindful (Adj)
   Inflection- minding (verb)

1.3.

a) morphological patterns- compounding along with base modification (mouse → mice) and concatenation (catch → catcher).
b) morphological patterns- compounding along with concatenation (label → labelling)
c) morphological patterns- compounding with concatenation (two lexemes combine: over+sleep= oversleep → overslept)
d) morphological patterns- concatenation (un-abbreviate-able)
e) morphological patterns- compounding. I believe there is also some concatenation involved here (transform+ation)
f) morphological patterns- compounding with concatenation (table → tables)
g) morphological patterns- compounding
h) morphological patterns- alphabet-based abbreviation with compounding
i) morphological patterns- compounding with concatenation (America+n→ American)
j) morphological patterns- compounding with concatenation (mind+ed+ness →mindedness)

1.4.

List the words that are inflected:

- overslept (inflected verb of oversleep)
- stick-on labelling (labelling is infected verb of label)
- ping-pong tables (tables: s- inf affix)

2.1.

2.2.

2.3.

2.4.

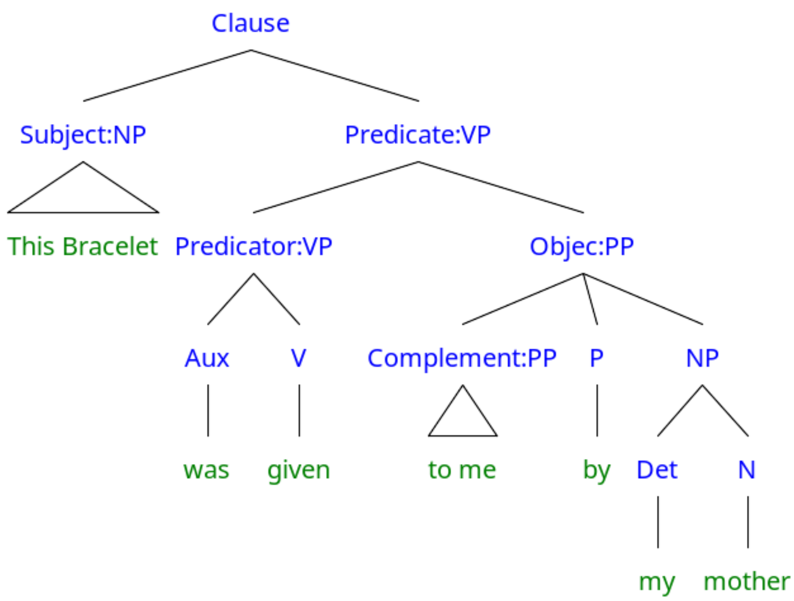
2.5.

Mystery Language X

1	Watiŋku kuɭpirpa ŋaλakatiŋu.	The man brought the kangaroo.
2	Ţiţi ŋuraŋka ɲinaṇu.	The child sat in camp.
3	Papa paṇaŋka ɲinaṇu.	The dog sat on the ground.
4	Papaŋku ţiţi paţaṇu.	The dog bit the child.
5	Ţiţi yulaŋu.	The child cried.
6	Ŋayulu ţiţi kulinu.	I heard the child.
7	Watiŋku ŋura wantiŋu.	The man left the camp.
8	Watiŋku kuɭpirpa kuɭţuṇu.	The man speared the kangaroo.
9	Kuɭpirtu wati pirinu.	The kangaroo scratched the man.
10	Yuṇţaltu ţiţi manţinu.	The daughter picked up the child.
11	Miɲma ŋaλakulpaŋu.	The woman returned.
12	Miɲmaŋku ŋayuṇa ṇaŋu.	The woman saw me.
13	Ŋayulu miɲma waţaṇu.	I told the woman.
14	Ŋayulu mirpaṇariŋu.	I became angry.
15	Ɲura ŋayuɲa ɲaŋu.	You saw me.
16	Miɲma-ŋku ɲuraɲa ɲaŋu.	The woman saw you.
17	Yuṇţalpa ŋaλapiţaŋu.	The daughter came.
18	Kuɭpirpa iluriŋu.	The kangaroo died.
19	Miɲma mapiţaŋu.	The woman went away.
20	Ŋayulu ţiţi makatiŋu.	I carried the child away.
21	Ṇuṇulu ŋayuɲa ɲaŋu.	Nunu saw me.
22	Paluúu wati waţaṇu.	He told the man.
23	Watiŋku paluɲa kulinu.	The man heard him.
24	Watiŋku ampinŋa yaλţiŋu.	The man called Ampin.
25	Ampinŋa pakaṇu.	Ampin got up.
26	Paluúu mapiţaŋu.	He went away.
27	Ŋura ŋaλapiţaŋu.	You came.
28	Ampintu ɲuraɲa ɲaŋu.	Ampin saw you.
29	Ŋanaṇa ɲinakatiŋu.	We (pl) sat down.
30	Ŋanaṇa yuṇţalpa yaλţiŋu.	We called the daughter.
31	Ŋali yuṇţalpa ţapinu.	We (2) asked the daughter.
32	Watiŋku ŋanaṇaɲa wanaṇu.	The man followed us (pl).
33	Ampintu ŋaliɲa yaλţiŋu.	Ampin called us (2).
34	Ɲuramuka ţiţi kulinu.	You (pl) heard the child.
35	Pililu ɲuramukaɲa ɲaŋu.	Pili saw you (pl).
36	Ţana ţiţi makatiŋu.	They (pl) took the child away.
37	Ţiţiŋku ţanaɲa pirinu.	The child scratched them (pl).
38	Ţana ţiţiŋka ɲinaŋu.	They (pl) sat on the child.
39	Ţana pakaṇu.	They (pl) got up (arose).
40	Piliɲa mirpaṇariŋu.	Pili was angry.
41	Watiŋku piliɲa puŋu.	The man hit Pili.

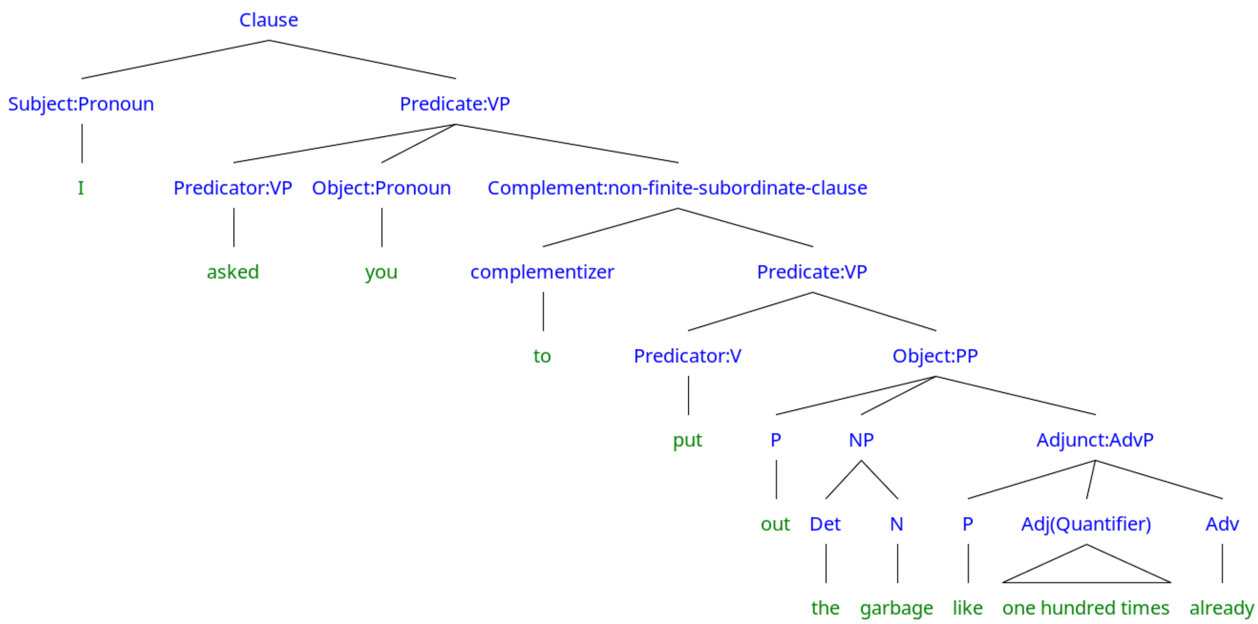
3.1.a.
This bracelet was given to me by my mother.

[Clause [Subject:NP This Bracelet] [Predicate:VP [Predicator:VP [Aux was] [V given]] [Objec:PP [Complement:PP to me] [P by] [NP [Det my] [N mother]]]]]



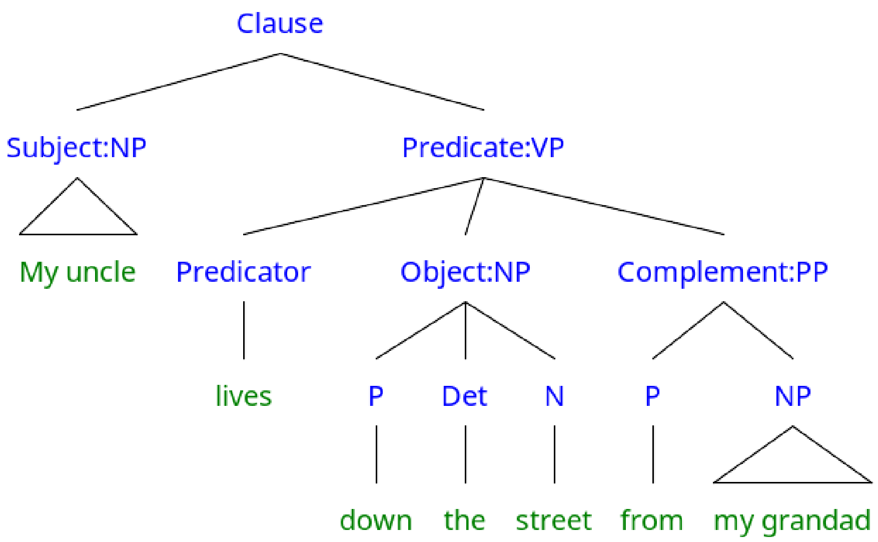
3.1.b.
I asked you to put out the garbage like one hundred times already.

