Misleading Estimation of Backwardness through NITI Aayog SDG index: A study to find loopholes and construction of alternative index with the help of Artificial Intelligence

Sen, Sugata and Sengupta, Soumya

Panskura Banamali College (Autonomous), Panskura Banamali College (Autonomous)

6 February 2020

Misleading Estimation of Backwardness

through

NITI Aayog SDG index:

A study to find loopholes and construction of alternative index with the help of Artificial Intelligence

Soumya Sengupta[1], Dr. Sugata Sen[2]

JEL Code: C 630, O 150

Abstract:

UNDP Rio +20 summit in 2012 evolved a set of indicators to realise the targets of SDGs within a deadline. Measurement of the performances under these goals has followed the methodology as developed by UNDP which is nothing but the simple average of performances of the indicators under different domains. This work concludes that this methodology to measure the goal-wise as well as the composite performances is suffering from major shortcomings and proposes an alternative using the ideas of artificial intelligence. Here it is accepted that the indicators under different goals are inter-related and hence constructing index through simple average is misleading. Moreover the methodologies under the existing indices have failed to assign weights to different indicators.

This work is based on secondary data and the goal-wise indices have been determined through normalised sigmoid functions. These goal-wise indices are plotted on a radar and the area of the radar is treated as measure under composite SDG performance. The whole work is presented through an artificial neural network.

Observed that the goal-wise index as developed and tested here has shown that the UNDP as well as NITI Aayog index has delivered exaggerated values of goal-wise as well as composite performances.

Keywords: *SDG Index, Sigmoidal Activation Function, Artificial Neural Network*

[1] Faculty of Computer Science, Panskura Banamali College (Autonomous), West Bengal, INDIA 721152, Email: ssg747@gmail.com

[2] Associate Professor of Economics, Panskura Banamali College (Autonomous), West Bengal, INDIA 721152, Email: sensugata@gmail.com

Introduction:

The idea of Sustainable Development emerged from the efforts to tackle the burning issues of the 21st Century: poverty, increasing inequality, environmental and human health degradation. United Nation Development Programme (UNDP) Rio +20 summit in 2012 evolved a group of indicators to ensure the targets of sustainable development through a set of goals within a certain deadline. Following this process a set of indicators as well as methodologies appeared to measure the performances of different economies to fulfil the targeted values of the goals. Incidentally, all of these measurements have followed the basic methodology as developed by UNDP which is nothing but the simple average of performances of different indicators under different domains. Though there was no consensus on the set of indicators, a broad consensus appeared on the methodology to measure the performances. This work concludes that these existing methodologies to measure the goal-wise as well as composite performances of different economies are suffering from major shortcomings and proposes an alternative using the ideas of artificial intelligence. It is observed that the newly developed indices have delivered values which are completely different from the existing index.

Review of Literature:

The United Nations Millennium Declaration committed to combat eight goals to reduce the human hardship. All the 191 UN member states agreed to achieve those by the year 2015. This Millennium Development Goals (MDGs) had some specific targets and indicators. Though there were significant progresses across all the indicators, the improvement was not even for all the countries. Moreover, millions of people were left behind due to their identity related to sex, age, disability, ethnicity, geographical location etc. (United Nations, 2015). To overcome these under-achievements a new set of achievable goals called Sustainable Development Goals (SDGs) appeared. The SDGs have been adopted as the United Nation agenda to be completed by 2030. SDGs are ambitious and have created a new paradigm of sustainable development. To implement the new outlook it has taken a multidisciplinary bottom-up approach and asked for multi stake holder participation (Neves, 2018). In contrast to conventional development agenda focusing on a restricted set of dimensions, the SDGs have provided a holistic and multidimensional view on development. Hence, interactions among the SDGs are inevitable and that may cause diverging results. The holistic nature of the SDG framework implies that a large number of interactions across the 169 targets have to be considered by policy makers (Pradhan, Costa, Rybski, Lucht, & Kropp, 2017).

