Representing Meaning Part 3

ICS 482 Natural Language Processing

Lecture 20: Representing Meaning Part 3

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بسم الله الرحمن الرحيم

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NLP Credits and Acknowledgment

These slides were adapted from presentations of the Authors of the book

SPEECH and LANGUAGE PROCESSING:

An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition

and some modifications from presentations found in the WEB by several scholars including the following

NLP Credits and Acknowledgment

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NLP Credits and Acknowledgment

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Previous Lectures

- Introduction and Phases of an NLP system
- NLP Applications - Chatting with Alice
- Finite State Automata & Regular Expressions & languages
- Morphology: Inflectional & Derivational
- Parsing and Finite State Transducers, Porter Stemmer
- Statistical NLP – Language Modeling
- N Grams, Smoothing
- Parts of Speech - Arabic Parts of Speech
- Syntax: Context Free Grammar (CFG) & Parsing
- Parsing: Earley's Algorithm
- Probabilistic Parsing
- Probabilistic CYK - Dependency Grammar
- Semantics: Representing meaning
- Semantics: FOPC
- Lexicons and Morphology – invited lecture

Today's Lecture

- Administration
  - Return Quiz 3
  - Assignments grading
  - Presentations Schedule
  - Teams for project (2 each)
- Lecture
  - Representing Meaning

Quiz 3

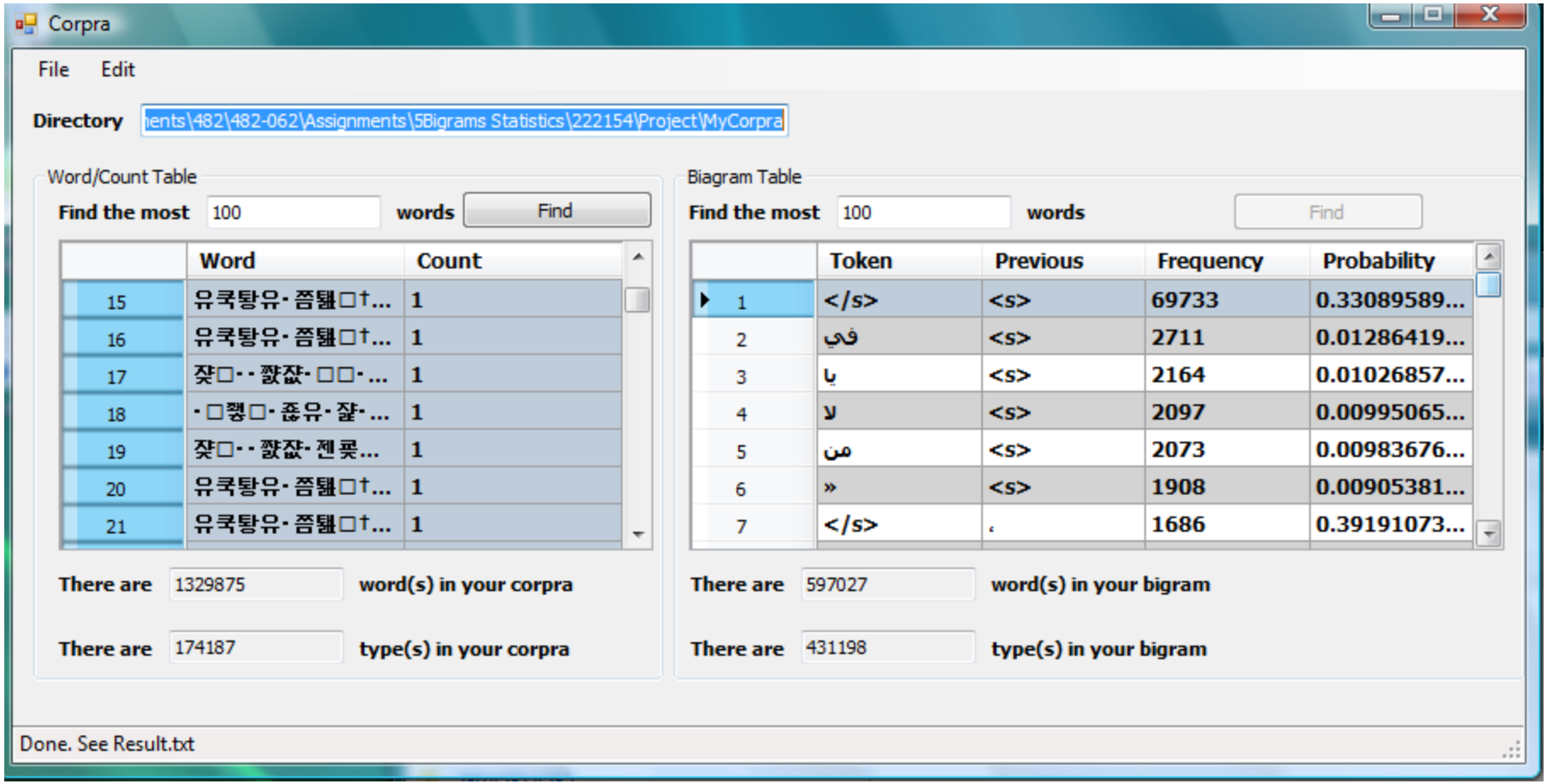
- Sample solution is on Keys at Course site
- View WebCt Statistics
- Any comments

