

Data Science: 4차 산업혁명의 핵심역량

2018년 1월 31일

김형주 교수

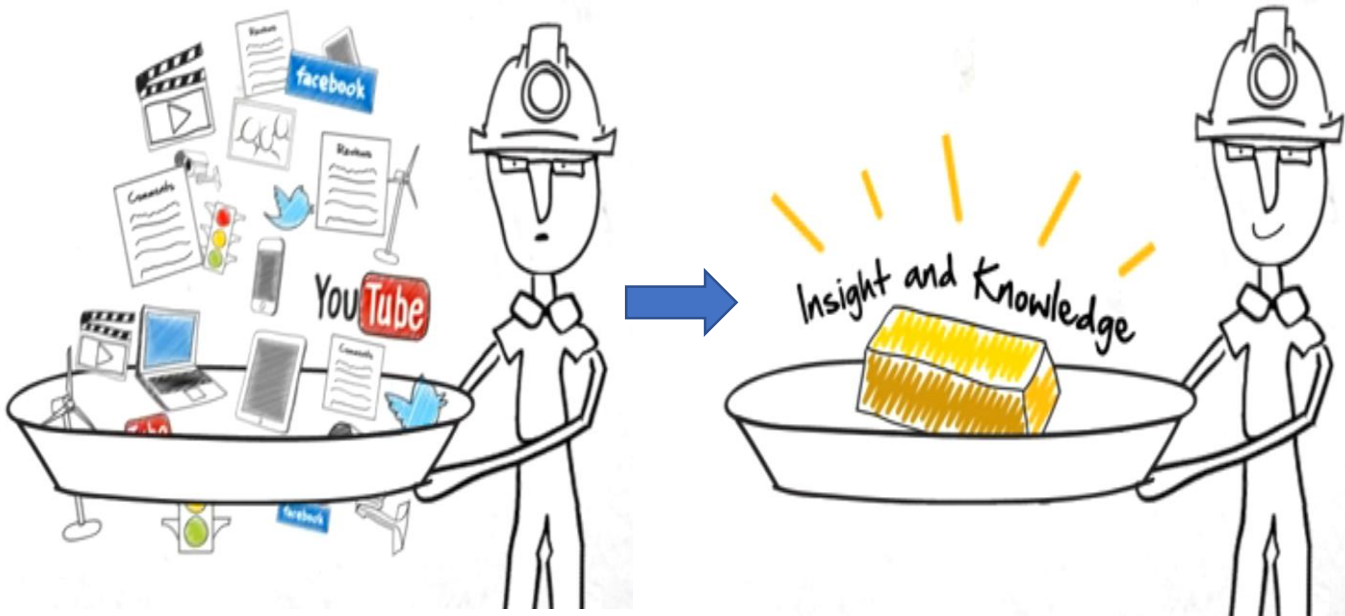
서울대 컴퓨터공학부

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- 삼성전자 DS^2 과정

Big Data가 주는 가치

- 데이터: **의미를 담고 있는** 기록된 사실 [Elmasri and Navathe. Fundamentals of Database Systems]
- 그렇다면, 다양하고 많은 "빅 데이터" → 다양하고 많은 의미?
 - "빅 데이터"를 처리, 분석하여 의미를 제대로 찾아낼 때에만!

