Where's the smartness of learning in smart territories ?

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Abstract. In the future smarter territories are expected to induce transformations of many aspects of the learning processes, but how their smartness is and will be related to that of the learning ecosystems ? In this paper, by means of Principal Component Analysis, we critically analyse methods presently used to benchmark and produce University rankings, by focusing on the case study of the Italian Universities. The outcomes of such analysis allow us to demonstrate the existence of a strong correlation between smart cities' and universities' rankings, i.e. between learning ecosystems and their territories of reference. Present benchmarking approaches, however, need to take in more consideration people feelings and expectations. Accordingly we suggest an innovative point of view on the benchmarking of learning ecosystems based, also, on the so called *flow*.

Keywords: Smart City Learning, University Rankings, Smart Learning Ecosystems, Smart City Benchmarking, City Smartness, PCA, Flow

1 Introduction

Much the same as the large diffusion of personal devices and network technologies have transformed the social behaviour of young generations (often referred as *digital native*), transformation of cities into smarter cities will progressively modify all constituent elements of learning ecosystems: spaces, contents, processes, skills, methods of assessment [1]. However to fully understand the on-going process, it is important to identify which are the factors that contribute to determine the smartness of a territory.

Because of this, recently, we have critically examined [2-4] the approaches used to benchmark the smartness of a city and, as well, to produce smart city rankings [5-7]. Apart from highlighting several methodological limitations of such approaches, it came out that the classical models of territorial and urban development are quite far from common perception. People, in fact, think that a city is smart when: supports the well-being of individuals (also when they play the role of a citizens); helps in preserving the environment where they live and carry on their activities; minimises mobility problems (also to allow for personal time optimisation). Among other

aspects, moreover, a city is considered smart when supports to some extend also culture, education and knowledge circulation [4].
At present there not exists any study that put in relationship the "smartness" of cities and territories with that of their learning ecosystems. This is also because *smart universities* or *smart schools* rankings have never been produced. There exist, however, several universities rankings. In the next paragraphs, in order to explore possible relationships between territories and learning systems, we will analyse in details one the most comprehensive Italian universities rankings [8,9] and investigate the existence of possible correlations with the work on smart city rankings of ref. [4].

2 University rankings: a critical analysis

Each year in Italy two university rankings are produced. The first one, elaborated by "Il Sole 24 Ore" [8] and from now on R1, is based on the 12 dimensions reported in Table 1. The second one, elaborated by “Censis" [9] and from now on R2, is based on the 5 dimensions reported in Table 2.

Table 1. List of the 12 factors used by R1 [8] to produce the last yearly edition ranking of the Italian universities: E1-E9 have been used to rank Education, while Re1-Re3 to rank Research.

Indicator	Description
E1: Attractiveness	% of enrolled students coming from outside the territory of reference
E2: Sustainability	average number of teachers for basic and core activities
E3: Internships	% of credits acquired during internships
E4: Int. Mobility	% of credits acquired abroad (e.g. Erasmus)
E5: Scholarships	% of eligible candidates who have been awarded scholarships
E6: Dispersion	% of students still enrolled in the second year
E7: Effectiveness	% inactive students
E8: Satisfaction	judgment expressed by undergraduates on courses and curricula
E9: Employment	% of students still looking for a job 1 year after graduation
Re1: Ext. Founds	funds attracted for research projects
Re2: Research Eval.	ANVUR evaluation of research products
Re3: High Education	ANVUR evaluation of higher education

Table 2. List of the 5 factors used by R2 [9] to produce the last yearly edition ranking of the Italian universities.

