

Data Science & Analytics in the *iSchools*—An Analytical Study with reference to future Potentialities towards Intelligent Systems

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Received: 17 Mar., 2022

Revised: 30 May 2022

Accepted: 05 Jun., 2022

ABSTRACT

Data Science is one of the important and emerging nomenclature and field of study internationally in many universities; not only developed countries but also in developing countries. Data Science is combined with various types of tools, techniques, technologies with reference to the algorithms, and machine learning principles. Further Data Science is also dedicated to discover hidden patterns of the data from the raw data. The experts involves in the tasks are called Data Science, Data Analyst etc. They not only does the exploratory analysis of the data and similar facets to discover insights from it, but also they also uses various kind of advanced techniques and machine learning algorithms for the purpose viz. to identify the occurrence of a particular event in the future. The field Data Science is very much close with the Big Data, Data Analytics. Big Data is also known as Big Data Management which simply the techniques and procedure for the managing complex and large amount of data in different forms and format. Data Analytics is another area responsible for real analysis and predicting for the problem solving also. Initially in Computer Science and Mathematical Sciences the fields of Big Data, Data Analytics, Data Sciences etc were practiced but gradually various other disciplines and subjects also using these fields. Regarding as a field Data Science is normally offered in the academic units of Computer Science, Mathematical Sciences. But in recent past this is also can be noted in the academic units of Information Science, which is literary has different objects and role than Computer Science and Mathematical Sciences. *iSchools* which is considered as an important academic consortium in information related fields are also in recently started academic programs on Data Science with a little different focus to create manpower who not only understand about the Data but also it's the issues, managerial context, social implications etc. for developing a smarter and intelligent society. This paper is theoretical in nature and exploratory in nature with aspects of Data Science in general emphasizing its current situation and offering in the *iSchools* with reference to the American region. The paper also aimed as a policy works for the other *iSchools* or the academic institutions and body may have potentialities in Data Science for creation of smarter systems.

Keywords: Data Science, *iSchools*, Information Science, Analytics, Intelligent Systems and Society, Emerging Degrees

How to cite this article: Paul, P.K. (2022). Data Science & Analytics in the *iSchools*—An Analytical Study with reference to future Potentialities towards Intelligent Systems. *IJASE*., 10(01): 01-22.

Source of Support: None; **Conflict of Interest:** None

iSchools are kind of educational institutes, schools, programs that deals with information; directly and indirectly in most context. However these schools are basically offers different educational programs, research programs related not only to the information but also to the technologies related to the information. Initially only Information Science programs was started in such schools and gradually other interdisciplinary programs also been added in such schools. As far as Historical foundation is concerned in the year 1998 three educationalist and information science experts have started the initiative on formation of the *iSchools*; these are Toni Carbo from the School of Information Science, University of Pittsburgh, United States; Donald Marchan from the School of Information Studies, Syracuse University; and Richard Lytle, College of Information Science and Technology, Drexel University United States.

Initially they have joined hands regarding the building of a common platform for information and technology related (which have direct and indirect connections on information) departments or Information related association nomenclature as *I-School* Caucus^{[1],[5],[31]}.

Though the ‘Gang of Five’ were noticeable from ‘three’ and since 2003 also several other Information and technology related schools, institutes and academic units have joined and makes the wider and diverse arena of information system practice. Though, most of the *iSchools* keeps general and traditional information fundamentals. Among the schools few important are include—

- ❑ University of North Carolina, United States
- ❑ Florida State University, United States
- ❑ Indiana University, United States
- ❑ University of Illinois, United States etc.

This way the institutes moves to group of ten and gradually the nomenclature of the institutes/ group moved to *iSchools* teams changed the conventional name from *I-School* caucus to simply *iSchools Organizations* having wider and healthy potentialities in new and more sophisticated programs, facilities and agenda^{[3],[13],[18]}. Such types of organization are directly involved with Information and allied fields such as Computer Science, Computing, Information Technology, Electronics, Systems, and Telecommunication Technology etc. In Information segment, apart from the traditional Information Science, Information Studies, Library Science, LIS nomenclature; few important are—

- ❑ Information Science and Technology,
- ❑ Information Management,
- ❑ Information Systems and Management etc.

Moreover in this segment various domain specific Information Sciences and Technologies also been added viz. Health Informatics, Bio Informatics, Geo Informatics, Social Informatics and even Data Science, Data Analytics, Big Data. Significantly domain centric Data Science and Analytics are also been noted viz. Health Analytics, Business Analytics, Geo Analytics and Spatial Science, Marketing Analytics and so on. Data Science is an emerging problem solving, interdisciplinary, intelligent system development based domain and gaining rapidly internationally. Data Science is also close with other related areas viz. Database Management, Data Analytics, Data Mining, Data Warehousing etc. It uses scientific methods, processes, algorithms, technologies regarding the extraction of data from structured and unstructured data. However the approaches, model, curriculum etc. are somehow different in the *iSchools* with interdisciplinary components and holistic development^{[4],[14],[16]}.

Objective

The present paper is focused on following aim and objective (but not limited to the)—

- ❑ To learn about the basic of the *iSchools* including origin and development and emerging concern.
- ❑ To get the knowledge about the *iSchools* with reference to the features, functions and emerging programs etc.
- ❑ To learn about the basics, foundation, features and functions of the Data Science and Analytics.
- ❑ To know about the educational programs, availability, nomenclature available and basic difference between exiting or other school offered Data Science and Analytics program and at the *iSchools*.
- ❑ To find out the potentiality and possibilities of other programs related to the Data Science in the context of *iSchools*.

