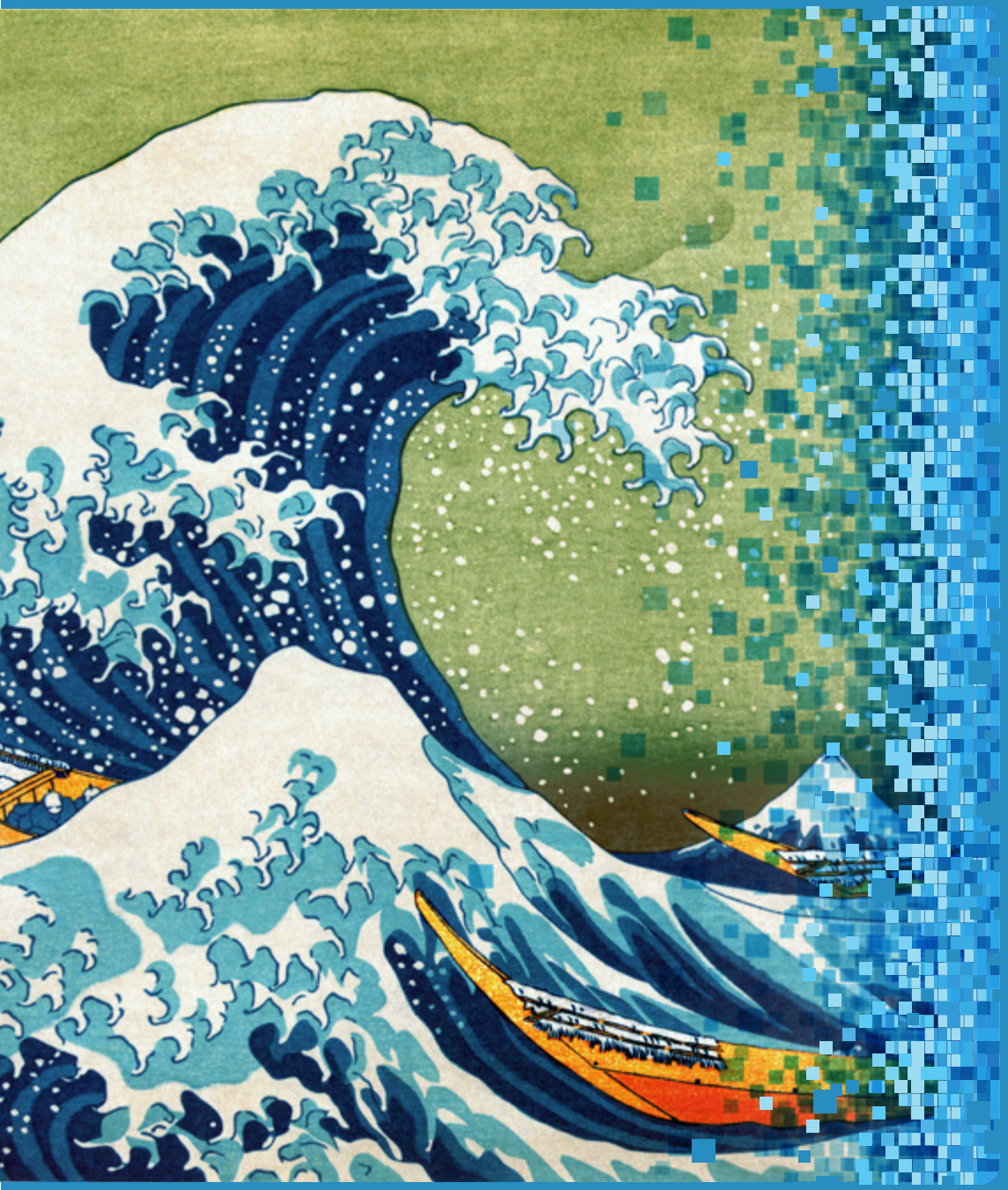


NC in the Next Tech Tsunami:

Navigating the Data Economy

NC Board of Science, Technology & Innovation

ncds | THE NATIONAL CONSORTIUM for DATA SCIENCE

*NC*ODE | *North Carolina* Opportunities in the Data Economy

NC IN THE NEXT TECH TSUNAMI: NAVIGATING THE DATA ECONOMY

November, 2016

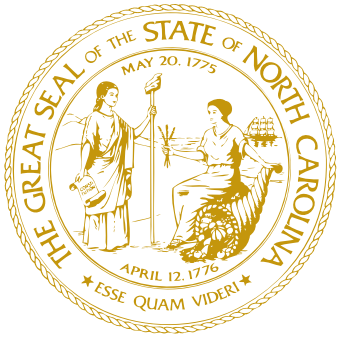
Scott Doron, North Carolina Board of Science, Technology & Innovation