Indicator	Description
Services	meals delivered over number of enrolled students; number of accommodation for enrolled students residing outside the region of reference
Grants	total amount of founds allocated
Infrastructures	halls' seats/students; libraries' seats/students; labs' places/students
Web	functionalities and content
Internationalization	% of foreigner students; % of students that had an experience abroad (e.g. Erasmus-outcome); % of visiting students (e.g. Erasmus-income); total amount of founds allocated for student mobility

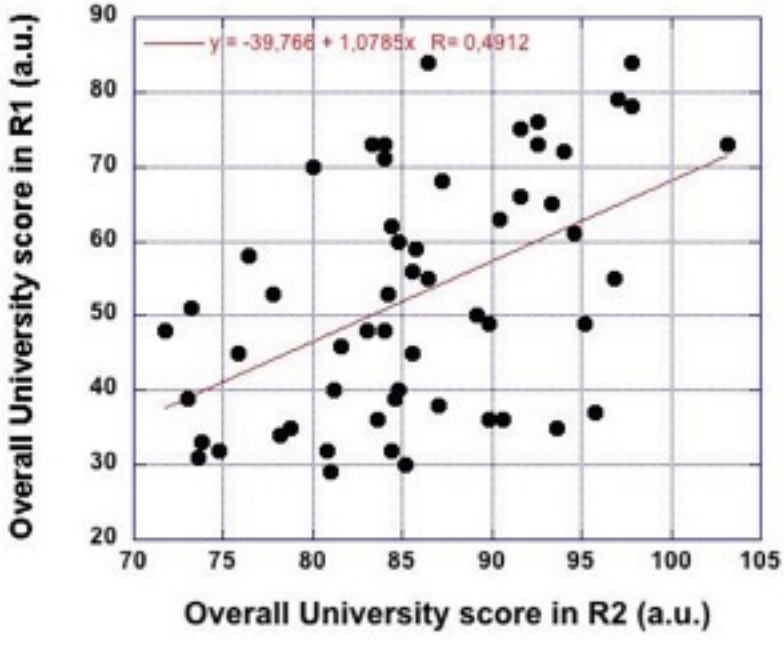

Figure 2. University overall score in R1 vs University overall score in R2

From the ensemble of the data considered, either in R1 or in R2, an overall normalized score (index) is worked out. The level of correlation existing between the

indices produced by the two ranking approaches is shown in Fig. 1 (year 2014-2015). R is equal to 0.49 and the medium level of correlation between the two indices suggests that the corresponding rankings are not fully comparable.

To carry further on our critical analysis of the University rankings we decide to investigate the statistical significance of such rankings. First of all we checked for the existence of correlations between the dimensions that have been taken in consideration to elaborate the rankings, see Tables 1 and 2.
If you do that, you find that both R1 and R2 suffer the same problems of smart city rankings based on soft factors [2-4]: many of the selected factors, in fact, are highly correlated with each others. Since it is almost impossible to identify dimensions that are completely uncorrelated we set as lower threshold for a tolerable correlation the value 0.3.
Fig. 2a refers to R1 and shows only correlations whose level is above such threshold.

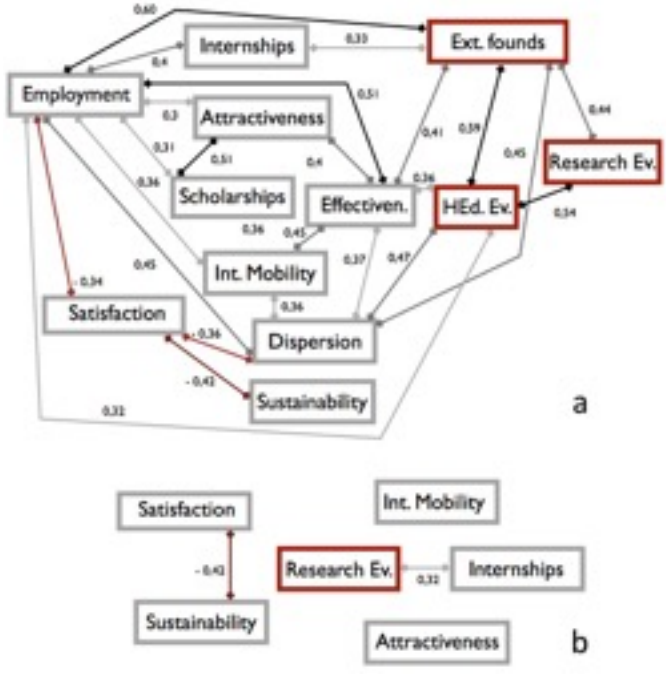

Figure 2. (a) map of the correlations affecting R1; (b) reduced representational space composed by 6 weakly correlated factors.