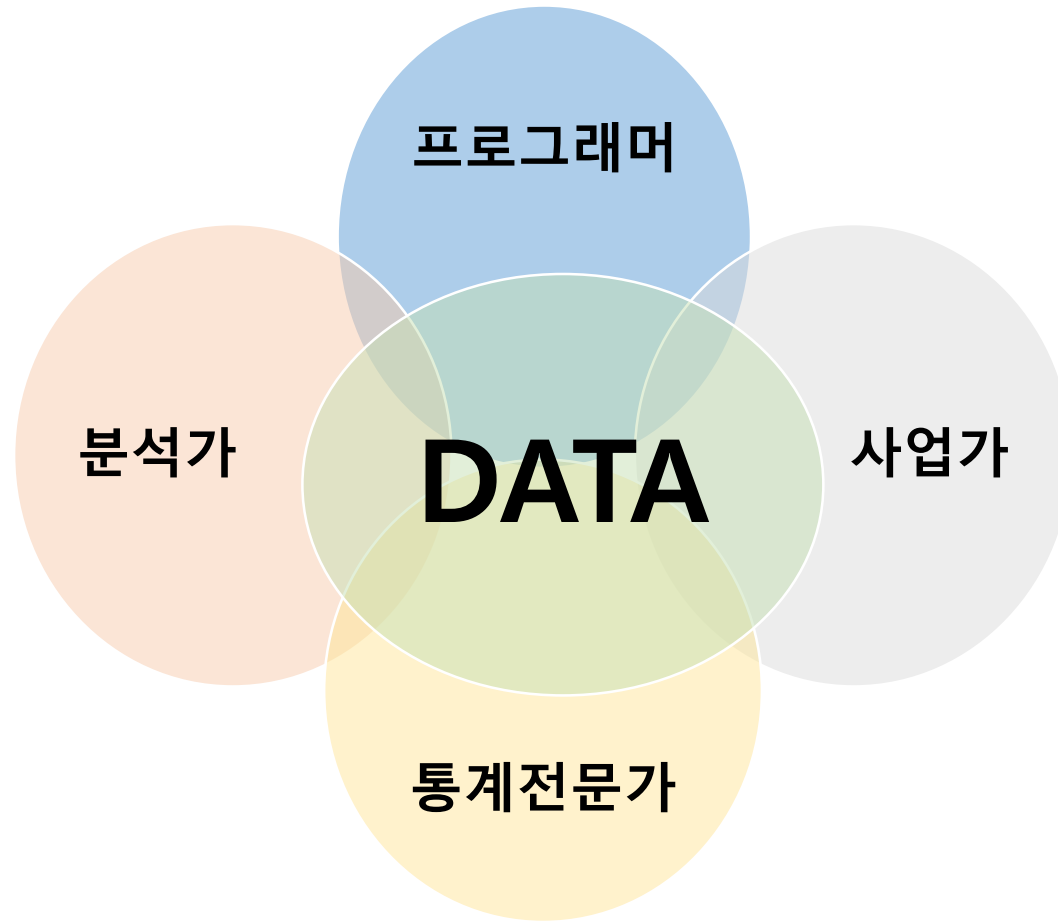


기계화/자동화 → 제조 프로세스 혁신

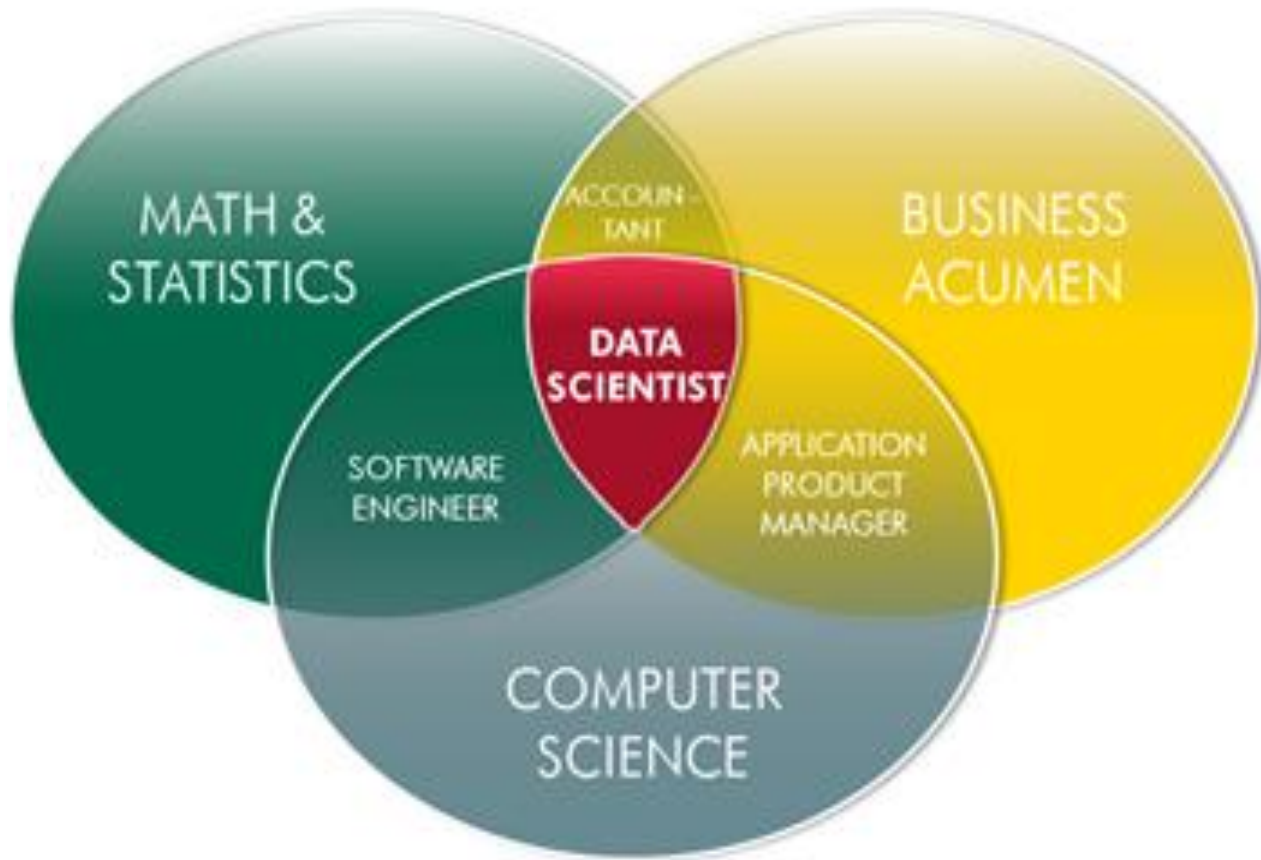
빅 데이터 분석 → **판단 프로세스** 혁신

데이터의 가치창출

- 데이터들을 수익적이고, 효율적으로 분석하기 →
사업가, 분석가, 프로그래머, 통계 전문가의 협업으로 구성



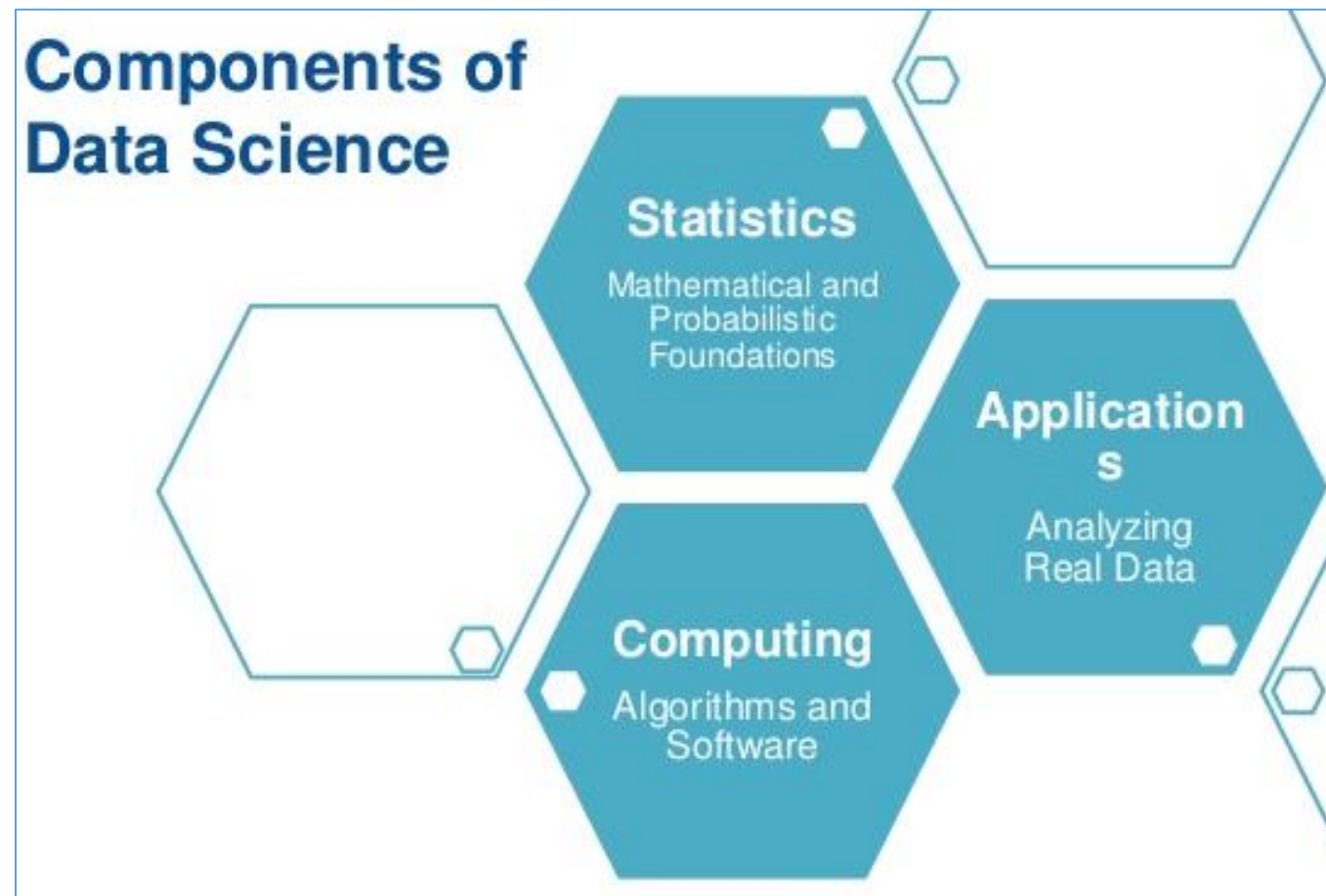
Data Scientist: 기술능력



Data Scientist

- 통계 전문가
- 프로그래머 / 개발자
- 비즈니스 분석가

Components of Data Science



Data science = statistics +
data processing +
machine learning +
scientific inquiry +
visualization +
business analytics +
big data + ...

Data science is the best job in America

25 Best Jobs in America

Employees' Choice Awards

Other Lists

Oddball Interview Questions

Best Jobs

Best Cities for Jobs

Trends

Additional Resources

25 Best Jobs in America

2.5k
Shares



Want a new job? Glassdoor is here to help, identifying the 25 Best Jobs in America for 2016. The jobs that make this list have the highest overall Glassdoor Job Score, determined by combining three key factors – number of job openings, salary and career opportunities rating. These jobs stand out across all three categories.

