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Free and Open Systems Theory

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Systems Theory

- Important for Information Systems
- Challenging Areas
 - pandemics
 - prediction of earthquakes
 - world energy management policy
 - climate change
- Globalisation
- Freeness and Openness needed

Features of Dynamic Systems

- Natural entities
 - easier to recognise than to define
- Second-order Cybernetics
 - observer is part of the system
 - distinguish between
 - modelling components/components of system itself
- General Information Theory (Klir)
 - handling uncertainty
- Theory of Categories (Rosen)

System Theory

- Basic concepts
 - internal connectivity of components
 - Plato (government institution)
 - Aristotle (literary composition)
 - von Bertalanffy
 - theory of categories (vernacular)
 - to be replaced by an exact system of logico-mathematical laws.

Complexity of System

- System is a model of a whole entity
 - hierarchical structure
 - emergent properties
 - communication
 - control (Checkland)
- Complexity -- openness and freeness
 - self-organisation
 - anticipation (Dubois, Klir)
 - global interoperability

Key Elements in the Definition of a System

system	natural relationship	locality
closed	<i>intra-connectivity</i>	local
open	<i>inter-connectivity</i>	local
self-organised	<i>intra-activity</i>	non-local
free	<i>inter-activity</i>	non-local

Open System Definition

$$\frac{dx_i}{dt} = \sum_{j=1}^n a_{ij}x_j + c_i \quad (i = 1, 2, \dots, n)$$

Anatol Rapoport 1986

x_i is the mass of substance i

c_i is the input or output of matter, energy or, in other contexts, of information.

Openness from non-zero values for c_i

Closed if all $c_i = 0$

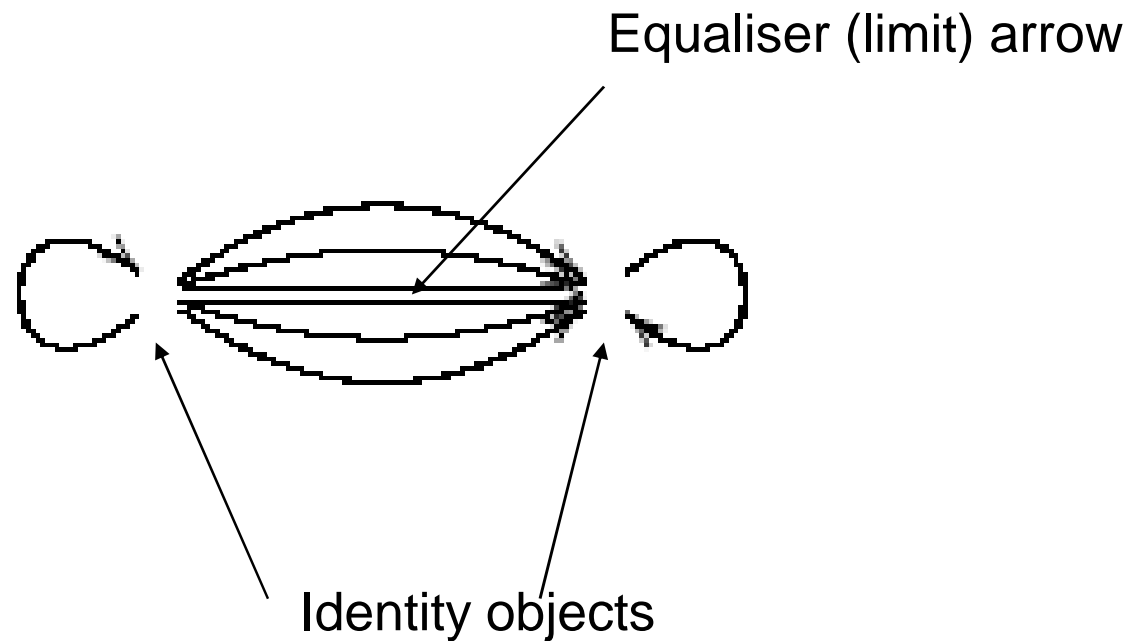
Concept of Openness

- Open
 - defined inductively on open interval -- difficult to formalise
- Dedekind cut
 - section of pre-defined field -- local
- Topology
 - \mathcal{S} -open
 - system is open to its environment
 - intuitionistic logic
 - Limited by reliance on set theory

