



UNIVERSITÀ DI PISA



Sant'Anna
Scuola Universitaria Superiore Pisa



Consiglio Nazionale delle Ricerche

Book of Short Papers

SIS 2020



Società
Italiana di
Statistica

Editors: Alessio Pollice, Nicola Salvati and Francesco Schirripa Spagnolo

Copyright © 2020

PUBLISHED BY PEARSON

WWW.PEARSON.COM

ISBN 9788891910776

Contents

Specialized sessions

Accounting for record linkage errors in inference (S2G-SIS).....	2
Probabilistic record linkage with less than three matching variables.	3
<i>Tiziana Tuoto and Marco Fortini</i>	
Advanced methods for measuring and communicating uncertainty in official statistics	9
A model for measuring the accuracy in spatial price statistics using scanner data.	10
<i>Ilaria Benedetti and Federico Crescenzi</i>	
Communication of Uncertainty of Official Statistics.	16
<i>Edwin de Jonge and Gian Luigi Mazzi</i>	
Measuring uncertainty for infra-annual macroeconomic statistics.	22
<i>George Kapetanios, Massimiliano Marcellino and Gian Luigi Mazzi</i>	
Bayesian methods in biostatistics	27
Network Estimation of Compositional Data.	28
<i>Nathan Osborne, Christine B. Peterson and Marina Vannucci</i>	
Using co-data to empower genomics-based prediction and variable selection.	34
<i>Magnus M. Münch, Mirrelijin M. van Nee and Mark A. van de Wiel</i>	
Data integration versus privacy protection: a methodological challenge?	40
Statistical Disclosure Control for Integrated Data.	41
<i>Natalie Shlomo</i>	
The Integrated System of Statistic Registers: first steps towards facing privacy issues.	47
<i>Mauro Bruno and Roberta Radini</i>	
Trusted Smart Surveys: a possible application of Privacy Enhancing Technologies in Official Statistics.	53
<i>Fabio Ricciato, Kostas Giannakouris, Albrecht Wirthmann and Martina Hahn</i>	
Designing adaptive clinical trials	59
Optimal designs for multi-arm exponential trials.	60
<i>Rosamarie Frieri and Marco Novelli</i>	
Education: students' mobility and labour market.....	66
From measurement to explanatory approaches: an assessment of the attractiveness of the curricula programs supplied by Italian universities.	67
<i>Isabella Sullis, Silvia Columbu and Mariano Porcu</i>	
Pull factors for university students' mobility: a gravity model approach.	73
<i>Giovanni Boscaino and Vincenzo Giuseppe Genova</i>	
Spatial autoregressive gravity models to explain the university student mobility in Italy.	79
<i>Silvia Bacci, Bruno Bertaccini and Chiara Bocci</i>	

Environmental Statistics (GRASPA-SIS)	85
A Time Clustering Model for Spatio-Temporal Data. <i>Clara Grazian, Gianluca Mastrantonio and Enrico Bibbona</i>	86
Reconstruction of sparsely sampled functional time series using frequency domain functional principal components. <i>Amira Elayouty, Marian Scott and Claire Miller</i>	93
Methods for High Dimensional Compositional Data Analysis	98
Algorithms for compositional tensors of third-order. <i>Violetta Simonacci</i>	99
High-dimensional regression with compositional covariates: a robust perspective. <i>Gianna Serafina Monti and Peter Filzmoser</i>	105
Three-way compositional analysis of energy intensity in manufacturing. <i>Valentin Todorov and Violetta Simonacci</i>	111
Modern Statistics for Physics Discoveries	117
Identification of high-energy λ -ray sources via nonparametric clustering. <i>Giovanna Menardi, Denise Costantin, and Federico Ferraccioli</i>	118
Statistical Analysis of Macroseismic Data for a better Evaluation of Earthquakes Attenuation Laws. <i>Marcello Chiodi, Antonino D'Alessandro, Giada Adelfio and Nicoletta D'Angelo</i>	124
Network Modelling in Biostatistics.....	130
Natural direct and indirect relative risk for mediation analysis. <i>Monia Lupparelli and Alessandra Mattei</i>	131
New issues on multivariate and univariate quantile regression	137
Mixtures of quantile regressions for longitudinal data: an R package. <i>Maria Francesca Marino, Maria Giovanna Ranalli and Marco Alfò</i>	138
Multivariate Mixed Hidden Markov Model for joint estimation of multiple quantiles. <i>Luca Merlo, Lea Petrella and Nikos Tzavidis</i>	144
Recent methodological advances in finite mixture modeling with applications (CLADAG-SIS)	150
Aggregating Gaussian mixture components. <i>Roberto Rocci</i>	151
Local and overall coefficients of determination for mixtures of generalized linear models. <i>Roberto Di Mari, Salvatore Ingrassia and Antonio Punzo</i>	157
Statistical Analysis of Satellite Data (SDS-SIS)	163
Functional Data Analysis for Interferometric Synthetic Aperture Radar Data Post-Processing: The case of Santa Barbara mud volcano. <i>Matteo Fontana, Alessandra Menafoglio, Francesca Cigna and Deodato Tapete</i>	164
Recent Contributions to the Understanding of the Uncertainty in Upper-Air Reference Measurements. <i>Alessandro Fassò</i>	170
Statistical models and methods for Business and Industry	176
Modelling and monitoring of complex 3D shapes: a novel approach for lattice structures. <i>Bianca Maria Colosimo, Marco Grasso and Federica Garghetti</i>	177
Open data powered territorial planning - Case study: The Turin historical center. <i>Silvia Casagrande, Gianmaria Origi, Alberto Pasanisi, Martina Tamburini, Pascal Terrien, Tania Cerquitelli and Alfonso Capozzoli</i>	183
Process optimization in Industry 4.0: Are all data analytics models useful? <i>Alberto Ferrer</i>	189

Technology and demographic behaviours (AISP-SIS)	195
Internet and the Timing of Births.	196
<i>Maria Sironi, Osea Giuntella and Francesco C. Billari</i>	
The Internetization of Marriage: Effects of the Diffusion of High-Speed Internet on Marriage, Divorce, and Assortative Mating.	202
<i>Francesco C. Billari, Osea Giuntella and Luca Stella</i>	