Shannon McKeen, National Consortium for Data Science

Lena Leonchuk, North Carolina State University

David Knowles, National Consortium for Data Science

John Hardin, North Carolina Board of Science, Technology & Innovation



NC Board of Science, Technology & Innovation

ncds | THE NATIONAL CONSORTIUM for DATA SCIENCE

North Carolina OPPORTUNITIES IN THE DATA ECONOMY (*NC*ODE) PARTNERS

With support from the Labor and Economic Analysis Division, North Carolina Department of Commerce.

Two organizations produced this NCODE report: The Board of Science, Technology & Innovation, and The National Consortium for Data Science.

The North Carolina Board of Science, Technology, & Innovation and the National Consortium for Data Science thank all participants in the data gathering process for this report: public and private executives who submitted to personal interviews, the data economy employees who completed surveys, staff at the North Carolina Department of Commerce's Labor and Economic Analytics Division who provided strategic insight into relevant data (as well as providing key report data), and others who supported the project in a myriad of ways.

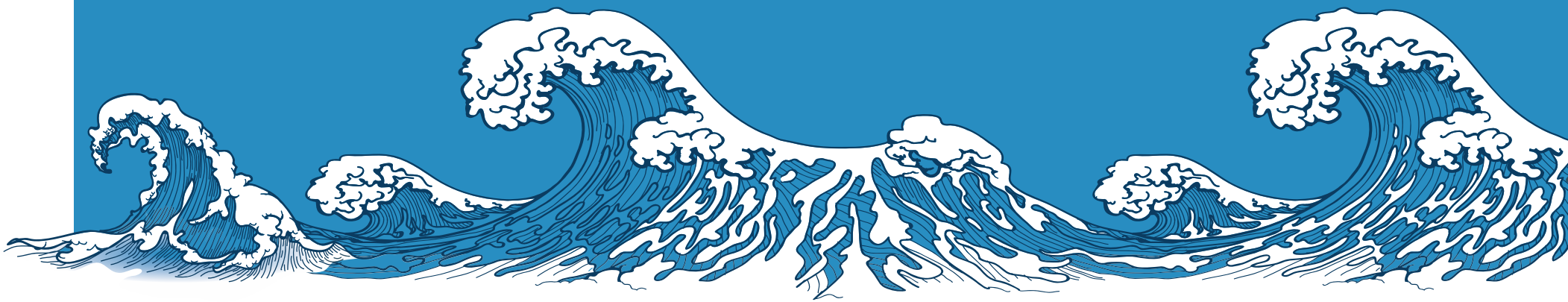
THE BOARD OF SCIENCE, TECHNOLOGY & INNOVATION

The gubernatorial and legislatively appointed North Carolina Board of Science, Technology & Innovation (BSTI) is one of the key proponents for the innovation economy in North Carolina. The Board's mission is *to improve the economic well-being and quality of life of all North Carolinians through advancing science, technology, and innovation*. The Board consists of representatives from the state's leading innovation organizations in the academic, corporate, and governmental domains.

THE NATIONAL CONSORTIUM FOR DATA SCIENCE

The National Consortium for Data Science (NCDS) is a public/private collaboration to help the U.S. take full advantage of the promise of the Big Data revolution, through new jobs and companies, better healthcare, data-driven discoveries in science, and competitive advantages for industry. The consortium launched in 2013 as an initiative of the University of North Carolina-Chapel Hill's Renaissance Computing Institute. The NCDS has a national scope, although most members at this time are North Carolina-based universities and companies with major presences in North Carolina.

CONTENTS



Executive Summary

NCODE: NORTH CAROLINA OPPORTUNITIES IN THE DATA ECONOMY

- The Data Tsunami
- NCODE: North Carolina Opportunities in the Data Economy
- Why Should North Carolina Target the Data Economy?
- North Carolina Has Impressive Data Economy Assets
- To Become a Top State, North Carolina Should...