[Clause [Subject:Pronoun I] [Predicate:VP [Predicator:VP asked] [Object:Pronoun you] [Complement:non-finite-subordinate-clause [complementizer to] [Predicate:VP [Predicator:V put] [Object:PP [P out] [NP [Det the] [N garbage]] [Adjunct:AdvP [P like] [Adj(Quantifier) one hundred times] [Adv already]]]]]]]



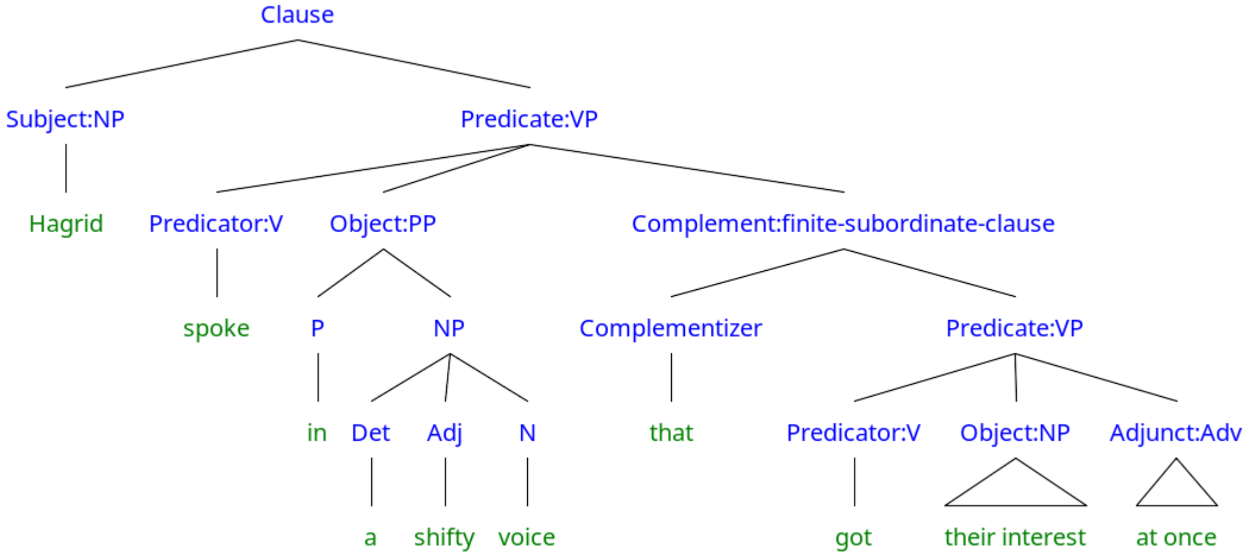
3.1.c.
My uncle lives down the street from my grandad.

[Clause [Subject:NP My uncle] [Predicate:VP [Predicator lives] [Object:NP [P down] [Det the] [N street]] [Complement:PP [P from] [NP my grandad]]]]



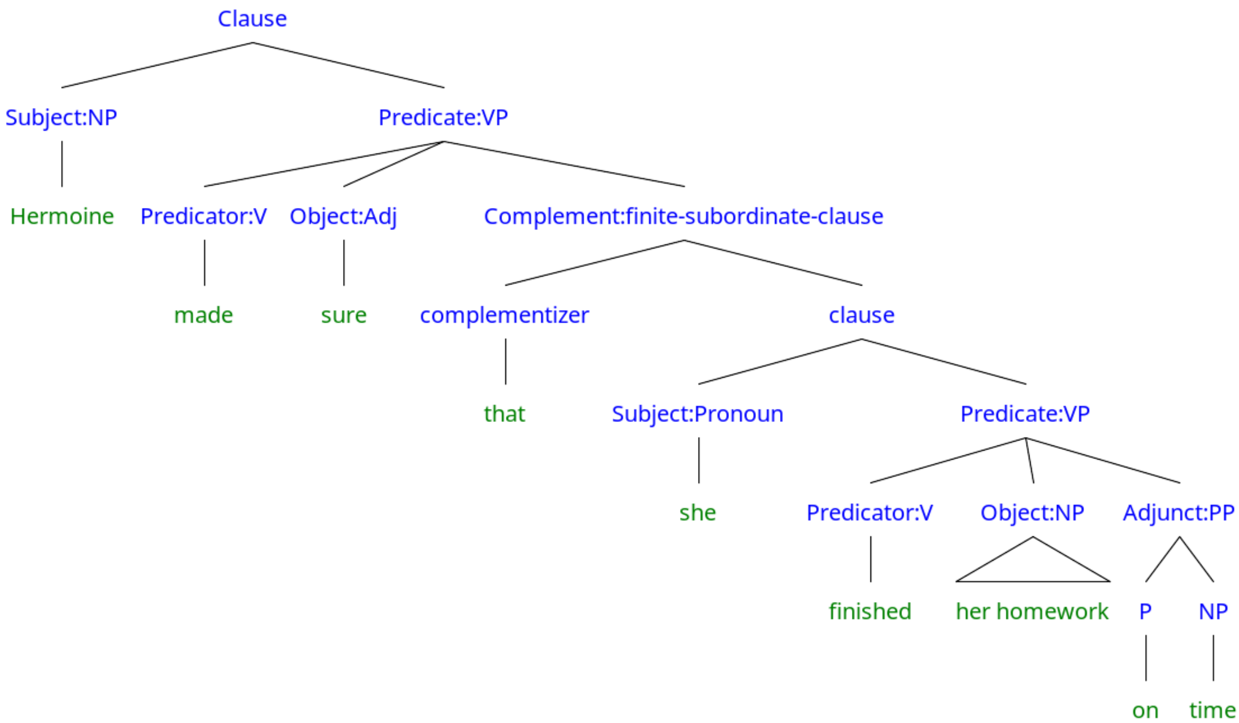
3.1.d.
Hagrid spoke in a shifty voice that got their interest at once.

[Clause [Subject:NP Hagrid] [Predicate:VP [Predicator:V spoke] [Object:PP [P in] [NP [Det a] [Adj shifty] [N voice]]] [Complement:finite-subordinate-clause [Complementizer that] [Predicate:VP [Predicator:V got] [Object:NP their interest] [Adjunct:Adv at once]]]]]



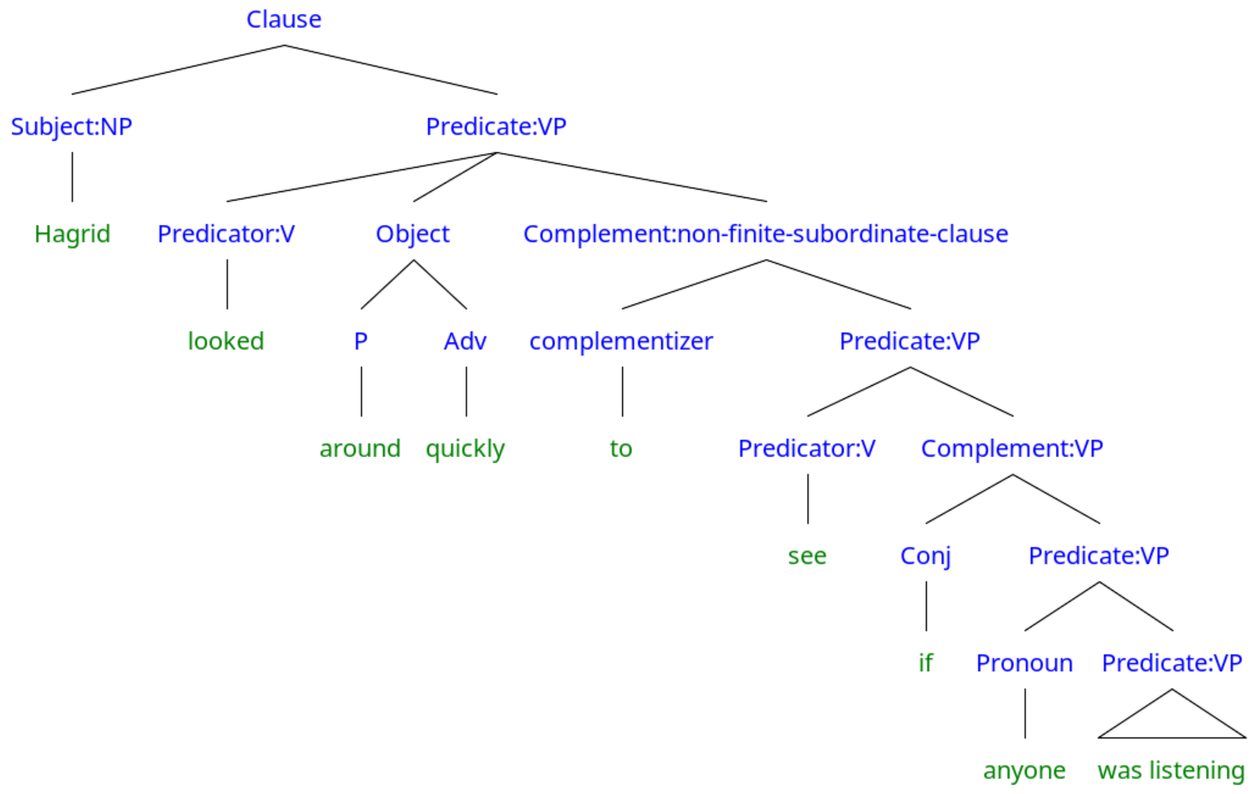
3.1.e.
Hermione made sure that she finished her homework on time.