Solicited Sessions

Advanced Statistical Methods in Health Analytics	209
Assessing the impact of the intermediate event in a non-markovian illness-death model.	210
<i>Davide Paolo Bernasconi, Elena Tassistro, Maria Grazia Valsecchi and Laura Antolini</i>	
Big data and AI: challenges and opportunities in healthcare.	216
<i>Vieri Emiliani, Gian Luca Cattani and Fabrizio Selmi</i>	
Statistical methodology for volume-outcome studies.	222
<i>Marta Fiocco and Floor van Oudenhoven</i>	
Advances in textual data mining	228
Distance measures for exploring pairs of novels in a large corpus of Italian literature.	229
<i>Matilde Trevisani and Arjuna Tuzzi</i>	
Supervised vs Unsupervised Latent Dirichlet Allocation: topic detection in lyrics.	235
<i>Mariangela Sciandra, Alessandro Albano and Irene Carola Spera</i>	
Advances in the interaction between artificial intelligence and official statistics	241
Automated Land Cover Maps from Satellite Imagery by Deep Learning.	242
<i>Fabrizio De Fausti, Francesco Pugliese and Diego Zardetto</i>	
CROWD4SDG: Crowdsourcing for sustainable developments goals.	248
<i>Barbara Pernici</i>	
Permanent Population Census: evaluation of the effects of regional strategies on the process efficiency. The direct experience of Tuscany.	253
<i>Linda Porciani, Luisa Francovich, Luca Faustini and Alessandro Valentini</i>	
Capture-recapture methods	259
Bayesian Model Averaging for Latent Class Models in Capture-Recapture.	260
<i>Davide Di Cecco</i>	
Combining "signs of life" and survey data through latent class models to consider over-coverage in Capture-Recapture estimates of population counts.	266
<i>Marco Fortini, Antonella Bernardini, Marco Caputi and Nicoletta Cibella</i>	
Population size estimation with interval censored counts and external information.	272
<i>Alessio Farcomeni</i>	
Changes in environment extremes and their impacts	278
FPCA Clustering of rainfall events.	279
<i>Gianluca Sottile, Antonio Francipane, Leonardo Noto and Giada Adelfio</i>	
Trends in rainfall extremes in the Venice lagoon catchment.	285
<i>Ilaria Prosdocimi and Carlo Gaetan</i>	

Copulas: models and inference	291
Analysis of district heating demand through different copula-based approaches. <i>F. Marta L. Di Lascio and Andrea Menapace</i>	292
CoVaR and backtesting: a comparison between a copula approach and parametric models. <i>Michele Leonardo Bianchi, Giovanni De Luca and Giorgia Riveccio</i>	298
Estimating Asymmetric Dependence via Empirical Checkerboard Copulas. <i>Wolfgang Trutschnig and Florian Griessenberger</i>	304
Strong Convergence of Multivariate Maxima. <i>Michael Falk, Simone A. Padoan and Stefano Rizzelli</i>	310
Data Science: when different expertise meet	316
Bayesian stochastic modelling of the temporal evolution of seismicity. <i>Elisa Varini and Renata Rotondi</i>	317
Cluster Analysis for the Characterization of Residential Personal Exposure to ELF Magnetic Field. <i>Gabriella Tognola, Silvia Gallucci, Marta Bonato, Emma Chiaramello, Isabelle Magne, Martine Souques, Serena Fiocchi, Marta Parazzini and Paolo Ravazzani</i>	323
Statistical Assessment and Validation of Ship Response in High Sea State by Computational Fluid Dynamics. <i>Andrea Serani, Matteo Diez and Frederick Stern</i>	328
Uncertainty Quantification for PDEs with random data using the Multi-Index Stochastic Collocation method. <i>Lorenzo Tamellini and Joakim Beck</i>	334
Emerging challenges in official statistics: new data sources and methods	340
Small area poverty indicators adjusted using local spatial price indices. <i>Stefano Marchetti, Luigi Biggeri, Caterina Giusti and Monica Pratesi</i>	341
Smart solutions for trusted smart statistics: the European big data hackathon experience. <i>Francesco Amato, Mauro Bruno, Tania Cappadozzi, Fabrizio De Fausti and Manuela Michelini</i>	347
The ESSnet Project Smart Surveys: new data sources and tools for Surveys of Official Statistics	353
Factorial and dimensional reduction methods for the construction of indicators for evaluation (SVQS-SIS).....	359
A comparison of MBC with CLV and PCovR methods for dimensional reduction of the soccer players' performance attributes. <i>Maurizio Carpita, Enrico Ciavolino and Paola Pasca</i>	360
A framework of cumulated chi-squared type statistics for ordered correspondence analysis. New tools and properties. <i>Antonello D'Ambra, Pietro Amenta and Luigi D'Ambra</i>	366
Exploring drug consumption via an ultrametric correlation matrix. <i>Giorgia Zaccaria and Maurizio Vichi</i>	372
Ranking extraction in ordinal multi-indicator systems. <i>Marco Fattore and Alberto Arcagni</i>	378
Gender statistics	384
Gender differences in Italian STEM degree courses: a discrete-time competing-risks model. <i>Marco Enea and Massimo Attanasio</i>	385
Some Challenges and Results in Measuring Gender Inequality. <i>Fabio Crescenzi and Francesco Di Pede</i>	391

How Deep is Your Plot? Young SIS and deep statistical learning (ySIS)..	397
A modal approach for clustering matrices.	398
<i>Federico Ferraccioli and Giovanna Menardi</i>	
A Note on Detection of Perturbations in Biological Networks.	404
<i>Vera Djordjilović</i>	
Bayesian inference for DAG-probit models.	410
<i>Federico Castelletti</i>	
Variational Bayes for Gaussian Factor Models under the Cumulative Shrinkage Process.	416
<i>Sirio Legramanti</i>	
Measuring poverty and vulnerability	421
Choosing the vulnerability threshold using the ROC curve.	422
<i>Chiara Gigliarano and Conchita D'Ambrosio</i>	
New advances in applications, a Bayesian nonparametric perspective	428
Bayesian Mixture Models for Latent Class Analysis.	429
<i>Raffaele Argiento, Bruno Bodin and Maria De Iorio</i>	
Non-Parametric Inference and Forecasting of Functional and Object Data	435
An interpretable estimator for the function-on-function linear regression model with application to the Canadian weather data.	436
<i>Fabio Centofanti and Matteo Fontana</i>	
Statistical process monitoring of multivariate profiles from ship operating conditions.	440
<i>Christian Capezza</i>	
Prior choice in Bayesian Modelling (SISbayes)	446
Bayesian Learning of Multiple Essential Graphs.	447
<i>Luca La Rocca, Federico Castelletti, Stefano Peluso, Francesco Claudio Stingo and Guido Consonni</i>	
Bayesian post-processing of Gibbs sampling output for variable selection.	453
<i>Stefano Cabras</i>	
Priors on precision parameters of IGRMF models.	459
<i>Aldo Gardini, Fedele Greco and Carlo Trivisano</i>	
Sequence Analysis: methods and applications	465
Internal migration, family formation and social stratification in Europe. A life course approach.	466
<i>Roberto Impicciatore, Gabriele Ballarino and Nazareno Panichella</i>	
Socio economic integration of migrants	472
A study on the characteristics of spouses who intermarry in Italy.	473
<i>Agnese Vitali and Romina Fraboni</i>	
Statistical Analysis for mobility and transportation	479
A multilevel Analysis of University attractiveness in the network flows from Bachelor to Master's degree.	480
<i>Silvia Columbu and Ilaria Primerano</i>	
Analysis of mobility data through a novel Cheng and Church algorithm for functional data.	486
<i>Marta Galvani, Agostino Torti and Alessandra Menafoglio</i>	
Bridge closures in a transportation network: analysis of the impacts in the region of Lombardy.	491
<i>Agostino Torti, Marika Arena, Giovanni Azzone, and Piercesare Secchi</i>	