United States

2016

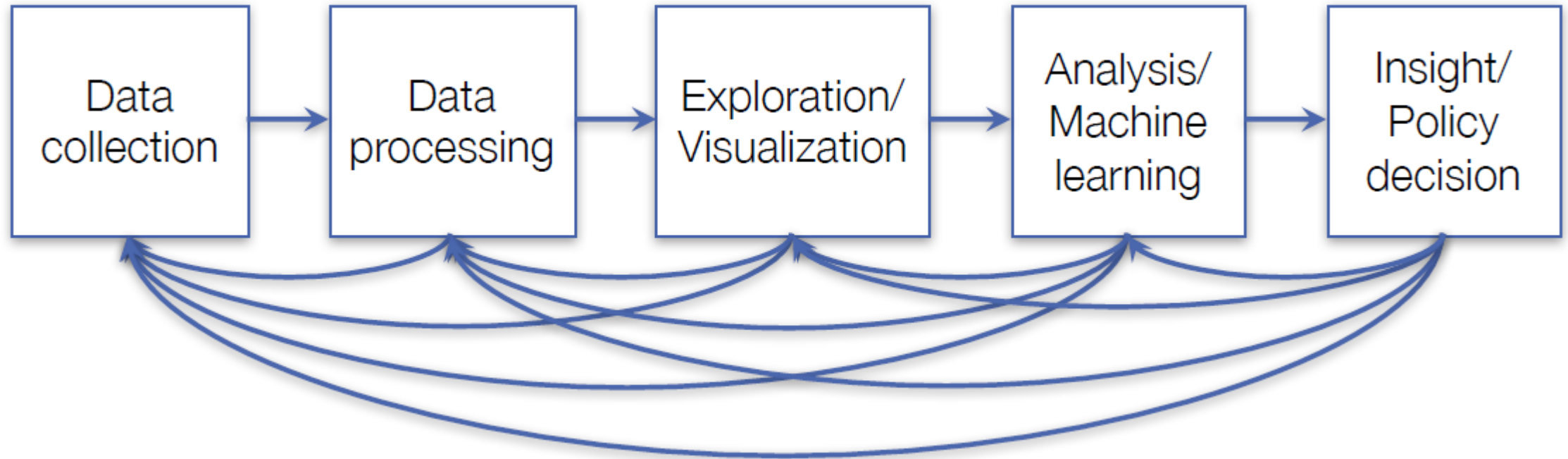
1



Data Scientist

Job Openings	1,736
Median Base Salary	\$116,840
Career Opportunity	4.1
Job Score	4.7

Major Steps of Data Analytics



Intuition Behind Machine Learning

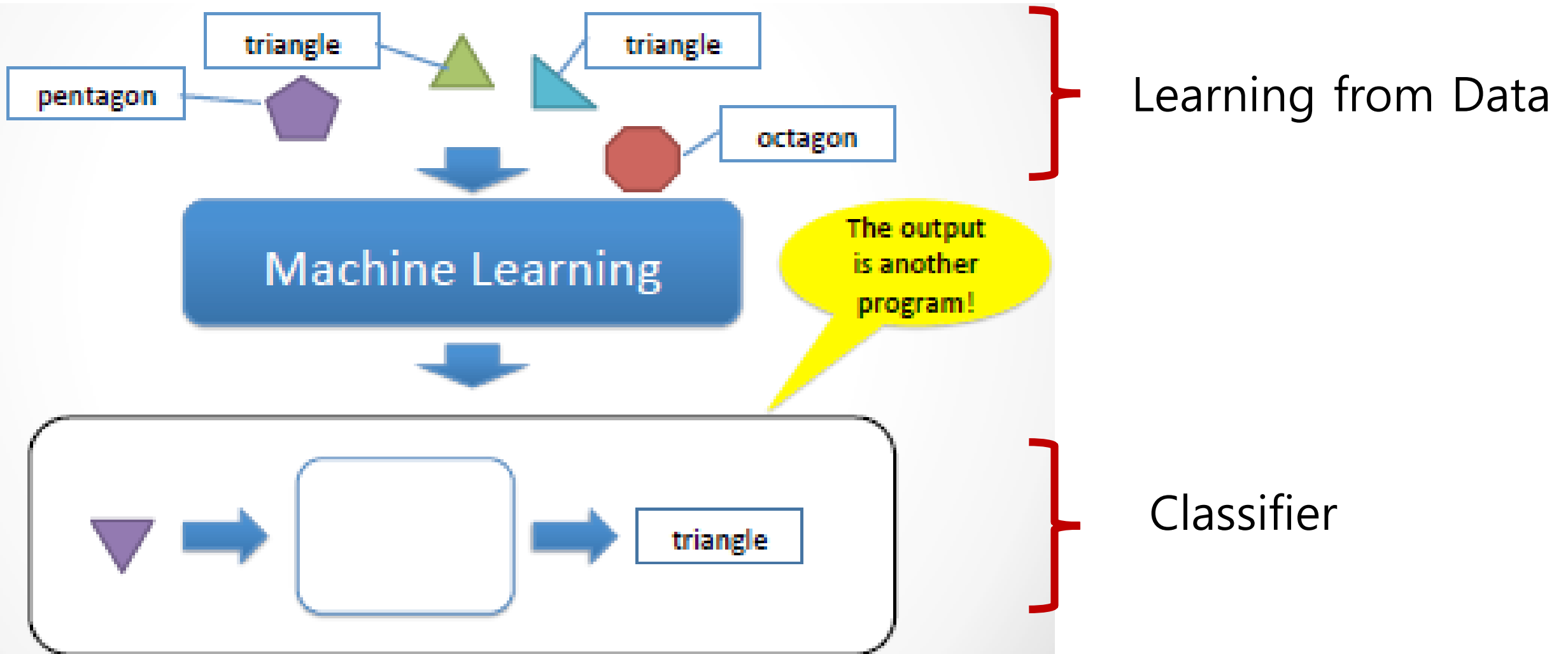


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Data Scientist 부족현상관련 자료 [1/4]

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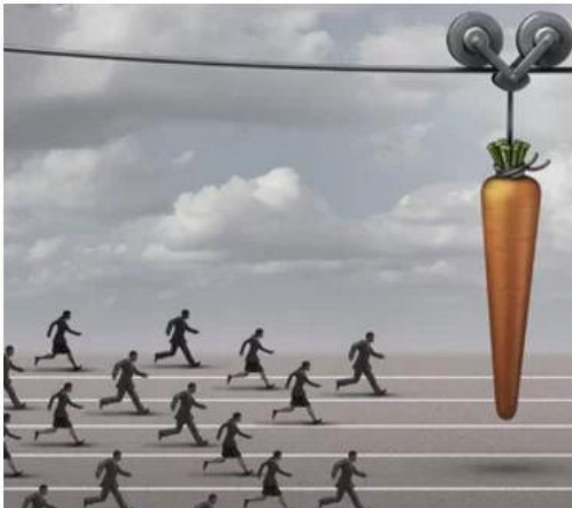
Expert Advice

Big Data, Big Problem: Coping With Shortage of Talent in Data Analysis

BY BUSINESS.COM EDITORIAL STAFF

Business.com / Hiring / Last Modified: February 22, 2017

SHARE THIS



Forty percent of companies are struggling to find and retain data analytics talent, and the picture is starting to look even more bleak.

Big data is a big deal. The sheer quantity of data generated over just the last few years far exceeds the entirety of the previously accumulated human historical data record.

Moreover, [CyberCoders reports on an estimate](#) that the digital universe will reach 40 zettabytes (45 trillion gigabytes) by the end of the decade, a 50-fold growth.

However, as Jonatahn Shaw pointed out in *Harvard Magazine*, it's not the amount of data that makes it a really big deal, it's the ability to actually [do something with it](#).

Data Scientist 부족현상관련 자료 [2/4]

HPC wire

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HPC wire
JAPAN

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intel

ATTUNITY

March 25, 2016

Tracking the Data Science Talent Gap

Alex Woodie



(eelnosiva/Shutterstock)

attempted to put numbers to the problem.

Back in 2012, the research firm Gartner said there would be a shortage of 100,000 data scientists in the United States by 2020. A year earlier, McKinsey put the national gap in data scientists and others with deep analytical expertise at 140,000 to 190,000 people by 2017, resulting in demand that's 60 percent greater than supply. In 2014, the consulting firm Accenture found that more than 90 percent of its clients planned to hire people with data science expertise, but more than 40 percent cited a lack of talent as the number one problem.

Compensation is another way to track the skills shortage. In O'Reilly's 2015 Data Science Salary Survey, data scientists in the United States earned a base median salary of \$104,000, while a Glassdoor survey found the national median to be about \$113,000, nearly double the median for a regular programmer.

datanami
• BIG DATA • BIG ANALYTICS • BIG INSIGHTS •

If your company is looking to hire data scientist right now, good luck. Five years after Harvard Business Review first shone the spotlight on the data scientist shortage, the gap between data science supply and demand remains substantial. In fact, the gap may be getting bigger.

How big is the data science skills gap? There are several ways to attack that problem, and a number of smart people at renowned organizations have

Data Scientist 부족현상관련 자료 [3/4]

THE WALL STREET JOURNAL.