[Clause [Subject:NP Hermoine] [Predicate:VP [Predicator:V made] [Object:Adj sure] [Complement:finite-subordinate-clause [complementizer that] [clause [Subject:Pronoun she] [Predicate:VP [Predicator:V finished] [Object:NP her homework] [Adjunct:PP [P on] [NP time]]]]]]]



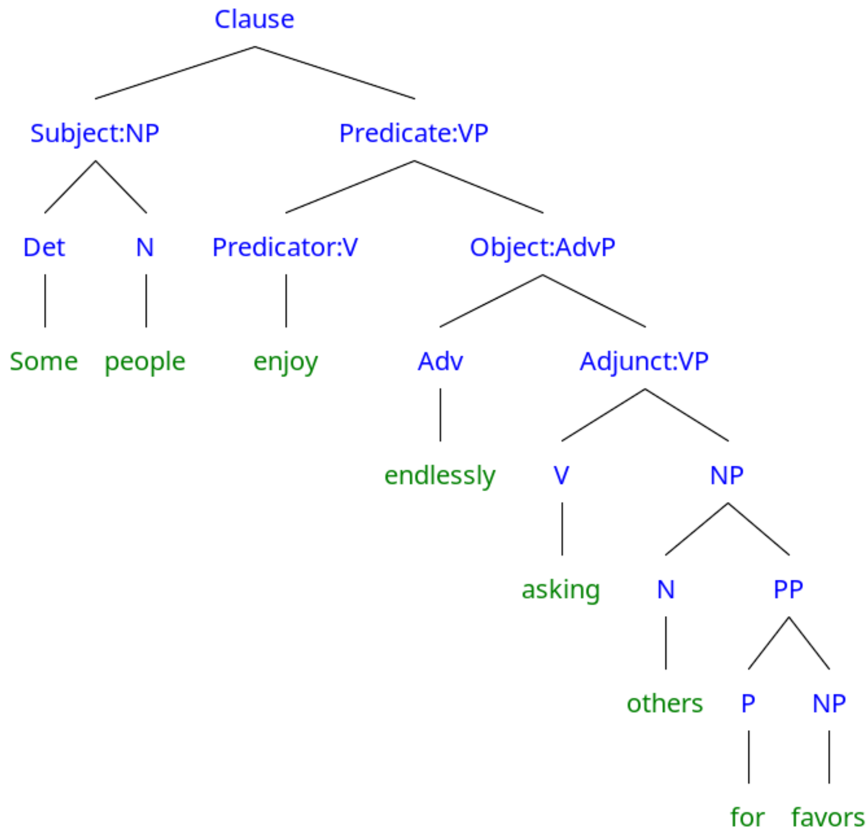
3.1.f.
Hagrid looked around quickly to see if anyone was listening.

[Clause [Subject:NP Hagrid] [Predicate:VP [Predicator:V looked] [Object [P around] [Adv quickly]] [Complement:non-finite-subordinate-clause [complementizer to] [Predicate:VP [Predicator:V see] [Complement:VP [Conj if] [Predicate:VP [Pronoun anyone] [Predicate:VP was listening]]]]]]]



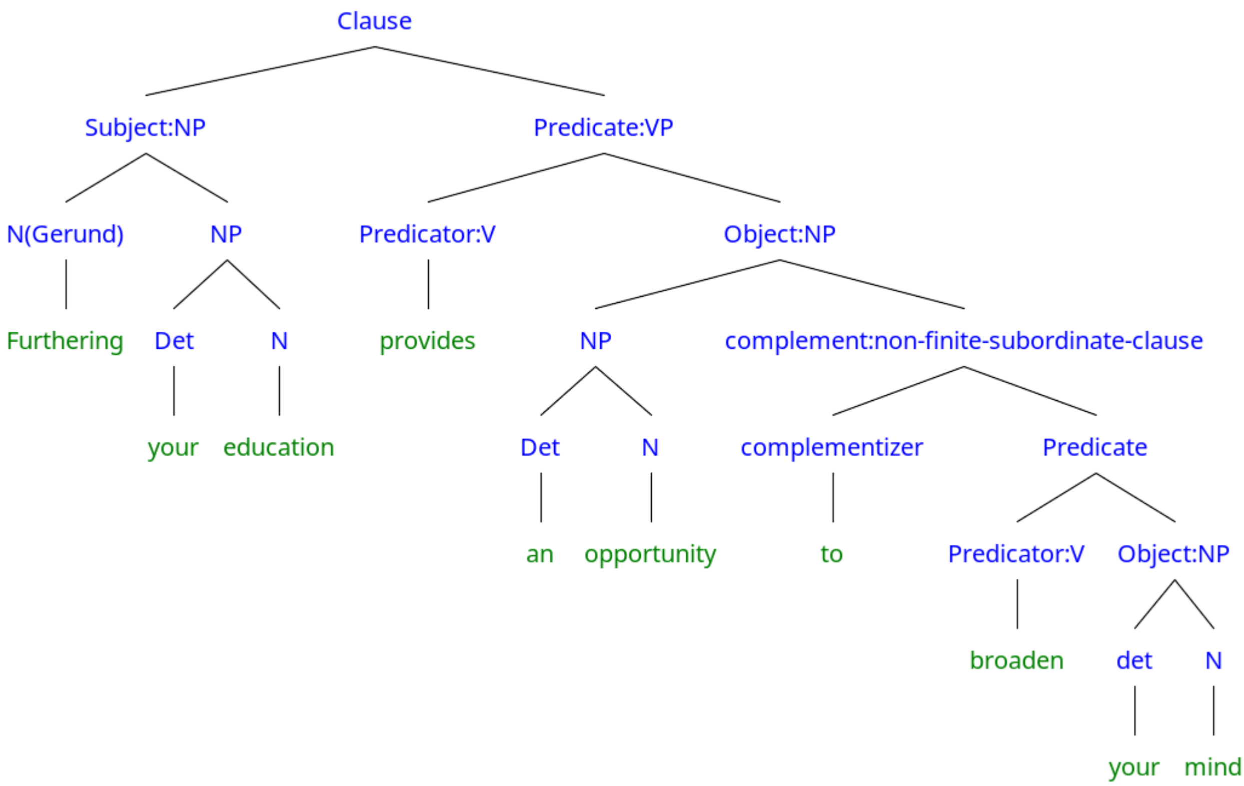
3.1.g.
Some people enjoy endlessly asking others for favors.

[Clause [Subject:NP [Det Some] [N people]] [Predicate:VP [Predicator:V enjoy] [Object:AdvP [Adv endlessly] [Adjunct:VP [V asking] [NP [N others] [PP [P for] [NP favors]]]]]]]



3.1.h.
Furthering your education provides an opportunity to broaden the mind.

[Clause [Subject:NP [N(Gerund) Furthering] [NP [Det your][N education]]] [Predicate:VP [Predicator:V provides] [Object:NP [NP [Det an][N opportunity]] [complement:non-finite-subordinate-clause [complementizer to][Predicate [Predicator:V broaden][Object:NP [det your] [N mind]]]]]]]



Reference: https://yohasebe.com/rsyntaxtree/

3.1.i.

<u>This bracelet</u> was given to me by my mother.
<u>Furthering your education</u> provides an opportunity to broaden the mind.
Constituency tests to identify subjects:
Sentence fragment test:
What was given to you by your mother?
This bracelet

What provides an opportunity to broaden the mind?
Furthering your education

3.2.ii.

I asked you to put out the garbage like one hundred times already.
Sentence fragment constituency test
What exactly did she ask you to do with the garbage?
<u>Pharasal V:</u> put the garbage out

We can separate out the verb and preposition.
For example: I asked you to put the garbage out.

Cleft
It was [PP out] where you were asked to put the garbage

My uncle lives down the street from my grandad.
Sentence fragment constituency test
Where exactly does your uncle live?
Prepositional V: down the street
Here the object must come right after the preposition. Altering its position would give not meaningful sense.
For example: My uncle lives the street down.
This does not make sense

Cleft
It is *[PP down] the street where my uncle lives.

Hagrid spoke in a shifty voice that got their interest at once.
Sentence fragment constituency test
What kind of voice did Hagrid speak?
Prepositional V: in a shifty voice
Here the object must come right after the preposition. Altering its position would give not meaningful sense.

Cleft
It was *[PP in a shifty voice] that Hagrid spoke.

3.2.iii.
It is a non-wh relative clause because there is no wh-relative pronoun.