Statistical Methods and Applications in Social Network Analysis	496
A clustering procedure for ego-networks data: an application to Italian elders living in couple. <i>Elvira Pelle and Roberta Pappadà</i>	497
Analysing the mediating role of a network: a Bayesian latent space approach. <i>Chiara Di Maria, Antonino Abbruzzo and Gianfranco Lovison</i>	503
Network-time autoregressive models for valued network panel. <i>Viviana Amati</i>	509
University student mobility flows and network data structures. <i>Maria Prosperina Vitale, Giuseppe Giordano and Giancarlo Ragozini</i>	515
Statistical Methods in Psychometrics	521
A simple probabilistic model to evaluate questionable interim analysis strategies. <i>Francesca Freuli and Luigi Lombardi</i>	522
Incorporating Expert Knowledge in Structural Equation Models: Applications in Psychological Research. <i>Gianmarco Altoè, Claudio Zandonella Callegher, Enrico Toffalini and Massimiliano Pastore</i>	528
Predicting social media addiction from Instagram profiles: A data mining approach. <i>Antonio Calcagni, Veronica Cortellazzo, Francesca Guizzo, Paolo Girardi, Natale Canale</i>	534
Structural entropy based modeling for psychological measurement. <i>Enrico Ciavolino, Mario Angelelli, Paola Pasca and Omar Carlo Gioacchino Gelo</i>	540
Statistical modelling in environmental epidemiology	546
A Time Varying Coefficient Model to Estimate the Short-Term Effects of Air Pollution on Human Health. <i>Pasquale Valentini, Luigi Ippoliti and Clara Grazian</i>	547
Joint Analysis of Short and Long-Term Effects of Air Pollution. <i>Annibale Biggeri, Dolores Catelan, Giorgia Stoppa and Corrado Lagazio</i>	551
Statistical Modelling of Scientific Evidence for Forensic Investigation and Interpretation	557
DNA mixtures with related contributors. <i>Peter J. Green and Julia Mortera</i>	558
Forensic Statistics: How to estimate life expectancy after injury. <i>Jane L Hutton</i>	564
The additional contribution of combining genetic evidence from multiple samples in a complex case. <i>Giampietro Lago</i>	570
The history of forensic inference and statistics: a thematic perspective. <i>Franco Taroni and Colin Aitken</i>	576
Topological learning: interpretable representations of complex data.....	581
Comparing Neural Networks via Generalized Persistence. <i>Mattia G. Bergomi and Pietro Vertechi</i>	582
On the topological complexity of decision boundaries. <i>António Leitão and Giovanni Petri</i>	588
Persistence-based Kernels for Data Classification. <i>Ulderico Fugacci</i>	594
Topological and Mixed-type learning of Brain Activity. <i>Tullia Padellini, Pierpaolo Brutti, Riccardo Giubilei</i>	600

Contributed papers and Posters

Bayesian Statistics	607
A Bayesian approach for modelling dependence among mixture densities. <i>Mario Beraha, Matteo Pegoraro, Riccardo Peli and Alessandra Guglielmi</i>	608
A change of glasses strategy to solve the rare type match problem. <i>Giulia Cereda and Fabio Corradi</i>	614
A new prior distribution on the simplex: the extended flexible Dirichlet. <i>Roberto Ascari, Sonia Migliorati and Andrea Ongaro</i>	620
ABC model choice via mixture weight estimation. <i>Gianmarco Caruso, Luca Tardella and Christian P. Robert</i>	626
An ABC algorithm for random partitions arising from the Dirichlet process. <i>Mario Beraha and Riccardo Corradin</i>	632
Bayesian Inference of Undirected Graphical Models from Count Data. <i>Pier Giovanni Bissiri, Monica Chiogna and Nguyen Thi Kim Hue</i>	638
Bayesian IRT models in NIMBLE. <i>Sally Paganin, Chris Paciorek and Perry de Valpine</i>	644
Bayesian modelling of Facebook communities via latent factor models. <i>Emanuele Aliverti</i>	650
Bayesian nonparametric adaptive classification with robust prior information. <i>Francesco Denti, Andrea Cappozzo and Francesca Greselin</i>	655
Choosing the right tool for the job: a systematic analysis of general purpose MCMC software. <i>Mario Beraha, Giulia Gualtieri, Eugenia Villa, Riccardo Vitali and Alessandra Guglielmi</i>	661
Empirical Bayes estimation for mixture models. <i>Catia Scricciolo</i>	667
Improving ABC via Large Deviations Theory. <i>Cecilia Viscardi, Michele Boreale and Fabio Corradi</i>	673
Learning Bayesian Networks for Nonparanormal Data. <i>Flaminia Musella and Vincenzina Vitale</i>	679
Measuring well-being combining different data sources: a Bayesian networks approach. <i>Federica Cugnata, Silvia Salini and Elena Siletti</i>	685
Penalising the complexity of extensions of the Gaussian distribution. <i>Diego Battagliese and Brunero Liseo</i>	691
Predictive discrepancy of credible intervals for the parameter of the Rayleigh distribution. <i>Fulvio De Santis and Stefania Gubbiotti</i>	697
Small-area statistical estimation of claim risk. <i>Francesca Fortunato, Fedele Greco and Pierpaolo Cristaudo</i>	702
Subject-specific Bayesian Hierarchical model for compositional data analysis. <i>Matteo Pedone and Francesco C. Stingo</i>	708
Wasserstein consensus for Bayesian sample size determination. <i>Michele Cianfriglia, Tullia Padellini and Pierpaolo Brutti</i>	714
Biostatistics	720
A comparison of the CAR and DAGAR spatial random effects models with an application to diabetes rate estimation in Belgium. <i>Vittoria La Serra, Christel Faes, Niel Hens and Pierpaolo Brutti</i>	721
A functional approach to study the relationship between dynamic covariates and survival outcomes: an application to a randomized clinical trial on osteosarcoma. <i>Marta Spreafico, Francesca Ieva and Marta Fiocco</i>	727

