WHAT UNIFIES HUMAN LANGUAGE?:
- It's a computational property that all languages share.

- Computation property related to structure.

- We know a sequence of sounds that can be strung together to make a word.

- Words also have to go in the right order and the meaning of the sentence.

- All these things have to come together to form a proper sentence.

- Language is all about rules and structure.

- Each do, ain has its own rules and own structure.

PATTERNS OF SOUNDS:
- Every language has an inventory of sounds.

- Languages can vary in how many sounds they have in their inventory.

- Languages have different rules that govern what kind of sounds can appear in certain phrases.

- All the sound patterns of all the world languages can fall under the **regular region (the region that can be computed by finite state machines).**

- We can subdivide that lowest region into non-counting, **strictly local,** and **strictly piecewise regions.**

- Rules only operate from one sound to the next sound.

- They are **strictly local** because they are operating from one sound to the next adjacent sound.

- We can finite state machines operation over strings of sounds/symbols.

- English has something called **nasal place assimilation** that is in the language's inventory.

- It sounds like 'M' and 'N'.

- They are nasal because we open up our nasal passageway and air flows through our nose out our nostrils when making those 2 sounds.

- If you take a prefix like 'im', and put it in front of the word 'possible', you can create 'impossible'

- The nasal sound in the prefix is assimilating to the sound that follows it.

- This is another example of a **strictly local rule.**

- For some rules in other languages, you have to use **sequences** instead of strings.

- A **sequence** is extracting out sounds you care about from the entire word and looking at just those sounds in a row.

    Example:
    - For the word '**sh**toyonowonowa**sh**,' the rule is there must be two 'sh' sounds in the word, and there is one at the beginning and end.

    - We can still process this with machinery, but just with a different representation.

- There is a region that sits above the **strictly local rule** and **sequence rule** called the **non-counting rule.**

- **The non-counting rule** is above the English rules.

- These rules turn out to be extremely difficult, if not impossible to learn.

- It tells us how our minds are organized for the purpose of performing computations related to language.

- The set of computations in this domain of sound pattern is highly restricted to just a few of the very lowest levels of the complexity hierarchy.

- It is only a few sub-parts of the regular region.

- Words have a simple structure that is local and all about strings, and sequences.

RULES OF CREATING SENTENCES:
- An important property that computational machinery use for generating sentences has an element of **recursion.**

- **Recursion:** When the output of a rule can be used as an input for another application of the same rule.

- This recursive property is how we get infinitely long possible strings and long possible senses.

Example:
- Original Sentence: Dana saw Fox.

    Updates of the sentence due to recursion:
    - Dana saw Fox at the movies.

    - Dana saw Fox at the movies with his mother.

    - Walter told Alex that Dana saw Fox at the movies with his mother.

- You can just keep iterating because of the recursive property of language.

- This embedding illustrates that recursive property.

- This was formulated by Noam Chomsky in 1957 when he wrote syntenic structure.

- This is what makes syntactic structures so influential today.

- General linguistics is all about the idea that we have this highly productive computational machinery that includes the element of recursion that generates infinitely many sentences.

- Since our minds are finite we refer to them as the **finite infinite puzzle.**

- Language itself is very finite because there are finite many atomic units to work with.

- Somehow we can produce infinitely sentences.

- **Sentences are hierarchical structured.**

    Example:
    - Sentence: "John saw the elk with the binoculars."

    - This sentence is ambiguous because we don't know who has the binoculars.

    - It can be thought John saw an elk through the binoculars he is holding.

    - Maybe it can be thought as john saw an elk that had binoculars.

    - We can't know from the sentence itself.

    - We have a sentence that consists of certain words in a certain order, but that same strings of words map do 2 different meanings.

- This is why we need **structure** because there are 2 different **structures** that can be mapped to the same string/sentence.

- We recreate a tree structure in our mind when examining a sentence to understand the meaning of the sentence.

- We try to reconstruct the hierarchical structure of a sentence.

- In linguistics, modification happens between sisters between nodes at the same level.

- If the sister node in this sentence is "elk with the binoculars" then that means the elk have the binoculars.

- If the sister node of "with the binoculars" is the entire verb phrase, then john is the one with the binoculars because john's the one doing the seeing.

- It is the event itself that is being modified by the binoculars.

- These 2 tree structures give us a way to model the sentence.

- This is what is going on in our minds whenever we are reading a sentence.

Negative Polarity Items:
- There is a rule in English where you can't use the word 'anybody' in a sentence whenever you feel like it.

- You have to say it in very specific contexts.

- One context you can use the word 'anybody' is when there's negation.

- When you have the word 'not' in a sentence.

    Example:
    - You can say "I don't have any gum" because there is a negation in the sentence.

    - You can't say "I do have any gum" because there is no negation.

    - Negative polarity items have to go with a negative context in a sentence.

- You have to have some type of negation preceding the 'anybody.'

- However, there is a problem.

- if we just want the negation to precede 'anybody' then we should be able to say "the book I did not buy appealed to anybody."