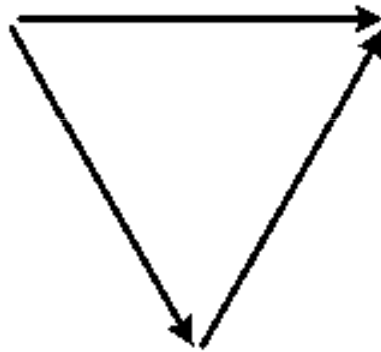
Category of Systems

- To make formal
 - intraconnectivity
 - interconnectivity
 - intra-activity
 - Interactivity
- Theory is realisable -- constructive
- Work on process -- Whitehead

The Limit of Intraconnectivity between Identity Objects

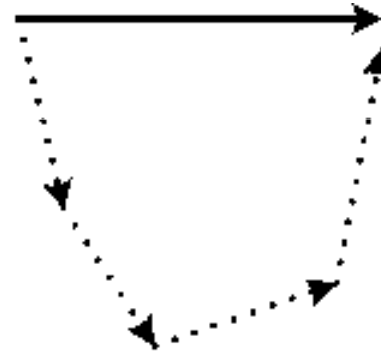


General Intraconnectivity Represented by a Triangle



(a)

Apex as drawn
represents general entity
or finite sequence of entities
Abstract



(b)

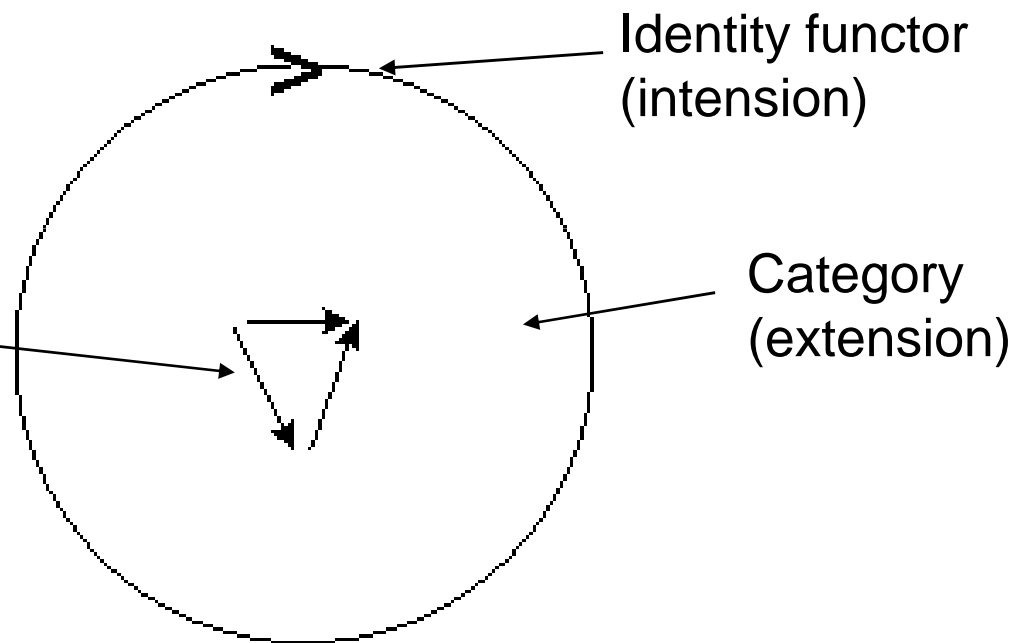
Composite curvilinear arrow
intraconnecting any number
of identity objects
Detailed path

