From Functional to the Functorial Praxis and Dynamics of Language

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Talk to SFLIG2021:
Systemic Functional Linguistics Interest Group
by Zoom, 17 November 2021

Age of Information

- Promoted different types of academic disciplines needed to fit a radically transformed World:

  - Fundamental underlying principles of life may remain invariant in essence but now appear in a quite different form in the use of language and data

  - Computer science

    - Much formal work on machine-based languages

Age of Information 2

- There are added dimensions in the dynamic character of communications and the prevalence of the electronic medium.

    - These have fresh interpretations of classical notions in space and time.

    - They are global not just local and have moved on from closed to open systems

Typology/Types

- Of course there is nothing entirely new and these fresh disciplines have long existed in other varied forms.

- Typology is as old as its narrative of the Garden of Eden but employed in more recent mundane times by Bertrand Russell to resolve the paradoxes of set theory.

    - He was not successful and moved up to the higher level of ramified type theory but that too still proved inadequate.

Types/Signs

- Types are now of great practical importance in the use of computers and currently a continuing study in data science.
  - Computer code as language is a prime subject of functional linguistics.
  - Cybernetics the study of automated control and Semiotics on the significance of signs are new disciplines that have been around for a century or more and have taken on added importance.
  - Currently newer notions have been identified like Anticipatory Systems and Legitimation Code Theory.

Context for Functional Linguistics

- All are allied to Functional Linguistics and none of these disciplines can be partitioned off one from another. Consequently any treatment relating to functional linguistics needs to be treated in the context of these other disciplines.

Holistic World

- It is no news that we live in a holistic world.

- The issue is whether we lack the interdisciplinary competence to deal with its significance and how to react to it.

Implementation Needs

- On top of all this it is no coincidence that all the new disciplines relate to a very practical world demanding implementation.

  – The standard linguistic classification of syntax, semantics and pragmatics covers the ground from formal structure to the practical use of language in any context whether real or artificial.

  – Functional linguistics is concerned with penetrating the final boundary from semantics to praxis and concentrates on the dynamics of the context just outlined. It lies within the boundaries of the subject of communication.

Modes of Communication

- Graphics and pictures are a rival mode of communication
  - but the tongue remains supreme and has been advanced by the diversity of written textual formats to express the semantics of deeper expressions of thought.
- Rhetoric according to mediæval analysis consisted of the four major tropes of
  - metaphor, metonymy, synecdoche, and irony.
- These are inherent to the most inscrutable phenomenon of language – humour.

Wide Ambit for Language

- The ambit of language is very wide.

- Beyond the obvious there is a whole spectrum of genres from the melody in music to the very different chemical language of plant sociolectism in the soil.

- The following has some bias:
  - Towards formal languages
  - Favouring a framework over detail
  - Glossing over the many subtleties of natural language

Adjointness

- What do all these areas have in common?

- It is adjointness.

- For this we need to rise from the functionality of models to the functorality of metaphysics.

- This paper explores formally the dynamics of language and communication in that context.

Formal Category Theory

- Based on functions (arrows)

- Multiple levels (functions, functors, natural transformations)
  - Functions map between objects
  - Functors map between collection of functions
  - Natural transformations map between functors

- Everything is arrows
  - objects are identity arrows, categories are collections of arrows