Reference: http://www.ello.uos.de/field.php/Syntax/TGRelC

3.2.iv.
finite subordinate clause: e, g
In order to check the finitness we look for verb that show the tense.
For example in e:
Hermione made sure that she **finished** her homework on time.
Here the verb **finished** says that the event has already occurred so Past tense

non-finite subordinate clause: f, h
While for non-finite clause we generally look for “to-finite” or a participle.
For example in g:
Hagrid looked around quickly **to see** if anyone was listening.

3.2.v.

I asked you to put out the garbage like one hundred times already.

How many times were you asked to put out the garbage?

TODO:

4. Bonus question.

4.a.

Assign each word to one of the following classes: nouns, pronouns, verbs, adjectives, adverbs, determinatives, prepositions, coordinators, subordinators, interjections. Use the colours given to each word class.

Hagrid shuffled into view, hiding something behind his back. He looked very out of place in his moleskin overcoat.

'Jus' lookin',' he said, in a shifty voice that got their interest at once. 'An' what're you lot up ter?' He looked suddenly suspicious. 'Yer not still lookin' fer Nicolas Flamel, are yeh?'

'Oh, we found out who he is ages ago,' said Ron impressively. 'And we know what that dog's guarding, it's a Philosopher's St–'

'Shhhh!' Hagrid looked around quickly to see if anyone was listening. 'Don' go shoutin' about it,

what's the matter with yeh?'

'There are a few things we wanted to ask you, as a matter of fact,' said Harry, 'about what's guarding the Stone apart from Fluffy –'

'SHHHH!' said Hagrid again. 'Listen – come an' see me later, I'm not promisin' I'll tell yeh anythin', mind, but don' go rabbitin' about it in here, students aren' s'pposed ter know. They'll think I've told yeh –'

'See you later, then,' said

Harry. Hagrid shuffled off.

4.b.

Words trickier to classify-

ter (short for 'to here')

'An' (short form for 'and' in an conversation)

fer (short for 'for')

yeh (short for 'you' mostly in British accent)

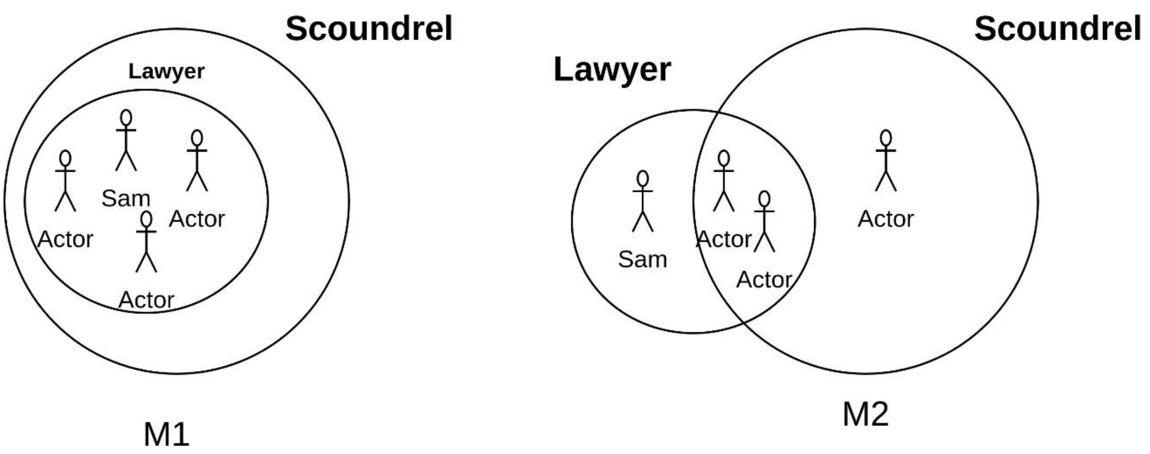
Yer (short for You're)

Its trickier to classify them into suitable parts of speech because these "modified" words exits only in flowing conversations. In order to classify them, its important that we read and understand the context when they were uttered, accordingly we classify them into an appropriate lexical category.

Part II: Semantics

5.1.
A: Sam is a lawyer.
B: All lawyers are scoundrels.

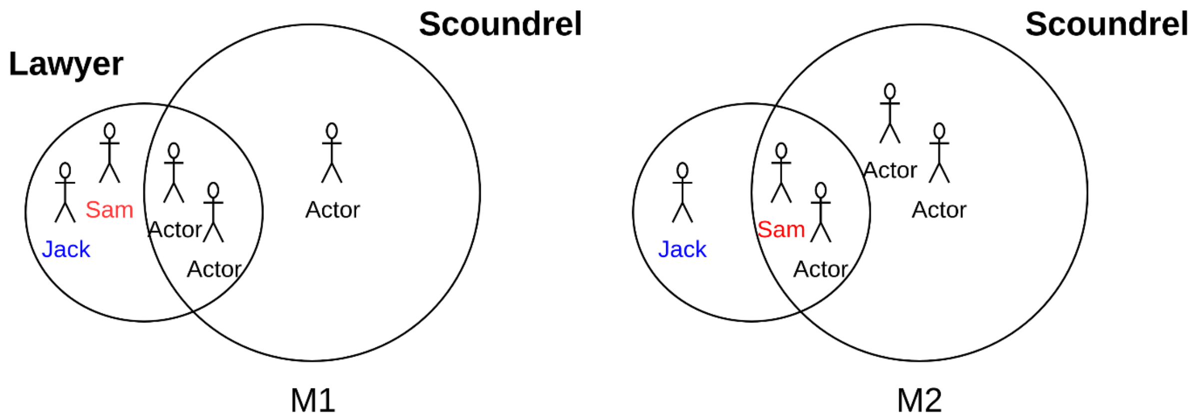
So A here claims that Sam is a lawyer, but does not implicate about any personal character traits for Sam.
Next, B claims that all layers scoundrels. Now, we take a situation where Sam happens to be a good and decent lawyer (M2) and a general case where Sam is a scoundrel lawyer (M1). We can represent this situation as:



In model M1 we see that Sam happens to be a scoundrel lawyer.
Since Sam is good and a decent lawyer, it is excluded from the set of scoundrels for model M2. This makes B a false statement.
Hence there exists two model M1 and M2, in which they have different truth values. That is to say:
- in M1 Sam is scoundrel
- in M2 Sam is not scoundrel
 Therefore their meaning is different.

5.2.
Lets illustrate and investigate reverse of the statement.

A: Sam is a lawyer.
B: Not all lawyers are scoundrels.



M1 we have Sam who is a lawyer but not scoundrel.
M2 we have Sam who is a scoundrel lawyer.

We say that A and B hold different truth values for M1 and M2 and thus have different meaning. If according to the statement we say that B is false, this would modify B's claim as – "All layers are scoundrel". This is however untrue for Jack who happens to be a lawyer, but not a scoundrel one.

Hence, the reverse does not hold true.

6.1.
Translating into first order predicate logic:
P1: $[\![\forall x(\text{snakes}(x) \rightarrow \text{reptiles}(x))]\!]$ M,g = 1

Use rule: $[\![\forall x\varphi]\!]^{M,g} = 1$ iff for all $d \in U_M$, $[\![\varphi]\!]^{M,g[x/d]} = 1$

iff for all $d \in U_M$, $[\![\text{snakes}(x) \rightarrow \text{reptiles}(x)]\!]^{M,g[x/d]} = 1$

Use rule: $[\![\varphi \rightarrow \psi]\!]^{M,g} = 1$ iff $[\![\varphi]\!]^{M,g} = 0$ or $[\![\psi]\!]^{M,g} = 1$

iff for all $d \in U_M$, $[\![\text{snakes}(x)]\!]^{M,g[x/d]} = 0$ or $[\![\text{reptiles}(x)]\!]^{M,g[x/d]} = 1$

Use rule: $[\![R(t_1, ..., t_n)]\!]^{M,g} = 1$ iff $\langle [\![t_1]\!]^{M,g}, ..., [\![t_n]\!]^{M,g} \rangle \in V_M(R)$

iff for all $d \in U_M$, $[\![x]\!]^{M,g[x/d]} \notin V_M(\text{snakes})$ or $[\![x]\!]^{M,g[x/d]} \in V_M(\text{reptiles})$

Use assignment function: $[\![x]\!]^{M,g} = g(x)$ ($\in U_M$) if x is a variable

iff for all $d \in U_M$, $d \notin V_M(\text{snakes})$ or $d \in V_M(\text{reptiles})$

Using logical reasoning

iff there is no $d \in U_M$, $d \in V_M(\text{snakes})$ and $d \notin V_M(\text{reptiles})$

iff $V_M(\text{snakes}) \subseteq V_M(\text{reptiles})$

P2: $[\![\forall x(\text{reptile}(x) \rightarrow \neg \text{fur}(x))]\!]$ M,g = 1

Use rule: $[\![\forall x\varphi]\!]^{M,g} = 1$ iff for all $d \in U_M$, $[\![\varphi]\!]^{M,g[x/d]} = 1$

iff for all $d \in U_M$, $[\![\text{reptile}(x) \rightarrow \neg \text{fur}(x)]\!]^{M,g[x/d]} = 1$

Use rule: $[\![\varphi \rightarrow \psi]\!]^{M,g} = 1$ iff $[\![\varphi]\!]^{M,g} = 0$ or $[\![\psi]\!]^{M,g} = 1$

iff for all $d \in U_M$, $[\![\text{reptile}(x)]\!]^{M,g[x/d]} = 0$ or $[\![\neg \text{fur}(x)]\!]^{M,g[x/d]} = 1$