World U.S. Politics Economy **Business** Tech Markets Opinion Arts Life

CIO JOURNAL

The Myth of the Data Scientist Shortage

Technologists and business folks alike overstate the shortage of data scientists. They just need to know where to look.

—by **Tom Davenport**, senior advisor, Deloitte Analytics, professor, Babson College

Data scientists—people who can manage and analyze big, unstructured data—were once as scarce as vegetarian dogs. If your business wasn't based in Silicon Valley or Boston, if you couldn't offer massive stock options, and if you didn't have a sexy business model, you were unlikely to be able to hire any. When I interviewed 35 of them in 2013 for [an article in Harvard Business Review](#), my co-author (D.J. Patil, now a data scientist in the White House) and I wrote, "The shortage of data scientists is becoming a serious constraint in some sectors." The most common educational background among the 35 data scientists I interviewed was a Ph.D. in experimental physics, and there aren't a lot of those sitting around.



Data Scientist 부족현상관련 자료 [4/4]



2017.06.06 (화) 광주 22.6°C



한국경제 산업

빅데이터 수요 맞추려면 전문가 양성 서둘러야

입력 2014-09-05 07:00
수정 2014-09-05 10:26

산업

#모바일



스타론
주식자금 대출문의

Let's Master 빅데이터 (6) 전문인력 양성

데이터 개발·분석전문가 등
분야별로 세분화해 육성을

미국은 84개 프로그램에
총 2억달러 예산 투입

英·日도 전문가 양성 서둘러

미국계 빅데이터 전문업체인 맵알테크놀로지스 등 전문업체들이 잇따라 국내 시장에 상륙하면서 빅데이터 시장이 서서히 달궈지고 있다. 전문가들에 의하면, 양적으로도 2015년 3000억원, 2020년 1조원 규모로 성장할 전망이다. 국내 빅데이터 업체들도 치열한 한판 승부를 각오하고 있지만 애로사항이 첩산중이다.

프리미엄 (주)파이터코리아

주요뉴스

- 1 롯데 유통
- 2 11.2조 일
- 3 "볼거리!"
- 4 치솟는 집
- 5 문재인 디
- 6 울산서 A
- 7 애플 '10.5
- 8 美 증시 기
- 9 위기의 톨
- 10 "경유차

보문듣기



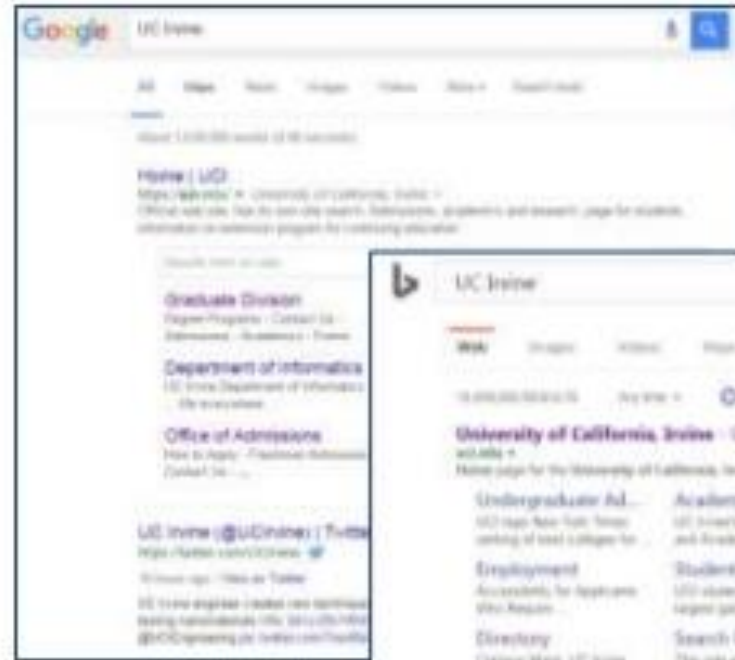
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Data Scientist가 필요한 응용분야 [1/7]

Web Search:

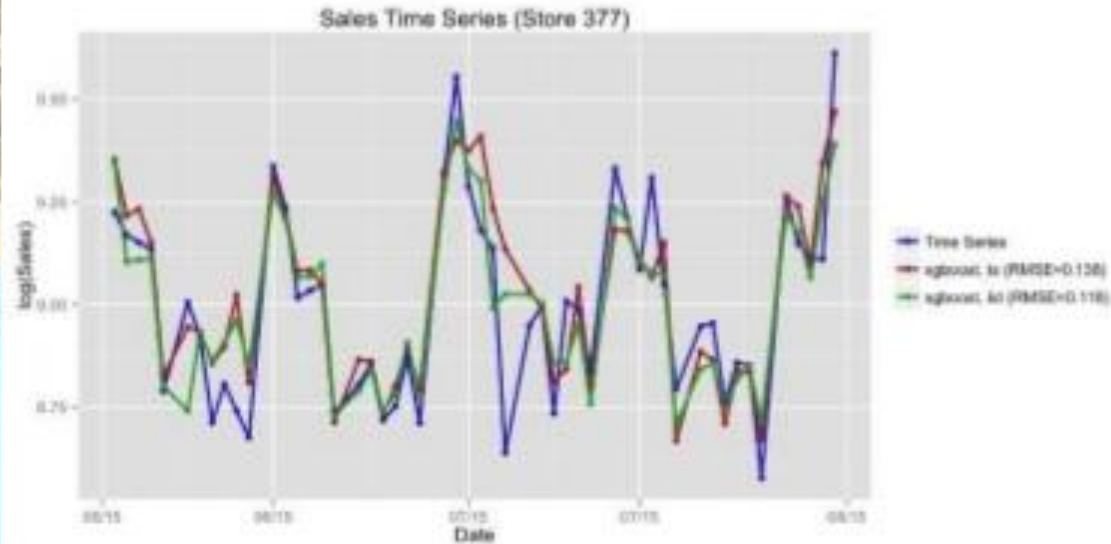
How do search engines rank search results?



Data Scientist가 필요한 응용분야 [2/7]



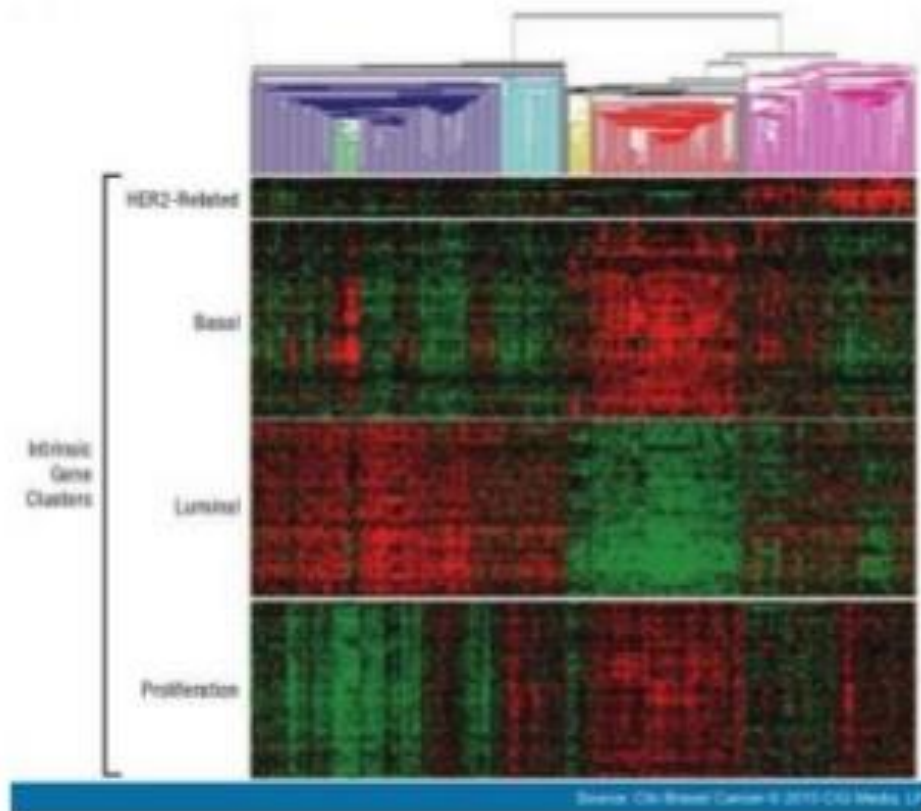
Shopping:
How does Amazon forecast how many items it needs to store in its warehouses?