METHODS

The paper entitled ‘Data Science & Analytics in the *iSchools*—An Analytical Study with reference to future Potentialities towards Intelligent Systems’ is an interdisciplinary work and combined with the areas of *iSchools*, educational sciences, aspects of Data Science and Analytics. For completion of this work various methods been analyzed and mapped and among these important are review of literature on existing areas and topic, analyzing primary data specially the journals and to map the actual situation of the Data Science in the *iSchools* the official websites of the *iSchools* been analyzed emphasizing American Region. Furthermore the analysis report been reported herewith. The web review on the said school program was conducted during April, 2020 to July, 2020. Further here only Data Science and Data Analytics program been considered avoided other allied areas viz. Robotics, AI & Machine Learning.

iSchools, Programs and Institutions: An Overview

Information Science becomes changed entirely by adding newer components and fields specially emerging IT and management including required social science components. Therefore many universities have started newer ways in delivery of Information related programs integrated with the interdisciplinary areas. In the *iSchools* Information Science and Technology many become an important nomenclature. This nomenclature of IST was first changed by the American Society of Information Science and Technology and it was from the existing *American Society of Information Science*. Soon after various other universities, institutes, research centers also introduced or changed their nomenclature as Information Science and Technology and also other allied areas with an agenda of integration and concentration of ‘Information-Technology-People’ and furthermore these are also very close to the society and community by the Information and Technology^{[8],[26]}. The *iSchools* Organization established as an international body and association in the year 1988 at United States (initially as *iSchool* caucus).

iSchools are the kind of academic departments or schools or institutions engaged in the wide range of Information Sciences with diverse field of study viz. Information Science, Communication Science, Information Systems, Computing and Information Technology. And also other fields which are directly or indirectly related to Information and Computing regarding the scientific and healthy information solution as well as management^{[1],[12],[20]}. Information Science initially in European nations called as Informatics and gradually other areas also familiar with both Informatics and Information Science. Many schools

internationally from different parts of the continents are associated with the *iSchools* Organizations. It has officially categorized into three regions (and as of study total numbers of *iSchools* are 111. The details of the schools, universities and countries are depicted in Table: 1.

Table 1: List of *iSchools* registered under the *iSchools* Organization, United States

Sl. No.	University & Academic Unit (<i>iSchools</i>)	Country
American <i>iSchools</i> Directory		
1	University at Albany, College of Emergency Preparedness, Homeland Security and Cybersecurity	USA
2	University of Arizona School of Information	USA
3	University of California, Berkley School of Information	USA
4	University of British Colombia The School of Information	Canada
5	Carnegie Mellon University Heinz College of Information Systems and Public Policy	USA
6	University of Cincinnati School of Information Technology	USA
7	University of Colorado, Department of Information Science	USA
8	Cornell University Faculty of Computing and Information Science	USA
9	Dominican University School of Information Studies	USA
10	Drexel University College Computing and Informatics	USA
11	Florida State University College of Communication and Information	USA
12	Georgia Institute of Technology College of Computing	USA
13	University of Illinois at Urbana Champaign School of Information Sciences	USA
14	Indiana University at IUPUI School of Informatics and Computing	USA
15	Indiana University, Bloomington School of Informatics, Computing and Engineering	USA
16	University of California, Irvine Donald Bren School of Information and Computer Science	USA
17	Kent State University School of Information	USA
18	University of Kentucky College of Communications and Information	USA
19	Long island University University Palmer School of Library and Information Science	USA
20	Louisiana State University School of Library & Information Science	USA

21	University of Maryland, Baltimore County Department of Information Systems	USA
22	University of Maryland College of Information Studies	USA
23	McGill University, Montreal School of Information Studies	Canada
24	Michigan State University Department of Media and Information	USA
25	University of Michigan School of Information	USA
26	University of Missouri School of Information Science and Learning Technologies	USA
27	University of Montréal School of Library and Information Science	Canada
28	University of North Carolina, Chapel Hill School of Information and Library Science	USA
29	University of North Texas College of Information	USA
30	University of Oklahoma School of Library and Information Studies	USA
31	The Pennsylvania State University College of Information Science and Technology	USA
32	University of Pittsburg School of Computing and Information	USA
33	Pontifical Xavierian University Department of Information Science	Colombia
34	Pratt Institute School of Information	USA
35	The State University of New Jersey, Rutgers School of Communication and Information	USA
36	San Jose State University School of Information	USA
37	University of São Paulo School of Communication and Arts (ECA)	Brazil
38	Simmons University, Boston School of Library and Information Science	USA
39	University of South Carolina School of Library and Information Science	USA
40	University of South Florida School of Information	USA
41	State University of New York, Buffalo Department of Information Science	USA
42	Syracuse University School of Information Studies	USA
43	The University of Tennessee School of Information Sciences	USA

44	Texas A&M University – Kingsville Department of Electrical Engineering & Computer Science	USA
45	University of Texas at Austin School of Information	USA
46	University of Toronto Faculty of Information	USA
47	University of California at Los Angeles Graduate School of Education and Information Studies	USA
48	University of Washington The Information School	USA
49	Wayne State University School of Information Sciences	USA
50	University of Wisconsin, Madison The Information School	USA
51	University of Wisconsin, Milwaukee School of Information Studies	USA