Right now there are lots of indices to measure the performances under the sustainable development goals. Among them one of the most important is the Europe Sustainable Development Report initiated by the Institute of European Environmental Policy in 2019 (Europe Sustainable Development Report 2019, 2019). This report has measured the

performances of the EU and its 28 member states for all the 17 SDGs and provided a detailed country- wise performance index. The 2019 Arab Region SDG index covered all the 22 Arab counties and contained 30 new indicators to highlight the issues which were relevant to the region (2019 Arab Region SDG Index and Dashboards Report , 2019) . The SDG Center for Africa and the SDSN have jointly published the first annual Africa SDG index in 2018 (Africa SDG Index and Dashboards Report 2018, 2018). Incidentally, these indices along with the other established global indices have followed a single methodology of calculating the SDG performances through the average of the performances of corresponding SDG indicators without putting any importance to the interactive causal relationships among these indicators. Further, these methodologies have assigned equal weight of one to all the indicators. Ignoring the differential weights for different indicators is nothing but generalization of a more acute problem. Moreover assigning equal weight among the indicators gives birth to another problem of substitutability within the indicators.

These discrepancies in the measurement of SDG performances have not gone un-noticed among the economists. Nilsson et. al. (Nilsson, et al., 2018) have shown important interaction among the SDG indicators. Beyond 2015 has also reported serious methodological snags within SDG performance estimation appearing due to ignoring of the inter-indicator dependency (Beyond2015, 2015). The report of the Expert Group meeting on SDG agenda has also traced inter-linkages across the SDG targets and indicators. They have unanimously concluded that the existing model and framework have serious methodological limitations (United Nations, 2018).

The discrepancies within the SDG indices as discussed in the previous sections can well be minimized by using the ideas of Artificial Intelligence (AI). AI is a part of Computer Science where the programmable machine reacts like human being. Rainer (Schnell, 1991) first applied AI for computer simulation and theory construction in Social Sciences. His most promising application of simulation models in social sciences are used in explication of ration choice based theories. Another important area in AI is knowledge representation. Claude et.al. (Claudé & Combe, 2018) have tried to provide a better understanding of the role of human and Artificial Intelligence in the organization decision making process in the presence of inter-connected factors. Here AI has been used as a decision making support rather than manual decision making system. Tin Miller (Miller, 2018) has also applied Artificial Intelligence in social sciences to find the optimum in the presence of complexities. In all the above cases of artificial intelligence ANN or Artificial Neural Network has played an important role. Under ANN activation function, weights and bias are the most important components to get the output. It is true that in the above all the works the activation functions are of different forms but most of them have followed the procedure of back propagation of learning procedure to generate the weights as well as activation functions.

The international Council for Science has elaborately used the concepts of Artificial Intelligence to estimate SDG performances incorporating the inter-indicator causal relationships and by assigning differential weights to different indicators (ICSU, 2019). They have developed a

matrix to show the weights of inter-SDG indicator causal incidences using Artificial Intelligence. To that respect they have developed a seven point scale ranging from -3 to +3. Their deduced weights in their seven point scale explained different states of causal relationship among the SDG indicators. But they have limited their work within three SDG goals namely zero hunger, good health and wellbeing and affordable and clean energy instead if seventeen SDG goals for the sake of simplicity.

Context:

Thus it appears that though there are a handful of measurable indices of SDG performances, most of them have followed the same methodology which suffers from serious shortcomings. All of these works have failed to recognise the inter-indicator causal relationships. Further, in the presence of inter goal relationship through inter-indicator causalities the idea to measure composite performances through simple average is not free from flaws. This problem of absence of inter-indicator causality in the creation of goal-wise as well as composite indices can well be managed through the ideas of artificial intelligence. So this work wants to identify the loopholes in the SDG index as proposed by NITI Aayog, Govt. of India and wants to develop a goal-wise as well as composite index incorporating the inter-indicator causality using artificial intelligence. More specifically the objectives of this study are the following.

Objectives:

- To locate the loopholes of the NITI Aayog SDG index.
- To deduce a new goal-wise index incorporating the inter-indicator causality.
- To develop a new methodology to derive composite SDG index after incorporating inter-goal dependency.
- To determine the difference in performance outcomes as measured by the NITI Aayog index and the newly developed index.