From cdn.wonderfulengineering.com (top), formaspace.com (bottom) and linkedin.com (right)

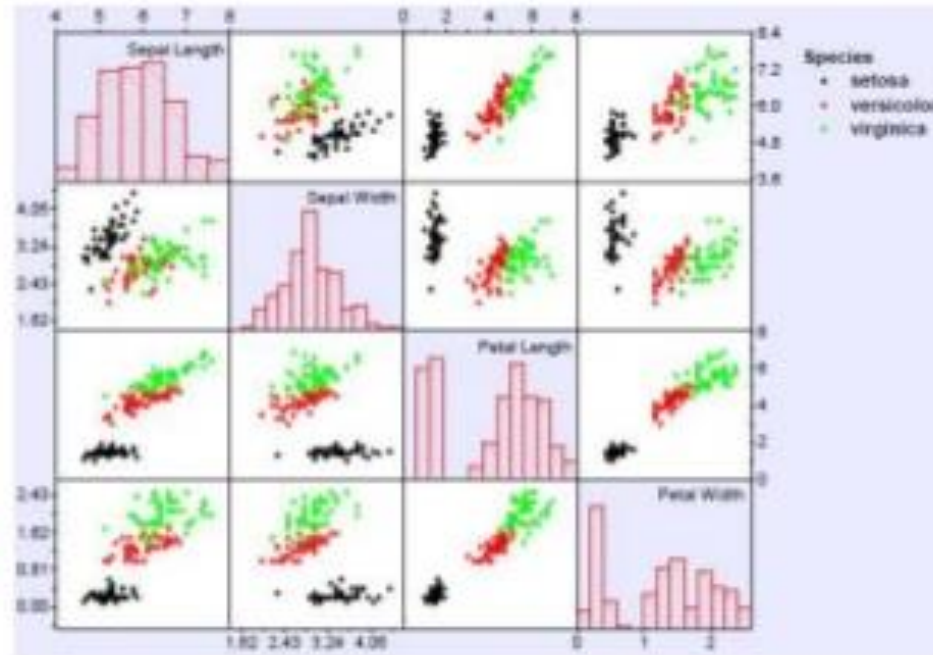
Data Scientist가 필요한 응용분야 [3/7]

Medicine: How can genomics help to personalize medical recommendations?



Data Matrix:

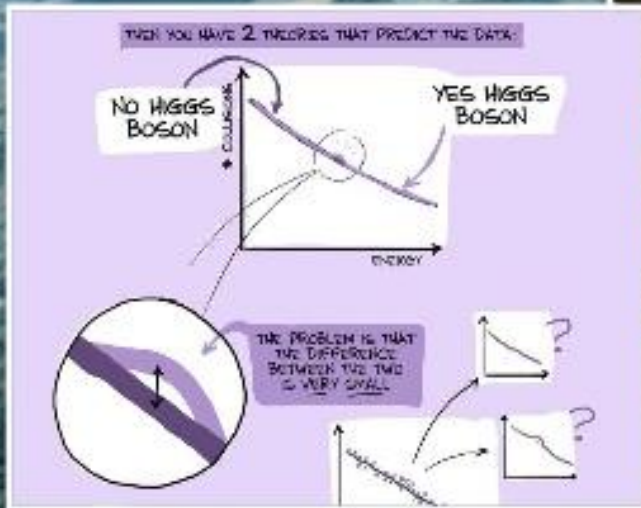
Rows = genes, Columns = patients



Data Scientist가 필요한 응용분야 [4/7]

Physics: How do you write software to search for new physics particles?

Large Hadron Collider:
700 Mbytes/second
60 Terabytes/day
20 Petabytes/year



Data Scientist가 필요한 응용분야 [5/7]

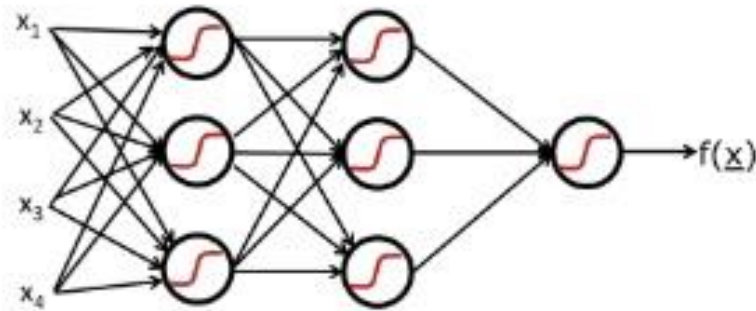
Sports: How do we visualize and understand massive amounts of game sensor data?



Data Scientist가 필요한 응용분야 [6/7]



Social media: How does Facebook recognize people in images?



Data Scientist가 필요한 응용분야 [7/7]

Climate: How does NASA automatically detect land changes using satellite image data?

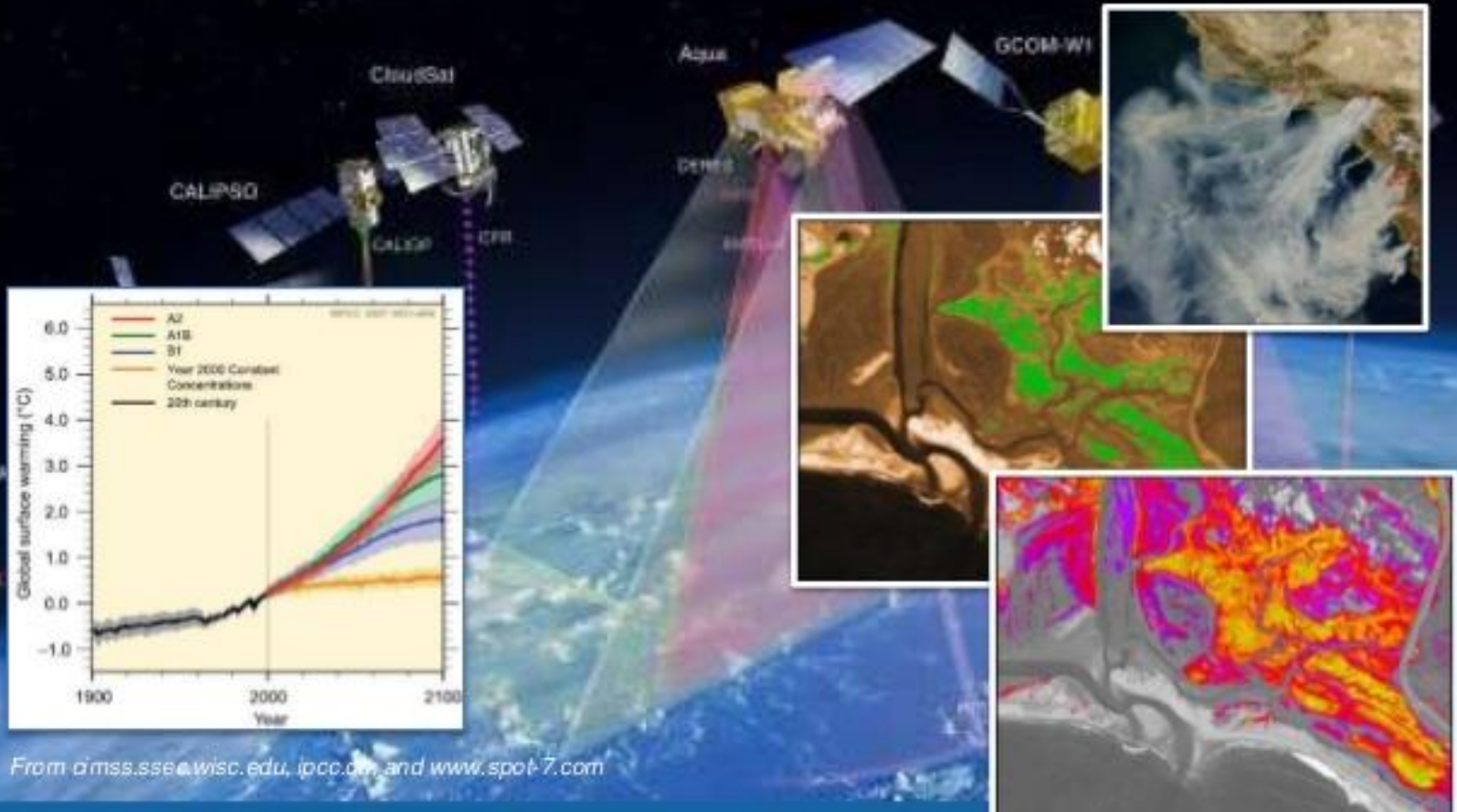


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최근 5년간 미국에 Data Science관련 학위과정 450여개 신설

