Scope without Syntax
Towards a Game Theoretic Approach

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- Languages have what are called *quantifiers*, which are words which delineate particular quantities of nouns that they modify.
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  - **Existential quantifiers** – a, one, some (∃)
  - **Negation** – not, no (¬)
  - Many others – numerals, much, many, few, etc.
- For the purposes of sentence interpretation, quantifiers are quite a puzzle. Especially when there are multiple quantifiers in a sentence, a sentence may become ambiguous.

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- In the second, we say that the $\exists$ takes wide scope over the $\forall$.

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  - Sensitive to linear order

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- This can allow us to formally analyze an apparent "functional" alternation.

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  - Players are awarded payoffs based on the strategies taken by each player.

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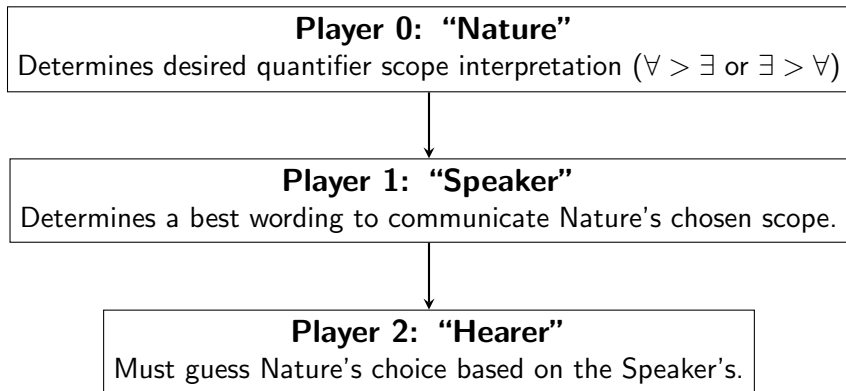
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- Normal human:
    - "If he wanted to say 'Billy ate all the chocolates', he would've said just that!"

Our Quantifier Scope Game

Player 0: "Nature"
Determines desired quantifier scope interpretation ($\forall > \exists$ or $\exists > \forall$)

↓

Player 1: "Speaker"
Determines a best wording to communicate Nature's chosen scope.

↓

Player 2: "Hearer"
Must guess Nature's choice based on the Speaker's.

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- Moving around nouns via 'transformations' (passivization, clefting, etc.) is costly/marked/undesirable.
- Scrambling (to be discussed later), as opposed to transformations are not similarly costly.

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- Here, the strongly preferred reading is the one where there is a pair of men for each hole ($\forall > \exists$), while the case where there is two specific men for each hole is harder to get out of the blue.

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- Passive sentences tend to be unambiguous, preferring only surface scope.

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- This game is **non-zero sum Coordination Game**, meaning that both active players' interests are aligned.
- The players **do not** have perfect information. While the Hearer knows what the Speaker's strategy is, he does not know what Nature has chosen.
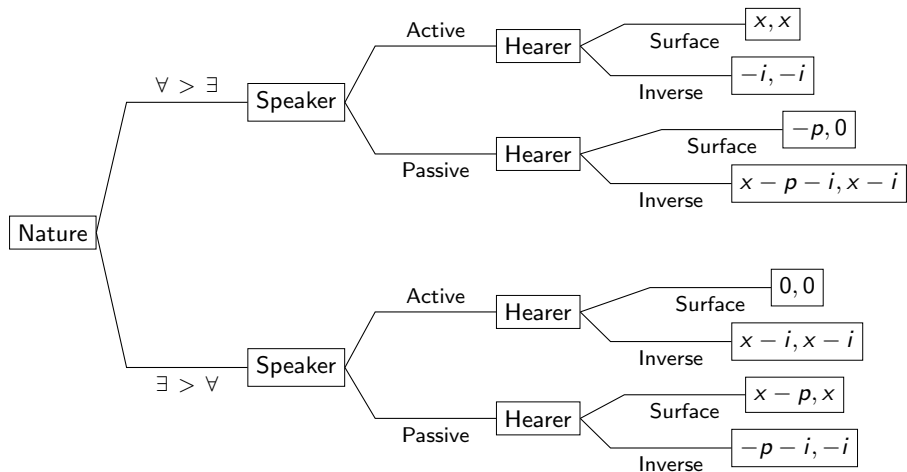
The Decision Tree

Figure: Decision Flow of the Game of "Everybody loves somebody"

Speaker

	Active	Passive
Surface	x	$-y$
	x	0
Inverse	$-i$	$x - p - i$
	$-i$	$x - i$

Hearer

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Speaker

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    - or it is not, but the Speaker didn't want to accrue the passive penalty (p).

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- However, both of these sentences *must have* **surface scope**. They cannot be ambiguous.