A Statistical Approach to the Alignment of fMRI Data. <i>Angela Andreella, Ma Feilong, Yaroslav Halchenko, James Haxby and Livio Finos</i>	733
Adaptive clinical trials: Bayesian decision-theoretic and frequentist approaches for cost-effectiveness analysis. <i>Martin Forster and Marco Novelli</i>	739
Bootstrap corrected Propensity Score: Application for Anticoagulant Therapy in Haemodialysis Patients. <i>Maeregu W. Arisido, Fulvia Mecatti and Paola Rebora</i>	745
Combining multiple sources to overcome misclassification bias in epidemiological database studies. <i>Francesca Beraldi, Rosa Gini, Emanuela Dreassi, Leonardo Grilli and Carla Rampichini</i>	751
Deep Sparse Autoencoder-based Feature Selection for SNPs Validation in Prostate Cancer Radiogenomics. <i>Michela Carlotta Massi, Francesca Ieva, Anna Maria Paganoni, Andrea Manzoni, Paolo Zunino, Nicola Rares Franco, Tiziana Rancati and Catharine West</i>	756
Graphical models for count data: an application to single-cell RNA sequencing. <i>Nguyen Thi Kim Hue, Monica Chiogna and Davide Rizzo</i>	762
Interregional mobility, socio-economic inequality and mortality among cancer patients. <i>Claudio Rubino, Mauro Ferrante, Antonino Abbruzzo, Giovanna Fantaci and Salvatore Scondotto</i>	768
PET radiomics-based lesions representation in Hodgkin lymphoma patients. <i>Lara Cavinato, Martina Sollini, Margarita Kirienko, Matteo Biroli, Francesca Ricci, Letizia Calderoni, Elena Tabacchi, Cristina Nanni, Pier Luigi Zinzani, Stefano Fanti, Anna Guidetti, Alessandra Alessi, Paolo Corradini, Ettore Seregni, Carmelo Carlo-Stella, Arturo Chiti and Francesca Ieva</i>	774
Prediction of late radiotherapy toxicity in prostate cancer patients via joint analysis of SNPs sequences. <i>Nicola Rares Franco, Michela Carlotta Massi, Francesca Ieva, Anna Maria Paganoni, Andrea Manzoni, Paolo Zunino, Tiziana Rancati and Catharine West</i>	780
Predictive versus posterior probabilities for phase II trial monitoring. <i>Valeria Sambucini</i>	785
Profile networks for precision medicine. <i>Andrea Lazerini, Monia Lupporelli and Francesco C. Stingo</i>	791
Proton-Pump Inhibitor Provider Profiling via Funnel Plots and Poisson Regression. <i>Dario Delle Vedove, Francesca Ieva and Anna Maria Paganoni</i>	797
Selecting optimal thresholds in ROC analysis with clustered data. <i>Duc Khanh To, Gianfranco Adimari and Monica Chiogna</i>	803
Environment, Physics and Engineering	809
A hidden semi-Markov model for segmenting environmental toroidal data. <i>Francesco Lagona and Antonello Maruotti</i>	810
An experimental analysis on quality and security about green communication. <i>Vito Santarcangelo, Emilio Massa, Davide Scintu, Michele Di Lecce and Massimiliano Giacalone</i>	816
An improved sensitivity-data based method for probabilistic ecological risk assessment. <i>Sonia Migliorati and Gianna Serafina Monti</i>	822
Comparing predictive distributions in EMOS. <i>Giummolè Federica and Mameli Valentina</i>	828
Compositional analysis of fish communities in a fast changing marine ecosystem. <i>Pierfrancesco Alaimo Di Loro, Marco Mingione, Giovanna Jona Lasinio, Sara Martino and Francesco Colloca</i>	834
FDA dimension reduction techniques and components separation in Fourier-transform infrared spectroscopy. <i>Francesca Di Salvo, Elena Piacenza and Delia Francesca Chillura Martino</i>	840
Functional Data Analysis for Spectroscopy Data. <i>Mara S. Bernardi, Matteo Fontana, Alessandra Menafoglio, Diego Perugini, Alessandro Pisello, Marco Ferrari, Simone De Angelis, Maria Cristina De Sanctis and Simone Vantini</i>	846
Functional graphical model for spectrometric data analysis. <i>Laura Codazzi, Alessandro Colombi, Matteo Gianella, Raffaele Argiento, Lucia Paci and Alessia Pini</i>	852
Local LGCP estimation for spatial seismic processes. <i>Nicoletta D'Angelo, Marianna Siino, Antonino D'Alessandro and Giada Adelfio</i>	857

Observation-driven models for storm counts. <i>Mirko Armillotta, Alessandra Luati and Monia Lupparelli</i>	863
Statistical control of complex geometries, with application to Additive Manufacturing. <i>Riccardo Scimone, Tommaso Taormina, Bianca Maria Colosimo, Marco Grasso, Alessandra Menafoglio, Piercesare Secchi</i>	869
Tree attributes map by 3P sampling in a design-based framework. <i>Lorenzo Fattorini and Sara Franceschi</i>	875
Unsupervised classification of texture images by gray-level spatial dependence matrices and genetic algorithms. <i>Roberto Baragona and Laura Bocci</i>	880
Finance, business and official statistics	886
A discrete choice approach to analyze contractual attributes in the durum wheat sector in Italy. <i>Stefano Ciliberti, Simone Del Sarto, Giulia Pastorelli, Angelo Frascarelli and Gaetano Martino</i>	887
A fuzzy approach to the measurement of the employment rate. <i>Bruno Cheli, Alessandra Coli and Andrea Regoli</i>	893
A proposal to model credit risk contagion using network count-based models. <i>Arianna Agosto and Daniel Felix Ahelegbey</i>	898
A similarity matrix approach to empower ESCO interfaces for testing, debugging and in support of users' experience. <i>Adham Kahlawi, Cristina Martelli, Lucia Buzzigoli, Laura Grassini</i>	904
Adding MIDAS terms to Linear ARCH models in a Quantile Regression framework. <i>Vincenzo Candila and Lea Petrella</i>	910
Company requirements in Italian tourism sector: an analysis for profiles. <i>Paolo Mariani, Andrea Marletta, Lucio Masserini and Mariangela Zenga</i>	916
Determinants of Firms' Default Risk after the 2008 and 2011 Economic Crises: a Latent Growth Models Approach. <i>Lucio Masserini, Matilde Bini and Alessandro Zeli</i>	921
Double Asymmetric GARCH-MIDAS model - new insights and results. <i>Alessandra Amendola, Vincenzo Candila and Giampiero M. Gallo</i>	927
European SMEs and Circular Economy Activities: Evaluating the Advantage on Firm Performance through the Estimation of Average Treatment Effects. <i>Luca Secondi</i>	933
Financial Spillover Measures to Assess the Stability of Basket-based Stablecoins. <i>Paolo Pagnottoni</i>	939
Forecasting Banknote Flows in Bdl Branches: Speed-up with Machine Learning. <i>Marco Brandi, Monica Fusaro, Tiziana Laureti and Giorgia Rocco</i>	945
Fully reconciled GDP forecasts from Income and Expenditure sides. <i>Luisa Bisaglia, Tommaso Di Fonzo and Daniele Girolimetto</i>	951
GLASSO Estimation of Commodity Risks. <i>Beatrice Foroni, Saverio Mazza, Giacomo Morelli and Lea Petrella</i>	957
Measuring the Effect of Unconventional Policies on Stock Market Volatility. <i>Giampiero M. Gallo, Demetrio Lacava and Edoardo Otranto</i>	963
Multidimensional versus unidimensional poverty measurement. <i>Michele Costa</i>	969
Multiple outcome analysis of European Agriculture in 2000-2016: a latent class multivariate trajectory approach. <i>Alessandro Magrini</i>	975
Nowcasting GDP using mixed-frequency based composite confidence indicators. <i>Maria Carannante, Raffaele Mattered, Michelangelo Misuraca, Germana Scepi and Maria Spano</i>	981
On the tangible and intangible assets of Initial Coin Offerings. <i>Paola Cerchiello and Anca Mirela Toma</i>	987