European *iSchools* Directory

52	Aalborg University Department of Communication and Psychology	Denmark
53	University of Amsterdam Graduate School of Humanities, Archives and Information Studies	Netherlands
54	Bar-Ilan University Department of Information Science	Israel
55	University of Borås The Swedish School of Library and Information Science	Sweden
56	University Carlos III of Madrid Department of Library and Documentation	Spain
57	Open University of Catalonia Faculty of Computer Science, Multimedia and Telecommunications.	Spain
58	Charles University in Prague Institute of Information Studies and Librarianship (IISL)	Czech Republic
59	University of Copenhagen Department of Information Studies	Denmark
60	University College Dublin School of Information and Communication Studies	Ireland
61	University of Glasgow Humanities Advanced Technology and Information Institute	UK
62	Hacettepe University Department of Information Management	Turkey
63	Humboldt University of Berlin Berlin School of Library and Information Science	Germany
64	IMT Atlantique (A Technological University) Department of Logic Uses, Social Sciences and Information	France
65	Linnaeus University Information Institute (iInstitute)	Sweden
66	University College London Department of Information Studies	United Kingdom

67	Makerere University The College of Computing and Information Sciences	Uganda
68	Northumbria University Department of Computing and Information Sciences	United Kingdom
69	Nova University Lisabon Information Management School	Portugal
70	Manchester Metropolitan University Information and Communications	United Kingdom
71	The University of Minho ALGORITMI Center School of Engineering	Portugal
72	Oslo Metropolitan University Department of Archivistics, Library and Information Science	Norway
73	University of Oxford The Oxford Digital Information Group	Oxford
74	Polytechnic University of Valencia School of Informatics	Spain
75	University of Porto Faculty of Engineering in cooperation with the Faculty of Arts	Portugal
76	University of Regensburg Institute for Information and Media, Language and Culture	Germany
77	Robert Gordon University Department of Information Management of Aberdeen Business School	United Kingdom
78	University of Sheffield Information School	United Kingdom
79	University of Siegen School of Media and Information (iSchool)	Germany
80	University of Strathclyde Computer and Information Sciences	United Kingdom
81	Josip Juray Strossmayer University of Osijek, Croatia Department of Information Sciences	Croatia
82	Tampere University Faculty of IT and Communication Sciences	Finland

Asia Pacific *iSchools* Directory

83	Central China Normal University School of Information Management	China
84	Charles Sturt University School of Information Studies	Australia
85	University of the Chinese Academy of Sciences Department of Library, Information and Archives Management	China
86	University of Hong Kong Human Communication, Development, and Information Sciences (CDIS)	China
87	Jilin University School of Management	China
88	Khon Kaen University (KKU) Department of Information Science	Thailand
89	Kyungpook National University (KNU) Department of Library and Information Science	Korea

90	Kyushu University Department of Library Science, Graduate School of Integrated Frontier Sciences	Japan
91	National Chengchi University Graduate Institute of Library Information and Archival Studies	Taiwan
92	Nanjing University of Science and Technology School of Economics and Management	China
93	Nanjing University School of Information Management	China
94	Monash University Faculty of Information Technology	Australia
95	University of Melbourne Department of Computing & Information Systems	Australia
96	National Taiwan University Department and Graduate Institute of Library and Information Science	Taiwan
97	National Taiwan Normal University Graduate Institute of Library and Information Studies	Taiwan
98	Renmin University of China School of Information Resource Management	China
99	Shanghai University Department of Library, Information and Archives	China
100	Soochow University Department of archives and e-government	China
101	University of South Australia School of Information Technology & Mathematical Sciences	Australia
102	National Taiwan University Department and Graduate Institute of Library and Information Science	Taiwan
103	Peking University Department of Information Management	China
104	University of the Philippines School of Library and Information Studies	Philippines
105	Sun Yat-Sen University School of Information Management	China
106	Sungkyunkwan University Library and Information Science	South Korea
107	University of Technology, Malaysia (MARA) Faculty of Information Management	Malaysia
108	University of Tsukuba Graduate School of Library, Information, and Media Studies	Japan
109	Waikato University School of Computing and Mathematical Sciences	New Zealand
110	Wuhan University School of Information Management	China
111	Yonsei University Department of Library and Information Science	South Korea

iSchools are very much engaged in academic innovations and new types of programs and as a result Data Science and Analytics also been offered in the institutions tagged as *iSchools*^{[9],[18],[27]}. The following section provide a details on the Data Science, Analytics and Big Data related areas before reaching about

the Data Science programs at the *iSchools*.

Data Science: The Emergence

Data Science is a concept, technique, procedure and technology for extracting data from the large data sets and base; such data can be structured or unstructured. Here various statistical methods, machine learning, etc. played an important role. Here various techniques, theories, tools and principal of allied field viz. computer science, information science, mathematical science etc. are important to note. The field is become very interdisciplinary apart from the subjects mentioned above some other fields also considered as important in Data Science. The areas viz. Information Visualization, Graphic Designing, Management, Human Computer Interaction also considered as important in Data Science practice^{[15],[21],[32]}. This field according to the American Statistical Association is deals with the following major components (in 2015) viz.

- Database Management.
- Statistics
- Machine Learning
- Distributed and Parallel Systems

Therefore Data Science is basically dedicated and responsible in making of decisions and predictions making and here the major tools are used viz. predictive causal analytics, prescriptive analytics and machine learning. However prescriptive analytics is concern with the predictive plus decision science.

