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The Production of Techno-Scientific Articles Worldwide

It grew globally by an average of 37.2% between 2013 and 2020

Scientific and technical journal articles refers to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, earth and space sciences.

Ranking of countries by production of scientific articles in 2020. China ranks first in value of the number of scientific articles produced with the amount of 669,744.3 units, followed by the United States with the amount of 455,855.57, followed by India with a value of 149,212 units from Germany with 109.3178 and from the UK with an amount of 105,564.47 units. In the middle of the table are Syria with 453.27, followed by North Macedonia with 427.34 units, Myanmar with 418.54, Senegal with 395.73, Sudan with 378.39, and Botswana with 329.26. Sao Tome and Principe close the ranking with 2.09, Equatorial Guinea with 1.7, Marshall Islands with 1.58, Nauru with 0.9, Tuvalu with 0.39.

Ranking of countries by percent change in scientific paper production between 2013 and 2020. North Korea has a value of percent change in scientific paper production amounting to 1813.76%, followed by Sao Tome and Principe with a value of 1206, Myanmar with a value of 1110.59%, Iraq with 1102.24% and Indonesia with 1083.18%. In the middle of the table are Uruguay with a value of 64.11%, followed by Grenada with 62.64%, Montenegro with a value of 62.58%, Benin with 62.55%, Barbados with 62.06%, Mali with 60.53%. The ranking is closed by Turkmenistan with a value of -19.71%, followed by Equatorial Guinea with an amount of -26.41%, Venezuela with a variation equal to -45.14%, Dominica with a value of -46, 85%, and Comoros with a value of -61.93%.

Machine learning and predictions. An analysis of the use of eight machine-learning algorithms for predicting the future value of the production of scientific articles worldwide is presented below. The algorithms are classified according to their ability to maximize the R-Squared and to minimize the statistical errors, i.e. Mean Squared Error-MSE, Root Mean Squared Error, MAE-Mean Average Error. The algorithms were trained with 80% of the available data while the remaining 20% was used for the actual prediction. In particular, the following ordering of the algorithms has been identified, namely:

- Gradient Boosted Tree with a payoff value of 6;
- Polynomial Regression with a payoff value of 13;
- Tree Ensemble with a payoff value of 14;
- Random Forest with a payoff value of 15;
- Simple Regression Tree with a payoff value of 18;
- Linear Regression with a payoff value equal to 22;
- ANN-Artificial Neural Network with a payoff value of 26;

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- PNN-Probabilistic Neural Network with a payoff value of 30.

Therefore, by applying the Gradient Boosted Tree, i.e. the most performing algorithm in predictive terms, it is possible to identify the future trend of countries in terms of production value of scientific articles and newspapers. The countries are then divided into two subgroups, namely winners, which are the countries for which a growth in the future value of scientific and newspaper articles is predicted, and the losers countries for which a reduction in the corresponding value is instead forecast.

Winning countries. The winning countries are Syria with a value of 129.94%, followed by Tajikistan with 35.7%, Venezuela with 35.18%, South Sudan with 31.29%; Yemen with 26.87%, Uganda with 5.64%, Sweden with 3.19%, Solomon Island with 3.11%; United Arab Emirates with 3.02%; Sri Lanka with a value of 2.84%, Ukraine with 2.77%, St. Kittis and Nevis with 2.15%; Tunisia with 2.13%; Switzerland with 1.8%, Suriname with 1.73%, Uruguay with 1.4%, Spain with 1.06%, Tuvalu with 0.84%, Slovenia with 0.79%, United Kingdom with 0.05%.

Losing countries. There are also losers countries or countries for which a reduction in the future value of scientific and technological publications is expected such as for example Zimbabwe with a value of -0.02%, St. Lucia with -0.11%, Thailand with -0.24%, St. Vincent and the Grenadines with -0.81%, Trinidad and Tobago with -1, Zambia with -2.03%, United States with -2.06%, South Africa with -2, 75%, Tonga with -2.93%, Tanzania with -3.54%, Turkey with -4.03%, Vanuatu with -4.08%, Timor Leste with -5.61%, Vietnam with -8.75 %, Turkmenistan with -11.7%, Sudan with -14.9%, Uzbekistan with -30.2%; Somalia with -57.64%.