Seasonality variation of electricity demand: decompositions and tests. <i>Luigi Grossi and Mauro Mussini</i>	993
SMEs circular economy practices in the European Union: Implications for sustainability. <i>Nunzio Tritto, José G. Dias and Francesca Bassi</i>	999
Tax Incentives' Effect on the Provision of Occupational Welfare in Italian Enterprises. <i>Alessandra Righi</i>	1005
The determinants of eco-innovation: a country comparison using the community innovation survey. <i>Ida D'Attoma and Silvia Pacei</i>	1011
World ranking of urban sustainability through composite indicators. <i>Elena Grimaccia, Alessia Naccarato and Silvia Terzi</i>	1017
Machine Learning and Data Science.....	1023
A novel approach for Artificial Intelligence through Lorenz zonoids and Shapley Values. <i>Paolo Giudici and Emanuela Raffinetti</i>	1024
A warning signal for variable importance interpretation in tree-based algorithms. <i>Anna Gottard and Giulia Vannucci</i>	1030
Assessment of the effectiveness of digital flyers: analysis of viewing behavior using eye tracking. <i>Gianpaolo Zammarchi, Claudio Conversano and Francesco Mola</i>	1036
At risk mental status analysis: a comparison of model selection methods for ordinal target variable. <i>Elena Ballante, Silvia Molteni, Martina Mensi and Silvia Figini</i>	1042
Categorical Encoding for Machine Learning. <i>Agostino Di Ciaccio</i>	1048
Dynamic Quantile Regression Forest. <i>Mila Andreani and Lea Petrella</i>	1054
Estimating the UK Sentiment Using Twitter. <i>Stephan Schlosser, Daniele Toninelli and Michela Cameletti</i>	1059
Forecasting local rice prices from crowdsourced data in Nigeria. <i>Ilaria Lucrezia Amerise and Gloria Solano Hermosilla</i>	1065
Generalized Mixed Effects Random Forest: does Machine Learning help in predicting university student dropout? <i>Massimo Pellagatti, Chiara Masci, Francesca Ieva and Anna Maria Paganoni</i>	1071
HateViz: a textual dashboard Twitter data-driven. <i>Emma Zavarrone, Maria Gabriella Grassia, Marina Marino, Rocco Mazza and Nicola Canestrari</i>	1077
How to perform cyber risk assessment via cumulative logit models. <i>Silvia Facchinetti, Silvia Angela Osmetti and Claudia Tarantola</i>	1083
Machine learning prediction for accounting system. <i>Chiara Bardelli and Silvia Figini</i>	1087
Teaching statistics: an assessment framework based on Multidimensional IRT and Knowledge Space Theory. <i>Cristina Davino, Rosa Fabbriatore, Carla Galluccio, Daniela Pacella, Domenico Vistocco, Francesco Palumbo</i>	1093
The weight of words: textual data versus sentiment analysis in stock returns prediction. <i>Riccardo Ferretti and Andrea Sciandra</i>	1099
Unsupervised Energy Trees: clustering with complex and mixed-type variables. <i>Riccardo Giubilei, Tullia Padellini and Pierpaolo Brutti</i>	1105
Using anchoring vignettes to adjust self-reported life satisfaction: a nonparametric approach leading to a Semantic Differential scale. <i>Sara Garbin, Serena Berretta, Maria Iannario and Omar Paccagnella</i>	1111
Variable selection for robust model-based learning from contaminated data. <i>Andrea Cappozzo, Francesca Greselin and Thomas Brendan Murphy</i>	1117

Variable Selection in Text Regressions: Back to Lasso? <i>Marzia Freo and Alessandra Luati</i>	1123
Web Usage Mining and Website Effectiveness. <i>Maria Francesca Cracolici and Furio Urso</i>	1129
Models and methods - Categorical, Ordinal, Rank Data	1135
Aberration for the analysis of two-way contingency tables. <i>Roberto Fontana and Fabio Rapallo</i>	1136
An investigation of the paradoxical behaviour of κ -type inter-rater agreement coefficients for nominal data. <i>Amalia Vanacore and Maria Sole Pellegrino</i>	1142
Analyzing faking-good response data: Combination of a Replacement and a Binomial (CRB) distribution approach. <i>Luigi Lombardi and Antonio Calcagni</i>	1148
BOD – min range: A Robustness Analysis Method for Composite Indicators. <i>Emiliano Seri, Leonardo Salvatore Alaimo and Vittoria Carolina Malpassuti</i>	1154
Comparing classifiers for ordinal variables. <i>Silvia Golia and Maurizio Carpita</i>	1160
Discovering Interaction Effects Between Subject-Specific Covariates: A New Probabilistic Approach For Preference Data. <i>Alessio Baldassarre, Claudio Conversano, Antonio D'Ambrosio, Mark De Rooij and Elise Dusseldorp</i>	1166
Hybrid random forests for ordinal data. <i>Rosaria Simone and Gerhard Tutz</i>	1171
Model-based approach to biclustering ordinal data. <i>Monia Ranalli and Francesca Martella</i>	1177
New algorithms and goodness-of-fit diagnostics for ranked data modelling with the Extended Plackett-Luce distribution. <i>Cristina Mollica and Luca Tardella</i>	1183
Non-metric unfolding on augmented data matrix: a copula-based approach. <i>Marta Nai Ruscone and Antonio D'Ambrosio</i>	1189
Ordinal probability effect measures for dyadic analysis in cumulative models. <i>Maria Iannario and Domenico Vistocco</i>	1194
Simulated annealing for maximum rater agreement. <i>Fabio Rapallo and Maria Piera Rogantin</i>	1200
Models and methods – Regression.....	1206
A Clusterwise regression method for Distributional-valued Data. <i>Rosanna Verde, Francisco de A. T. de Carvalho and Antonio Balzanella</i>	1207
A nonparametric approach for nonlinear variable screening in high-dimensions. <i>Francesco Giordano, Sara Milito and Lucia Maria Parrella</i>	1213
Adjusted scores for inference in negative binomial regression. <i>Euloge C. Kenne Pagui, Alessandra Salvan and Nicola Sartori</i>	1219
Estimation of the treatment effect variance in a difference-in-differences framework. <i>Marco Doretti and Giorgio E. Montanari</i>	1224
Exploring multicollinearity in quantile regression. <i>Cristina Davino, Tormod Naes, Rosaria Romano and Domenico Vistocco</i>	1230
Generalized M-quantile random effects model. <i>Francesco Schirripa Spagnolo and Vincenzo Mauro</i>	1236
Goodness-of-fit assessment in linear quantile regression. <i>Ilaria Lucrezia Amerise and Agostino Tarsitano</i>	1242
Joint Redundancy Analysis by a multivariate linear predictor. <i>Laura Marcis and Renato Salvatore</i>	1248