THE DATA TSUNAMI[1]

A technology tsunami is washing over businesses, institutions, and people worldwide. Massive amounts of data have coalesced into a wave of change. Every day, routine actions by people and machines generate floods of data: smart phones communicate, sensors detect, robots manufacture, banks network, cameras surveil—just to name a few. Humans have created more data in the past two years than in the entire history of the world.[2]

In the face of this storm, North Carolina has a choice. It can either actively pursue the data economy toward increased economic prosperity, or be swept away by the economic rip currents. The choice is sink or swim; this report advocates for action. North Carolina must act now, in strategic ways, to maintain and enhance its stature as a leader in the data economy.

WHO NEEDS DATA SKILLS?

- All NC Students
- All NC Companies, Big and Small
- All NC Industries
- All Areas of the State

NCODE: NORTH CAROLINA OPPORTUNITIES IN THE DATA ECONOMY

North Carolina has significant assets to steam ahead in the data economy: marquee companies, strong centers and programs at the state's public and private universities, large numbers of workers and university graduates critical to the industry, and relevant national organizations. Many of North Carolina's most critical industries, such as manufacturing (aerospace, automotive), financial services, life sciences, and agriculture—employing hundreds of thousands of workers—are increasingly dependent on data skills and tools.

Despite these strong assets, North Carolina has unrealized potential to be recognized nationally and internationally as top in the data economy—a must-be location for high-paying researchers and workers, labs, centers, and new and established companies.

WHY SHOULD NORTH CAROLINA TARGET THE DATA ECONOMY?

Fast Growth in a slow-growth economy: global data economy revenues are expected to increase over 50 percent to $187 billion in 2019.[3]

High Wages:

- North Carolina technology wages: $115,239.[4]
- North Carolina average wages: $43,000.

Extreme Need for Talent: over 9,000 postings for database administrators nationwide.

Improved Rural Economies: agriculture and forestry industries are rapidly utilizing crop data analytics, sensors, drones, artificial intelligence, and robots.

Strengthen Companies by making other North Carolina industries more competitive:

- Manufacturing ranks as the third largest industry needing data professionals.
- Retail ranks fourth.

THE NCODE NARRATIVE

- **Chapter 1:** The data economy is expanding rapidly.
- **Chapter 2:** NC ranks high, but not the top among the states.
- **Chapter 2:** NC has the assets to be a top state.
- **Chapters 3 & 4:** NC has the workforce and graduates needed by the data economy.
- **Chapter 5:** NC should act now to maintain its standing and prevent stature erosion.
- **Chapter 6:** Next Step: Form a working group.

NORTH CAROLINA HAS IMPRESSIVE DATA ECONOMY ASSETS

Large Number of Marquee Data Companies:

- Data Science: SAS, IBM, Red Hat, Cisco, Inmar, Tresata.
- Data Intensive: Quintiles, MetLife, PPD.
- Data Enabled: Bank of America, BB&T, Fidelity Investments, Credit Suisse, Deutsch Bank.

World Class Universities: Duke University, Wake Forest University, UNC-Chapel Hill, North Carolina State, UNC-Charlotte, and many more.

Large Numbers of Relevant Professionals: nearly 140,000.

Large and Increasing Number of Relevant Graduates: nearly 40,000 last year college graduates.

Leading Research/Education/ Government Centers with expertise in statistics, analytics, training, and modeling.

Vibrant Entrepreneurial Environment:

- $1.24 billion in total startup funding.
- One of nine Google Hubs in the U.S.
- 9th ranked state in venture capital.

TO BECOME A TOP STATE, NORTH CAROLINA SHOULD:

1. Elevate the data economy to the top tier of economic development priorities.
2. Grow and support the data science startup ecosystem across the state, and promote it nationally.
3. Create a pipeline of data science education and data literacy, K-20+.
4. Position North Carolina as the “Open Data” state.
5. Support world-class data science research in North Carolina.

[1] The Executive Summary does not include footnotes except for references not appearing in subsequent chapters of the report.

[2] Marr, Bernard. "Big Data: 20 Mind-Boggling Facts Everyone Must Read". *Forbes* http://www.forbes.com/sites/bernardmarr/2015/09/30/big-data-20-mind-boggling-facts-everyone-must-read/#72c315b6c1d3. (September 30, 2015).