Use rule: $[\![R(t_1, ..., t_n)]\!]^{M,g} = 1$ iff $\langle [\![t_1]\!]^{M,g}, ..., [\![t_n]\!]^{M,g} \rangle \in V_M(R)$ and

$[\![\neg\varphi]\!]^{M,g} = 1$ iff $[\![\varphi]\!]^{M,g} = 0$

iff for all $d \in U_M$, $[\![x]\!]^{M,g[x/d]} \notin V_M(\text{reptile})$ or $[\![\text{fur}(x)]\!]^{M,g[x/d]} = 0$

iff for all $d \in U_M$, $[\![x]\!]^{M,g[x/d]} \notin V_M(\text{reptile})$ or $[\![x]\!]^{M,g[x/d]} \notin V_M(\text{fur})$

Use assignment function: $[\![x]\!]^{M,g} = g(x)$ ($\in U_M$) if x is a variable

iff for all $d \in U_M$, $d \notin V_M(\text{reptile})$ or $d \notin V_M(\text{fur})$

Using logical reasoning

iff there is no $d \in U_M$, $d \in V_M(\text{reptile})$ and $d \in V_M(\text{fur})$

iff $V_M(\text{reptile}) \wedge V_M(\text{fur}) = \phi$

Similarly:

P3: $[\![\forall x(\text{snake}(x) \rightarrow \neg \text{fur}(x))]\!]^{M,g} = 1$

iff $V_M(\text{snake}) \wedge VM(\text{fur}) = \phi$

Goal: to show- $[\![C]\!]^{M,g} = 1$

We assume that $[\![P1]\!]^{M,g} = 1$ and $[\![P2]\!]^{M,g} = 1$

$\Rightarrow$ P1 , P2 $\vDash$ C

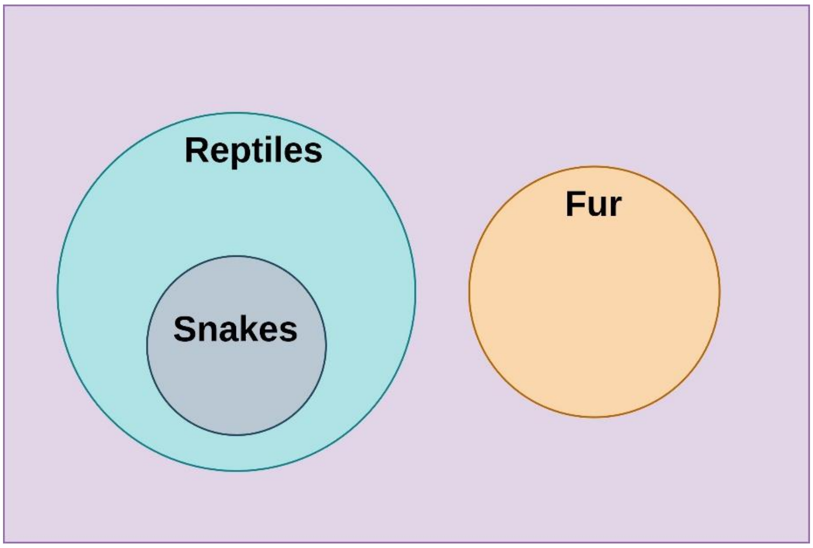
$\Rightarrow$ $V_M(\text{snakes}) \subseteq V_M(\text{reptiles}) \wedge V_M(\text{fur}) = \phi$

$\Rightarrow$ $V_M(\text{snakes}) \wedge V_M(\text{fur}) = \phi$

$\Rightarrow$ $V_M(\text{snakes}) \wedge \neg V_M(\text{fur}) = 1$

$\Rightarrow$ $V_M(\text{snakes}) \wedge \neg V_M(\text{fur}) = 1$

$\Rightarrow$ $[\![C]\!]^{M,g} = 1$



6.2.

No snake: $\lambda P \neg \exists x(\text{snake}'(x) \wedge P(x))$

$[\![\text{no snake}]\!]^M = \{ P \subseteq U_M \mid [\![\text{snake}]\!] \cap P = \emptyset \}$

"No snake" denotes the properties that do not apply to any snake.

A: No snake was killed.

B: No snake was killed last year.

A $\vDash$ B

Here:

- Let VP1 = "killed" and VP2 = "killed last year" and NP = "No snake"
- $[\![\text{killed}]\!] \supseteq [\![\text{killed last year}]\!]$
- NP VP1 $\vDash$ NP VP2

However, All snakes were killed last year $\nvDash$ All snakes were killed.

Hence the above example is monotone decreasing.

6.3.

Quantifier Q is monotone increasing iff it holds for all interpretations:
If $P \in Q$ and $P \subseteq P'$, then $P' \in Q$
This is equivalent to the relation: If $P \cap P' \in Q$, then $P \in Q$ and $P' \in Q$.
These quantifiers are closed under conjunction and disjunction.
Example:
All tourists went for a walk along the river $\models$ *All tourists went for a walk.*
Here:

- Let VP_1 = "walk along river" and VP_2 = "walk" and NP = "All tourist"
- ⟦walk along river⟧$\subseteq$⟦walk⟧
- NP $VP_1 \models$ NP VP_2

However, *no tourist went for a walk along the river* $\not\models$ *No tourist went for a walk*.
Hence the above example is monotone increasing.

Quantifier Q is monotone decreasing iff it holds for all interpretations:
If $P \in Q$ and $P' \subseteq P$, then $P' \in Q$.
This is equivalent to the relation: If $P \cup P' \in Q$, then $P \in Q$ and $P' \in Q$.
Example:
No tourist went for a walk $\models$ *No tourist went for a walk along the river.*
Here:

- Let VP_1 = "walk" and VP_2 = "walk along river" and NP = "No tourist"
- ⟦walk⟧ $\supseteq$ ⟦walk along river⟧
- NP $VP_1 \models$ NP VP_2

However, *All tourist went for a walk* $\not\models$ *All tourist went for a walk along the river*.
Hence the above example is monotone decreasing.

Reference:
http://www.coli.uni-saarland.de/courses/semantics-15/lectures/ST05-Quantifiers_PtI.pdf
https://web.stanford.edu/~azaenen/LING-7800-019/LSABoulder1b.pdf

7.1.a.
Harry is a wizard because he can do magic.
do_magic(Harry) ∧ Wizard(Harry)

Available predicates:
do_magic(Harry): Harry can do magic
Wizard(Harry): Harry is a wizard

7.1.b.
Every wizard learns magic at Hogwarts.
$\forall x$ (wizard(x) $\rightarrow$ magic(x, Hogwarts))

Available Predicates:
wizard(x): x is a wizard
magic(x, Hogwarts): x learns magic at Hogwarts

7.1.c.

No Muggle can do magic or knows anyone who can.

Splitting the sentence:

- No Muggle can do magic
    - $\forall x(\text{muggle}(x) \rightarrow \neg\ \text{do\_magic}(x))$
- No muggle knows anyone who can do magic:
    - $\forall x\ \forall y(\text{muggle}(x) \rightarrow \neg\ (\text{knows}(x, y) \land \text{do\_magic}(y)))$

Simplifying:

$\Rightarrow \forall x(\text{muggle}(x) \rightarrow \neg\ \text{do\_magic}(x)) \land \forall x\ \forall y(\text{muggle}(x) \rightarrow \neg\ (\text{knows}(x, y) \land \text{do\_magic}(y)))$

$\Rightarrow \forall x((\text{muggle}(x) \rightarrow \neg\ \text{do\_magic}(x)) \land \forall y(\text{muggle}(x) \rightarrow \neg\ (\text{knows}(x, y) \land \text{do\_magic}(y)))$

Available Predicates:

muggle(x): x is a Muggle who can do magic

do_magic(y): y is anyone who can do magic

knows(x, y): x is someone knows that any y who can do magic

7.2.a.

All predicates

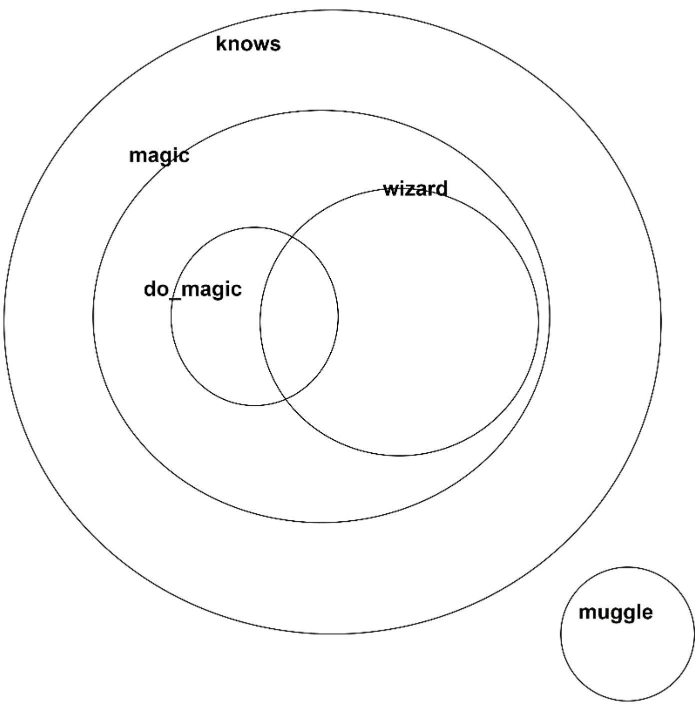
wizard(x): x is a wizard

magic(x, Hogwarts): x learns magic at Hogwarts

muggle(x): x is a Muggle who can do magic

do_magic(y): y is anyone who can do magic

knows(x, y): x is someone knows that any y who can do magic



7.2.b.