Methodology:

This work is based on secondary data collected form reputed sources like NITI Aayog[3], Govt. of India and International Council for Science. The weights of the inter-indicator causal incidences have been collected from the ICSU database (Griggs, Nilsson, Stevance, & McCollum, 2017). The relationship between the goals and the indicators has been determined through the normalization of the available average of inter-incidence weights. Finally the index values of the goals have been determined through sigmoid functions and the estimated values are normalized

[3] The NITI Aayog (Hindi for *Policy Commission*) (abbreviation for National Institution for Transforming India) is a policy think tank of the Government of India, established with the aim to achieve sustainable development goals with cooperative federalism by fostering the involvement of State Governments of India in the economic policy-making process using a bottom-up approach.

in a 100 point scale. Further, these seventeen established SDG are treated as nodes of a radar. The area of the radar is treated as performance of an economy under composite SDG performance (Chart I). The whole work is presented through an artificial neural network. The architecture of layer wise neural network is given below (Chart II). Finally the existing NITI Aayog values of the goal-wise as well as the composite indices are compared with the newly created indices. As an initial pilot work and due to non-availability of adequate data this work has developed this model only on the basis of three SDG goals; SDG2- Zero Hunger, SDG3- Good health and Well-being, SDG7- Affordable and clean energy. Naturally this work has some limitations but the methodology and the techniques developed here are unique in nature and can easily be extended to seventeen goals subject to the availability of sufficient data.

Chart I

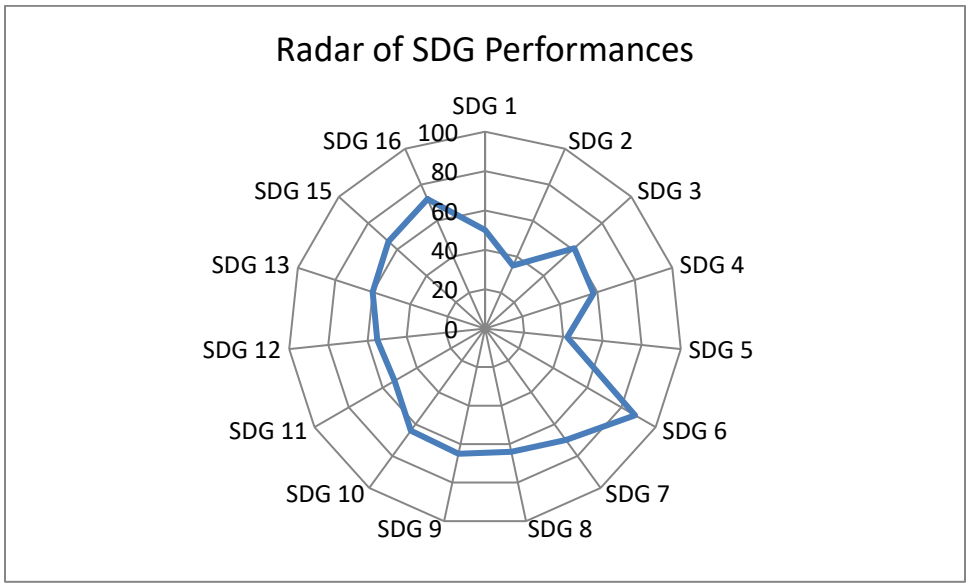
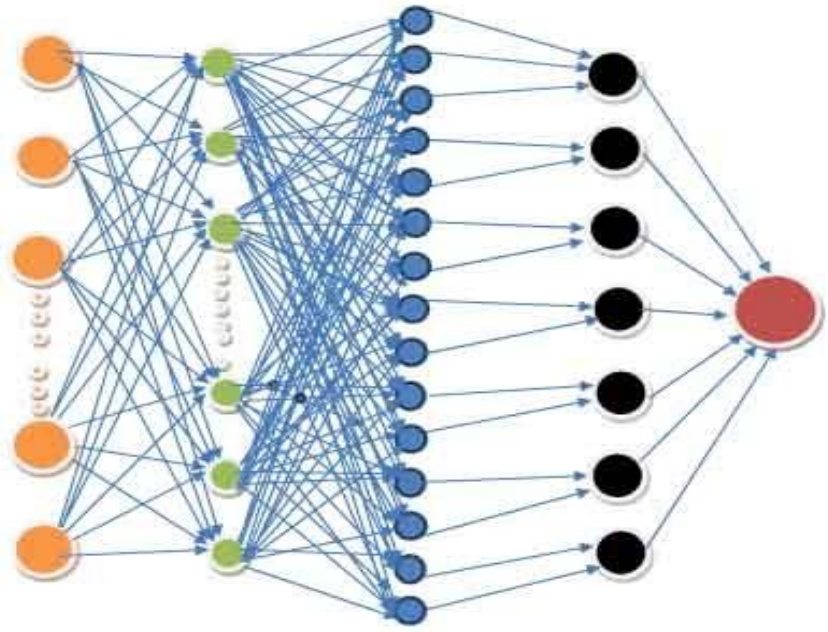