All three factors used to benchmark the research are strongly correlated each others and some factors, such as *Effectiveness*, *Employment* and *Dispersion*, show correlations with a large number of other indicators. The elimination of the most

correlated indicators led us to identify a representational space composed by only 6 relatively uncorrelated factors, Fig. 2b, that includes also *Satisfaction* as representative of the subjective judgments expressed by the students.

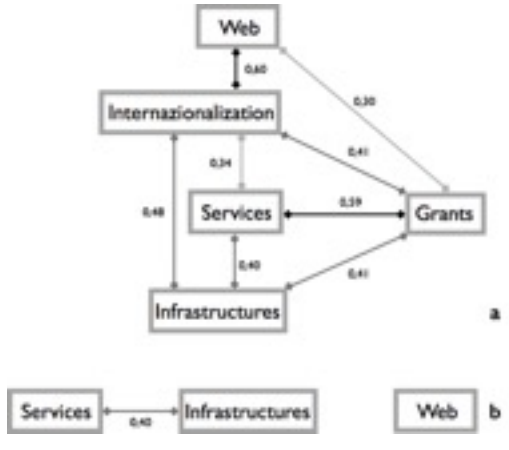

Figure 3. (a) map of the correlations affecting R2; (b) reduced representational space composed by 3 weakly correlated factors.

Much the same as Fig. 2a for R1, Fig. 3a shows the correlations that affect R2. *Web* and *Internationalization* are strongly correlated like *Services* and *Grant*. The elimination of two of such dimensions led to the loosely coupled space of representation of Fig. 3b.

Once that the reduced representation subspace of Figures 2b and 3b have been determined we are in the position to apply them a Principal Components Analysis (PCA).

As far as R1, Fig. 4 highlights, beside the clustering among universities with similar characteristics, the existence of a demarcation line (red line) that, with very few exceptions, separates universities located in the South-Central Italian regions from those located in the North-Central ones. In addition, a second demarcation line (green line) separates the universities that insist on big cities from those insisting on medium size and small cities. The tendency to locate in the upper zone of Fig. 2 is mainly determined by low *Satisfaction* and, to a less extend, by a limited *Attractiveness*, while the positioning in the lower part is mainly due to a limited *Sustainability*. The value of the first principal component, Y1, is mainly determined by *Attractiveness* and *Research Evaluation* and slightly less by *Internships* and *International mobility*.

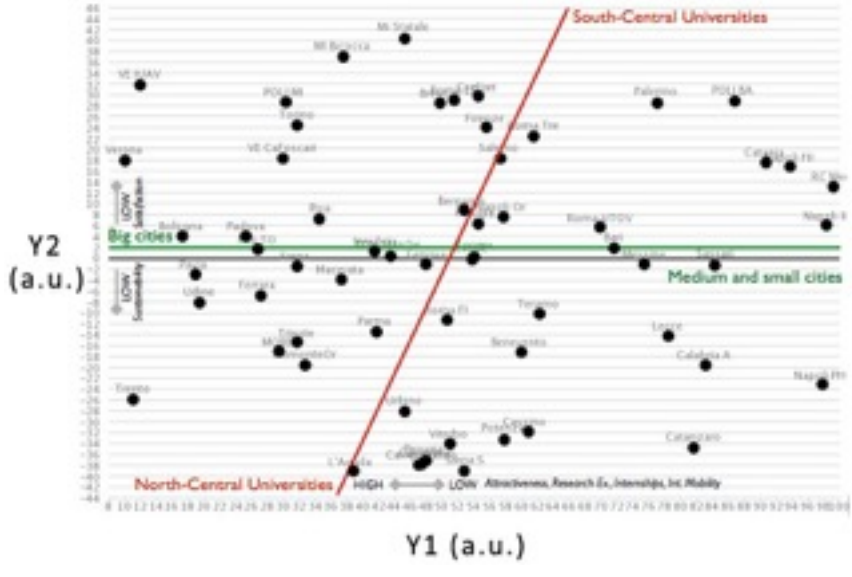

Fig. 4. First (Y1) vs. second principal component (Y2) plot derived from the PCA applied to the reduced representational space (see Fig. 1) of R1 [8]