Web Site:

101.datascience.community

Data Science 101

Learning To Be A Data Scientist

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DATA SCIENCE EDUCATION WEEK, LEARN DATA SCIENCE

COLLEGES WITH DATA SCIENCE DEGREES

APRIL 9, 2012 RYAN SWANSTROM 389 COMMENTS

Colleges and Universities are slowly starting to notice the demand for employees with data science skills. Most of the programs are not named data science, but they all focus on producing *data* people.

Below are a couple of the programs I have noticed so far.

Updated: Last update February 2017

SCHOOL[PROGRAM]	DEGREE	ONLINE/ON-CAMPUS
Auburn University[Online Master of Business Administration with concentration in Business Analytics]	Masters	/ On-campus
Auburn University[Data Science]	Bachelors	/ On-campus
The University of Alabama[Master of Science in Marketing, Specialization in Marketing Analytics]	Masters	Online /
The University of Alabama[MS in Operations Management – Decision Analytics Track]	Masters	/ On-campus
The University of Alabama[M.S. degree in Applied Statistics, Data Mining Track]	Masters	/ On-campus
The University of Alabama[MBA with concentration in Business Analytics]	Masters	Online /
Arkansas Tech University[Business Data Analytics]	Bachelors	/ On-campus
University of Arkansas[Graduate Certificate in Business Analytics]	Certificate	Online /
University of Arkansas[Master of Information Systems with Business Analytics Concentration]	Masters	/ On-campus

Bachelors, Masters, PhDs

참고: Big Data Analytics 관련 미국대학 학부(Undergraduate) 과정

- **Columbia University**
 - Dept of Statistics: **BS in Computer Science-Statistics**
 - <http://www.stat.columbia.edu/program/undergraduate-programs>
- **Carnegie Mellon University**
 - **BS in Machine Learning & Statistics**
 - <http://www.stat.cmu.edu/new-majors-launch/program/stat-ml.html>
- **Johns Hopkins University**
 - **BS in Applied Mathematics and Statistics**
 - <http://engineering.jhu.edu/ams/major-requirements/>
- **Univ of Michigan Ann Arbor**
 - **BS in Information**, School of Information
 - <https://www.si.umich.edu/content/bsi>
- **Univ of Washington, Seattle**
 - **BS in Informatics** in Information School
 - <http://ischool.uw.edu/academics/informatics/curriculum>
- **Univ of Illinois at Urbana-Champaign**
 - Dept of Statistics: **BS in statistics and computer science**
 - <http://www.stat.illinois.edu/>

주목할만한 주요대학 Data Science 석사과정

- Stanford University
- University of Washington
- Carnegie Mellon University

Stanford | Department of Statistics

Search this site...



ACADEMIC PROGRAMS

M.S.

Data Science

Requirement 1 : Foundational (12 units)

Students must demonstrate foundational knowledge in the field by completing the following core courses. Courses in this area must be taken for letter grades.

COURSE NAME & NUMBER	COURSE TITLE	UNITS
CME 302	Numerical Linear Algebra	3
CME 305	Discrete Mathematics and Algorithms	3
CME 307	Optimization	3
CME 308	Stochastic Methods in Engineering	3
or		
CME 309	Randomized Algorithms and Probabilistic Analysis	3

Requirement 2 : Data Science Electives (12 units)

Data Science electives should demonstrate breadth of knowledge in the technical area. The elective course list is defined. Courses outside this list are subject to approval. Courses in this area must be taken for letter grades.

COURSE NAME & NUMBER	COURSE TITLE	UNITS
STATS 200	Introduction to Statistical Inference	3
STATS 203	Introduction to Regression Models and Analysis of Variance	3
or STATS 305A	Introduction to Statistical Modeling	
STATS 315A	Modern Applied Statistics: Learning	2-3
STATS 315B	Modern Applied Statistics: Data Mining	2-3

Requirement 3: Advanced Scientific Programming and High Performance Computing Core (6 units)

COURSE NAME & NUMBER	COURSE TITLE	UNITS
CME 212	Advanced Software Development for Scientists and Engineers	3
Parallel Computing/HCP courses: (3 units)		
CME 213	Introduction to parallel computing using MPI, openMP, and CUDA	3
CME 323	Distributed Algorithms and Optimization	3
CME 342	Parallel Methods in Numerical Analysis	3
CS 149	Parallel Computing	3-4
CS 315A	Parallel Computer Architecture and	3