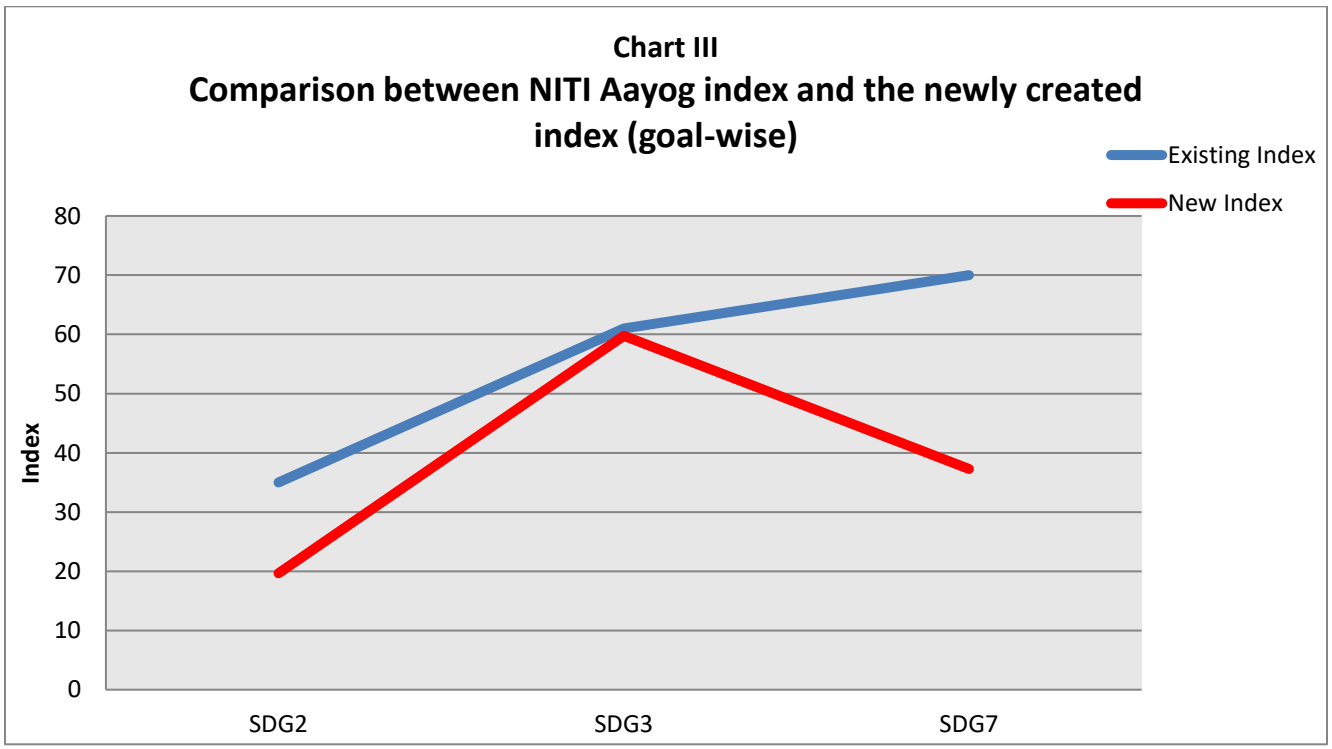
Chart II



Findings:

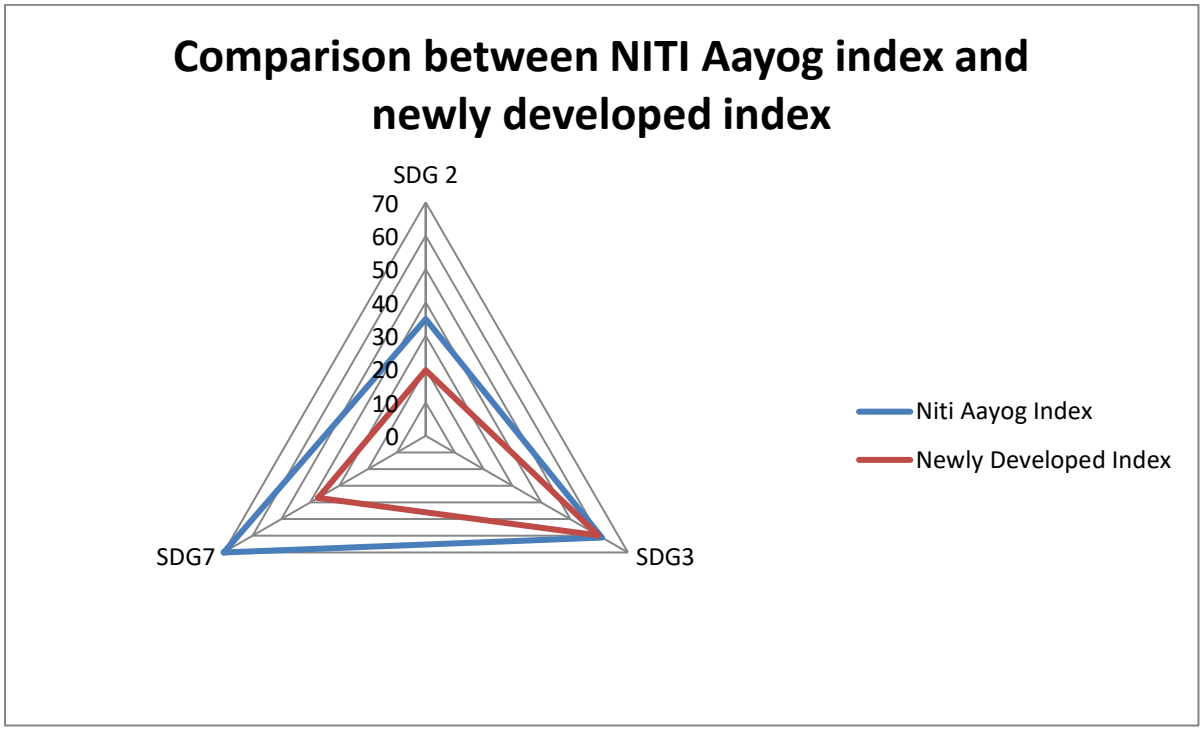
The findings generated through the application of the available dataset using the above stated methodology is depicted through the following table. This table also compares the SDG performance indices under SDG2, SDG3 and SDG7 as developed by our index and as prescribed by NITI Aayog.