M-quantile regression shrinkage and selection via the lasso. <i>M. Giovanna Ranalli, Lea Petrella and Francesco Pantalone</i>	1254
New insights into the Conditioning and Gain Score approaches in multilevel analysis. <i>Bruno Arpino, Silvia Bacci, Leonardo Grilli, Raffaele Guetto and Carla Rampichini</i>	1260
Simultaneous confidence regions and curvature measures in nonlinear models. <i>Claudia Furlan and Cinzia Mortarino</i>	1265
Models and methods – Sampling	1271
Design-based consistency of the Horvitz-Thompson estimator for spatial populations. <i>Lorenzo Fattorini, Marzia Marcheselli, Caterina Pisani and Luca Pratelli</i>	1272
Empirical likelihood in the statistical matching for informative samples. <i>Daniela Marella and Danny Pfeffermann</i>	1278
Evaluating a Hybrid One-Stage Snowball Sampling through Bootstrap Method on a Simulated Population. <i>Venera Tomaselli and Giulio Giacomo Cantone</i>	1284
How optimal subsampling depends on guessed parameter values. <i>Laura Deldossi and Chiara Tommasi</i>	1290
Indicators for risk of selection bias in non-probability samples. <i>Emilia Rocco and Alessandra Petrucci</i>	1296
On the behaviour of the maximum likelihood estimator for exponential models under a fixed and a two-stage design. <i>Caterina May and Chiara Tommasi</i>	1302
Pseudo-population based resamplings for two-stage design. <i>Pier Luigi Conti, Daniela Marella and Vincenzina Vitale</i>	1308
Models and methods - Theoretical Issues in Statistical Inference	1314
A new mixture model for three-way data. <i>Salvatore D. Tomarchio, Antonio Punzo and Luca Bagnato</i>	1315
A Sequential Test for the Cpmk Index. <i>Michele Scagliarini</i>	1320
Probability Interpretations and the Selection of the Most Effective Statistics Method. <i>Paolo Rocchi</i>	1326
Robust Composite Inference. <i>Valentina Mamei, Monica Musio, Erlis Ruli and Laura Ventura</i>	1332
Statistical hypothesis testing within the Generalized Error Distribution: Comparing the behavior of some nonparametric techniques. <i>Massimiliano Giacalone and Demetrio Panarello</i>	1338
Stochastic dependence with discrete copulas. <i>Fabrizio Durante and Elisa Perrone</i>	1344
Models and methods - Time Series and Longitudinal Data.....	1350
Bootstrap test in Poisson-INAR models. <i>Lucio Palazzo and Riccardo Ievoli</i>	1351
Continuous Time-Interaction Processes for Population Size Estimation. <i>Linda Altieri, Alessio Farcomeni, Danilo Alunni Fegatelli and Francesco Palini</i>	1357
Longitudinal data analysis using PLS-PM approach. <i>Rosanna Cataldo, Corrado Crocetta, Maria Gabriella Grassia and Marina Marino</i>	1363
Long-memory models for count time series. <i>Luisa Bisaglia, Massimiliano Caporin and Matteo Grigoletto</i>	1369

Combining multiple frequencies in Realized GARCH models. <i>Antonio Naimoli and Giuseppe Storti</i>	1375
Models with Time-Varying Parameters for Realized Covariance. <i>Luc Bauwens and Edoardo Otranto</i>	1381
Pitman-Yor mixture models for survival data stratification. <i>Riccardo Corradin, Luis Enrique Nieto Barajas and Bernardo Nipoti</i>	1387
Prediction is not everything, but everything is prediction. <i>Leonardo Egidi</i>	1393
The Generalized Dynamic Mixtures of Factor Analyzers for clustering multivariate longitudinal data. <i>Francesca Martella, Antonello Maruotti and Francesco Tursini</i>	1399
Trends and long-run relations in cointegrated time series observed with noise. <i>Angelica Gianfreda, Paolo Maranzano, Lucia Parisio and Matteo Pelagatti</i>	1405
Population and society	1411
A dimensionality assessment of refugees' vulnerability through an Item Response Theory approach. <i>Simone Del Sarto, Michela Gnalzi, Yara Maasri and Edouard Legoupil</i>	1412
Accounting for Interdependent Risks in Vulnerability Assessment of Refugees. <i>Daria Mendola, Anna Maria Parroco and Paolo Li Donni</i>	1418
Active ageing in China: What are the domains that most affect life satisfaction in the elderly? <i>Ilaria Rocco</i>	1424
Analyzing the waiting time of academic publications: a survival model. <i>Francesca De Battisti, Giuseppe Gerardi, Giancarlo Manzi and Francesco Porro</i>	1430
Clustering of food choices in a large sample of students using university canteen. <i>Valentina Lorenzoni, Isotta Triulzi, Irene Martinucci, Letizia Toncelli, Michela Natilli and Roberto Barale, Giuseppe Turchetti</i>	1436
Cruise passengers' expenditure at destinations: Review of survey techniques and data collection. <i>Caterina Sciortino, Stefano De Cantis, Mauro Ferrante and Szilvia Gyimóthy</i>	1442
Educational integration of foreign citizen children in Italy: a synthetic indicator. <i>Alessio Buonomo, Stefania Capecechi and Rosaria Simone</i>	1448
Estimating the Change in Housework Time of the Italian Woman after the Retirement of the Male Partner: An Approach Based on a Two-Regime Model Estimated by ML. <i>Giorgio Calzolari, Maria Gabriella Campolo, Antonino Di Pino and Laura Magazzini</i>	1454
First and Second Year Careers of STEM Students in Italy: A Geographical Perspective. <i>Antonella D'Agostino, Giulio Ghellini and Gabriele Lombardi</i>	1460
Future Scenarios and Support Interventions for the Family: Involving Experts' Participation through a Mixed-Method Research Study. <i>Mario Bolzan, Simone Di Zio, Manuela Scioni and Morena Tartari</i>	1466
Gender and Monetary Policy Preferences: a Diff-in-Diff Approach. <i>Donata Favaro, Anna Giraldo and Ina Gollikja</i>	1472
Headcount based indicators and functions to evaluate the effectiveness of Italian university education. <i>Silvia Terzi and Francesca Petrarca</i>	1478
Identify the speech code through statistics: a data-driven approach. <i>Andrea Briglia, Massimo Mucciardi and Jérémi Sauvage</i>	1484
Inspecting cause-specific mortality curves by simplicial functional data analysis. <i>Marco Stefanucci and Stefano Mazzucco</i>	1490
Intertemporal decision making and childless couples. <i>Daniela Bellani, Bruno Arpino and Daniele Vignoli</i>	1495
Italian Households' Material Deprivation: Multi-Objective Genetic Algorithm approach for categorical variables. <i>Laura Bocci and Isabella Mingo</i>	1501

LI-CoD Model. From Lifespan Inequality to Causes of Death. <i>Andrea Nigri and Susanna Levantesi</i>	1507
Modeling Well-Being through PLS-SEM and K-M. <i>Venera Tomaselli, Mario Fordellone and Maurizio Vichi</i>	1513
News life-cycle: a multiblock approach to the study of information. <i>Rosanna Cataldo, Marco Del Mastro, Maria Gabriella Grassia, Marina Marino and Rocco Mazza</i>	1519
Short-term rentals in a tourist town. <i>Silvia Bacci, Bruno Bertaccini, Gianni Dugheri, Paolo Galli, Antonio Giusti and Veronica Sula</i>	1525
Sportstat: a playful activity to developing statistical literacy. <i>Alessandro Valentini and Francesca Paradisi</i>	1531
Statistical modeling for some features of Airbnb activity. <i>Giulia Contu and Luca Frigau</i>	1537
Tertiary students with migrant background: evidence from a cohort enrolled at Sapienza University. <i>Cristina Giudici, Donatella Vicar and Eleonora Trappolini</i>	1543
The Causal Effect of Immigration Policies on Income Inequality. <i>Irene Crimaldi, Laura Forastiere, Fabrizia Mealli and Costanza Tortù</i>	1549
The job condition of academic graduates: a joint longitudinal analysis of AlmaLaurea and Mandatory Notices of the Ministry of Labour. <i>Maria Veronica Dorgali, Silvia Bacci, Bruno Bertaccini and Alessandra Petrucci</i>	1557
The joint effect of childcare services and flexible female employment on fertility rate in Europe. <i>Viviana Cocuccio and Massimo Mucciardi</i>	1565
The Left Behind Generation: How the current Early School Leavers affect tomorrow's NEETs? <i>Giovanni De Luca, Paolo Mazzocchi, Claudio Quintano and Antonella Rocca</i>	1571
The probability to be employed of young adults of foreign origin. <i>Alessio Buonomo, Francesca Di Iorio and Salvatore Strozza</i>	1577
The risk of inappropriateness in geriatric wards: a comparison among the Italian regions. <i>Paolo Mariani, Andrea Marietta, Marcella Mazzoleni and Mariangela Zenga</i>	1583
The role of the accumulation of poverty and unemployment for health disadvantages. <i>Annalisa Busetta, Daria Mendola, Emanuela Struffolino and Zachary Van Winkle</i>	1589
Unemployment and fertility in Italy. A regional level data panel analysis. <i>Gabriele Ruiu and Marco Breschi</i>	1595
University drop out and mobility in Italy. First evidences on first level degrees. <i>Nicola Tedesco and Luisa Salaris</i>	1601
Worthiness-based Scale Quantifying. <i>Giulio D'Epifanio</i>	1607
Young people in Southern Italy and the phenomenon of immigration: what is their perception? <i>Nunziata Ribecco, Angela Maria D'Ugento and Angela Labarile</i>	1613