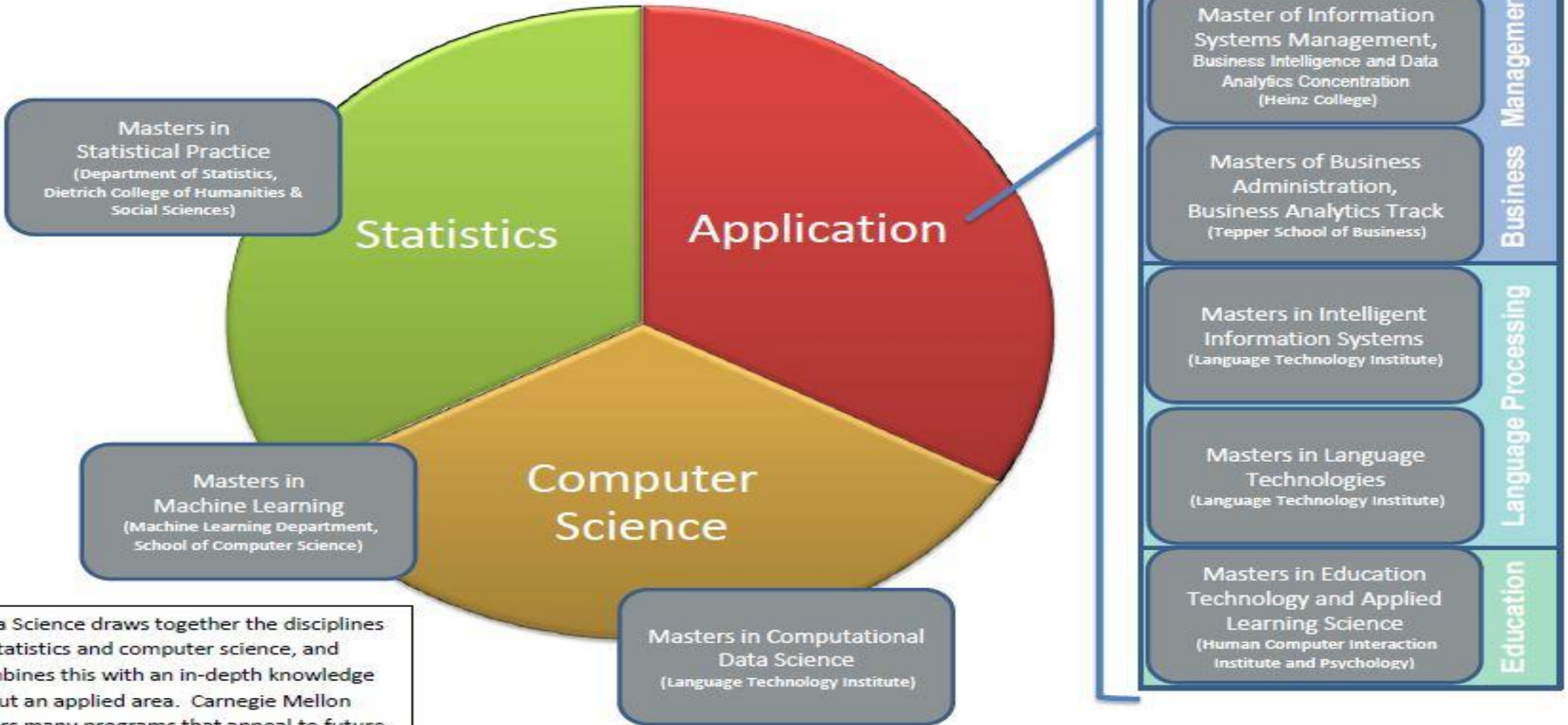


UNIVERSITY *of* WASHINGTON

Master of Science in Data Science

- DATA 556: Introduction to Statistics & Probability
- HCDE 511: Information Visualization with DATA 501: Data Science Visualization Lab
- DATA 557: Applied Statistics & Experimental Design
- DATA 514: Data Management for Data Science
- DATA 558: Statistical Machine Learning for Data Scientists
- DATA 515: Software Design for Data Science
- DATA 516: Scalable Data Systems & Algorithms
- DATA 512: Human-Centered Data Science
- DATA 590: Capstone 1 – Project Preparation
- DATA 591: Capstone II – Project Implementation

Professional Masters Programs for Studying Data Science at Carnegie Mellon University



Data Science draws together the disciplines of statistics and computer science, and combines this with an in-depth knowledge about an applied area. Carnegie Mellon offers many programs that appeal to future Data Scientists. Some are oriented towards an applied area, while others towards these underlying disciplines.

College		Degree	Length	Type	Background		Jobs
Heinz College		Master's in Public Policy, Policy Analytics Track	2 years	Professional masters	Business, science or technical degrees	➔	Government, consulting firms, think tanks
		Master of Information Systems Management, Business Intelligence and Data Analytics Concentration	1.5 years	Professional masters	Technical degree and work experience	➔	Financial services, tech companies, start-ups
Tepper School of Business		Master's of Business Administration, Business Analytics Track	2 years	Professional masters	Diverse backgrounds (see text)	➔	Consulting firms, IT firms, financial data analysis, etc.
School of Computer Science	Language Technology Institute	Masters in Computational Data Science	1.5 years	Professional masters	Computer Science or related	➔	Software engineering jobs at tech companies
		Master's in Intelligent Information Systems	1 year	Professional masters	Computer Science or related	➔	Software engineering jobs at tech companies
		Master's in Language Technologies	2 years	Research masters	Computer Science or related	➔	Software engineering jobs, PhD programs
	Human Computer Interaction Inst. and Psychology	Master's in Education Technologies	1 year	Professional masters	Psychology, education, CS, etc.	➔	Various
	Department of Machine Learning	Master's in Machine Learning	1.5 years	Coursework masters	Computer Science, statistics or related	➔	Software engineering jobs, Finance, PhD programs
Dietrich College of H&SS	Department of Statistics	Master's in Statistical Practice	1 year	Professional masters	Math or Statistics	➔	Consulting firms, finance, marketing, etc.

Carnegie Mellon University (Department of Machine Learning)

Master in Machine Learning (1.5 year program)

- Fall semester, year 1:
 - Intro to Machine Learning, Intermediate Statistics, Elective
- Spring semester, year 1:
 - Statistical Machine Learning, DAP Preparation, Elective
- Summer semester, year 1:
 - Practicum (internship)
- Fall semester, year 2:
 - DAP Research, 2 Electives
- Elective Courses: (4개 선택)
 - Deep Reinforcement Learning / Probabilistic Graphical Models / Convex Optimization / Graduate Artificial Intelligence / Multimedia Databases and Data Mining / Advanced Probability

Carnegie Mellon University (Dept of Statistics and Data Science)

Master in Statistical Practice (1 year program)

Fall Semester

- 36-601 Perspectives in Data Science I
- 36-611 Professional Skills for Statisticians I
- 36-617 Applied Linear Models
- 36-641 Statistical Methods in Epidemiology
- 36-650 Statistical Computing

Spring Semester

- 36-602 Perspectives in Data Science II
- 36-612 Professional Skills for Statisticians II
- 36-618 Experimental Design & Time Series
- 36-664 Data Mining
- 36-726 Statistical Practice

Carnegie Mellon University (Language Technologies Institute)

Master in Intelligent Information System (1.5 year)

Fall	10-601, Machine Learning	12 units	machine learning requirement
	11-642, Search Engines	12 units	application requirement
	11-791, Design and Engineering of Intelligent Systems	12 units	
	11-690, Directed Study (12 units, required)	12 units	required
Spring	11-761, Language and Statistics	12 units	
	11-611, Natural Language Processing	12 units	natural language requirement
	11-797, Question Answering (12 units)	12 units	
	11-690, Directed Study	12 units	required
	11-696, MIIS Capstone Planning Seminar	6 units	required
Summer	Internship	3 units	required
Fall	10-643, Scalable Text Analytics	12 units	
	11-697, MIIS Capstone Project	36 units	required
		153 units	

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V9, Issue2, 2014, NANOCHIP Fab Solutions



THE MOVE TO BIG DATA AND PREDICTIVE ANALYTICS IN SEMICONDUCTOR MANUFACTURING

BY
JAMES
MOYNE AND
MICHAEL
ARMACOST

The move from reactive to predictive analytics in semiconductor manufacturing is being enabled by the corresponding move to big data solutions for advanced process control (APC) systems.

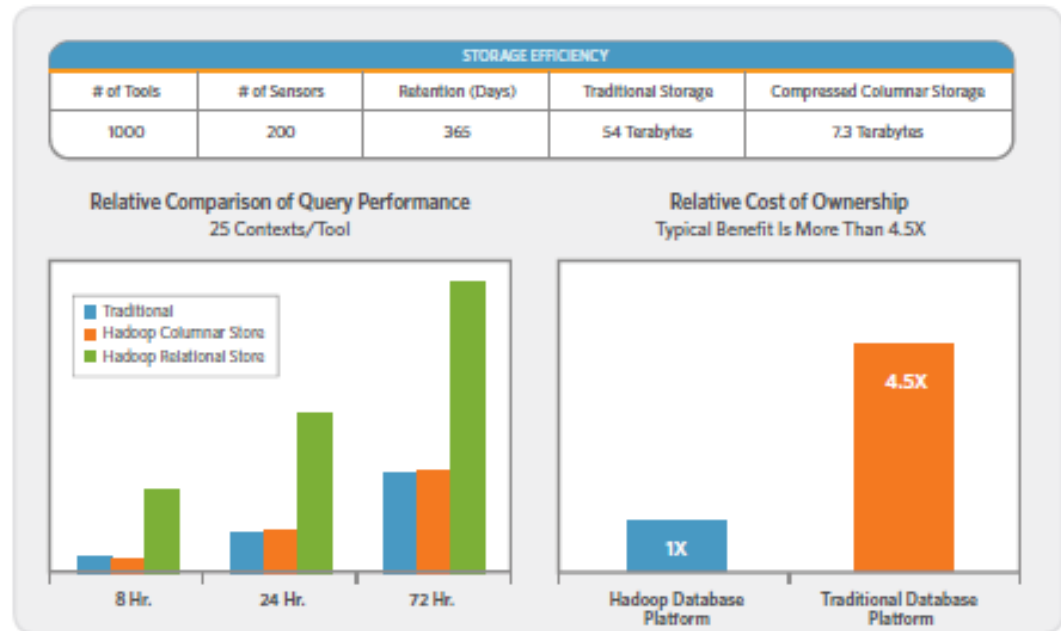


Figure 1. Comparison of traditional and Hadoop-type data platforms (analysis performed as part of the Applied APC big data solution development processes).⁽¹⁾