Predictive Causal Analytics

Predictive casual analytics is a kind of model that are required in predicting the possibilities of any object or event or future. This will be helpful in predicting the future; therefore useful in many context. In financial segment there are huge uses on such models^{[6],[11],[30]}.

Prescriptive Analytics

This kind of analytics or modeling are very much useful in making of own decisions and also the ability to modify using dynamic parameters. This is relatively new field and also in providing advice, can suggest a range of prescribed actions as well as associated outcomes in proper way. The prime example of this is Google Self driving car; more clearly the decisions like when to turn, which path to take, when to slow down or speed up can be monitored by the prescriptive analytics^{[20],[27],[30]}.

Machine learning for Making Predictions

Machine learning (ML) is deals with the computer algorithms which is dedicated in improving automatically through experience and machine learning is considered as a subset of artificial intelligence and here algorithms build by the mathematical model which are based on sample data. In making predictions therefore Machine Learning can be considered as important and valuable with the paradigm of supervised learning^{[7],[17],[22]}.

Machine learning for Pattern Discovery

In case of without specific parameters and to make predictions, hidden patterns within the dataset and to able in making of meaningful predictions; Pattern Discovery can be considered as important and valuable. As mentioned in the Fig. 1 Data Analysis is includes the descriptive analytics as well a prediction to a certain extent whereas Data Science is deals with the Predictive Causal Analytics and Machine Learning.

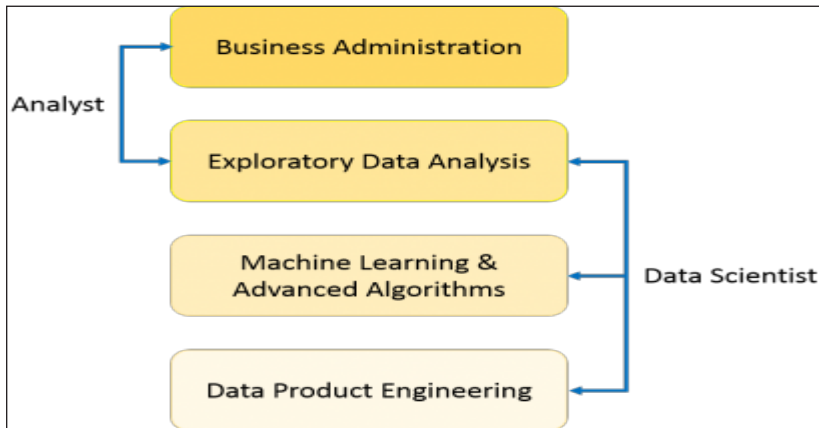


Fig. 1: Data Science and Analytics: The functioning

Data Science, Allied Fields and Data Scientist

There are different fields related to the Data Science viz. Analytics, Big Data etc. Data Science for its real life operation and activities are having many phases viz. as depicted in Fig. 2.

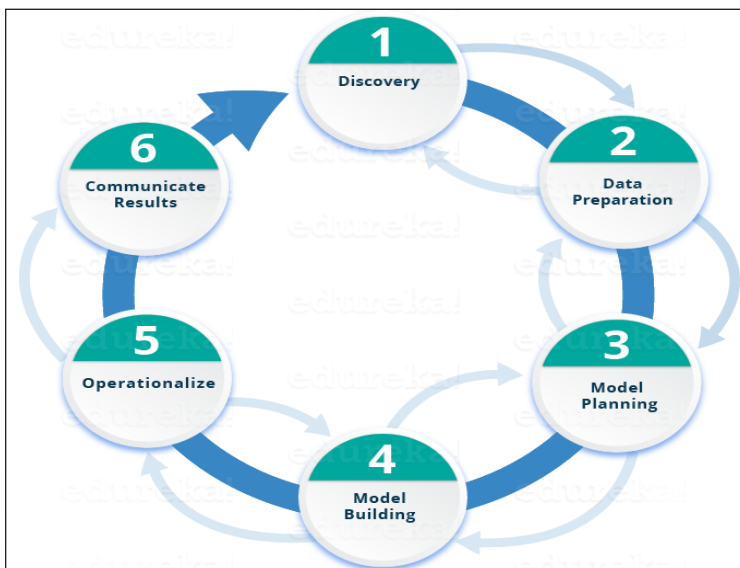


Fig. 2: Major phases in Data Science operations

The professionals primarily engaged in the Data Science related jobs are called as Data Scientist who practices the art of Data and solve the problem with the allied elements, tools, techniques, procedure of the Computer Science, Mathematics, Statistics etc. The Data Scientist are normally draws a lot of information which are needed in problem solving statistics or mathematics. Data scientists are those who also used different kind of latest technologies in finding solutions and reaching conclusions for the proper and healthy growth and development of the organization. They present the data in a presentable and structured way and in useful form as compared to the structured as well as unstructured forms. Business Intelligence or BI is also an allied field of Data Science and in many a context confused with BI. If we analyzed properly then following are the core concern in the Data Science Vs. Business Intelligence^{[12],[23],[29]}.