- Can produce complex arrow diagrams
  - A succession of arrows is composable
  - Alternative routes commute (equivalent)
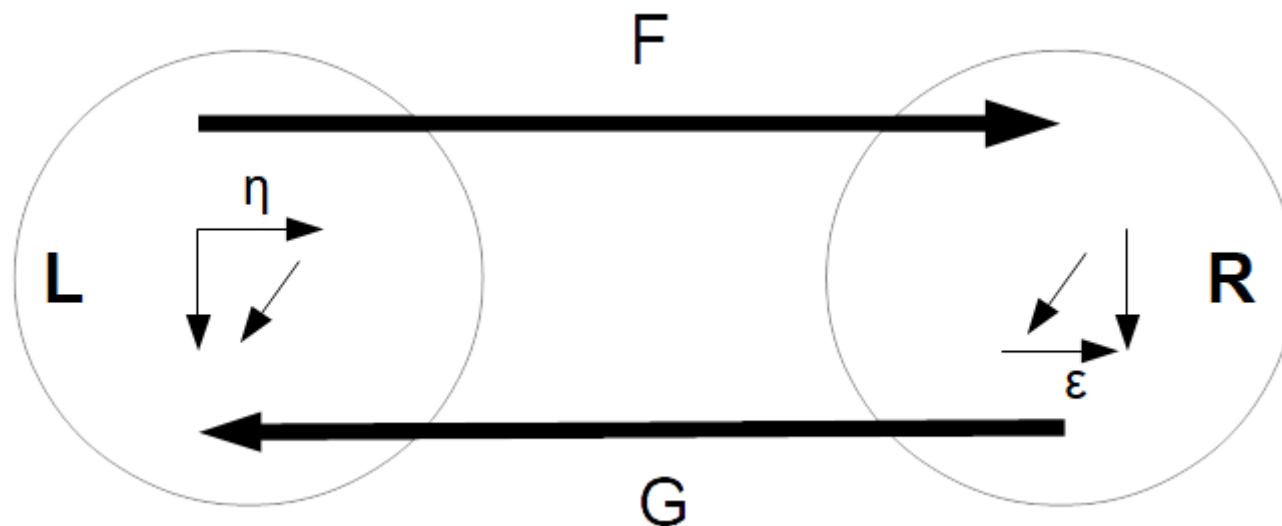
Compare with Set Theory

- Objects are termed elements

- Functions map from element to element

- Mappings between functions are termed higher-order.

- Basic theory is built around sets of elements rather than collections of arrows.

- Structure is basically flat with higher-order as an afterthought.

Adjointness between Functors: Metaphysics

A 'cycle' GF:

Assessing unit η in L and counit ε in R to ensure overall consistency

'Cycles' are performed simultaneously (a snap, not each cycle in turn)

F

η

L

R

ε

F -| G

G

Categories L, R

Functors F, G

1_L 1_R identity arrows

$η: 1_L \rightarrow GF(L)$
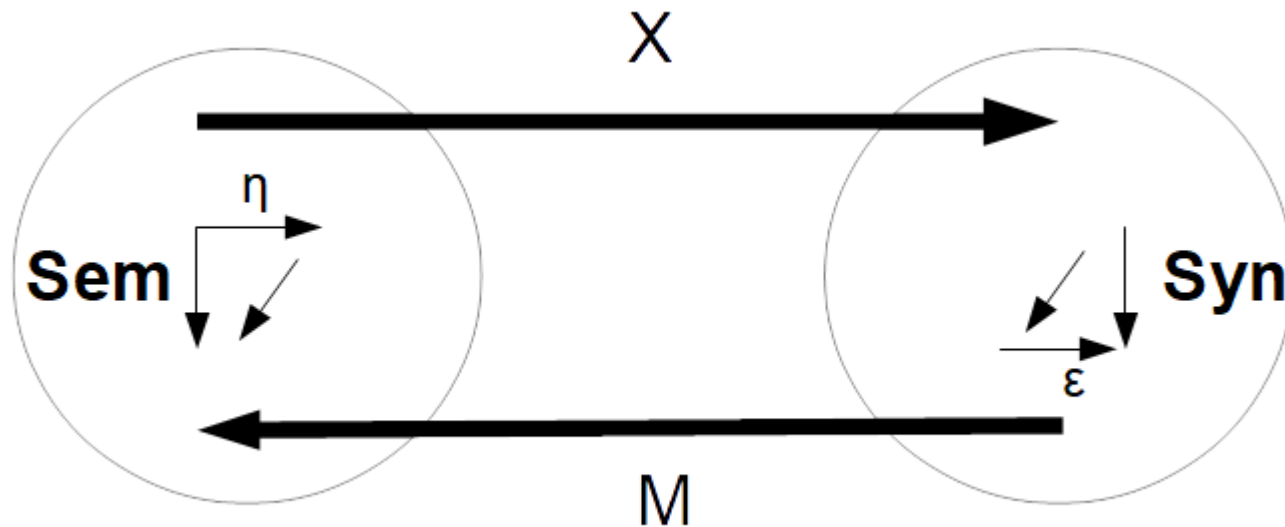
$ε: FG(R) \rightarrow 1_R$

