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University of Pavia – Department of Electrical, Computer and Biomedical Engineering

Social Networks and Computational Sustainability: Challenges and Proposals

Keynote speech

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Outline

- An introduction to the University of Pavia
- Research/Development field: Computational Sustainability
 - ✓ Key definitions and concepts
- Our two applications
 - ✓ Land use metric: the Anthropoenthropy Factor.
 - ✓ Social Networks in the Academic Environment, a
 - **Gamefication Based System**
- Conclusions

University of Pavia

- \checkmark Officially established in 1361
- ✓ Notable professors:
 - ✓ Alessandro Volta (1745-1827)
 - ✓ Girolamo Cardano (1501-1576)
 - ✓ Antonio Scarpa (1752-1832)
 - ✓ Camillo Golgi (1843-1926)
- ✓ Today:
 - \checkmark 24000 students, from Italy and from overseas.
 - ✓ Around 4500 graduations per year, with around 700 students obtaining a post-graduate qualification



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• COMPUTATIONAL SUSTAINABILITY



UniPV - CSU

Computational Sustainability Unit (LINK), Department of Electrical, Computer and Biomedical Engineering Director: prof. Maria Grazia Albanesi

Multidisciplinary approach:

- Department of Economics and Management
- ✓ Department of Earth and Environmental Sciences

Computational Sustainability

- First conference: 2009, USA.
- ✓ Most recent: <u>http://www.compsust.net/compsust-2017/</u>
- The Computational Sustainability Network: <u>http://www.compsust.net/</u>
- Definition(1987, <u>«Report of the World Commission on Environment and</u>)

Development: Our Common Future»):

«Sustainable development is development that meets the *needs of the present* without compromising *the ability of future generations to meet their own needs*»

- Two key concepts:
 - Present and future needs
 - Limitations to the ability to satisfy those needs.

What is implicit in the definition:

✓ Time.

- The need to measure the effects of human development.
- The existence of a contrast between the immediate needs (short-term) vs. the future needs (long-term).



Environmental Sustainability:

- ✓ Air quality metrics
- Food production optimization
- Land use
- Low impact oil drills



Social Sustainability

- Information Sharing.
- Gender and social based discrimination in the education/market.
- Knowledge management.



Economic Sustainability:

- Decoupling economic
 development from environment
 degradation
- ✓ Green IT and Green Economy
- Nature and nature preservation as an economic system



Our Proposals

- Web Applications for...
 - Land use computation
 - Academic teaching
- Leverage the power of social networks to increase the engagement of people into activities that are either preliminary or central to Computational Sustainability

Social Networks for

CALCED USE COMPUTATION

Land Use Computation

The percentage of land occupied by:

- Houses and buildings in general (firms, schools, hospitals etc.)
- Roads and Railways
- Intensive agricultural sites (i.e., plant nursery)

Has different negative effects on the environment around each of these structures.

Land Use: Negative Effects

Soil sealing

Fragmentation and reduction of biodiversity

Pollution

111 788 ha/year in EU* Land take in Italy: + 6.3%** (1956-2006)

Sources: * European Environment Agency, **ISPRA



An Example of Negative Effect: Fragmentation





An Example of Negative Effect: Fragmentation







An Example of Negative Effect: Fragmentation

Landscape Fragmentation in Europe, EEA -FOEN T.R n. 2/2011



An example of negative effect: Fragmentation

Landscape Fragmentation in Europe, EEA - FOEN T.R n. 2/2011



Effective mesh density $s_{\rm eff}$ (number of meshes per 1 000 km²)

Fragmentation

An example of suboptimal indicator:



(1) AC-7 refers to the ACs shown in the graph.

Data on EU and AC infrastructure refer to 1998.

Source: EEA-ETC/TE, 2002.