- ❑ As far as Data Sources are concerned in Data Science act in both structured and unstructured data with the tools viz. logs, cloud data, SQL, NoSQL, text etc whereas Business Intelligence (BI) is only concern with the Structured data and usually with the SQL, and often Data Warehouse.
- ❑ Regarding Approaches Data Science is concern with the Statistics, Machine Learning, Graph Analysis, Neuro-Linguistic Programming (NLP); whereas Business Intelligence is concern with the Statistics and Visualization only.
- ❑ As far as focus on attention is concerned Data Science and Analytics is concerned with the present and future whereas Business Intelligence is with the Past and Present only.
- ❑ Some of the useful technical tools are RapidMiner, Big ML, Weka, R whereas in Business Intelligence the core and used tools are Microsoft BI, R Programming, Pentaho, QlikView etc.

The Data Science is gaining popularity as a field and discipline internationally and to reach a full-fledged various contributors are engaged but among them William S. Cleveland considered as important and valuable. In 2001 he explained about the need and way of using statistics in technical areas and beyond traditional. Thereafter various academic events, programs, publications including Journal etc. launched on Data Science. In USA another significant changes was noted of changed name of Statistical Learning and Data Mining Section into Statistical Learning and Data Science (in 2014) of American Statistical Association. Soon many universities and educationalist have been started Data Science educational and academic program^{[3],[17],[24]}. The applications of data science have risen in the recent past with the applications in different and diverse areas in societal development and change of the life style also data science getting importance in wide sphere. Furthermore the field Data Science is not only applied in predicting industries' future trend even to solve the problem of common people and serve individuals issues and makes lives easier.

Big Data is another important area and allied to the Data Science and this is very much important and required in managing large amount of data as well as complex data. Big Data is actually deals with the humongous amount of volumes that is unable to process effectively by the general applications. Here raw data play a leading role with immense volumes of data and that may be unstructured and structured. Big Data is furthermore deals with the analyze insights of any datasets and similar facets and useful in making better decisions and strategic business moves^{[19],[25]}. According to the Gartner “Big data is high-volume, and high-velocity or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation.”

Another important field is **Data Analytics** which involves application of the algorithmic as well as mechanical process to derive insights. Data Analytics applications in diverse areas are known as differently

viz. Business Analytics, Health Analytics, Marketing Analytics and so on. In several industries and organizations, companies it helps in healthy, efficient and better decision making using existing theories and models. Data Science, Data Analytics, Big Data etc. therefore comes with modern and techno-managerial job positions viz.—

- ❑ Data Scientist — is the person who involves in analyzing data of different formats, size, structure properly for the healthy and smarter decisions making and big data systems development.
- ❑ Data Engineer — is a professionals who are basically engaged with the “big data” infrastructure implementation, design and development that analyzed by Data Scientists. In this context software engineers can be consider as important who may design, develop and also integrate data from the wider areas and manage big data.
- ❑ Data Analyst — A Data Analyst is the person who basically involved in real time data analysis of various formats and serve to the Data Scientist and other next Data Science related professionals.
- ❑ Data Consultant — Data consultants is another possible designation that educated on the field may have. Further they serve the need of the client, company etc. for healthy operations, services and decision making.
- ❑ Data Architect — They are responsible in data solutions which are optimized for solving the performance and healthy design applications.
- ❑ Applications Architect — Applications architects is the kind of professionals that helps in business and also in interacting with the users and other applications.

iSchools are the kind of consortium that is responsible for the promoting information, and technological manpower and research related solutions by its innovative programs. As mentioned previously, apart from the existing programs, degrees *iSchools* in recent past started various academic programs in different levels. Since *iSchools* not only Computer Science or Information Science it holds mixed of academic institutions (refer Table: 1 for more about the school nomenclature) therefore the nature, nomenclature, approaches of Data Science and allied programs may differs. As far as American *iSchools* are concern they are having good amount of Data Science and Analytics programs. Here it is worthy to note that the programs are listed and available in most of the selected *iSchools* are with different major level viz.

- ❑ Bachelor Degree
- ❑ Master Degree
- ❑ Doctoral Degree (PhDs)

And even most of the programs are also not only comes with the full-fledged but also as a specialization there. Among the full-fledged nomenclature important are –

- ❑ Data Science.
- ❑ Data Analytics Engineering.
- ❑ Applied Data Science.
- ❑ Enterprise Data Systems.
- ❑ Data Science and Visualization.
- ❑ Advanced Big Data Analytics.
- ❑ Analytics.

- Information and Data Science.
- Applied Data and Information Science.
- Computational Data Analytics.

Apart from these mentioned nomenclatures on various Data Sciences domain or field specific Data Science and Analytics also rising gradually viz. Bio Medical Data analytics, Public Policy and Data Analytics, Healthcare Analytics and IT at the *iSchools*. Furthermore it is noted that most of the programs comes with the specialization on Data Science and Analytics related fields in the broad degrees viz. Informatics, Information Science, Information Systems and Management, Information Management and Systems, Information Technology, Library and Information Science etc. Table 2 herewith depicted the *iSchools* offering Data Science related programs (except robotics, Machine Learning etc.).