[3] IDC. "Worldwide Big Data and Business Analytics Revenues Forecast to Reach $187 Billion in 2019." *Worldwide Semiannual Big Data and Analytics Spending Guide*. May 23, 2015. Accessed October 24, 2016. https://www.idc.com/getdoc.jsp?containerId=prUS41306516.

[4] North Carolina Technology Association. *North Carolina State of Technology 2016: Wages*. February 22, 2016. Accessed September 9, 2016. http://www.ncstir.com/tech-report/tech-sector/average-wage/.

Potential and Peril in the Data Tsunami

THE DATA ECONOMY IS EXPANDING RAPIDLY

- The Data Tsunami: The Fourth Industrial Revolution
- The Potential for the North Carolina Economy
- The Peril for the North Carolina Economy
- North Carolina's Most Critical Industries Rely on Data

THE DATA TSUNAMI: THE FOURTH INDUSTRIAL REVOLUTION

"The Big-Data Future Has Arrived." *Wall Street Journal* [5]

"How Can Big Data Fight Terror." *Wall Street Journal* [6]

"A Cancer 'Moonshot' Needs Big Data." *Wall Street Journal* [7]

The data economy—an economy based on data collection and manipulation for insight and profit (this report uses data economy inclusive for other data terms like Big Data and data science)—will determine North Carolinians' future careers and prosperity.

The World Economic Forum emphatically describes the data economy moment:

> *We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before.*
>
> *The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century."* [8]

THE POTENTIAL FOR THE NORTH CAROLINA ECONOMY

Amidst these revolutionary undercurrents, North Carolina has the assets to sail through the turbulent data economy. This report identifies a number of steps North Carolina can take to maximize its data economy opportunities for accelerated economic growth. The most important step involves education and jobs. A statewide data-literate workforce will enable the rewards of a growing North Carolina data economy to be realized in all 100 counties and across all major industry sectors. Although opportunities in the data economy are often seen as being relevant only to technology companies and urban areas, in fact, the opportunities of the data economy flow across all jobs and industries and can enable all to flourish.

IMPORTANT TERMS FOR THIS REPORT

- **Data:** *facts, statistics, or items of information.*
- **Data Economy:** *an economy based on data collection and manipulation for insight and profit, but also including support for these activities. In this report, data economy is used as the general term inclusive of Big Data, data science, and analytics, except where further specificity of terms is needed.*
- **Big Data:** *data that is hard to manage because of increased complexity due to volume, velocity, variety, veracity, and visibility.*
- **Data Science:** *the systematic study of the organization and use of digital data in order to accelerate discovery, improve critical decision-making processes, and enable a data-driven economy.*
- **Analytics:** *processing of data for meaning and insights.*
- **Open Data:** *data in the public domain with no financial or security barriers for manipulation by the public.*

THE PERIL FOR THE NORTH CAROLINA ECONOMY

Although North Carolina has great opportunities in the data economy, the state cannot simply tread water, resting on its current assets in this rapidly evolving sector. Acting now during the field's early evolution will maximize the opportunity for job growth in all companies, in all industries, in all areas.

Significant efforts are underway in other states and regions to capitalize on their data assets (see Appendix). Without deliberate and targeted action, North Carolina's current advantages could be eclipsed by other states investing in their data economy assets. For example, Massachusetts, Nebraska, Ohio, and Nevada are building university data science centers. Massachusetts is spending an additional $15 million on hiring data science faculty and conducting research.[9] California, Texas, and Washington promote the data economy focused in urban areas.[10] North Carolina can be the first with a statewide initiative that includes rural and suburban areas.

"The (company) founders are graduates from NCSU. And Quality of Life here is second to none. There's unlimited opportunity. North Carolina should be the Internet of Things/ Data Science state."

David Houghton, Director, Bright Wolf

REVOLUTION	YEAR	WHAT HAPPENED?
First Revolution	1784	Steam and water power runs mechanical production equipment.
Second Revolution	1870	Electricity enables mass production.
Third Revolution	1969	Computer and electronics fuel technology-driven economy.
Fourth Revolution	?	Mobile communications and sensors blur boundaries between people, the Internet and the physical world.

Based on "Data and the fourth industrial revolution." World Economic Forum.

There will be many winners, and some losers, in the data economy. Advances in data tools will enable new technologies like machine learning, robotics, and 3D printing, which put education and training pressures on existing employees. Still, these advances will lead to productivity improvements that may offset manufacturing labor advantages overseas and promote a surge in manufacturing employment back in North Carolina. These new or returning manufacturing jobs will be different than past manufacturing jobs, because they require more advanced skills in math, statistics, analytics, and information technology. Workers without education and skills will be left further behind.