Table I			
Comparison between existing SDG index and the Newly created SDG index			
	SDG2	SDG3	SDG7
Existing Index (Developed by NITI Aayog)	35	61	70
New Index (Developed by the authors)	19.65464	59.76294	37.29378
Source: NITI Aayog, GoI and the calculation of the authors			



From the above figure it appears that the SDG performance index as published by Govt. of India has overestimated the performances under different goals. The goal wise index as developed by us simply shows that the NITI Aayog index has delivered exaggerated values of goal wise performances. It appears that though the difference between the two indices in case of good health and well-being is very low; the difference in case of hunger eradication and creation of clean energy are remarkable. Using the ideas of radar presentation the estimation of the composite performances are as follows

Chart IV

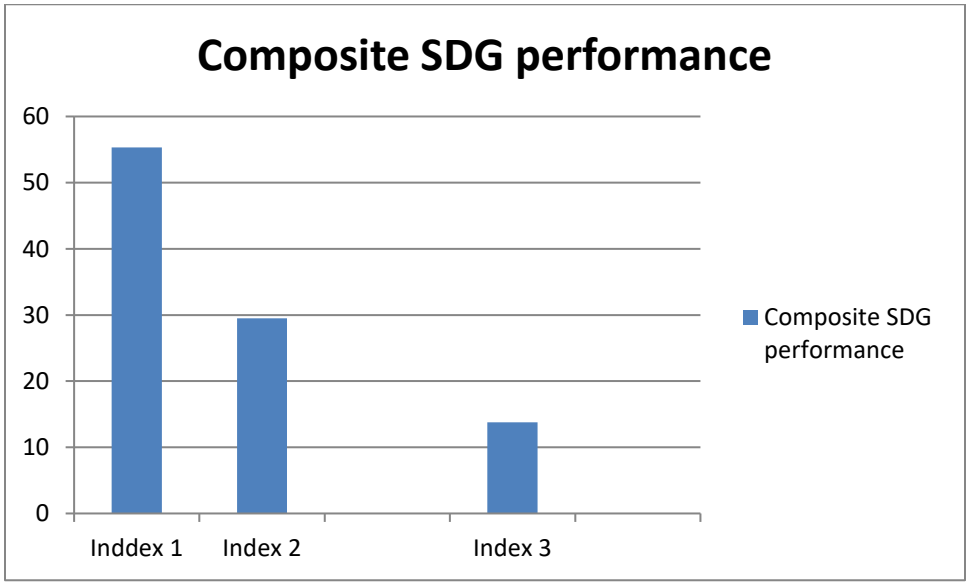


The radar presentation following the NITI Aayog estimated goal values and our new methodological goal values are presented graphically in the above diagram. The comparative values of the indices are given in the following table II. Index developed by Niti Aayog using ideas of simple arithmetic mean is mentioned as Index 1, index developed by using the goal values delivered by Niti Aayog within the radar diagram is mentioned as Index2 and our newly developed composite index using our estimated goal values on the radar methodology is mentioned as Index 3.

Table II	
	Composite SDG performance
Index development by NITI Aayog using the ideas of simple arithmetic mean	55.33
Index development by NITI Aayog using the ideas of radar diagram	29.51667
Newly developed index using the newly developed values of goals as well as radar methodology	13.788
Source: NITI Aayog, ICSU and the calculation of the authors	

From the above table it is clear that the existing SDG index - which has been constructed on the basis of the UNDP guidelines, suffers from multiple discrepancies. It appears from the above table as well as from the above discussion that the NITI Aayog index has wrongly estimated the goal wise as well as composite indices. The exaggeration in the performance as published by the existing NITI Aayog composite index is clear from the following diagram.

Chart V



Conclusion:

From the very beginning this work has tried to establish that the existing SDG indices suffer from important methodological shortcomings. After overcoming those loopholes, this work has developed new indices of goal wise as well as composite SDG performances. To develop these new indices it is accepted that the SDG indicators are inter-related and measuring SDG performances without recognizing these inter-indicator causal relationships would led to

misleading estimations. At the same time it is also concluded that the methodologies followed by NITI Aayog to develop the composite index is also not flawless. Testing these propositions through the existing dataset has also proved our hypothesis that the NITI Aayog index is misleading. It is observed that the NITI Aayog SDG index has actually exaggerated the goal wise as well as composite performances. For proper policy prescription proper estimation of the performances are necessary. To that respect NITI Aayog has failed to display the actual scenario. The new indices developed here with the help of artificial intelligence have solved many methodological problems related to persisting inter-indicator causal relationships. It is expected that the use of artificial intelligence in the studies of SDG performances will open new era of performance estimation.