Assignment grading notes

- Read Please
- Bigram for the whole corpus
- Text File format
- No updated corpus
- Team work without agreement
- Report
- Results
- Be creative: Choose where to save results
- Limitation view
- Late
- No submission

Assignment grading notes

- Why this is like this?



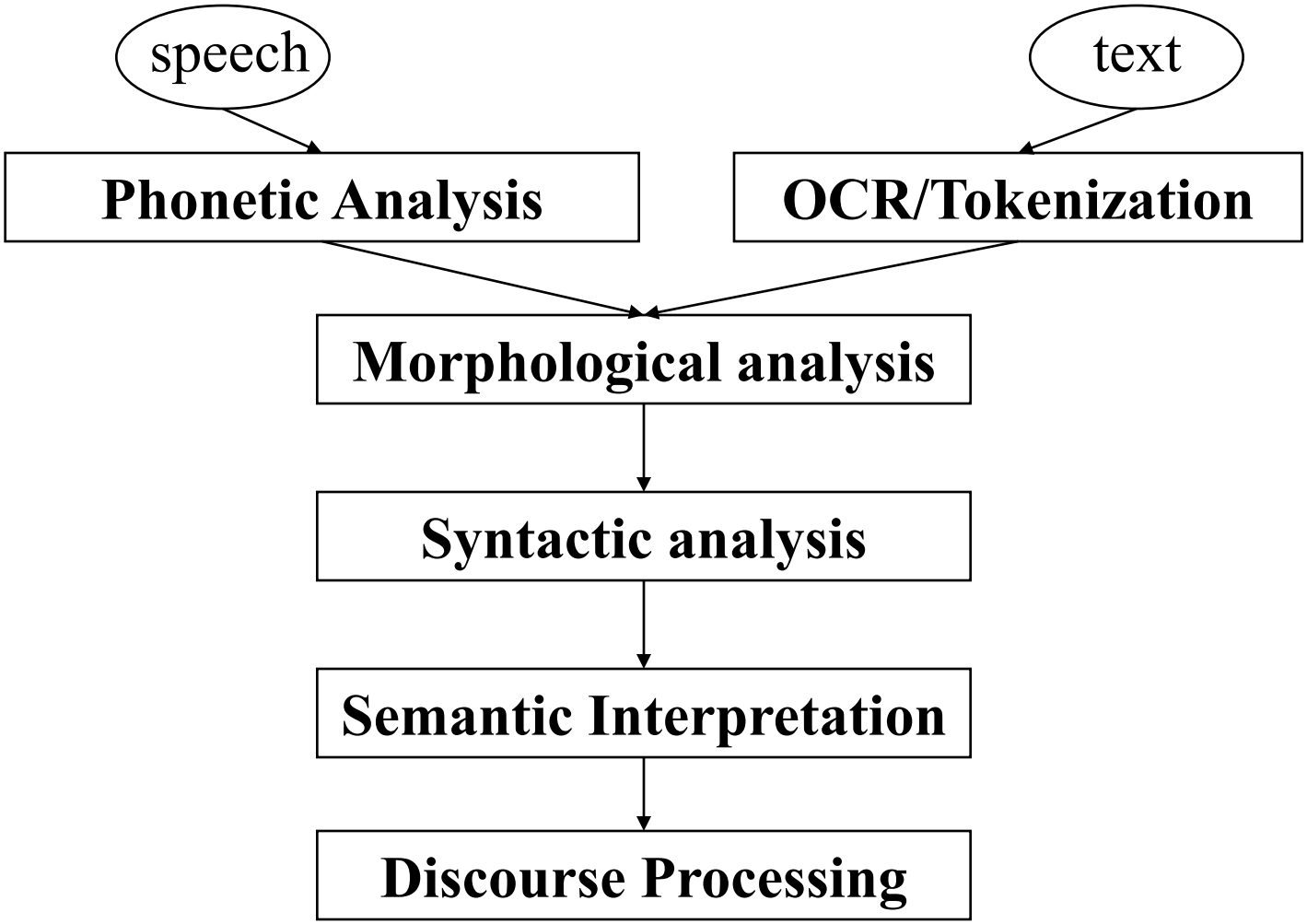
Presentations Schedule

- Presentations at class time
- 13th, 15th, 20th, and 22nd May
- visit the calendar section of this website
- Go to the month of May
- choose one slot in one of the assigned days for presentations
- Add a public entry in the most suitable slot for you
- Max 3 students per slot
- Presentation time: 25 minutes
  - 20 for presentation
  - 5 for discussions
- Put the title of your topic in the entry you are adding