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- However, **scrambling** is not similarly costly. . . so it's a new strategy.
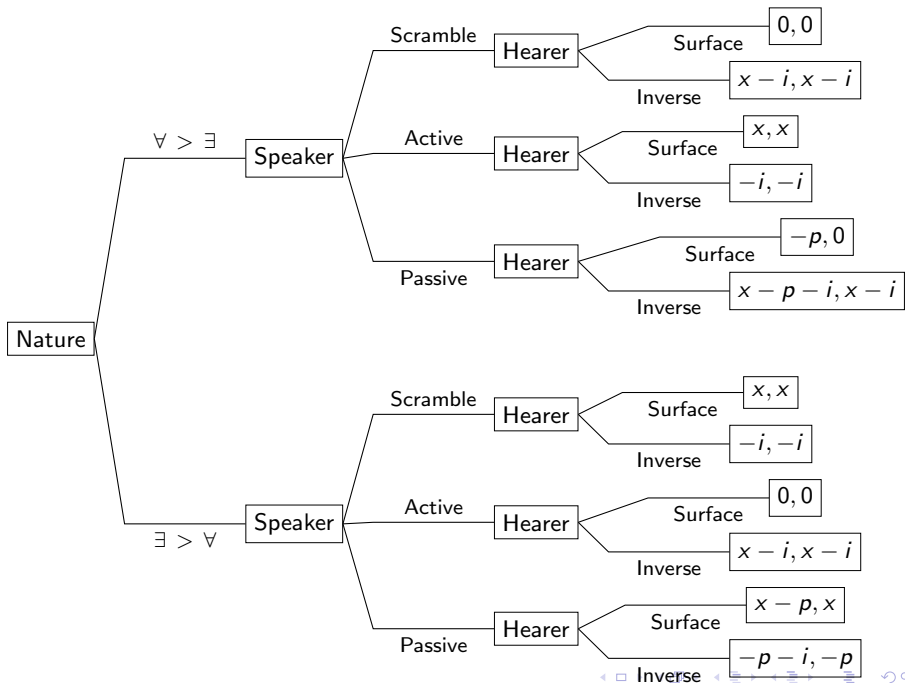
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- Since there is no longer cost to reordering for the Speaker, the focal strategies are to use whatever strategy avoids the need for inverse scope.
- Seeing this, the Hearer's best strategy should always be to assume **surface scope**.
- Therefore, for each sentence (active or scrambled), there should only be only one unambiguous interpretation.

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- The "markedness" of inverted scope or passivization are *vital* to communication, as they signal the Speaker's intention and indirectly create the focal points.

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- These two possibilities produce scope ambiguity.

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- Since he can do this, the unscrambled sentence has an unambiguous surface scope interpretation.
- **Sidenote:** Potentially related, languages with scrambling/flexible word order, usually rely on things like passivization less often.

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- This holds in similar languages with scrambling and stable negation location (e.g. Korean).

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- "Scrambling" languages are unambiguous in normal sentences, but are in more rigid constructions, ambiguity arises.
  - This is because the ambiguity is not a language-specific parameter, but a result of the strategies employable in any given context.

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          "Everyone arrested a woman." ($\forall > \exists$)

     b. (You) yige nüren meigeren dou zhuazou.
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But in languages where negation is *always* flexible...

...like Chinese, we *always* have a lack of ambiguity!

(19) Shujuan keyi **bu** gen Guorong tiao wu.
Shujuan may not with Guorong dace

"Shujuan is permitted not to dance with Guorong." ($may > \neg$)

(20) Shujuan **bu** keyi gen Guorong tiao wu.
Shujuan not may with Guorong dance

"Shujuan can't dance with Guorong." ($\neg > may$)

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All of these are ambiguous.	**All of these are non-ambiguous.**

The General Theory

- Quantifier scope interpretaions are not so much syntactically *licensed* so much as they are **pruned** from the all possible combinations of scopes ($q!$ where $q =$ number of quantifiers).

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- Without any syntactic machinery, we have already done a lot of the work of narrowing in on what interpretations are possible.
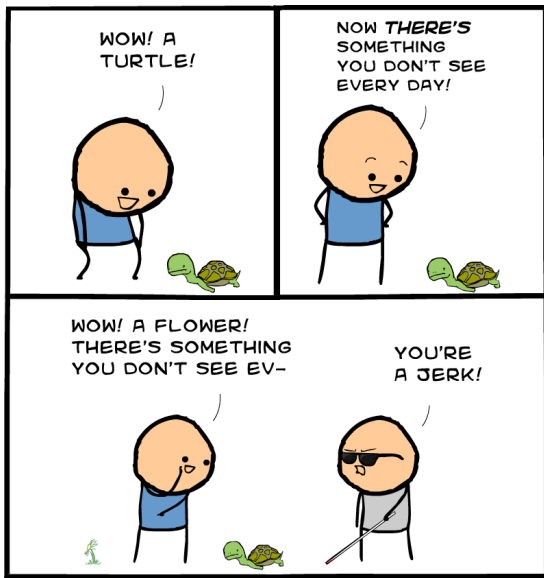- But the story is not done yet!

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- Similar accounts for related phenomena? C-command? Cross-over?
- Extensive Game Theory w.r.t different quantifiers and remodelling given data.

The End