Identity Functor as Intension of Category-System

Cartesian closed
category

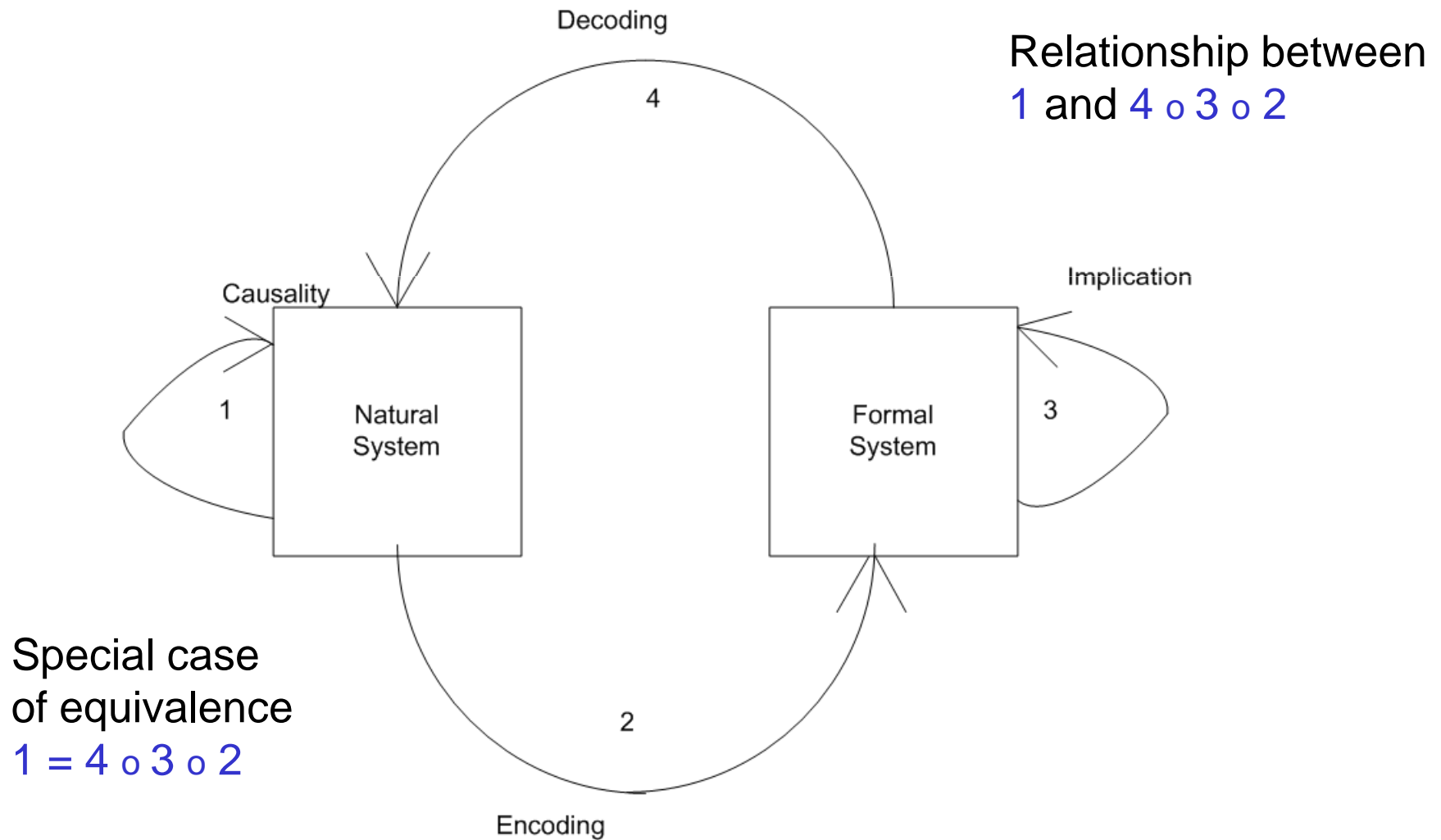
Curvilinear
polygon

Intraconnectivity

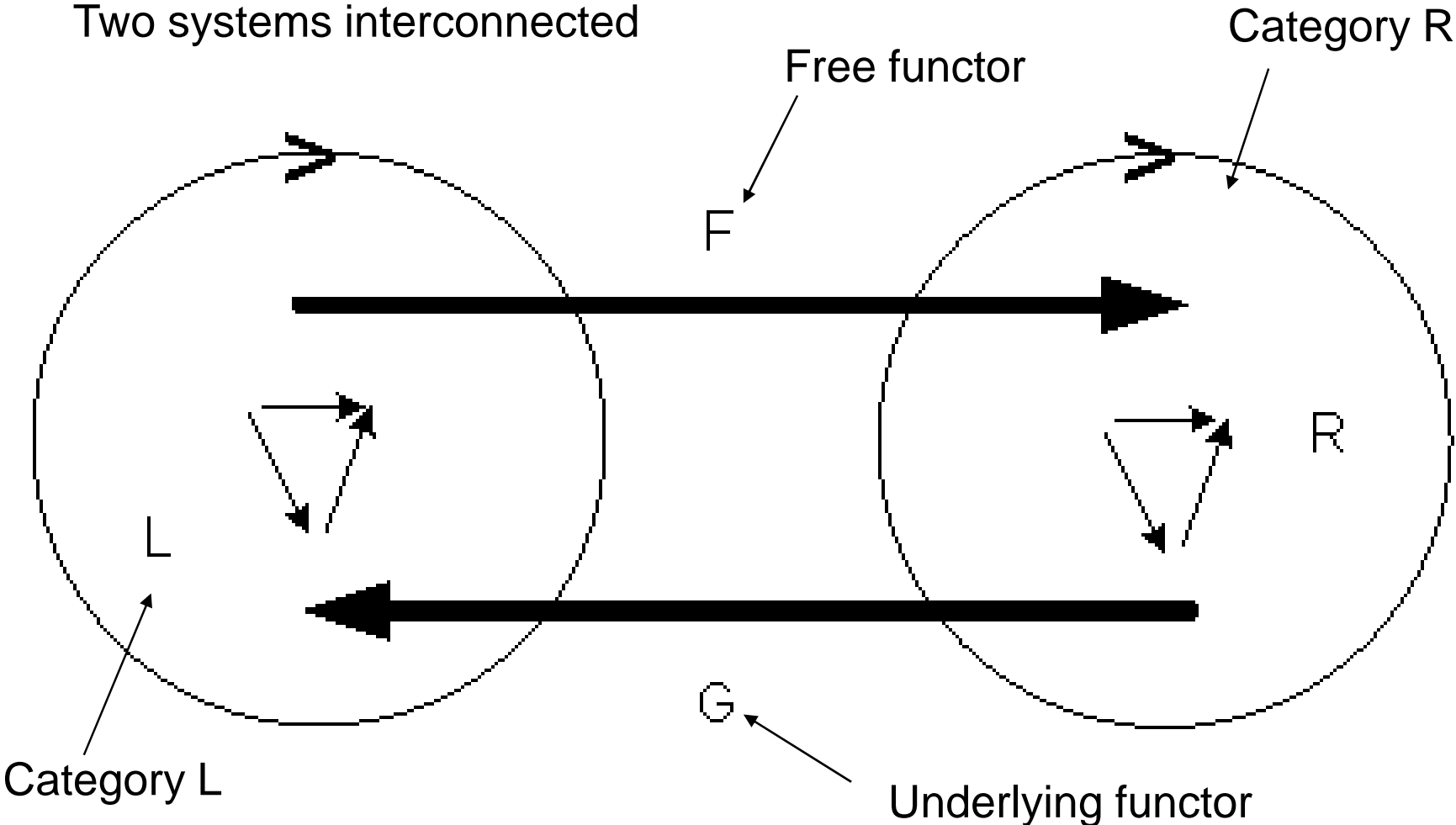


System is one large arrow (process)
Identity functor is intension
All internal arrows are extension

Early Adjointness from Rosen



Interconnectivity between two Identity Functors leading to Interactivity between Category-Systems.



Features of Adjointness $F \dashv G$

- Free functor (F) provides openness
- Underlying functor (G) enforces rules
- Natural so one (unique) solution
- Special case
 - $GF(L)$ is the same as L AND
 - $FG(R)$ is the same as R
 - Equivalence relation
- Adjointness in general is a relationship less strict than equivalence
 - $1_L \leq GF$ if and only if $FG \leq 1_R$

Category-Systems

- Makes formal
 - intraconnectivity identity functor
 - interconnectivity functors
 - intra-activity self-organisation (L and R
are indistinguishable)
 - interactivity adjointness
- Right-hand category-system R
 - free and open category system
 - freedom from free functor F
 - determination by underlying functor G