Conclusions. The value of scientific production worldwide grew between 2013 and 2020 by an amount equal to 37.25%. China's science-tech production surpassed America's in 2016. Since then, China's science-tech production value has grown further to 669,744 units. In a broad sense, it is possible to note a growth in the production of techno-scientific articles in almost all countries. However, the growing role of the new Asian giants, namely China and India, which together produce about 800,000 techno-scientific articles, is indisputable. Controlling the productivity of techno-scientific articles is relevant as the current global economic condition is based on technological comparison especially in the IT, new energies and new materials fields. It follows therefore that countries seek a new hegemony in the knowledge economy also through the growth of investments in research and development. However, it must be considered that the growth of Asian countries leads to a certain marginalization of the West in the aggregate sense, even if many Western countries have nevertheless increased the number of their techno-scientific publications, as for example in the case of Italy. On the other hand, the case of France goes against the trend, where the number of techno-scientific articles published decreased from 2013 to 2020. It is therefore necessary that the Western world continues to invest heavily in research and development and create incentives for the production of techno-scientific articles in order to continue to be competitive internationally and to support economic growth.

Declarations

Data Availability Statement. The data presented in this study are available on request from the corresponding author.

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Declaration of Competing Interest. The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication.

Software. The authors have used the following software: Gretl for the econometric models, Orange for clusterization and network analysis, and KNIME for machine learning and predictions. They are all free version without licenses.