- The negation is in front of the 'anybody' in the sentence above.

- We care about is the structure of the sentence.

- That's why we can have a situation where negation is preceding 'anybody' but it still does not do the job because it's not in the right structural relationship.

- The structural relationship in this context is called the **c-command.**

- In a tree structure, if you start the thing that is **c-commanding** something else.

- If you go up one level in the tree and then down a level.

- If the thing you are supposed to **c-command** is in that domain, then you are good.

- Else, it is not good.
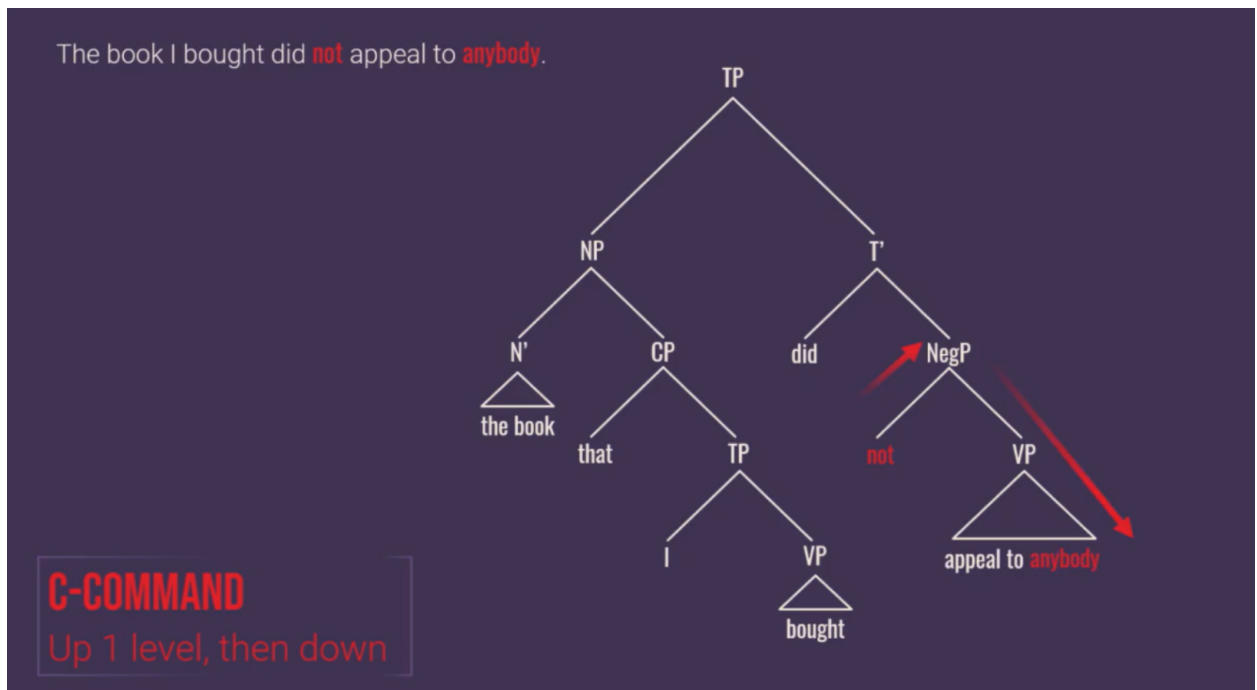
- 'Anybody' is being **c-commanded** by the negation.

- Linear rules are not good enough to describe the patterns we see in syntax.

- **We need structure.**

- This hierarchical structure is a very deep property of human language and something all languages share and is equally complex in this domain.

- The hierarchical structure is necessary to model the types of sentences we can actually produce.

- We can produce these sentences infinitely because it does not require memory without any added difficulty.

- That is why finite state machines can process them.

- We can either exit that finite state machine or keep looping forever in a sentence by adding more words.

- Certain kinds of sentences can also be computed with similar simple machinery.

- Some languages are going to do this differently, however.

- Some languages have to do subject, subject, subject, verb, verb, verb.

- The problem is that you need to have the same number of subjects and verbs.

- You have to wait until you get all your subjects before you do all your verbs.

- For a finite state machine, this is a problem because **it requires memory.**

- You have to remember how many subjects there were by the times you get to verbs, so you can have the same amount of subjects and verbs.

- Finite state machines do not keep track of how you got to a certain state.

- You won't know how many times you go through that verb loop.

- **Pushed down** gives us a way of keeping track of how many times we output a subject.

- For each verb we output, we can take one of those memory bits off the stack that corresponds to each subject.

- You build the stack up for subjects and then you take it down for verbs.

- If you end in 0 things in a stack, then you have an equal amount of subjects and verbs.

- Humans don't have infinite memory, so it becomes difficult for us.

  Example:
  - **Sentence:** "The rat the cat chased fell."

  - **If we repeat the loop more than once:**
    - In principle, we should be able to use our recursive property.

    - **Sentence:** "The rat the cat the dog bit chased fell."