8. Bonus question.

We get the idea of soundness and completeness from the semantic and syntactic consequence.

Soundness is defined as "if A is syntactic consequence of some premises gamma (Γ), then A is semantic consequence of those premises". This essentially means that if an argument is derivable

by our stipulated rules then it is valid and then there is no interpretation that makes the premises true and the conclusion false. So it has no counter example. Mathematically:

$$\text{if } \Gamma \vdash A, \text{ then } \Gamma \vDash A.$$

A system is sound only if it does not allow the derivation of arguments for which there is counterexample.

While completeness on the other hand is defined as "if A is semantic consequence of gamma (Γ) then A is syntactic consequence of gamma (Γ)". So, if an argument is valid i.e. if there is no counterexample to the argument then it can be derived. Mathematically:

$$\text{If } \Gamma \vDash A, \text{ then } \Gamma \vdash A.$$

A system is complete only if all the arguments that have no counter example can be derived

Soundness and completeness together mean that we can derive all and only valid arguments of a system.

Reference: Lecture Slides

Part III: Pragmatics

9.1.

The following variables shall be used to lay foundations for further discussion:

U_n: current utterance

U_{n-1}: previous utterance

U_{n+1}: next utterance

C_f: forward looking center

C_b: backwards looking center

C_p: preferred looking center

Following are the different components of centering theory:

a) The centering theory considers only two utterances at a time U_n and U_{n-1}.
b) Each utterance (except the first) has C_b which connects U_n with U_{n-1}. We initialize C_b as undefined for initial utterance and then later update it.
c) Each utterance has explicitly specified C_f which are noun phrases and this establishes entities for linking with U_{n+1}.
d) The ordering of C_f goes like subject < object < others. This ordering is important so as to select C_p later.
e) C_p is the highest ranked element in the above ordering (leftmost element ranks the highest).
f) The leftmost element of C_f of U_{n-1} th utterance becomes the C_b of U_n th utterance.

The rules of centering theory also indicate that CONTINUES are preferred to RETAIN, which are preferred to SMOOTH-SHIFTS, which are preferred to ROUGH-SHIFTS.

Before describing phenomena captured by centering theory- let's break down this term. We have “Centering” + some theory. It's based on the idea that, at a given point in a discourse, there is always one entity that is being “centered” on. The premise of centering theory is that if the discourse continues to center on the same entity in the next sentence, that next sentence is more coherent with the original sentence than an alternative sentence that does not center on the same entity.

Observations captured are as follows:

- local coherence of a discourse segment
- coherence in texts created by repeated entity mentions.
- Applications- anaphora resolution, but recent ones- NLG, text summarization

Reference: http://www.lrec-conf.org/proceedings/lrec2008/pdf/676_paper.pdf

9.2.

Centering theory specifies that entities that have been centered in an utterance should be pronominalized. If the backward center for the next utterance is the same, since it may reduce coherence to restate the full proper noun directly.

That is, using terminologies discussed above- if the C_b of the current utterance is the same as the C_b of the previous utterance, a pronoun should be used.

9.3.

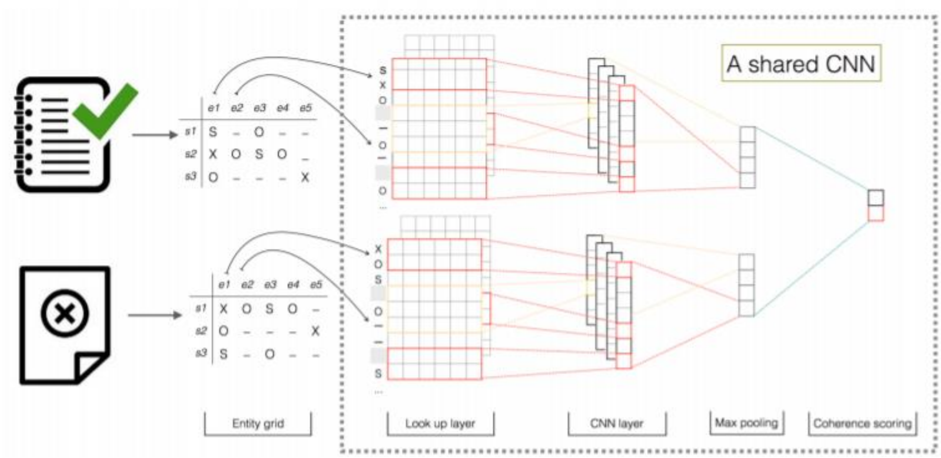
The entity grid model is another way to capture entity-based coherence, based on patterns in the way that entities are mentioned. It captures the distribution of discourse entities across text sentences. The entity grid model improvises centering theory by measuring coherence based on patterns in local entity transitions where each possible transition ends up with a probability, while centering theory only captures local coherence of discourse segment. In entity grid each-

- grid cell contains information about its grammatical role in the given sentence.
- grid column corresponds to a string from a set of categories reflecting the entity’s presence or absence in a sequence of sentences.

TODO: Write about shortcomings

Reference: https://arxiv.org/pdf/2004.14626.pdf

9.4.



The neural entity grid starts with the entity grid i.e. taking documents as inputs and generating grammatical roles (S – O – –) except these grammatical roles are encoded as feature vectors. This allows us to see how similar these S's and O's are and have more learnable representation. Then we a 2nd layer i.e. convolution layer in the network thats allows us to achieve some location invariance of patterns (basically this lets us look over specific transitions).

The following layer i.e. max pooling layer reduces the dimensions and allows us to capture most local features from the convolutional layer thus allowing to learn from data.

Finally, we have some coherence scoring as rankings where we put in both coherent document and incoherent document and then train the model (using back-propagation) to score the coherent ones as the better one. This is how the neural entity model works.

Advantages:

- neuralizes the basic entity grid model that considers only entity transitions without distinguishing between types of the entities
- can model sufficiently long entity transitions, and can incorporate entity-specific features

Reference: https://raihanjoty.github.io/papers/nguyen-joty-acl-17.pdf

10.
All the conversation below are excerpts from the show "Big Bang Theory".

Implicature_O for quality maxim
Reference: https://youtu.be/mUGXcuKbGlc?t=194

Sheldon: Now, Introduction to Physics. What is physics?

Sheldon: Physics comes from the ancient Greek word "physika. " "Physika" means the science of natural things. And it is there, in ancient Greece, that our story begins.

In this scene the lead role Penny asks Sheldon to teach her Physics so that she could participate actively in scientific conversation with Leonard. To this Sheldon prompts the first questions as what is physics, and answers this himself- “Physika" means the science of natural things” which happens to be most appropriate definition of Physics. His utterance is true and also carries proper evidence in world knowledge.

Implicature_F for quality maxim
Reference: https://www.youtube.com/watch?v=vEM8gZCWQ2w&ab_channel=MissMillard

Sheldon: Doesn't anyone want to know
where he's (Leanord) going?
Penny: Okay, where is he going?
Sheldon: Leonard is going to the office.
In this scene Leonard happens to secretly tell Sheldon where he’s actually going (his girlfriend’s place). He instead requests him to lie about it that he is going to office, if anyone asked about his whereabouts. He keeps Leonard’s secret and lies to Penny when she asks where is he going! Sheldon, thus flouts quality maxim by intentionally uttering a false statement.

Implicature_F for quantity maxim
Reference: https://www.youtube.com/watch?v=yzM1fzf2-ZU&ab_channel=Twitystar11

Rajesh (asks to Sheldon): Sheldon, is that ketchup on that table?
Sheldon: yes, there is, but, here's a fun fact - a ketchup was a general term for sauce typically made of mushrooms or fish brine with herbs and spices. Some popular early main ingredients included blueberry anchovy oyster kidney bean and grape.
Rajesh: no that's okay I'll get it.

In this scene Rajesh asks Sheldon if there is a ketchup on that table. To which he begins to say about the history of ketchup and how was it made. In this scene, Sheldon flouts quantity maxim as his contribution is excessive and over informative than what Rajesh asked.

Implicature_F for relevance maxim
Reference: https://www.tv-quotes.com/shows/the-big-bang-theory/quote_20960.html

Howard: Leonard, settle this. Of the two of us, who’s the obvious sidekick?
Rajesh: Yeah, Leonard, who?
Leonard: 12 years after high school, and I’m still at the nerd table.

In this scene, Howard wants Leonard to settle an argument between him and Rajesh and presents Leonard with a question “who is the obvious sidekick” between them. To which he feels that he need not answer that obvious question and instead says that even 12 years later he is still stuck with their stupid conversation. His answer is not relevant to what was asked. His answer could have been either Howard or Rajesh. Hence Sheldon, in this scene, flouts relevance maxim.

Implicature_F for manner maxim
Reference: https://www.youtube.com/watch?v=OXpXFsQb_Sg&ab_channel=CarlosLoria

Penny: Um, me, okay, I'm Sagittarius, which probably tells you way more than you need to know.
Sheldon : Yes, it tells us that you participate in the mass cultural delusion that the Sun's apparent position relative to arbitrarily defined constellations and the time of your birth somehow effects your personality.
Penny : Participate in the what?