Selective Bibliography:

Academy, E. D. (2019). *2019 Arab Region SDG Index and Dashboards Report .* Sustainable Development Solution Newwork.

Africa, T. S. (2018). *Africa SDG Index and Dashboards Report 2018.* Sustainable Development Solution Network.

Atkinson, G., Dietz, S., & Agarwala, M. (2014). *Handbook of sustainable development.* Edward Elgar.

Beyond2015. (2015). *1Sustainable Development Goals and the relationship to a post 2015 global development framework.* United nations.

Claudé, M., & Combe, D. (2018). *THE ROLES OF ARTIFICIAL INTELLIGENCE AND HUMANS IN DECISION MAKING: TOWARDS AUGMENTED HUMANS?* Umea: Umeå School of Business, Economics and Statistic.

Grebmer, K. v., Bernstein, J., Patterson, F., Wiemers, M., Chéilleachair, R. N., Foley, C., et al. (2019). *GLOBAL HUNGER INDEX: THE CHALLENGE OF HUNGER AND CLIMATE CHANGE.* Dublin: Helvetas.

Griggs, D., Nilsson, M., Stevance, A., & McCollum, D. (2017). *A Guide to SDG Interactions: from Science to Implementation.* Paris: International Council for Science (ICSU).

ICSU. (2019, March 13). *International Science Council*. Retrieved December 20, 2019, from A Guide to SDG Interactions: From Science to interactions: https://council.science/publications/a-guide-to-sdg-interactions-from-science-to-implementation/

Izario, D., Izario, B., Castro, D., & Iano, Y. (2017). Face recognition techniques using artificial intelligence for audio-visual animations. *Set International Journal of Boardcasting Engineering*, 78-83.

Miller, T. (2018, Auguet 16). Explanation in Artificial Intelligence:Insights from the Social Sciences. 1-66.

Mukerji, R. (2019). 2019 Global Hunger Index. *Climate Justice: A New Narrative for Action* .

Nabiyev, V. V., Çakiroğlu, Ü., Karal, H., Erümit, A. K., & Çebi, A. (2016). Application of Graph Theory in an Intelligent Tutoring System for Solving Mathematical Word Problems. *Eurasia Journal of Mathematics, Science & Technology Education*.

Neves, P. (2018). LITERATURE REVIEW ON SUSTAINABLE DEVELOPMENT _ The spirit and critics of SD and SDGs. *José LuÍs Cardoso's Lab*.

Nilsson, M., Chisholm, E., Griggs, D., Howden-Chapman, P., McCollum, D., Messerli, P., et al. (2018). Mapping interactions between the sustainable development goals: lessons learned and ways forward. *Sustainability Science*, 1489-1503.

Nilsson, N. J. (2005). Human-Level Artificial Intelligence? Be Serious! *American Association for Artificial Intelligence*, 68-75.

Papadimitriou, A. (2016). The future of communication Artificial Intelligence and Social Networks. *Media & Communication Studies*.

Policy, Institute of European Environment. (2019). *Europe Sustainable Development Report 2019.* Paris: EU .

Pradhan, P., Costa, L., Rybski, D., Lucht, W., & Kropp, J. P. (2017). A Systematic Study of Sustainable Development Goal (SDG) Interactions. *Earth's Future* .

Ramesh, A., Kambhampati, C., Monson, J., & Drew, P. (2004, October). Artificial intelligence in medicine. *Annals of The Royal College of Surgeons of England*, 334-338.

Schnell, R. (1991). Artificial Intelligence, Computer Simulation and theory construction in the social science.

United Nations. (2015). *The Millennium Development Goals Report 2015.* New York: United Nations.

United Nations. (2018, January 25). *Expert Group Meeting on Advancing the 2030 Agenda: Interlinkages and Common Themes at the HLPF 2018.* Retrieved February 03, 2020, from Sustainable Development Goals Knowledge Platform: https://sustainabledevelopment.un.org/index.php?page=view&type=13&nr=2592&menu=1634