    - Our brain crashes at some point because there is an upper limit of how many of these embedding we can comprehend.

    - We have finite memory.

    - If we balance the prosody, we make it sound better to comprehend it better, but they're always **an upper limit due to the requirement of needing memory.**

- Every language has sound patterns that can be computed with finite state machines.

- All languages have structures that can be computed by finite state machines in the syntactic domain.

STUDY OF SEMANTICS:
- The study of semantics grew out of the philosophy of science and mathematics.

- Formal semantics are doing kind lambda calculus.

- Gottlob Frege came up with original formulations of thinking of meaning.

- He made a distinction between force vs. context.

  Example:
  - You ask yourself the question "is snow white?"

  - That has an interrogative force (question).

  - The statement "snow is white" is torque force (a statement).

- This question and statement have different force, but they have the same content.

- The only thing that is different is how you are using that content.

- Semantics is the study of context.

- We don't care about force in semantics.

- One of the most important principles of semantics is **compositionality**.

Compostionlatiy principle:
- A principle that constrains the relation between form and meaning.

- It requires that the meaning of a complex expression is built up from the meaning of its constituent parts and how they are combined.

- It's the structure of a sentence that causes the difference in meaning and not the words themselves.

- The meanings of sentences are functions of their structure.

- Most expressions are compositional.

We can separate meaning into 2 components:
- **Reference:** Refers to the thing in the world that the word refers to, which is the **referent.**

- **Sense:** Refers to a mental conceptual representation of a word's meaning.

Examples:
- Every bird in the real world is a reference to the word 'bird' because they are the referent.

- This gets cloudy when we have a word like 'freedom.'

- We have a sense of the word freedom but the referent is not 100% clear because it is abstract.

- Some expressions have a **sense** but not a **reference.**

- We can have expressions that share a reference but do not share a sense.

Example:
- Joe Biden and the President of the US are referring to the same thing.

- If Joe Biden resigned then they would have different senses and references.

2 Schools of Thought:

Externalism:
- Takes meaning as a reference.

- The meaning of an expression is equivalent to the reference that the expression refers to.

- The meanings are aspects of our shared environment.

- Meanings are mind-independent things that speakers can coordinate on.

- It is what the word refers to.

- It gives us something concrete we can point to the world and help us verify something.

- It also gives us a meaning of the truth of propositions because we can point at things in the world that expressions point to.

Internalism:
- Takes meaning as mental representation.

- This is meaning in a very individualistic sense.

- Meaning is equivalent to whatever your mental representation for a thing is.

- You will point to your own mental representation and is personal to what you meant when saying an expression.

- You don't refer to something in the world and refer to your own mental representations.

- Meaning does not boil to reference.

- The meaning of the expression is all about the reference.

Example:
- If Lois Lane says "Superman is a hero," then that means she is also saying Clark Kent is a hero.

- If you say she believes Clark Kent is a hero, but she does not know it yet.

- That makes you an **externalist** because the meaning of the expression is all about the reference and not Lois' mental representation of the reference.

- If you think Lois Lane has separate beliefs about Clark Kent and Superman and the statements of both of them can be true, then you are an **internalist**.

- You can't resolve that meaning by calculating over reference because the reference is the same.

- Lois cannot believe that Clark Kent is not a hero and Superman is a hero.

- If both are those are computed over the same referent then it would be contradictory.

- In order for both of those to be true at the same time, we have to say that the meaning of those expressions is being computed by Lois' mental representation.

- Her mental representations for Clark Kent and Superman are very different.

- They seem like very different people according to her mental representations.

Twin Earth Thought Experiment:
- Created by Hilary Putnam.

- Imagine 2 planets.

- Earth and another planet called Twin Earth that is identical in every possible respect except one.

- There is only one major difference between the two.

- On Twin Earth, water has a different molecular structure.

- It is functionally the same thing and has the same properties.

- When we refer to the word 'water' on Earth and when people on Twin Earth use the word 'water,' do those refer to the same meaning?

- The issue is they are not referring to the same thing.

- They have different references.

- Water and water on twin earth are different substances.

- Does the issue of whether they mean the same thing or different things rely on what the people know about the substance they are referring to?

- This experiment is to help you evaluate your own intuitions.

- Do you feel that the word 'water' has the same meaning on Twin Earth and Earth?

- If you do then you are an **internalist** because what matters is your mental representation.

- If you think they are different because it refers to a different thing then you are an **externalist.**

- What matters is what it actually is rather than what people think.

- **Internalism** is a functionalist semantics in some sense.

- If the words are used in the same way, then they mean the same thing.

- We are describing meaning in functional terms.

- **Externalist** is a kind of a physical semantics.

- If the words have different references in the physical world, then they can't mean the same thing.

- **Meaning is the process of computing a referent.**

KEY CONCEPTS:
- Sound patterns.

- Subregular structure.

- Hierarchical Structure.

- Recursion.

- Regular and Context-Free structure.

- Meaning as truth condition.

- Compositionality.

- Sense and Reference.

- Externalism vs Internalism.