IEEE Transactions on Semiconductor Manufacturing

A Deep Learning Model for Robust Wafer Fault Monitoring With Sensor Measurement Noise

2월-01
2017

A Convolutional Neural Network for Fault Classification and Diagnosis in Semiconductor Manufacturing Processes

5월-03
2017

Failure Prediction Using Sequential Pattern Mining in the Wire Bonding Process

7월-31
2017

A Comprehensive Big-Data-Based Monitoring System for Yield Enhancement in Semiconductor Manufacturing

10월-23
2017



EMBEDDED SYSTEMS WEEK

OCTOBER 15-20, 2017 | SEOUL, SOUTH KOREA

2017 Conference Program



Keynote: Small Neural Nets Are Beautiful:
Enabling Embedded Systems with Small
Deep-Neural-Network Architectures

Kurt Keutzer, *Univ. of California, Berkeley*

Time: 9:00am to 10:00am

Location: Crystal

DS²과정 강사진

- 서울대 컴퓨터공학부
- 서울대 산업공학과
- 서울대 통계학과
- 서울대 융합대학원 디지털융합전공

DS²과정 Curriculum

- **첫째 학기: 6주과정 (4과목)** (기반기술 과정)
 - Computational Thinking with Python (4주 32시간) 강사: 김형주교수
 - Statistical Methods for BigData Analytics (5주 40시간) 강사: 임채영교수, 이재욱교수(산공)
 - DataBase System Concepts (5주 40시간) 강사: 이상구교수
 - Introduction to AI (3주 24시간) 강사: 김건희교수
- **둘째 학기: 5주과정 (3과목)** (핵심기술 과정)
 - Big Data Processing with Python (3주 24시간) 강사: 김형주교수
 - Data Mining (5주 48시간) 강사: 조성준교수, 김용대교수
 - Data Visualization (5주 48시간) 강사: 서진욱교수, 권가진교수
- **셋째 학기: 5주과정 (4과목)** (고급기술 과정)
 - Large Scale Data Processing (4주 36시간) 강사: 문봉기교수, 이재욱교수(컴공)
 - Cloud for Big Data (3주 28시간) 강사: 전병곤교수
 - Machine Learning (4주 32시간) 강사: 이원종교수, 김건희교수
 - Deep Learning (4주 32시간) 강사: 강유교수

- **실습과정: 4주과정**

Kaggle.com에 있는 Data Analysis Competition 문제중에 1문제를 선택하여

3인 1조로 지도교수 지도하에 4주 작업후 결과물을 제출하여 평가를 받는 방식으로 진행

DS²과정 상세 Curriculum: 1학기 6주 [1/3]

총 강의시간 140시간: 일반강의 136시간 + 특강 4시간

Computational Thinking with Python (4주 32시간)

객체지향 프로그래밍
비정형데이터의 표현과 처리
GUI 프로그래밍
Data Structure 기초
-- Stack/Queue/Tree/Graph
GraphViz module

Database System Concepts (5주 40시간)

Database 개관
관계형 DBMS
SQL기초
SQL중급
SQL고급
Database Application작성
DBMS 구조와 기능
Relational Database설계

Statistical Methods for BigData Analytics (5주 40시간)

Linear Algebra 개관
-- Vector, Matrix

Statistics 개관
-- Statistical Inference
-- Linear Regression

Probability 개관
-- likelihood, EM

Optimization 개관

Introduction to AI (3주, 24시간)

Logic, Knowledge, Reasoning in AI
Problem Solving:
-- Search
-- Constraint Satisfaction Problem
Computer Vision
Natural Language Processing
Reinforcement Learning

DS²과정 상세 Curriculum: 2학기 5주 [2/3]

총 강의시간 122시간: 일반강의 120시간 + 특강 2시간

Big Data Processing with Python (24시간)

Data Analysis를 위한 Module

- Numpy module
- Pandas Module
- Matplotlib Module
- SK Learn Module
- NLTK Module

Data Visualization (48시간)

정보시각화 개요
데이터와 과업 추상화
디자인 프로세스
시각적 인지 모델 및 인간정보처리 모델
그래픽 마크와 채널
퍼소나와 프로토타이핑
그래픽 디자인과 디자인 휴리스틱
검증과 평가 방법론

Data Mining (48시간)

데이터 전처리
회귀분석
분류분석: SVM, Decision Tree, 신경망
군집분석: K-means, DBScan,
주성분분석
연관분석
시계열데이터분석

삼성-서울대 BigData Expert 과정 상세 Curriculum: 3학기 5주 [3/3]

총 강의시간 124시간: 일반강의 124시간

Large-Scale Data Processing (34시간)

분산/병렬 컴퓨팅 개론
Hadoop과 HDFS
Spark 개요 / Spark 응용
Resilient Distributed DataSets (RDD)
NoSQL 시스템 개관
-- KeyValue Store / Document Store
-- Column Store / Large Graph Store

Cloud기반 빅데이터 환경구축 (28시간)

빅데이터 분석을 위한 클라우드 환경 셋업(3)
클라우드상 배치 처리 분석 (6)
클라우드상 대화형 질의 분석 (4)
클라우드상 스트림 처리 분석 (5)
클라우드상 기계학습 분석 (4)
클라우드상 딥러닝 분석 (6)

Machine Learning(32시간)

Classification
-- Decision Tree/ Regression / SVM / Neural Nets
Boosting
Expectation Maximization
Semi Supervised Learning
Ensemble Learning
Probabilistic Graphical Models

Deep Learning(32시간)

Deep feed forward network
CNN
RNN
Regularization
Optimization
Visualizing and Understanding
Practical Method
DeepLearning Applications

서울대 빅데이터연구원

- **초학제적 연구기관**
 - 서울대 본부 직할 연구기관 (2014년 4월 10일 설립)
 - 문이과를 아우르는 Data Science 연구와 인력 양성 선도
- **연구사업**
 - Big Data Big Computing = Supercomputer X BigData
 - 지능형 모빌리티 기술 연구센터
 - 서울시 도시문제 해결형 빅데이터 연구 사업
- 서울대 **도시데이터사이언스 연구소**
 - 개포디지털혁신센터내 (서울시 지원, 2017.4.12)
- 서울대 **데이터 사이언스 혁신(DS&I) 대학원** 설립 추진
 - 2018년 개원 목표



인재 양성

과정명	교육 시간	대상	운영 전공	년 배출인원	기배출 인원	참여 교수	예산지원
대학원생을 위한 Big Camp	24	서울대 비전공 대학원생	빅데이터 인사이트, 빅데이터 엔지니어링	160	440	12	서울대
직장인을 위한 Big Data Academy	48	직장인	빅데이터 인사이트 빅데이터 엔지니어링	90	180	12	수혜자 (유료)
서울시민을 위한 Big Data Academy	80	서울 시민	빅데이터 분석가 빅데이터 엔지니어	300	200 (진행중)	10	서울시
4차산업혁명 아카데미	1,000	미취업자 경력전환 준비자	인공지능 에이전트, 빅데이터 플랫폼 기술, 빅데이터 비즈니스 분석 (핀테크, 로보틱스)	150 ~180	90 (진행중)	30	고용부
기업 맞춤형 (삼성, SK, 농협 등)	140~ 5개월	그룹 임직원 연구원 등	빅데이터, AI, Analytics	100	160	6	기업

서글프게도 2018년의 대한민국은

- “4차산업혁명시대” 구호는 매일 외치면서
- SW Engineer 육성은 이미 오랜기간동안 안되어 왔고....
 - 서울대 컴퓨터공학부 대학원과정 계속 미달
- Big Data분석 전문가인 Data Scientist 육성은 전무하고...
 - Data Science 정규과정 전무
- 결론: 너무나 취약한 SW 생태계! Data분석 생태계!