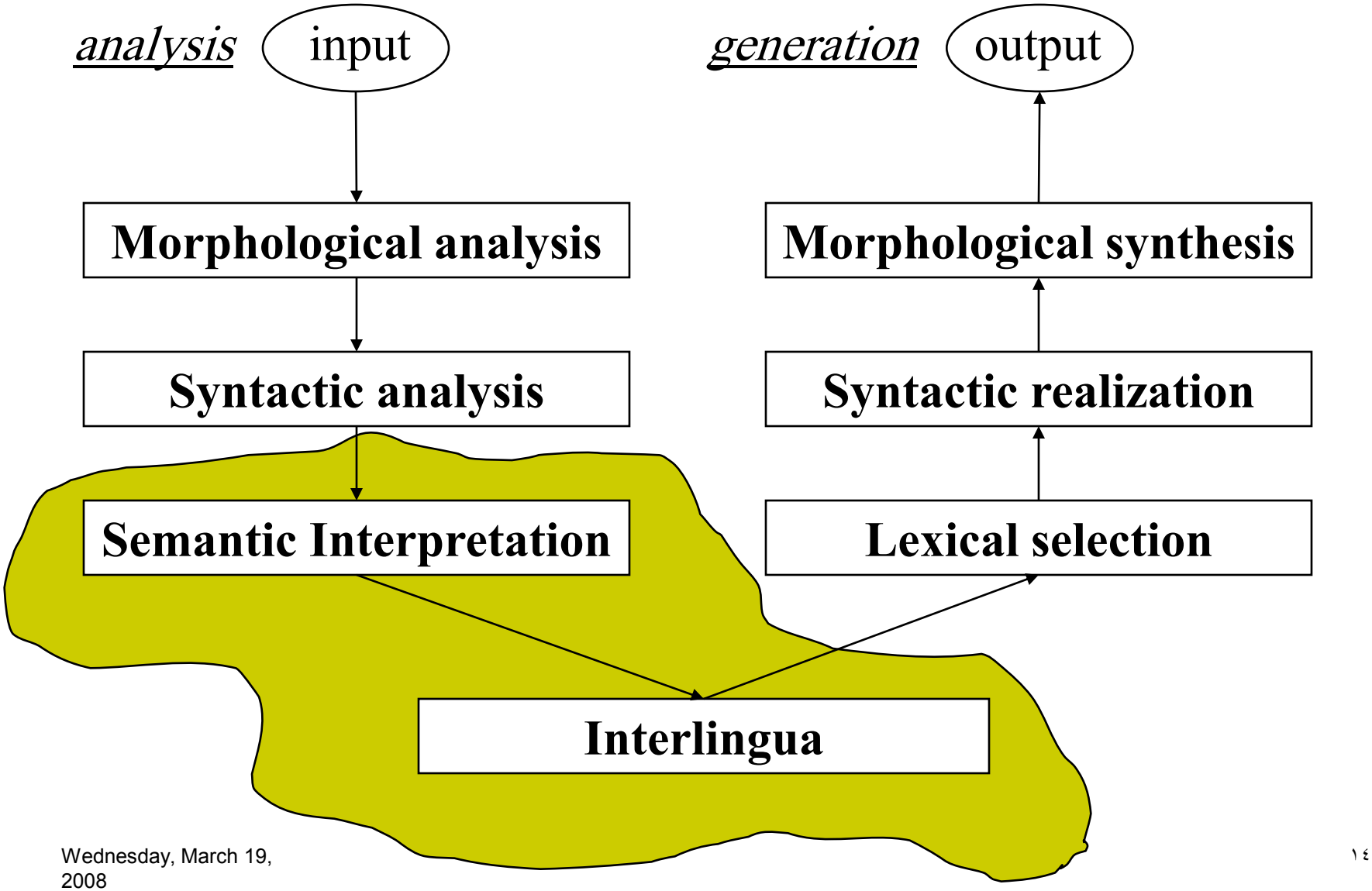
Team

- 2-3 Members (alone)
  - Team Name (Your own)
  - Team logo (Your design idea)
  - By next class
- How to choose Team members
  - Similar goal
  - Easiness of communications
  - Consistency, harmony, and relaxation
  - ??
- WebCt Discussion list – Team Selection
- Project Ideas?

NLP Pipeline



Machine Translation



FOPC Syntax

- *Formula* → *AtomicFormula*
  | *Formula Connective Formula*
  | *Quantifier Variable … Formula*
  | ¬ *Formula* | *(Formula)*
- *AtomicFormula* → *Predicate (Term…)*
- *Term* → *Function (Term…)* | *Constant* | *Variable*
- *Connective* → ∧ | ∨ | ⇒
- *Quantifier* → ∀ | ∃
- *Constant* → *A* | *VegetarianFood* | الكتاب
- *Variable* → *x* | *y* | …
- *Predicate* → *Serves* | *Near* | …
- *Function* → *LocationOf* | *CuisineOf* | …

Break: What is what?

- Identify:
  - *Connective:* ∧
  - *Quantifier:* ∃
  - *Constant:* *MexicanFood* *ICSI*
  - *Variable:* *x*
  - *Predicate:* *Restaurant* *Serves* *Near*
  - *Function:* *LocationOf*
  - *AtomicFormula:* *Restaurant*
  - *Formula:* ∃ *xRestaurant(x)* ∧ *Serves(x, MexicanFood)* ∧ *Near(LocationOf(x), LocationOf(ICSI))*
  - *Term:* *x* *ICSI* *LocationOf*

$$\exists\, xRestaurant(x) \wedge Serves(x, MexicanFood) \wedge Near(LocationOf(x), LocationOf(ICSI))$$