Table 2: List of *iSchools* with Data Science and Analytics and allied programs at American Region

Sl. No.	University & Academic Unit (<i>iSchools</i>)	Academic Programs	Country
American <i>iSchools</i> Directory			
1	University at Albany, College of Emergency Preparedness, Homeland Security and Cybersecurity	BS-Informatics (Data Analytics) MS Information Science (Data Analytics) PhD Information Science (Data Analytics)	USA
2	University of Arizona School of Information	MS-Information (Data Science) Certificate in Data Science & Visualization	USA
3	University of California, Berkley School of Information	Master of Information Management and Systems (Applied Data Science and Machine Learning) Master of Information and Data Science-Online Master of Information & Data Science (Integrated 5 Years)	USA
4	Carnegie Mellon University Heinz College of Information Systems and Public Policy	MS-Public Policy & Data Analytics MS-Healthcare Analytics & IT MS-IT (Business Intelligence & Data Analytics) PhD-Information System & Management (Machine Learning & Large Scale Data Analytics)	USA
5	Cornell University Faculty of Computing and Information Science	BA-Information Science (Data Science) BS-Information Science (Data Science) Master of Professional Studies (Data Science) MPS-Applied Statistics (Data Science)	USA
6	Drexel University College Computing and Informatics	BS-Data Science Minor (Bachelor)-Data Science Certificate (Post Bachelor)-Applied Data Science MS-Information Systems (Data Analytics & Knowledge Management) Minor (Masters)- Applied Data Science Certificate (Post Bachelor)- Computational Data Science) PhD-Information Science (Data Science)	USA

7	George Mason University Department of Information Science & Technology, Virginia, US	MS-Applied Information Technology (Data Analytics & Intelligence Methods) MS-Data Analytics Engineering MS-Analytics (Analytical Tools/ Business Analytics/ Computational Data Analytics) Minor (Bachelor)- Computational Data Analysis	USA
8	University of Illinois at Urbana Champaign School of Information Sciences	MS-Information Management (Data Science & Analytics)	USA
9	Indiana University at IUPUI School of Informatics and Computing	BS-Applied Data & Information Science (Applied Data Science) BS-Informatics (Applied Data Science/ Data Studies) Certificate (Bachelor)-Applied Data Science MS-Applied Data Science MS- Applied Data Science (Crisis Informatics) MS- Applied Data Science (Sports Analytics) MS- Applied Data Science (Crisis Informatics) MS-Applied Data Science (User Experience Design) Certificate (Masters)-Biomedical Data Analytics	USA
10	Indiana University, Bloomington School of Informatics, Computing and Engineering	BS/BA-Computer Science (Data Science) BS-Data Science (Fundamentals of Data Science/ Data Systems/ Network & Applied Data Science/ Data Science Design) Master of Information Science (Data Science) Master of Library Science (Data Science) Certificate (Masters)-Data Science PhD (Minor)-Data Science	USA
11	University of California, Irvine Donald Bren School of Information and Computer Science	BS-Data Science	USA
12	University of Maryland College of Information Studies	BS-Information Science (Data Science)	USA
13	University of Michigan School of Information	MS-Information (Big Data Analytics) Master of Applied Data Science (Online) Certificate (Masters)-Data Science	USA
14	University of North Carolina, Chapel Hill School of Information and Library Science	Certificate (Bachelors)-Applied Data Science Certificate (Masters)-Applied Data Science	USA
15	University of North Texas College of Information	BA-Information Science & Applied Technology (Data Science) MS-Data Science	USA

16	The Pennsylvania State University College of Information Science and Technology	BS-Data Science-4Y (Applied Data Science/ Computational Data Science/Statistical Modeling Data Science)	USA
17	University of Pittsburg School of Computing and Information	BS-Information Science (Data Analytics) MS-Information Science (Big Data Analytics) Certificate (Bachelor)-Advanced Big Data Analytics	USA
18	Simmons University, Boston School of Library and Information Science	BS-Data Science & Analytics (Biology/ Finance/ Account/ Marketing/ Biochemistry/ Healthcare Management/Chemistry/ Communication/ Computer Science/ Economics/ Mathematics/ Political Science/ Public Health/ Sociology)	USA
19	University of South Florida School of Information	BS-Information Science (Data Science & Analytics) BS-Information Studies (Data Science & Analytics)	USA
20	Syracuse University School of Information Studies	BS-Information Management & Technology (Major)-(Data Analytics) MS-Applied Data Science MS-Enterprise Data Systems (Data Science Infrastructure & Applications) MS-Information Management (Structured Data Analytics and Visualization/ Textual Data Management and Analytics) Certificate (Masters)-Data Science PhD-Information Science & Technology (Data Science & Computation)	USA
21	University of Washington The Information School	MS-Information Management (Data Science)	USA
22	Wayne State University School of Information Sciences	MS-Information Management (Data Analytics) Master of Library & Information Science (Data Analytics)	USA
23	University of Wisconsin, Madison The Information School	MA-Library & Information Studies (Information Management & Analytics) Certificate (Masters)- Analytics for Decision Making	USA

Form this study it is note that the following level of programs, degrees are offered in majority of the *iSchools* in the discipline of Data Science and Analytics—

- Certificate
- Bachelors Certificare
- Masters Certificate
- Bachelors Degree
- Masters Degree (General viz. MS)

- ❑ Masters Degree (Professional viz. MPS, MLIS etc.)
- ❑ Doctoral (PhDs).

However apart from these Minors programs also importantly started in major *iSchools* as far as this study is concerned. The minor are normally offered with other subjects as Major. Here it is worthy to note that minors at Bachelor level counted with two institutes, whereas minor at Masters with one institutes (Indiana University, Bloomington, School of Informatics, Computing and Engineering) and minor at PhD level also counted with one. The masters programs are offered with highest number as a full-fledged degree and as a specialization details are given in Fig. 3. whereas the details of other programs are given in Fig: 4.