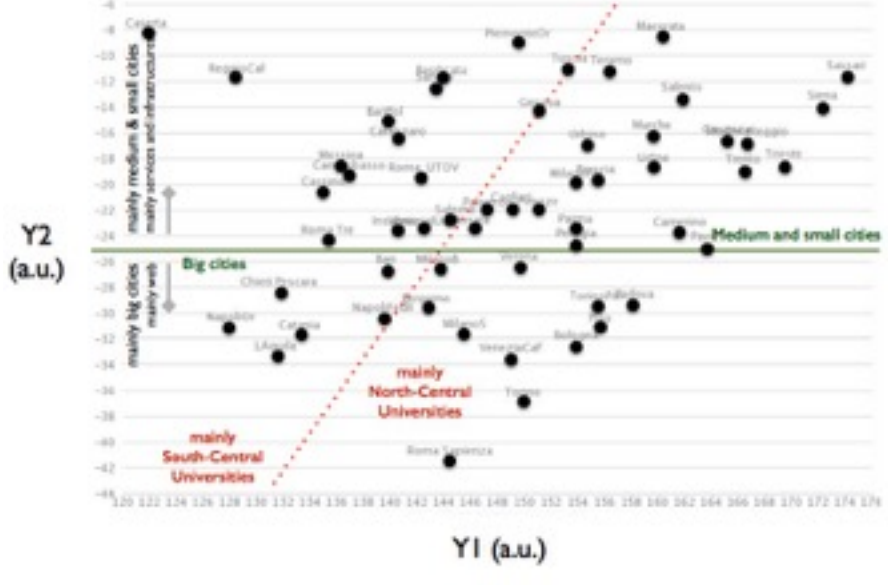

Fig. 5. First (Y1) vs. second principal component (Y2) plot derived from the PCA applied to the reduced representational space (see Fig. 1) of R2 [9]

As far as R2, Fig. 5 shows features very similar to those of Fig. 4 although adapted to the specific space of representation: the positioning of the universities on the Y1-Y2 plane tends to depend on the city size (quite clearly) and on its geographical location (more fuzzy dependence). Bigger cities seem to be characterized by higher *Web (*strongly correlated to *Internationalization)* and lower *Infrastructures* and *Services* contributions. Location along the Y1 axis is determined by a mixing of all factors, while the reduced dimensionality of the representation space determines the "diagonal" positioning of the points.

The overall result is that the location of the universities on the Y1-Y2 plane strongly depends on the characteristics of the city/territory of reference, similarly to what has been observed when the PCA has been applied to smart city rankings [4].

This fact let's hope for the existence of a possible relationship between the "quality" of the cities and that of the learning ecosystems that insist on their territory. In Fig. 6 we have plotted the value of Y1 derived from the PCA applied to the smart city ranking [4] versus the value of Y1 derived from Fig. 3. The linear correlation between the two variables is quite evident: R = 0,7.

The quality of the universities, thus, seems to be strongly correlated to the smartness of the corresponding city/territory of reference, but mechanisms supporting such correspondence requires further investigation to be fully uncovered.

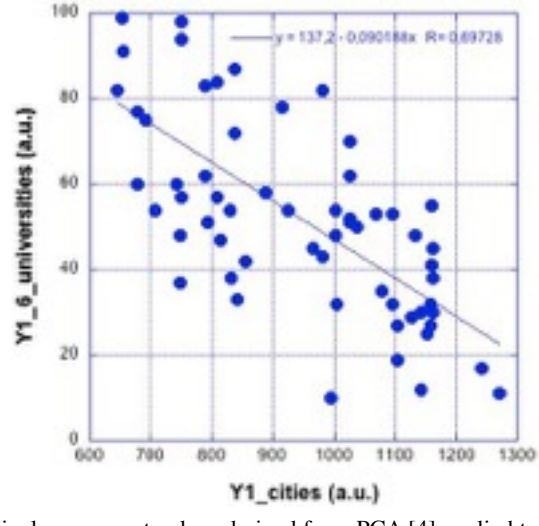

Fig. 6. First principal component values derived from PCA [4] applied to the city ranking of ref. [6] vs. First principal component values derived from Fig. 2