Categories L and R

- L is category Semantics (rename Sem)
  - Containing semantic objects (Intension)
  - Attributes, predicate calculus, lambda calculus, categorial grammar, dictionaries

- R is category Syntax (rename Syn)
  - Containing syntactical objects (Extension)
  - Grammar, rules, constructs

- Functors
  - X: Sem → Syn   (syntactic interpretation)
  - M: Syn → Sem   (semantic interpretation, denot.)

- Adjointness X --| M

Adjointness between X and M

A 'cycle' GF:

Assessing unit η in L and counit ε in R to ensure overall consistency

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X -| M

Categories Sem, Syn

Functors X, M
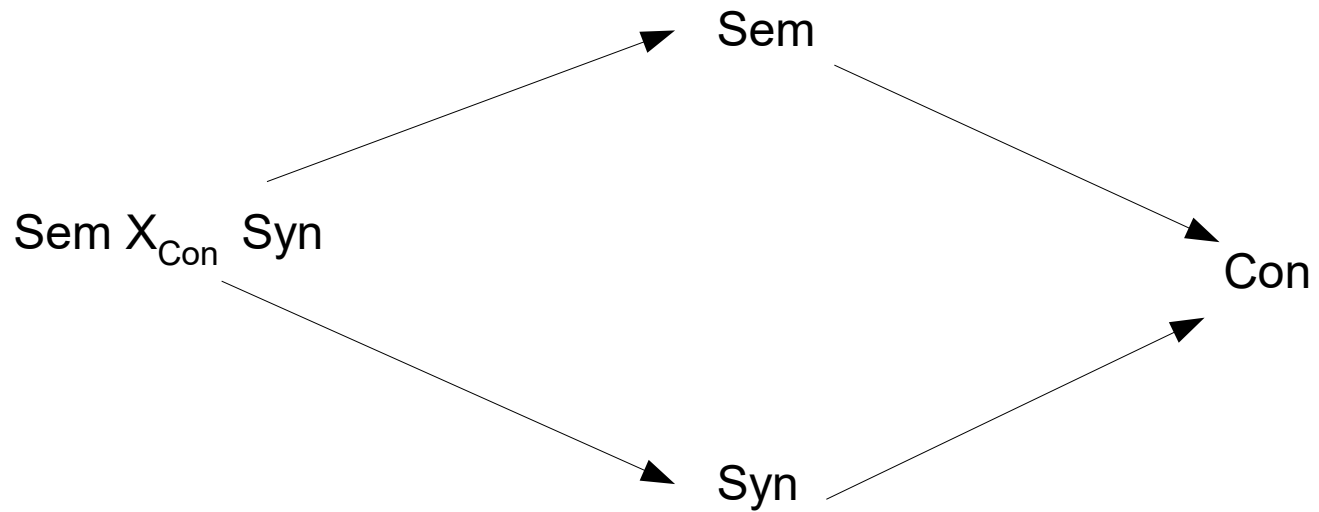
1_L 1_R identity arrows

$\eta: 1_L \rightarrow MX(L)$ $\varepsilon: XM(R) \rightarrow 1_R$

Pragmatics as Pullback

$$\text{Sem}$$
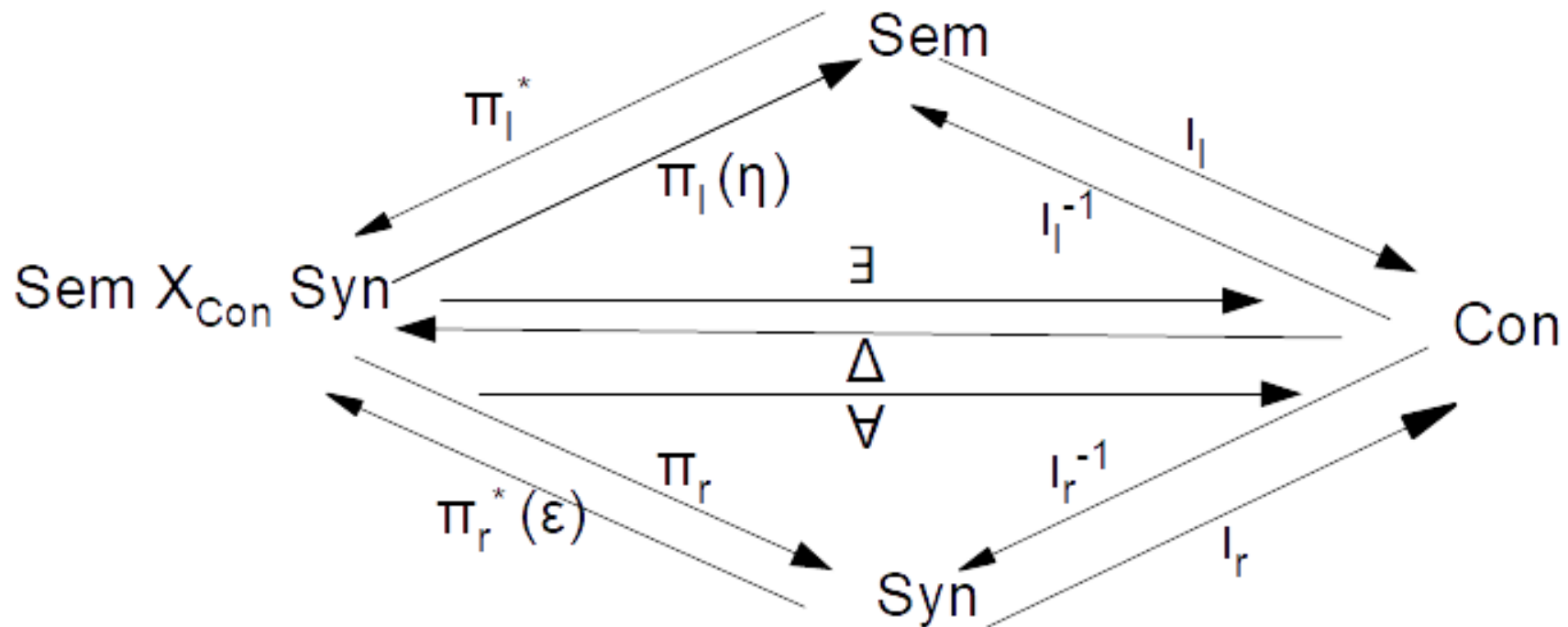
$$\text{Sem } X_{\text{Con}} \text{ Syn}$$

$$\text{Con}$$

$$\text{Syn}$$

Pragmatics

- Relationship of Semantics with Syntax in context.

- This is a pullback of Sem over Syn in context of Con category:

  - Sem X_{Con} Syn

  - X is Times, product of Sem and Syn in context of Con

  - Right-hand side is (Sem + Syn) + Con

  - Context includes language, semiotics

Pragmatics – More Arrows

Enhanced reasoning – projections, inclusions, quantifiers

Advantages of Category Theory

- Multiple Levels of arrows
    - Closure in classification, typing
    - Intension-extension handling
    - Expressing relationships
    - Comparing heterogeneous systems
    - Holistic and open
    - Relating functors, adjointness

- So Category Theory enables us to rise from functional linguistics to functorial linguistics
    - Integrating syntax, semantics and pragmatics at the functorial level