Inference

- Example

$$\frac{Vegetarian\,Restaurant(Rudys)\qquad \forall x\ VegetarianRestaurant(x) \Rightarrow Serve(x, VegetarianFood)}{Serve(Rudys, VegetarianFood)}$$

a new fact

Inference

- What about this?
- If we have

$$\forall x\ VegetarianRestaurant(x) \Rightarrow Serve(x, VegetarianFood)$$

- and

$$Serve(Babakhabbaz, VegetarianFood)$$

- Can we say that

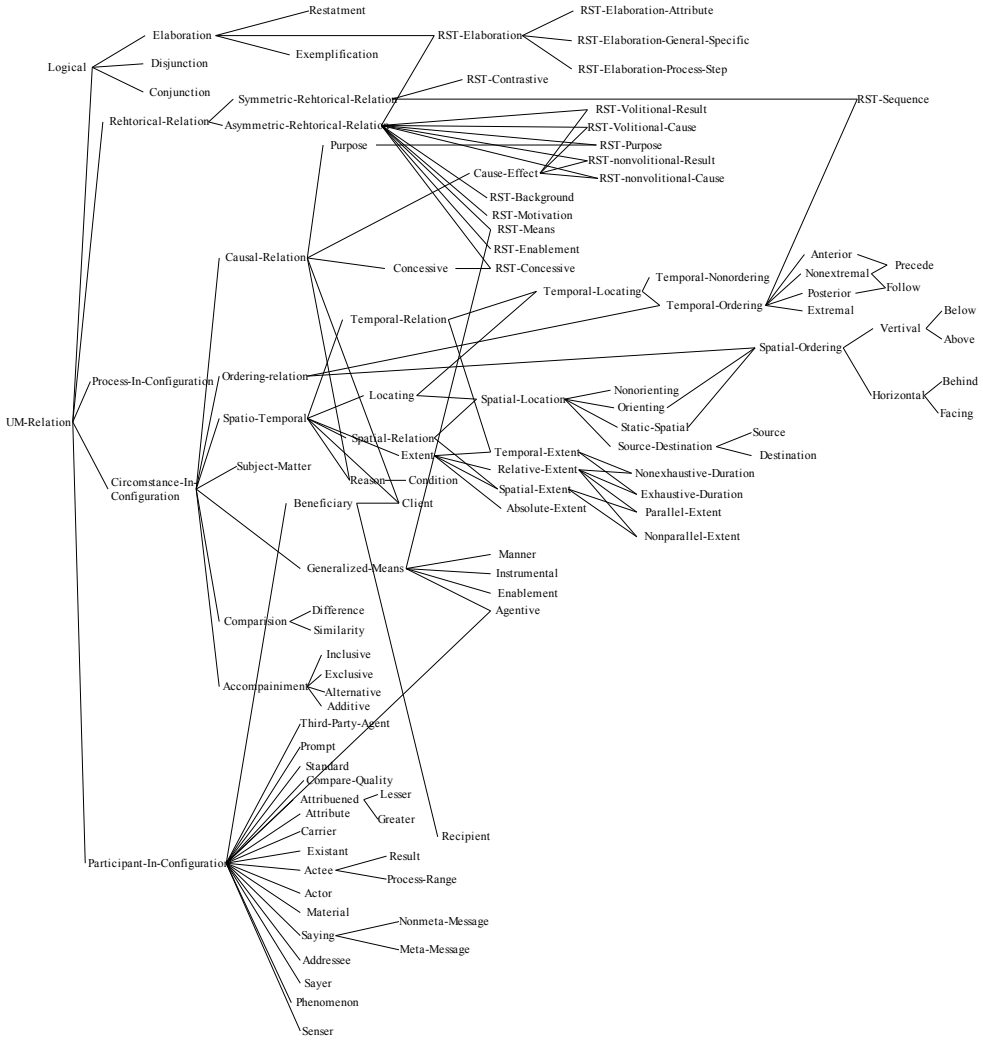
$$VegetarianRestaurant(Babakhabbaz)$$

- ??? – No - abduction, plausible reasoning

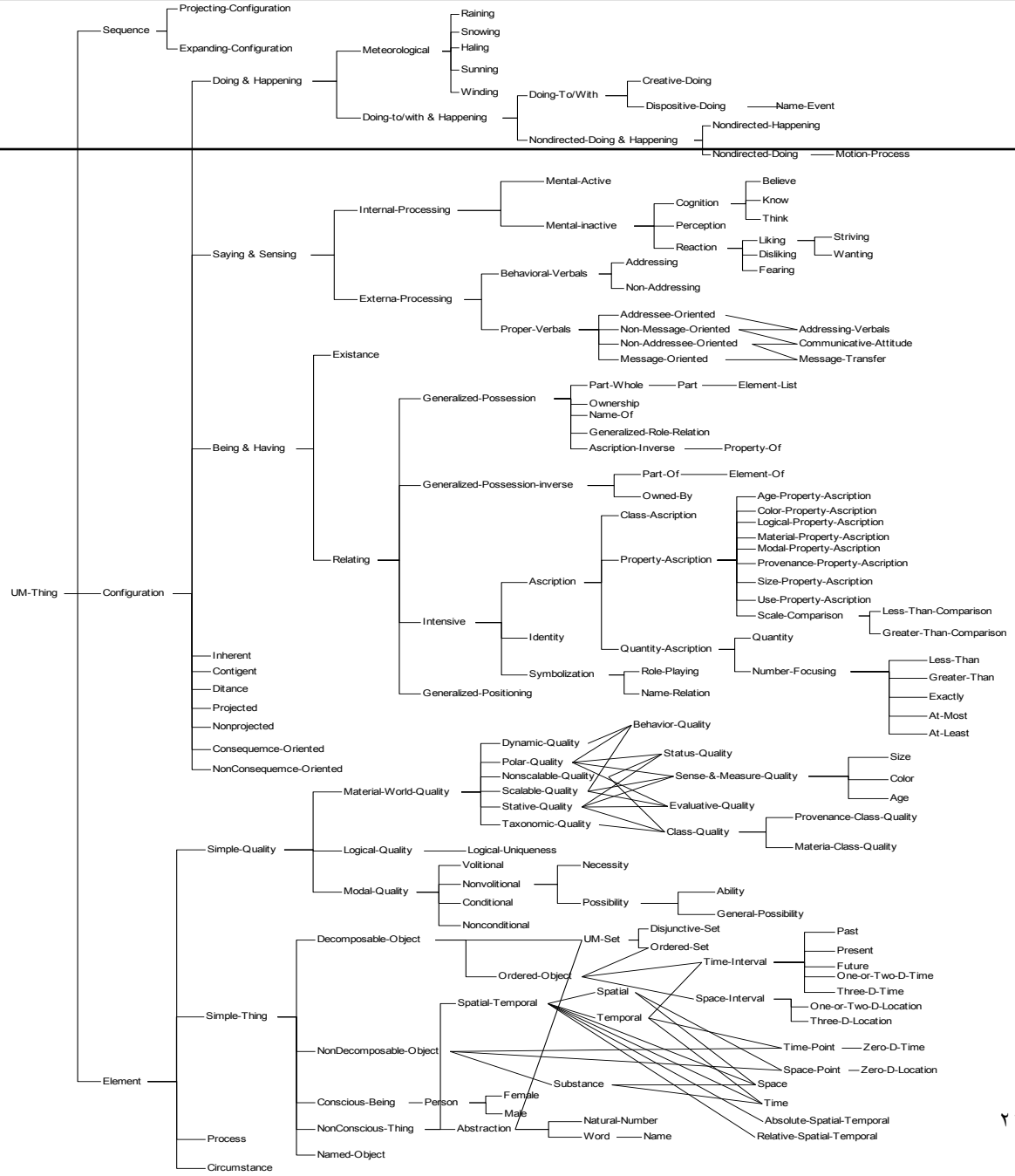
Knowledge Representation

- Some topics that have clear implication of language processing
  - Categories
  - Events
  - Time
  - Beliefs