Land Use – Common Indicators

Classical approach

- Population based
- Area based



Requested features

- Fragmentation and continuity
- Easy to be computed and updated
- Automatic or semi-automatic

A New Indicator: Anthropentropy

Anthropos ($Av\theta\rho\omega\pi\sigma\varsigma$) = man Entropy = disorder

The anthropentropy of a territory AF = DA / (S - NA)

Where

- S: Area of the territory
- DA: Death Area
- NA: Neutral area

Neutral Area

Neutral area is the part of the territory containing:
 ✓ inland water (lakes, lagoons etc.) larger than 2 km²
 ✓ lands located more than 3000 m above sea level.



Death Area

The anthropic area is increased by 50 m buffer in each direction (bidimensional metric).





Death Area and Fragmentation



The Metric

0.0 < AF <= 0.2	OK optimal environment preservation for land use, ideal	 0.1
condition	preservation for land use, ideal	 0.2
0.2 < AF <= 0.4	First worrying level	0.3
0.4 < AF <= 0.6	Serious degradation	0.4
0.6 < AF <= 0.8	Very serious degradation	0.5
0.8 < AF <= 1.0	Irreversible situation	0.6
[•] A possible application: to help local government in		0.7

0.0 --

0.8 --

0.9

1.0

A possible application: to help local government in planning new urban expansions.

Data Sources

Two main problems:

✓ Availability of annotated maps, where land use in terms of anthropic places is evident.

✓ Map scale accuracy: must be comparable with the size of the dilation chosen for the algorithm.

Possible Solutions

Our project has been developed in different phases:



Possible Solutions

Our project has been developed in different phases:



Possible Solutions

Our project has been developed in different phases:



Legend of Corine Land Cover

CLC types 2000

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Goal

Have each Italian municipality labelled with an AF value



0.0 -



Liguria





Lombardia







Pavia






The Complete Anthropentropy Map of Italy

Only a little part of Italy is covered with Corine Land Cover data

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Facebook Users linked to <u>www.albanesi.it</u>



UGC Data and Crowdsourcing

A "bottom-up", collaborative procedure generates, from Google Earth maps, a map with anthropic places and neutral zones.

Characteristics of the procedure:

"Bottom" side: It requires a low level of computer skills Based on open software and open data (Google Earth maps and Gimp).



"Up" side: Fully automated algorithm based on computer vision operators (Matlab)





User Generated Maps











Critical Issues

Drawbacks:

- Precision and knowledge of the territory vary form map to map.
- Collaboration is fundamental it could only work if enough person are willing to put effort in elaborating the maps.

Advantages:

- It increase awareness of the territory and environment degradation by the citizen
 The calculation procedure of AF can be used in a scenario "What if?"
- It reacts more quickly to changes in the area (bottom -up knowledge)



Some computed AF on UGC maps

Municipality	S (Area in kmq)	Neutral Area	AF
Scarperia	79.3700	0.00	0.1637
Erice	47.3000	0.00	0.214
Verbania	37.6200	0.37	0.674
Pomigliano d'Arco	11.4400	0.00	0.98040
Praia a Mare	22.9100	0.00	0.4370





45 maps received and processed in the first 3 months (rejected percentage <1%)

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An example





Adding Temporal Perpspective: the DANTHE Project

How can you estimate the future land use? Hypothesis on new anthropic places (ap)

DANTHE = Dynamic ANTHropentropy Expansion

A new ap is, in turn, capable of attracting new sites (anthropogenicity)

> Anthropic places are categorized

- > New expansions
 - > Uniform
 - Gravitational
 - Road



Anthropogenicity

Class Number	Classes of Anthropi	
	Class Name	Some Examples
1	Slow-growing settlements	schools, hotels, cemeteries, recreational small settlements, small shopping centers, including small parking lots
2	Fast-growing settlements	Houses (villas, cottages, mansions, possibly including small parking lots)
3	Commercial centers	Medium-large shopping centers, trade centers, malls
4	Industrial areas	Factories, industrial warehouses, logistics centers
5	Slow-growing areas of service production, venues for sport and health.	Business hubs, sports, recreational and health centers, waste treatment sites, energy production plants
6	Fast-growing areas of service production, venues for sport and health.	Stadiums, sports arenas, zoos, campuses, touristic resorts.
7	Airports and heliports	
8	Exhibition grounds	Venues for shows and trade fairs
9	Fast-growing roads	Highways or provincial roads
10	Slow-growing roads	Ring roads, railway lines, underground
11	Highways	
12	Stations	Bus, train stations