In this scene, Sheldon presents a brief definition of horoscope and rather confuse Penny. His explanation on horoscope is ambiguous to the situation. Instead of lecturing Penny about horoscope, he could have just said that this is a superstition and he does not believe in it. His explanation confused Penny because it is an overstatement and an unwanted definition of horoscope. He thus violates manner maxim by not being orderly and ambiguous in his answer.

Other resources:
https://www.grin.com/document/385395
https://www.grin.com/document/196608

11.1
Literal listener interprets an utterance according to its semantic meaning. Literal listener do no try to question the utterance to understand more about it. They simply infer the semantic content of the utterance.
A literal listener would interpret the utterance "smiling" as a person with broadened lips typically corners of the mouth turned up as this is semantically appropriate and correct. Hence a literal listener would interpret 2nd, 3rd,and 4th face as "smiling" as this is literally true for all these three faces.

11.2
Pragmatic speaker provides an insight into what it is for a linguistic expression to be used meaningfully. His utterance is capable to convey the invisible meaning in an unambiguous way using minimum words that otherwise a general speaker would fail to do so.
The third face would be referred as "glasses" because this is most un-ambigious term for that face. If I say "smiling" it could mean either of the 2nd, 3rd,and 4th face because all of them are smiling. The term "Smiling" would thus become an ambigious utterance to define the third face. It is only the glasses in the third face that separates it out from all other faces. Hence a pragmatic speaker would say "glasses" to refer to the third face.

11.3
The pragmatic listener considers the process that generated the utterance in the first place to interpret an utterance. It is capable to interpret and capture the invisible meaning conveyed by the pragmatic speaker.

	😦	😇	😎	🙂
Smiling	0	1	1	1
Fearful	1	0	0	0

Glasses	0	0	1	0
Halo	0	1	0	0

When the pragmatic speaker hears the utterance “smiling”, he would interpret it as the 🙂 4th face. Because if the pragmatic speaker wanted him to interpret:
- 2nd face he would have just “Halo” and only 2nd face is literally true for this utterances
- 3rd face he would have just “glasses” and only 3rd face is literally true this utterance.

Hence the pragmatic speaker definitely wanted pragmatic listener to perceive the utterance as the 4th face, because is the least ambiguous term for this face.

12. Bonus question.

Part IV: Phonetics

13.
Phonetics is the study of sound in isolation. It is the scientific study of human speech sounds. These are articulatory phonetics, acoustic phonetics and auditory phonetics. Articulatory phonetics basically studies the different organs of speech like alveolar ridge, lip, teeth, tongue, uvula, larynx, pharynx etc. and their use in pronouncing speech sounds. Acoustic phonetics happens to be the study of physical properties of speech sounds like mean squared amplitude of produced speech waveform, time duration, fundamental frequency, energy etc. Lastly, auditory phonetics is the study of way people perceive speech sounds. It investigates the relationship between speech stimuli, and a listener's responses to such stimuli.
Phonology studies the use and organization of speech sounds or sounds of natural language. It investigates the mental system for representing and processing speech sounds within particular languages. In order to determine the phonemes in a language is to search for minimal pair. For example: /wʊd/ (wood) and /gʊd/ (good) differ only in the first sound. The basic unit of phonology is phoneme. It is the basic unit of sound that is able to distinguish one word from another in a given language. The phonetic realization of a phoneme is termed as allophone. Since spellings are not always same as we pronounce words, there are universally accepted conventions for writing sounds called as IPA (or International Phonetic Alphabet). For example: cough /kɒf/ though /ðoʊ/
When we think of [b] and [p] as sounding very similar then we are thinking in a phonetic level. While if we think about how English speakers treat /p/, /t/, /k/ (voiceless stops) as a class of sounds differently than they treat /d, d, g/ (voiced stops) then we are thinking about them phonologically.
The caricature has been presented to illustrate the differences between phonetics and phonology. To the right of the picture, we can see a very detailed picture of an armor, minute and elaborated details on weapons, fences, fortress etc. and the person says, “Take that, you scoundrel”. Here the phonetic transcription is very detailed with all types of diacritic symbols, diphthongs etc. to describe how it was spoken. So, this is the phonetic view where every bit of minute detail counts. While on the left we see the same scene but with just a kind of framework or a kind of X-ray representation. This is the phonological view. Here even the dialogue has been represented with only phonemes and contains no information as to how was he said it. All that matters is the sequence of phonemes.

References:

- http://www.phon.ox.ac.uk/jcoleman/PHONOLOGY1.htm#:~:text=Phonetics%20deals%20with%20the%20production,different%20positions%20in%20words%20etc.
- https://www.angl.hu-berlin.de/department/staff-faculty/academic/mcintyre/unterrichtsmaterialien/intro.pho.new.pdf

14.

Connected speech is a technical term used for words that combine to form complex constructions. The speed and rhythm of speech can cause some segments to adopt a weaker articulation, some to drop out, some to be inserted, and some to change their character altogether. The most notable feature of connected speech in English is that it is subdivided into tone units where only few words are stressed. This has a number of interesting consequences concerning the rhythmic organization of English and triggers the following processes:

- Assimilation: process where phonemes might change
- Elision: a process where phonemes can be omitted altogether
- Weakening: a process where the central vowels of certain words can be reduced
- Liaison: an effect of linking

Example: “black art”:

- /blæk.ɑ:t/
- final voiceless velar plosive of black becomes voiced under the influence of the subsequent vowel art and the result would become: /blæg.ɑ:t/

Another example: See it: [si :‿jɪt]

We do not always pronounce words completely separately with a neat pause in between. In fact, many words affect each other when you put them into phrases and sentences. The end sound of one word often affects the beginning of the next word.

We invite you to have a great time in Paris.

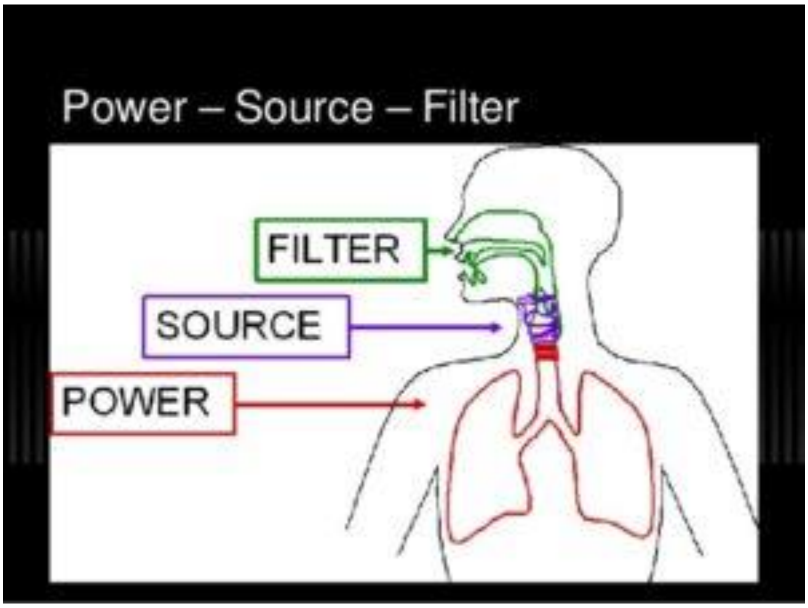
- Transition from one vowel to another:
    - “**We invite**”. When we say this phrase in a rhythm in a conversation, we a make a swift transition from the last vowel in We i.e. “e” to the first vowel in “invite” i.e. “i”. This rhythmic transition makes it sound like /‿j / as these two sounds overlaps.
    - “**have a**”. Here a transition is made from “e” to “a” and the resulting overlapping produced makes is sound like “‿a”
    - “**time in**”. Here a transition from “e” to “i” is made and the overlapping makes it sound like /‿j /
- Consonant to consonant transition:
    - “**great time**”. Here there is a transition from consonant to consonant. Since the ending (“t” in great) and beginning (“t” in time) consonants in “great” and “time” respectively are same, the overlapping makes it sound like a single “‿t” to keep the flow of speech.

Examples cited from: https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=16027&context=rtd

15.

16.

Source-filter model is a model of how speech sounds are produced that emphasizes the independence of the source of the sound and the vocal tract from the filter that shapes that sound to have its specific qualities. The basis idea is that source produces the sound and a filter shapes the sound. We get some energy up from the lungs producing the airflow. Then the vocal tract will filter all the frequencies of that sound produced in the larynx to produce a very specific phoneme.

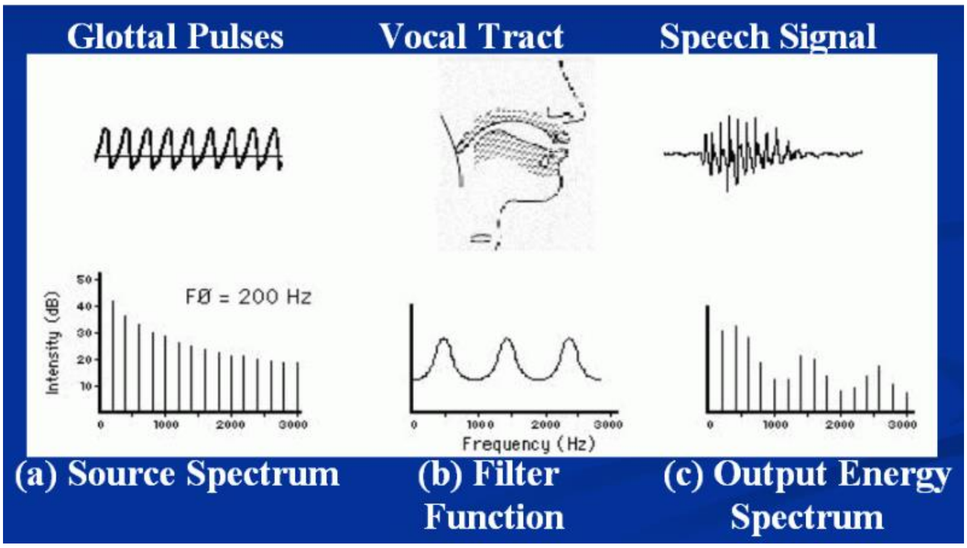


Reference:https://www.vocalsonstage.com/vocals-on-stage-blog/resonance-and-articulation

These are the different components of the speech-production model.