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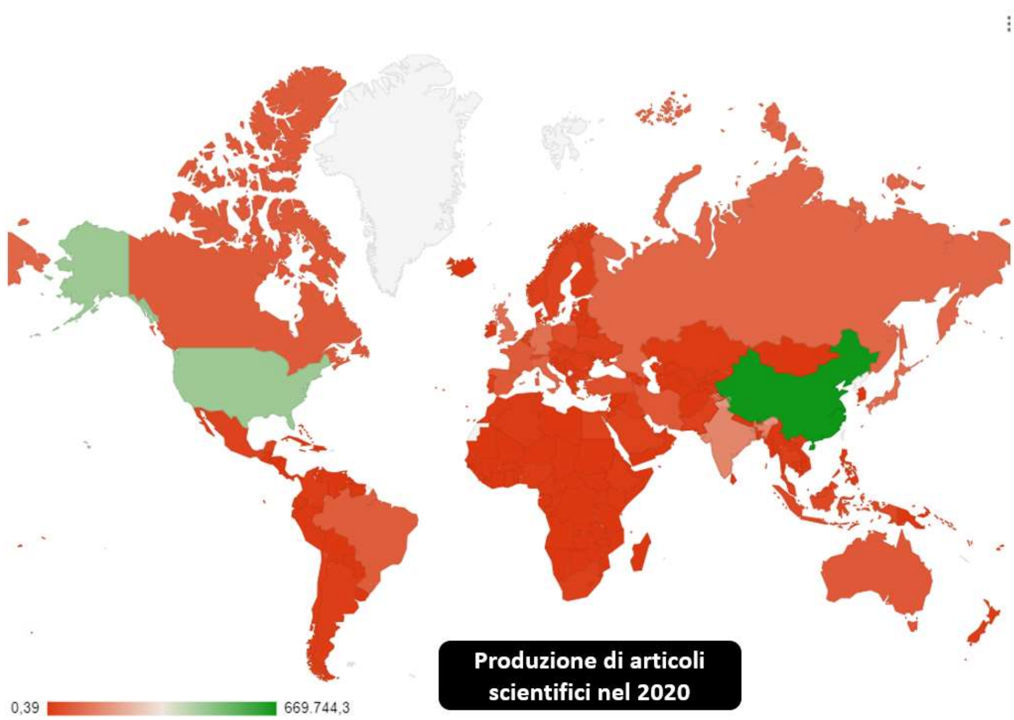
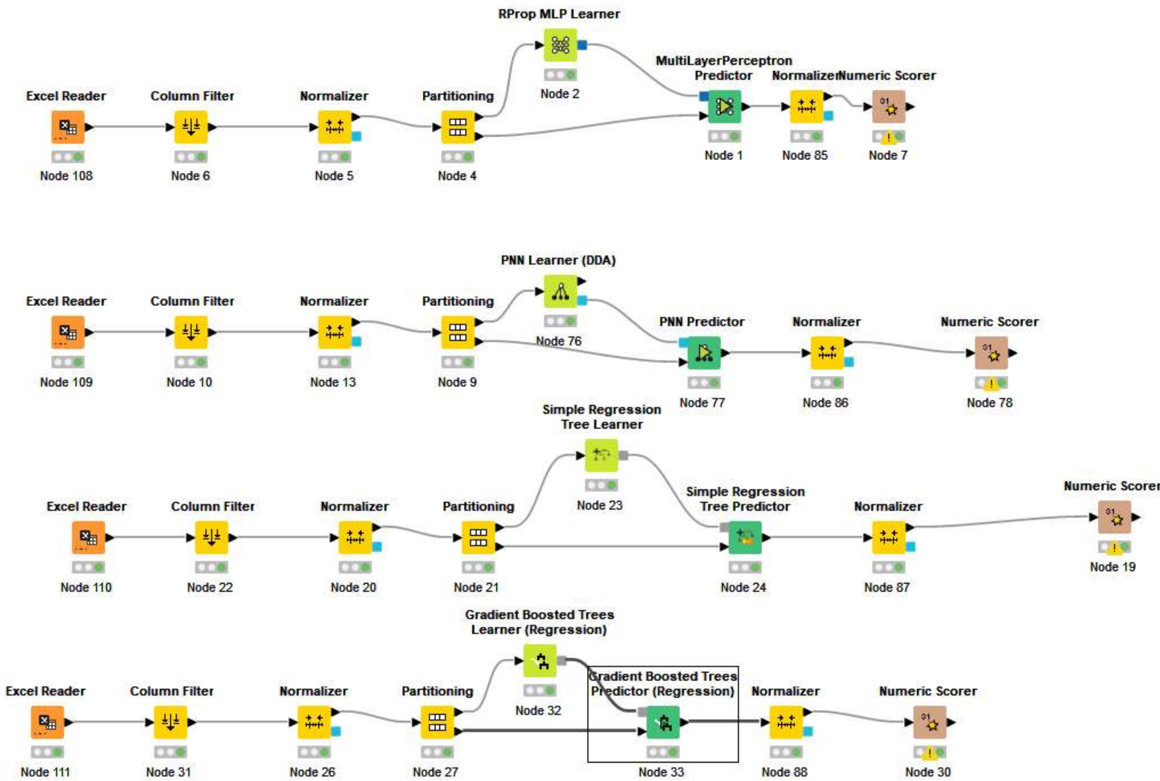
Appendix