A similarity matrix approach to empower ESCO interfaces for testing, debugging and in support of users' experience

Le matrici di similarità a sostegno della fruizione delle interfacce di ESCO per il test, il debug e il miglioramento delle esperienze di utilizzo

Adham Kahlawi, Cristina Martelli, Lucia Buzzigoli, Laura Grassini¹

Abstract This paper intends to apply the Latent Semantix Indexing approach to ESCO, the European language for labour description and coding, overcoming the limits attributable to the current querying instruments. This objective is strategic to bridge the gap existing between ESCO repository, whose richness and granularity suggests to adopt it as a current operative language for labour processes management, and the users' current language, not always able to select the proper keywords to satisfy their information needs. The paper also discusses an application of the proposed approach to testing and debugging of ESCO linguistic objects, intending to identify redundancies and anomalies in the overall knowledge base.

Abstract *Questo lavoro applica l'approccio Latent Semantic Indexing a ESCO, il linguaggio europeo del lavoro, per rafforzarlo e migliorarne la fruizione, superando alcuni limiti degli strumenti di interrogazione della piattaforma. Si tratta di un obiettivo strategico per colmare il divario esistente tra la grande granularità e ricchezza espressiva del repository di ESCO, che ne suggeriscono l'utilizzo nei processi di gestione del lavoro, e le capacità linguistiche degli utenti, non sempre in grado di individuare le parole chiave più adeguate. Questo lavoro discute, inoltre, un'applicazione del metodo al problema del collaudo e del debug del repository di ESCO, per individuarne eventuali ridondanze ed anomalie.*

Keywords: ESCO, labor market, natural language interfaces, similarity measures.

¹ Adham Kahlawi, Università di Firenze, adham.kahlawi@unifi.it
Cristina Martelli, Università di Firenze, cristina.martelli@unifi.it
Lucia Buzzigoli, Università di Firenze, lucia.buzzigoli@unifi.it
Laura Grassini, Università di Firenze, laura.grassini@unifi.it

1 Introduction

The dynamism of the current labour market and the rapid changes to which it is subjected require specific attention for the role of skills (competences and knowledge) in the professional placement / re-placement of workers, and for the preparation of training offers consistent with the market demands.

For years, numerous international organizations have reported the problem with the identification of megatrends and critical issues (WEF, 2018; ILO, 2019; OECD, 2019). The European Union, in particular, has stressed the role of skills in the program of the European Pillar of Social Rights (European Commission, 2016b, European Commission 2017) and in 2016 adopted the New Skills Agenda for Europe (European Commission, 2016a), which outlines the strategic role of skills in supporting employment, growth and competitiveness.

In this framework, which is part of Europe 2020 strategy (European Commission, 2010), a specific project was aimed at the implementation of an operational tool that establishes a European common language for the classification of Skills, Competences, Qualifications and Occupations, named ESCO (European Commission, 2019).

The main scope is to organize the knowledge on the European labour market and also on the sector of education and training, to improve both the matching between qualifications and labour market needs, and the matching between jobseekers and employers.

ESCO combines the assets of (i) a rigorous official coding standard and (ii) of a specialized language. Thanks to its high granularity, it can be used, in fact, also to provide a clear description of job profiles for job seeking or CV writing. Therefore, according to the most accredited information systems approaches, ESCO can be used for generating administrative data sets, easily suitable to be used as statistical registers.

This work intends to empower the ESCO functionalities in labour market governance and management, proposing a new approach to improve its capability of crossing users' natural language; the proposed approach also intends to support in ESCO components testing and debugging.

In particular, we intend to apply the Latent Semantic Indexing (LSI) approach to measure the similarity between ESCO objects descriptions; the aim is to allow explorative pathways for queries optimization and for identifying relations and redundancies among ESCO descriptive elements.

2 The current version of ESCO

The current full version, ESCO v1, can be freely consulted on the dedicated portal since 2017 and is published as Linked Open data. The classification is available in 27 languages and is organized in three interlinked 'pillars': occupations (2942 entries), skills, competences and knowledge (13485 entries) and qualifications (9457 entries).

A similarity matrix approach to empower ESCO...

The first two pillars have a rich and articulated content, while the qualifications pillar is not as well populated (European Commission, 2015). This is also due to the different methods of development: the pillars of occupations and skills are developed by ESCO contributors (sectoral reference groups and online consultations), managed and coordinated by the Commission, while for the qualifications pillar only external sources are used (typically national qualifications databases of the member states).

In our study we will focus on the first two pillars.

The pillar of occupations is organized hierarchically: the top four levels coincide with those of the international standard classification of occupations ISCO08 (ILO, 2012); the lower levels are specific to ESCO (ESCO occupations). For each occupation, ESCO provides a description, a set of alternative labels, the position in the hierarchy, and – only for the fifth level or lower, organized by means of broader/narrower relation – the essential or optional skills, competences and knowledge required for the occupation. Consequently, a connection is created between the pillars.

The pillar of skills, competences and knowledge, is usually called simply the skills pillar because in ESCO the concept of Skill is a general class that includes skill, competences and knowledge, that are different concepts. Nevertheless, it does not distinguish between skills and competences.

ESCO provides various criteria that the user can apply to classify what is generally called Skill. A first simple criterion is the distinction between skills (denoted by a verb) and knowledge (denoted by a noun), called *type*. Another criterion is the reusability level, which in the intentions of the ESCO drafters should be “crucial for supporting occupational mobility” (European Commission, 2019): each Skill is labelled as transversal, cross-sector, sector-specific and occupation-specific. Other distinctions arise on the basis of the “Skills to occupations” and “Skills to Skills” relationships. In both cases, each Skill can be defined ‘essential’ or ‘optional’ for other specific Skills or for specific occupations (another way to generate the interlinking among pillars).