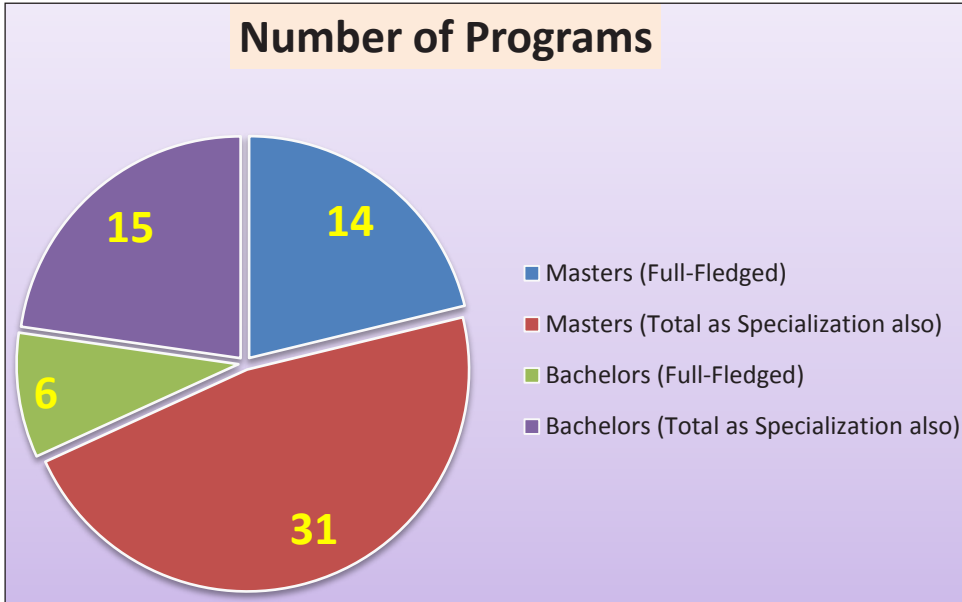


Fig. 3: Details of Bachelors and Mastrs programs number/ sharing

The table: 3 herewith provided the list of *iSchools* offering Data Science and Analytics with Certificate, Minors at different levels.

Table 3: List of *iSchools* having Data Science and Analytics at certificate, minors at American Region

Sl. No.	University & Academic Unit (<i>iSchools</i>)	Academic Programs	Country
American <i>iSchools</i> Directory			
1	University of Arizona School of Information	Certificate in Data Science & Visualization	USA
2	Drexel University College Computing and Informatics	Minor (Bachelor)-Data Science Certificate (Post Bachelor)-Applied Data Science Minor (Masters)- Applied Data Science Certificate (Post Bachelor)- Computational Data Science	USA

3	George Masson University Department of Information Science & Technology, Virginia, US	Minor (Bachelor)- Computational Data Analysis	USA
4	Indiana University at IUPUI School of Informatics and Computing	Certificate (Bachelor)-Applied Data Science Certificate (Masters)-Biomedical Data Analytics	USA
5	Indiana University, Bloomington School of Informatics, Computing and Engineering	Certificate (Masters)-Data Science	USA
6	University of Michigan School of Information	Certificate (Masters)-Data Science	USA
7	University of North Carolina, Chapel Hill School of Information and Library Science	Certificate (Bachelors)-Applied Data Science Certificate (Masters)-Applied Data Science	USA
8	University of Pittsburg School of Computing and Information	Certificate (Bachelor)-Advanced Big Data Analytics	USA
9	Syracuse University School of Information Studies	Certificate (Masters)-Data Science	USA
10	University of Wisconsin, Madison The Information School	Certificate (Masters)- Analytics for Decision Making	USA

These certificate and minors programs are offered in different nomenclature majority with the Data Science and Analytics except *Indiana University, Bloomington, School of Informatics, Computing and Engineering* which offers the nomenclature Biomedical Analytics.

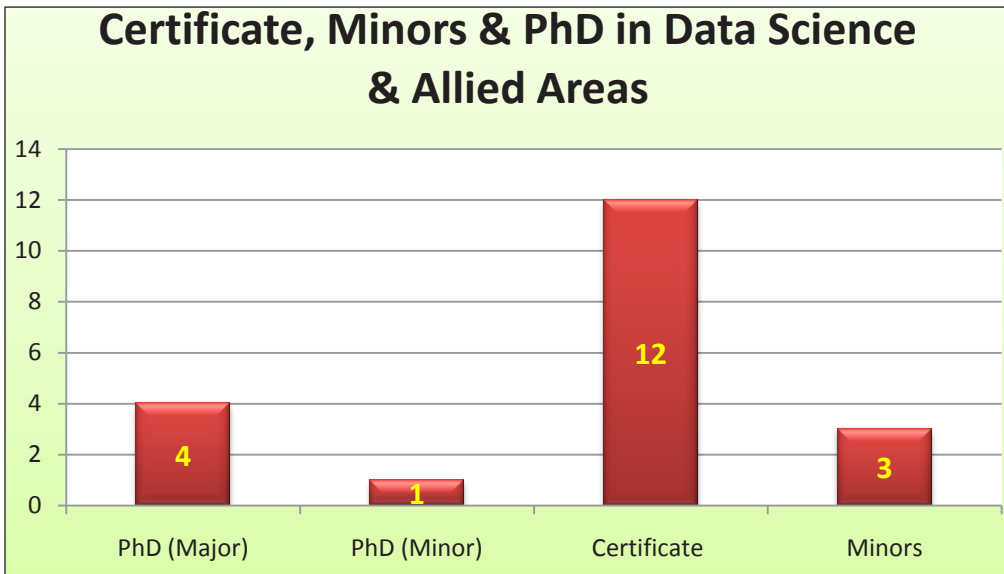


Fig. 4: Details of programs at PhDs, Certificates and Minors

There is a growing trend of Data Science and allied programs also at PhD level. As far as this study is concerned five institutes are offered PhD in Data Science and Analytics programs (except one as Minor). Here all these programs are offered only at the specializations of the information related programs. Refer table 4 for details.