- The source spectrum is like the power spectrum. The waveform is the consequence of the vocal folds vibrating and changes in air pressure in the signal that emerges from the vibration. Because of its shape it is also sometimes called as saw-toothed waveform. Also, the distance between two amplitudes peaks in the waveform of frequency 200 Hz would be 5 ms.
- Next, the signal generated at the vocal folds is sent downstream to the vocal tract and in here it receives more fine detailed structure as a function of the shape and size of vocal tract. The vocal tract has some dimension, and this kind of shape imposes a reinforcement of 500 Hz, 1.5 kHZ, 2.5 kHz etc in the form of peaks. All the frequencies in between these peaks are suppressed. A slight change in any dimension of vocal tract like position of tongue would change the location of peaks accordingly.
- The emitted signal is the speech signal. The spectrum of the speech signal is super imposition of the source spectrum and the filter function of the vocal tract. Looking at the output energy spectrum we see the individual harmonics of the voiced sourced spectrum and also envelope corresponding to the filter function of the vocal tract with a local peak at 500 Hz, 1.5 kHZ and 2.5 kHz.
  - first local peak 500 Hz is called the 1st formant.
  - second local peak 1.5 kHz is called the 2nd formant.

- Third local peak 2.5 kHz is called the 3rd formant.

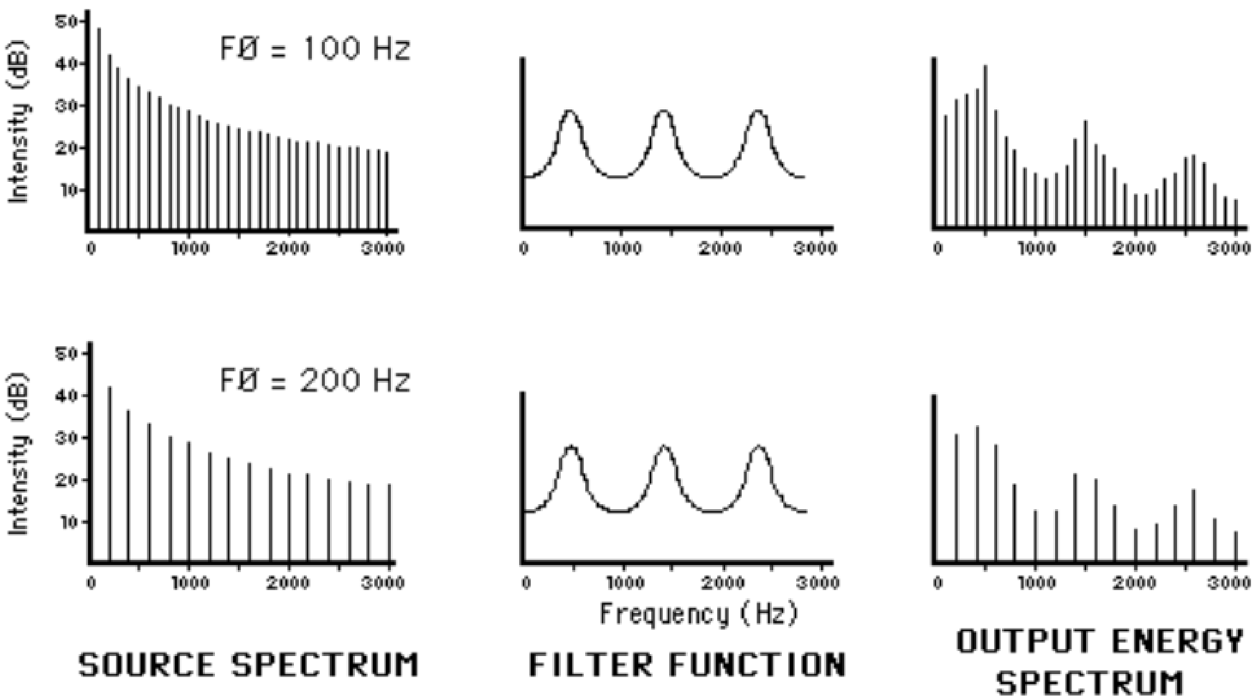


Reference: Lecture slides

Formants come from the vocal tract. They are spectral peaks i.e., energy maxima and we count them from the bottom i.e. F1, F2,..Fn. In other words, they are the regions at and around the resonant frequencies.

Formants emerge as a consequence of selective reinforcement of certain frequency ranges, corresponding to resonance characteristics of the vocal tract, while the other frequencies are suppressed in the energy. They are resonance of the vocal tract.

Reference: Lecture slides



Reference: Lecture slides

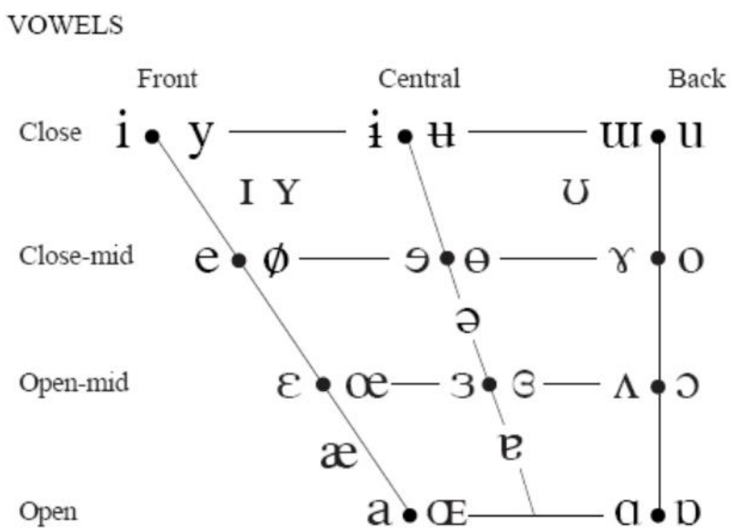
F0 is the fundamental frequency that relates directly to the rate of vibration of the vocal fold

- The source spectrum at the left bottom of the picture (Speaker 2) is a voiced signal of 200 Hz and at the left top (Speaker 1), voiced signal of 100 Hz.
- Calculations:
    - 1/100 Hz = 10 ms. The fundamental duration period for Speaker-1 signal is 10 ms
    - 1/200 Hz = 5 ms. The fundamental duration period for Speaker-2 signal is 5 ms
    - Hence, the fundamental period duration of Speaker 1 is twice as long as that of Speaker 2. The same can be reasoned for narrowly spaced signal for Speaker 1
- Then we have the same filter function for both speakers. This filter function imposes a reinforcement of 500 Hz, 1.5 kHZ, 2.5 kHz etc in the form of peaks which is same for both speakers.
- Then we get the same kind of output spectrum with a local peak at 500 Hz, 1.5 kHZ, 2.5 kHz. Again, we see more narrowly spaced harmonics in the Speaker 1 then in Speaker 2. The point to note here is that the overall envelope of the spectrum is the same for both speakers.

Thus, we conclude that vowels that the speakers produce will have the same vocal tract shape, same resonance frequencies but the pitch will be different because the fundamental frequency is different. This is the reason why no matter who pronounces the vowel, the formants are by and large independent of fundamental frequency produced the voiced source.
We can sing texts and when we sing, we change the pitch, the fundamental frequency produces different notes all the time, but the text remains same and it remains intelligible.

17. Bonus question.

The trapezoidal shape of the IPA vowels is inspired from the articulatory position and dimension of the vocal tract.



Where symbols appear in pairs, the one to the right represents a rounded vowel.

- The Y-axis represent the tongue height i.e. vertical position of the tongue in the vocal tract. Everything at the top i.e. [i] [y] [ɨ] [ʉ] [ɯ] [u] are produced with the tongue in a very high position. Conversely the sounds the bottom i.e. [a] [ɶ] [ɑ] [ɒ] are produced with the tongue in the low position. So, the vertical tongue position is motivation for articulatory dimension in Y-axis.
- In the X axis we have the horizontal position of the tongue. For example: [i], [y], [e],[ø] are produced with tongue in the front position whereas [ɯ] [u] are produced with tongue in the back position of vocal tract. So, this serves as the two dimensional for classification system of vowels.
- The IPA also uses a distinction between closed and open vowels in the Y axis. The terms like Close, close-mid, Open-mid and Open refer to the jaw. So closed vowel [i] [y] have the tongue in high position and jaw in rather closed position. Whereas the open ones basically describe the vowels being the jaw or the mouth wide open for e.g. [a].
- There is also a third articulatory dimension- lip rounding. All the symbols occurring in pairs at one particular position for e.g. [i] [y] then it means that the left symbol i.e. [i] represents an unrounded vowel whereas the right symbol [y] represents the rounded symbol.