The organization of the skills pillar is therefore not hierarchical, but a sort of hierarchy among Skills is made indirectly by the broader/narrower relation. In brief, for each Skill ESCO provides a description, a set of alternative labels, the Skill type, the reusability level, the occupations for which the Skill is essential/optional, the relationship with other Skills (essential/optional, broader/narrower).

All this information produces a rich database which lists occupations, skills, knowledge and qualifications that are relevant for the European labor market showing the relationships among them, that can be used in other European platforms for labour: for instance, it is the standard language expected for exchange of information in EURES, the network of European employment services (European Commission, 2016c).

Any ESCO object, both skill, competence or occupation is structured in a label and a description (Figure 1).

Up to now, ESCO is queryable only using keywords applied to the object labels: the only way to get an answer to users’ need is to use the exact keyword that individuates the required object. This fact represents a major limitation to the usage of ESCO for administrative and management purposes: in practice, it is impossible to

perform evolutive queries that, starting from a fuzzer request, allow aiming to the needed answer.

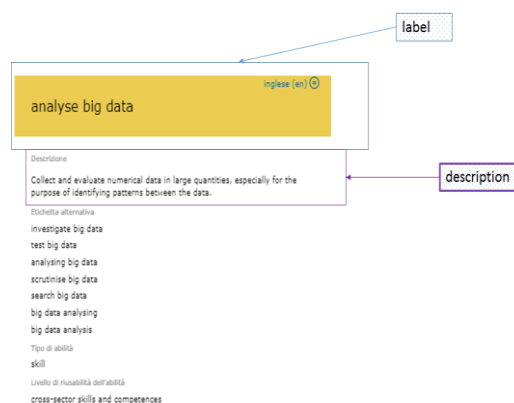


Figure 1: ESCO objects structure

Another aspect that hampers the current usage of ESCO in labour market management and governance is attributable to the redundancy of descriptions' contents. It is a sort of side effect of the impressive richness of ESCO knowledge base: sometimes it is not an easy task to discriminate between different elements, which appear quite similar even if allocated in very different areas of ESCO base.

3 The LSI approach to ESCO interface empowerment

In the application, we analyse similarity between every couple of skills by two different approaches.

Firstly, the similarity between the ESCO descriptions of two different skills is measured using LSI, and this measure is applied to all possible pairs of skills. LSI is an indexing and retrieval technique known for years in the literature on information retrieval, that is able to project queries and documents into a space with latent semantic dimensions (Rosario, 2000) exploring the co-occurrence of each word with every single word. In synthesis, LSI is a text mining processing that produces a corpus-based similarity measure for each pair of descriptions. The measure ranges from 0 to 1 (the greater the more similar).

Secondly, we calculate a use/connection-similarity index. This index is based on the connection between occupations and Skills.

Each ESCO occupation is described by a set of skills. The similarity indicator measures the extent to which a pair of skills are used together. In the specific:

N_x indicates the number of occupations requiring Skill x

N_y indicates the number of occupations requiring Skill y

N_{xy} indicates the number of occupations requiring both Skill x and Skill y

$Sim_{x/y}$ and $Sim_{y/x}$ are defined as follows:

A similarity matrix approach to empower ESCO...

$$Sim_{x|y} = \frac{N_{xy}}{N_y} \quad Sim_{y|x} = \frac{N_{xy}}{N_x}$$

Note that an index similar to $Sim_{y|x}$ has been used in Opik, et. al. (2018) to measure, in their case, the similarity between two occupations.

The analysis of the different indicators (LSI, $Sim_{x|y}$ and $Sim_{y|x}$) shows a number of interesting cases, some of which are presented in table 1.

Table 1. Some preliminary results

Case	Skill x (label)	Skill y (label)	Sim _{x y}	Sim _{y x}	LSI
Case 1	IBM Informix	DB2	1.0	1.0	0.9999
Case 2	liaise with union officials	perform internal investigations	0.0	0.0	1.0000
Case 3	provide health psychological concepts	Health psychology	1.0	0.5	1.0000
Case 4	assess chiropractic intervention	prescribe treatments related to surgical procedures	1.0	1.0	0.2181

Case 1 refers to skills that are always required together to describe an occupation; on the other hand, they have two almost identical descriptions. This observation puts the issue whether these skills have an own separate identity.

Case 2 refers to a pair of skills that are never required together to describe an occupation, even if they have identical descriptions. This situation encourages to check whether errors or inaccuracies may have occurred while describing the Skills.

Case 3 refers to a pair of skills that have identical descriptions; on the other hand, when a specific occupation requires Skill x , also Skill y is required but the opposite is not true. As a result, this is an indication of a possible hierarchy among skills.

Case 4 refers to skills that are always required together to describe an occupation but, as opposed to Case 1, they have two different descriptions. ESCO querying approach can take advantage of this occurrence: at present, it is impossible to perform incremental querying protocols, and the success of an interrogation relies only on the keywords' exact match. Embedding these indicators in ESCO interface it will be possible to move from a skill to the closer ones.

4 Conclusion

This paper intends to expand the information potentialities of ESCO repository, using also the description field as a query target, overcoming the limitations actually in place which limit to the labels the target of the queries.

The proposed approach relies on the LSI methodology which allows evaluating the similarity among textual objects: in this case, ESCO skills descriptions. These

preliminary results encourage to pursue the strategy of embedding the proposed indicators in ESCO interfaces, to empower queries protocols and to test and debug the repository contents on automatic ground.

References

1. European Commission: EUROPE 2020. A strategy for smart, sustainable and inclusive growth, COM (2010).
2. European Commission: The qualifications pillar in ESCO – building the bridge between education and training and employment with ESCO, ESCO SEC 046 DRAFT (2015).
3. European Commission: New Skill Agenda for Europe. Working together to strengthen human capital, employability and competitiveness, COM(2016) 381 final. (2016a).
4. European Commission: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2016) 127. (2016b) https://eur-lex.europa.eu/resource.html?uri=cellar:bc4bab37-e5f2-11e5-8a50-01aa75ed71a1_0004_02/DOC_1&format=PDF
5. European Commission: Regulation (EU) 2016/589 of the European Parliament and of the Council (2016c) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0589&from=EN>
6. European Commission: European Pillar of Social Rights. (2017). https://ec.europa.eu/commission/sites/beta-political/files/social-summit-european-pillar-social-rights-booklet_en.pdf.
7. European Commission: ESCO Handbook (2019).
8. ILO: International Standard Classification of Occupations (ISCO-08), Geneva (2012).
9. ILO: Work for a brighter future – Global Commission on the Future of Work, International Labour Office – Geneva (2019).
10. OECD: OECD Employment Outlook 2019: The Future of Work, OECD Publishing, Paris (2019). <https://doi.org/10.1787/9ee00155-en>.
11. Opik, R., Kirt, T. and Liivinnar, I.: Megatrend and Intervention Impact Analyzer for Jobs: A Visualization Method for Labor Market Intelligence. Journal of Official Statistics, 34(4), 961–979 (2018).
12. Rosario B.: Latent Sematic Indexing: An Overview, INFOSYS 240, Spring 2000. <https://pdfs.semanticscholar.org/9598/1f057cb76a24329fcf2b572f75d8c2b1613e.pdf> (2018)
13. WEF: The Future of Jobs. Report 2018, World Economic Forum, Geneva (2018).