Knowledge Representation



Knowledge Representation



Representation of Categories

- Categories are sets of objects or relations where all members share a set of features
- Method 1:
  - Create a unary predicate for each category
    - *VegetarianRestaurant(Maharani)*
  - Problem: Unable to talk about *VegetarianRestaurant*
    - Not a valid FOPC formula:
      - *MostPopular(Maharani, VegetarianRestaurant)*

Representation of Categories

- Method 2:
  - Reification اعتبره شيئا ماديا: Represent all concepts that we want to make statements about as full-fledged objects
  - *isa(Maharani, VegetarianRestaurant)*
  - *ako(VegetarianRestaurant, Restaurant)*
    (a kind of)

  - Reification: To regard or treat (an abstraction) as if it had concrete or material existence.

    www.dictionary.com

Representation of Events

- Not always single predicate
  - *I ate*
  - *I ate a turkey sandwich*
  - *I ate a turkey sandwich at my desk*
  - *I ate at my desk*
  - *I ate lunch*
  - *I ate a turkey sandwich for lunch*
  - *I ate a turkey sandwich for lunch at my desk*

Representation of Events

- Method 1:
  - –Create as many *different* eating predicates as are needed to handle all of the ways that eat behaves
  - *Eating1(Speaker)*
  - *Eating2(Speaker, TurkeySandwich)*
  - *Eating3(Speaker, TurkeySandwich, Desk)*
  - *Eating4(Speaker, Desk)*
  - *Eating5(Speaker, Lunch)*
  - *Eating6(Speaker, TurkeySandwich, Lunch)*
  - *Eating7(Speaker, TurkeySandwich, Lunch, Desk)*
  - Relate them using meaning postulates:
    - $\forall w, x, y, z\ Eating7(w, x, y, z) \Rightarrow Eating6(w, x, y)$

Representation of Events

- Problems:
  - Need too many meaning postulates
  - Difficult to scale up
- Method 2:
  - Use a *single* predicate where as many arguments are included in the definition of the predicate as ever appear with it in an input

Representation of Events

- $\exists$ *w, x, y Eating(Speaker, w, x, y)*
- $\exists$ *w, x Eating(Speaker, TurkeySandwich, w, x)*
- $\exists$ *w Eating(Speaker, TurkeySandwich, w, Desk)*
- $\exists$ *w, x Eating(Speaker, w, x, Desk)*
- $\exists$ *w, x Eating(Speaker, w, Lunch, x)*
- $\exists$ *w Eating(Speaker, TurkeySandwich, Lunch, w)*
- *Eating(Speaker, TurkeySandwich, Lunch, Desk)*

Representation of Events

- Problems:
  - Make too many commitments
    - Need to commit to all arguments (e.g., every eating event must be associated with a meal, which is not true)
  - Unable to refer to individual events
    - Event is a predicate, not a term

Representation of Events

- Method 3:
  - Use reification to elevate events to objects
  - Arguments of an event appear as predicates
  - Do not need to commit to arguments (roles) not mentioned in the input
  - Meaning postulates not needed

Representation of Events

- I ate.
  - $\exists$ w *isa(w, Eating)* $\wedge$ *Eater(w, Speaker)*
- I ate a turkey sandwich.
  - $\exists$ *w isa(w, Eating)* $\wedge$ *Eater(w, Speaker)* $\wedge$ *Eaten(w, TurkeySandwich)*
- I ate a turkey sandwich for lunch.
  - $\exists$ *w isa(w, Eating)* $\wedge$ *Eater(w, Speaker)* $\wedge$ *Eaten(w, TurkeySandwich)* $\wedge$ *MealEaten(w, Lunch)*

Temporal Representations

- How do we represent time and temporal relationships between events?
  - *Last year Ali was happy but soon he will be sad.*
- Where do we get temporal information?
  - Verb tense
  - Temporal expressions
  - Sequence of presentation

Thank you

- السلام عليكم ورحمة الله