Complex tourism digital ecosystems

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foreword
We are not students of some subject matter, but students of problems. And problems may cut right across the borders of any subject matter or discipline.

Karl Popper
In Sarsi I seem to discern the firm belief that in philosophizing one must support oneself upon the opinion of some celebrated author, as if our minds ought to remain completely sterile and barren unless wedded to the reasoning of some other person.

The Assayer, 1623

the global village
Digital ecosystem: the digital, ecological & socio-economic assets that interconnect & interact

anatomy & physiology
System

- Entity (conceptual or real) made of a number (normally not small) of elements interacting dynamically & generating some global behavior
  - in a system “the whole is more than the sum of its components”

*How do we look at systems?*
complex systems:

[many] elements
nonlinear relationships
emergent properties
self-organizing
no “master-mind”
no blueprint
evolving
adaptive (learning)
resilient

Systems

• Simple
  – few components, linear and predictable interactions, repeatable, decomposable, knowable

• Complicated
  – many components, cause and effect separated over time & space but repeatable, decomposable, analyzable

• Complex
  – nonlinear interactions, sensitivity to initial conditions, dynamic, adaptable to environment, produce emergent structures & behaviors, can become chaotic
    • non decomposable, non predictable, non tractable analytically

... a single system can go through different states & can look differently depending on scale of observation
The “system approach” toolbox

- A wide range of possible tools & techniques
  - based on modeling and numerical simulations
  - most quite old, dated back to XVIII-XIX century,
    but “usable” only with recent computer technology

- Toolbox
  - System dynamics
  - Agent-based modeling
  - Nonlinear dynamics
    (chaos & complexity theory)
  - Network science (✓)
Network science: a list of topics

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<td>Creativity &amp; innovation</td>
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<td>Data exploration</td>
<td>Efficient infrastructures (power, water, etc.)</td>
<td>Software structures</td>
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<td>Design of transport networks</td>
<td>Spam fighting (email &amp; Web)</td>
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<td>Data mining</td>
<td>Detect trusted/influential users</td>
<td>Supply chain analysis and management</td>
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<td>Data mining</td>
<td>Detection of community and social changes</td>
<td>Tourist flows</td>
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<td>Data mining</td>
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<td>Efficient infrastructures (power, water, etc.)</td>
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<td>Traffic Navigation</td>
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<td>Design of transport networks</td>
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<td>Trust propagation</td>
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<td>Detect trusted/influential users</td>
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<td>Viral marketing</td>
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<tr>
<td>Detection of community and social changes</td>
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<td>Web crawling (Page Rank)</td>
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... academic fun ...

... generate new insights ...

Behind a complex system there is a network, that defines the interactions between the components.

We cannot understand complex systems unless we map out and understand the networks behind them.
The network approach → modelling

Model: a concise, workable and predictive representation of the system (for a specific goal)

study structural properties of networks or ensembles of networks (even from different environments) to understand them and assess and their influence on the dynamic behaviors
Network: an abstraction

Network structural metrics

- **Macroscopic level** (system’s topological structure)
  - average measures, global metrics (density, diameter, etc.) functional form of distributions
    - Lorenz curve & Gini index of degree distribution
    - (WNG: care to be taken when fitting)

- **Mesoscopic level** (system’s intermediate structure)
  - modularity (communities), hierarchies...

- **Microscopic level** (nodal characteristics)
  - centrality: determine the relative importance of a node within the graph

... *interpretation needed*
Qualitative / quantitative (?)

By abolishing the unfortunate categories of qualitative/quantitative and natural sciences/social sciences that have been set against each other, and letting them join forces for a common goal - to learn about life - people open up for methodological creativity.

[Gummesson, 2007]

Multi-disciplinarity

Tourism, Hospitality etc.
Multi-disciplinarity

...reminder...

**Grand unification of exotic statistical physics**

Dietrich Stauffer

Institute for Theoretical Physics, Cologne University, Zulpicher str. 77 D-50923 Köln, Germany


1. **Introduction**

   If you mix Polish piwo with Jack Daniels from the USA, caipirinhas from Brazil, red wine from Bordeaux, red beer from Belgium, and Kölisch from the Prussian Occupied West Bank, your stomach may revolt.
Examined structural characteristics
- identify & characterize “important” stakeholders
- measure extent of and attitudes to collaboration
  • stakeholders, scholars, institutions etc.
- discover emergent communities
  (beyond traditional distinctions by type/geography etc.)
- assess ICT usage

Studied dynamic behaviors & optimization
- resilience towards external shocks
- diffusion of information & knowledge
- effectiveness of advertising & word-of-mouth
- destination’s visibility on WWW
- evolution models
A tourism destination

Geometry: where things are; Topology: how things are connected
Structure ↔ functions

Degree distributions (companies)
Degree distributions (web)

Structure of a tourism destination

Livigno
Complex network structures

modules: groups of nodes with denser connections within group than between groups
modularity index $Q \in [0,1]$

Hierarchical structure

Clustering coefficient:
$f({\text{deg}}) \rightarrow C(k) \rightarrow k^3$

Network structures

no structure  modular  hierarchical

one scale  multiscale
Structure of a tourism destination

Community identification (modularity algorithm)

System SELF-ORGANIZES

(color = type)

The digital ecosystem: a network of networks

Topological similarity & strong coupling between physical and virtual component
(can be measured: correlation & distribution comparison)
The digital ecosystem

Gini coeff: 0.078

Efficiency (local & global)

“Navigating” a destination

A model:
- Perform random walks (RV) and measure (RW)
- Simulate link growth
- Compare all RW measures with graph characteristic dimensions (e.g. diameter “size” of the “walkable” network)

Even a small increase in hyperlinks improves “navigability”
Cooperation & collaboration

Relationships: positions & roles

Occupancy vs Net position

Importance

High season

Low season
Creativity & innovation

“Simmelian” brokerage (B)

Tour. destinations
«Creative» environments

Analogy

Objects
Processes
Information diffusion

- Basic epidemiology: individuals in a population (N) can be: S(usceptible), I(nfected), or R(emoved)

- Numerical simulation on the network

Opinion diffusion

- Epidemics don’t always happen
- Main parameters:
  - Reproduction number $R_0 = \frac{\beta}{\gamma}$
    - no. of new infections caused by a “sick individual”
  - Starting points
    - single/multiple seed
    - individual’s “importance”
Combining...

Time-series $\rightarrow$ Network

Network $\rightarrow$ ABM $\rightarrow$ Network

Rewiring, optimizing, etc....

Rewire & optimize a network

«Rewire» a destination
(might be easier on «virtual» component)

- Build better connections btw stakeholders
- Foster collaborative practices
- Improve flow of information
- Optimize knowledge transfer
- Provide more «creative» environment
- Strengthen links btw real & virtual worlds

measure & assess changes & effects
Remarks

Tourism ecosystems are **complex adaptive systems** & need to be studied as such

Methods & techniques to measure, model and interpret behaviors & phenomena are available

Appealing from a theoretical point of view

Can become an interesting tool to assist **practical** endeavors

and...

*makes fun!*

(remember Richard Feynman)

References


- N.B. most of my papers at: http://www.iby.it/tourism