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Node 108
Column Filter
Node 6
Normalizer
Node 5
Partitioning
Node 4
MultiLayerPerceptron Predictor
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Node 85
Numeric Scorer
Node 7
PNN Learner (DDA)
Node 76
Excel Reader
Node 109
Column Filter
Node 10
Normalizer
Node 13
Partitioning
Node 9
PNN Predictor
Node 77
Normalizer
Node 86
Numeric Scorer
Node 78
Simple Regression Tree Learner
Node 23
Excel Reader
Node 110
Column Filter
Node 22
Normalizer
Node 20
Partitioning
Node 21
Simple Regression Tree Predictor
Node 24
Normalizer
Node 87
Numeric Scorer
Node 19
Gradient Boosted Trees Learner (Regression)
Node 32
Excel Reader
Node 111
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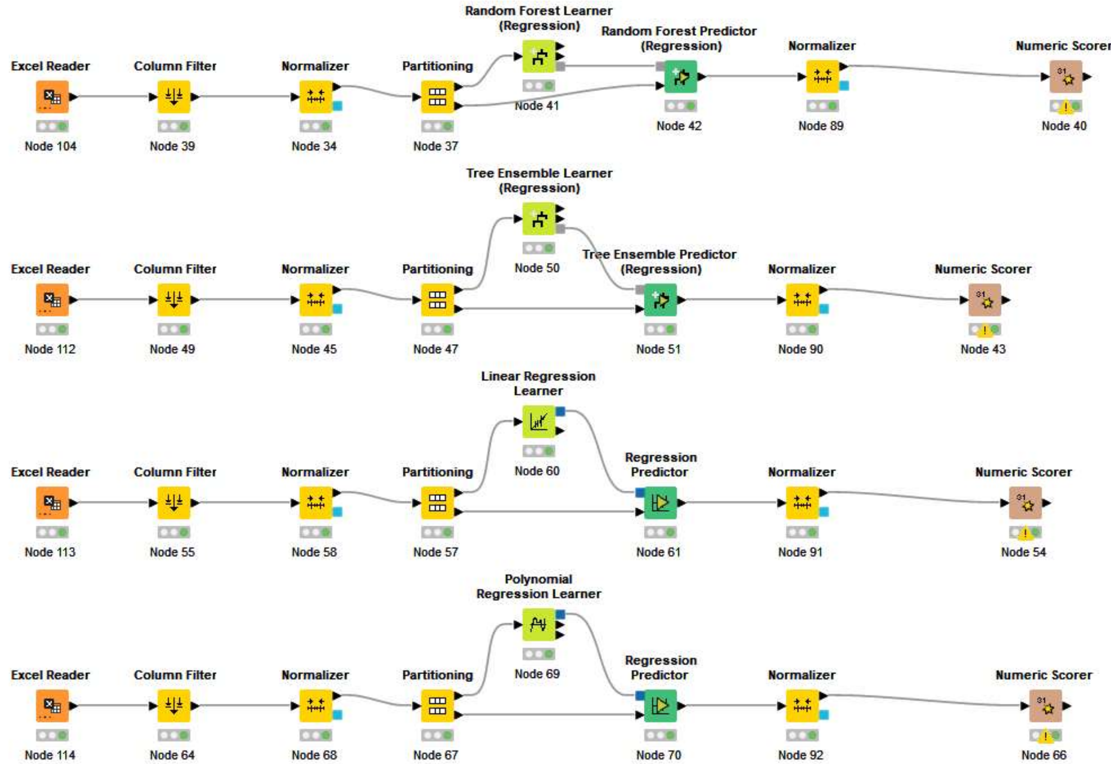
Node 27
Gradient Boosted Trees Predictor (Regression)
Node 33
Normalizer
Node 88
Numeric Scorer
Node 30



	R^2	*mean absolute error*	*mean squared error*	*root mean squared error*
ANN	0,973025	0,043938	0,002838	0,053269
PNN	0,971472	0,043229	0,003001	0,054782
Simple Regression Tree	0,986273	0,027688	0,001444	0,038001
Gradient Boosted Tree	0,993442	0,020006	0,001000	0,026265
Random Forest Regressio	0,993442	0,020006	0,010000	0,026265
Tree Ensemble Regressio	0,989258	0,026330	0,001130	0,033615
Linear Regression	0,975651	0,033218	0,002349	0,048464
Polynomial Regression	0,992690	0,016682	0,010000	0,024314

Algorithm	***R^2***	***mean absolute error***	***mean squared error***	***root mean squared error***	***Sum***
Gradient Boosted Tree	1	2	1	2	6
Random Forest Regression	2	3	7	3	15
Polynomial Regression	3	1	8	1	13
Tree Ensemble Regression	4	4	2	4	14
Simple Regression Tree	5	5	3	5	18
Linear Regression	6	6	4	6	22
ANN	7	7	5	7	26
PNN	8	8	6	8	30