Table 4: List of *iSchools* having Data Science and Analytics at PhD level at American Region

Sl. No.	University & Academic Unit (iSchools)	Academic Programs	Country
American <i>iSchools</i> Directory			
1	University at Albany, College of Emergency Preparedness, Homeland Security and Cybersecurity	PhD Information Science (Data Analytics)	USA
2	Carnegie Mellon University Heinz College of Information Systems and Public Policy	PhD-Information System & Management (Machine Learning & Large Scale Data Analytics)	USA
3	Drexel University College Computing and Informatics	PhD-Information Science (Data Science)	USA
4	Indiana University, Bloomington School of Informatics, Computing and Engineering	PhD (Minor)-Data Science	USA
5	Syracuse University School of Information Studies	PhD-Information Science & Technology (Data Science & Computation)	USA

Therefore the list of programs at the *iSchools* on the Data Science, Analytics are rising. This study is fully concentrated on Data Science and Analytics. However the programs on the areas viz. Machine Learning, Robotics, Artificial Intelligence, Computational Intelligence etc. are also increasing in all the *iSchools* not only in American Region but also in other regions. Since the study is only concentrated on Data Science and Analytics and allied nomenclature including domain specific Data Science and Analytics; therefore study can be also possible in other/ remaining areas.

SUGGESTIONS

The following are the potentiality for betterment in research and development activities on the said topic.—

- ❑ The programs are mostly offered at Masters Degrees; however in Bachelors Degree also such are required to offer with higher scale.
- ❑ The Programs are limited in domain specific however such can be offered with the domain specific nomenclature viz. Health Analytics, Business Analytics, Educational Analytics either a a full degree or as a specilization in other Information or Computer Centric nomenclature.
- ❑ Since there is a basic differences between the traditional Computing School with the Information Schools (*iSchools*) therefore the Data Science and Analytics programs should be integrated with the basic interdisciplinary aproaches, information and societal fundamentals. Most of the programs are focused with the aspects, in this regard example of Shiefiled University, UK is notable though in table 5 provided few other sample curricula of American Region; which may get few more courses on societal issues of information, computation and technologies.

Table 5: *iSchools* with sample courses/ paper at Data Science and Analytics (Masters)

Universities	Papers/ Courses
University of Sheffield Information School MSc- Data Science	Core Courses Data Visualization Introduction to Data Science Data Analysis Data and Society Data Mining Database Design Research Methods and Dissertation Preparation Dissertation Optional modules Choose from a range of optional modules including: Business Intelligence Information Governance and Ethics Researching Social Media Digital Advocacy Big Data Analytics User Interface Design and Human Computer Interaction
University of Arizona School of Information MS-Information (Data Science)	The Information Environment Information and Knowledge Organization Administration of Information Agencies Research Methods Text Analysis Database Systems and Data Analysis
University of Michigan School of Information MS-Information (Big Data Analytics)	Core Courses: Contextual Inquiry and Consulting Foundations Programming I Intermediate Programming Introduction to Statistics and Data Analysis Data Manipulation and Analysis Data Mining: Methods and Applications Plus two or more of: Natural Language Processing Natural Language Processing: Algorithms and People Networks Information Visualization Information Retrieval Applied Machine Learning

- Though in United States Doctoral Degrees are considered as highest level of degrees but in some of the American countries (viz. Mexico, Brazil) there is a potentiality to offer basic Post Doctoral/ Higher Doctoral Degree i.e. D.Sc. in Data Science and Analytics or allied areas; subject to having *iSchools* in such countries.

- ❑ Apart from the D.Sc. in other streams also Post/ Higher Doctoral Degrees can be offered viz. *Engg.D (Doctor of Engineering)*- Data Science and Analytics, *DBA (Doctor of Business Administration)*- Big Data Management and so on.
- ❑ Post Graduate Diploma may be an another programs in Data Science and Analytics or allied areas in the *iSchools*.
- ❑ Industry Integrated Programs or Curriculam is also very much important for a successful and healthy *iSchools* with Data Science and Analytics programs.
- ❑ *iSchools* with initial problem regarding the infrastructure in full fledged Data Science and Analytics may start as a specilization in the information.

CONCLUSION

Data Science and Analytics is emerging rapidly internationally and many universities, educational institutes, training centers have started programs with various nomenclature on Data Science and Analytics. Since *iSchools* are following different strategies and procedure therefore such programs will also expected with integration of the society-technology-information integration approaches. Since *iSchools* are very innovative and holds a variety of programs, subjects, and diversity in human resources, students and researchers therefore a Centre dedicated to the Data Science and Analytics would be best in all the *iSchools*. Furthermore the countries and the other territories of the *iSchools* may also join in the programs related to the Data Science and Analytics with a basic different approaches in making information and technologies to the different sectors, areas and clients to make each sector advanced and vis-à-vis intelligent society. Though, proper infrastructure, funding, initiative, planning, collaboration and cooperation and others among the stakeholders are highly solicited.

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