A plot equivalent to that of Fig. 6 where the Y1 values were derived from Fig. 4, i.e. from the PCA applied to R2, shows a lower level of correlation: R = 0.45. On the other hand, if the PCA is applied to the full space of representation of R1 (12 dimensions) and the Y1 values are plotted versus the Y1_cities values the level of

correlation increases to R = 0.81. Finally, applying the PCA analysis to the full space of R2 one does not goes beyond a correlation level of R = 0.56.

These results tell us that: a) the reduction of the representation space operated on R1 was quite reasonable and, in fact, with only half of the original dimension one still get a very high correlation level; b) the R2 approach does not perform so well as R1 in catching the relationships existing among a territory and its learning eco-systems. One may speculate that the high correlation level of Fig. 6 may depend on the inclusion of factors - the most significant of which appears to be the *Internships* - able to measure the level of interaction among universities and cities/territories. In R1 stands out, also, the relevance explicitly given to *Attractiveness*, which actually should be the ultimate goal to strive for, and that it is expected to be directly (not indirectly) correlated to all factors, not only to *Scholarships, Effectiveness and Employment* (see fig. 1a).

The high level of correlation shown by Fig. 6 can be partially justified by the analysis performed in references [2, 4] which showed how *smart economy* appears to be the leading factor when one use top-down approaches to smart city benchmarking. *Smart economy*, in fact, is closely related to the "rings" of Fig.1a most of which have in common the *Employment*. A noteworthy aspect of R1 is also the inclusion of subjective data - see the factor *Satisfaction* - that have been integrated with the objective ones although, up to now, the inclusion of subjective indications has been limited exclusively to the evaluation of the educational process as a whole.

3 Smartness of learning ecosystem: toward a novel benchmarking approach

In summary, the existence of a correlation between the "quality" of the universities and the smartness of cities and territories have clearly emerged, although the infrastructural and top-down nature of the benchmarking methodologies seems to confine the attractiveness of a learning ecosystems mostly to economic aspects.

On the other hand, we know [3,4] that the achievement of a smarter economy, although represents the engine on which one can build opportunities, is not a primary goal in people expectations. Because of that it would be advisable to modify the approaches to benchmarking and universities ranking, with the aim to obtain more detailed information, either qualitative and quantitative, on where the attractiveness of the learning ecosystems actually resides and, in turn, on their ability to meet people expectations.

To this end, as for the case of smart cities, we believe that it is important to explore novel analytic tools and approaches (to be integrated with the more traditional ones) with the aim to measure factors more closely related to the attractiveness of the environments and the positive tension that may sustain and stimulate individuals in their daily activities.

We have recently suggested that such positive tension should be identified with what has caused, throughout the history, the cultural dominance of specific regions, e.g. Florence during the Renaissance, and that can be defined as *territory flow* [10]. By transliterating from a person to a context (university, city, territory), we can state that *a smart context is a context where the human capital, (and more in general each individual/citizen) owns not only a high level of skills (possibly innovative ones), but is also strongly motivated by continuous and adequate challenges, while its needs are reasonably satisfied*. The *state of flow* of a context, thus, should be maintained by cooperative and convergent actions carried on by all main stakeholders belonging to a given community.

Accordingly, the main challenge for the future will be the identification of the most adequate indicators and dimensions (together with the development of suitable analytics: a preliminary proposal could be found in [11]) able to allow for a constant monitoring of the *state of flow* of all categories operating in a learning ecosystems. A goal that, unavoidably, call for an alliance among researchers with different background to fully uncover all aspects of the *territories'* and *learning eco-systems'* smartness.

A second challenge will be the extension of the present study to other learning eco-systems, like the *schools*, to investigate how deep is the relationship among cities' smartness and the full formal educational chain. Finally, a third challenge will be the extension of the investigations to the non-formal and informal learning eco-systems.

4 References

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