DANTHE

New expansion models

✓ Unlinked expansion

 \checkmark Linked expansion

 \checkmark Road based expansion



A Web-Based, ad-hoc tool

We developed a new web based app with the aim of increasing the ease of use of the system, in order to attract more *trained* users:

Albanesi, M.G., Amadeo, R.: "A Web-based Collaborative Tool for Land Use Computation on Satellite Images" (WEB2)



Social networks for

• ACADEMIC TEACHING

Introduction – Social Teaching

- Educational principles:
 - Consideration of the students' background.
 - Improving student's motivation
 - Lack of learning motivation in a student is mainly caused by his/her personality or by an underachieving teaching methodology (ineffective class presentation, lack of practical activities...)
 - Obtain precise students' feedback on their perception of the learning process
- We developed an *ad-hoc* social network to complement the usual structure and methodology of an Academic Course, to put emphasis on the previously described principles (Course Social Network – CSN)
- Final aim: to improve the learning process of students.

Course Social Network – Objectives and Motivation

- Creation of a "virtual class" environment, in order to offer the students and alternative tool to get to know each other. Improving the sense on community of a numerous class is beneficial to encourage information sharing and direct interaction between peers.
- Stimulation of User Generated Content creation.
- Utilization of the crowdsourcing paradigm to keep the course topic up to date and, if possible, to steer the lessons towards what the students find more interesting.
- Encourage the creation of online subgroups of students, to let them study and analyze topics not strictly inherent to the course
- Reward the most productive or talented students using the *gamification* paradigm.



Technical Features

- WordPress (PHP based CMS, it uses a SQL database)
 - Simplicity of implementation and management
 - Modularity (Plug-ins to add functionalities, themes)
 - Widely used, its interface is supposedly better known to students, making the system easier to use.
- Relevant plug-ins
 - BuddyPress (Social Network functions)
 - CubePoints (gamification)
 - GD Star Rating (UGC rated by other users)

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Gamification

- Gamification: a motivational technique born with the aim of helping users to perform activities or to learn and/or share information.
- Base idea: add gaming characteristic (rewards, challenges, interaction, leagues..) to web-based systems, increasing students' involvement in its use.
- Motivational affordances are the foundation of every gamification implementation (points, leaderboards, achievements, levels, story/theme, clear goals, feedback, rewards, progress, challenge)¹
- The *affordances* are combined with relevant topics of the course, in order to link the "fun and challenge" of the gamification approach to the learning process of the students.

¹Hamari, J., Koivisto, J., & Harri, S. (2014). Does Gamification Work? —A Literature Review of Empirical Studies on Gamification. 47th Hawaii International Conference on System Science (p. 3025 - 3034). Hilton Waikoloa, Big Island, Hawaii, USA: IEEE.



Implementation

- Student's participation is voluntary: there is no penalty if a student decides not to subscribe
- Non uniform privileges: the Professor can create content (*posts*) to steer the discussion or the topics in a certain direction, while students can (Hybrid realization, Blog/Social Network)
- Students can comment each post or create new topics (*discussion groups*)
- Students can also share information through private messages, create links (*friendships*) between them





Implementation

- Gamification awards points (CSN points) as a reward for every action taken (group creation, comment, private message, daily login) and creates a leaderboard. Moreover, the Professor can award points following someone contribution in class.
- At the end of the class, only the leaders of this leaderboard are awarded *prizes* (increased marks at the end of the tests, priority in case of thesis request...)