"NC has a big opportunity in data science and data analytics because of our strong universities, big businesses, and talented IT workforce. Plus, all this information resides in data centers, which NC has one of the largest data center concentrations in the country."

Chris Estes, Director, PricewaterhouseCoopers, Former North Carolina Chief Information Officer

North Carolina's Most Critical Industries Rely on Data

AEROSPACE

Aerospace companies use analytics to reduce production time and improve quality in the design, construction, and operation of aircraft.

North Carolina Example: Raleigh's **Precision Hawk** originally produced commercial drones to be used in the agriculture market. More recently, the company has focused on building software tools to manage and interpret drone data so it can be utilized to enhance decision-making across industries. The company's new software products open opportunities for businesses to safely capture aerial imagery using any drone and then automatically analyze the data by choosing from algorithms listed in the industry's first app store for drone data.[11]

U.S. Example: Boeing established the Boeing/Carnegie Mellon Aerospace Data Analytics Lab with an ultimate goal of planes that use data systems to automate flying and correct equipment failures.[12]

AGRICULTURE

Farmers are collecting data on weather, soil, and air quality through cameras, sensors, drones, and satellites. The collected data flows into analytic systems so farmers can make informed decisions such as type and amount of fertilizer, optimal water needs, and other factors that maximize yields while saving resources.

North Carolina Example: FarmShots, a spinout from Duke University, detects crop diseases on plant acreage through satellite imagery. The company currently services 300,000 acres of land.[13]

U.S. Example: The Climate Corporation examines weather, soil and field data to help farmers determine yield-limiting factors. The company installs sensors in John Deere tractors. The sensors relay data to computer screens in the tractor's cab. Monsanto bought the company for $1.1 billion in 2013. [14]

AUTOMOTIVE

Automotive companies use analytics to reduce production time and improve quality in the design, construction, and operation of automobiles.

North Carolina Example: SAS, the world's largest private software firm, has products aimed at automotive customers. Using this software, automotive dealers can collect customer data in real time, develop precision marketing campaigns, and make more effective car-purchase offers.[15]

U.S. Example: Automotive companies are partnering with technology companies to develop self-driving vehicles based on data gathering and analytics. Ford Motor Company teamed with Google, AT&T, and Amazon. Toyota Motor Corporation has a partnership with Microsoft and invested $1 billion into R&D, including the establishment of two new autonomous vehicle research centers next to Stanford and MIT.[16]

BANKING

Financial institutions use analytics to detect fraud, target customers, manage investments, trace financial transactions, and provide "robotic" financial advice using artificial intelligence systems.

North Carolina Example: Tresata, founded in Charlotte, provides a variety of customer analytics products. Its TEAK program helps investigators spot relationships and network patterns that signal money laundering and fraud. Formed in 2011 by a former Bank of America employee, the company appears in the *Inc. 500* listing of the fastest growing companies in the country, with a three-year average growth rate of 433 percent.[17]

U.S. Example: Market Prophit believes cutting-edge information on stocks, currencies, and commodities does not come from standard financial sources, but from blogs and social media. The company scans the Internet to evaluate the financial returns of finance tweeters and bloggers in order to find successful advisors not in mainstream finance.[18]

BIOSCIENCES

Drug companies generate vast and ever-increasing amounts of data from research, drug trials, regulatory compliance, patient care, modeling, and manufacture.

North Carolina Example: IBM's Watson—the artificial intelligence system—is working with the University of North Carolina School of Medicine to develop health care applications. When Watson examined a thousand cancer diagnoses, it found treatment options missed by doctors in 30 percent of the cases. Watson can scan and synthesize the 160,000 cancer research papers published each year and apply its findings to medical cases.[19]

U.S. Example: Atomwise uses supercomputers to predict which potential medicines will be effective and which are toxic, and to discover new uses for old medicines.[20]

ENERGY

Finding mineral deposits has always been a data-intensive process. Other energy data activities include analytics to monitor and maximize electric plants and grids, to optimize positioning for solar and wind power devices, and to create new services for home utility customers.

North Carolina Example: North Carolina has the second largest smart grid cluster in the U.S., with over 75 companies, including such leaders as ABB, Cree, Schneider Electric, and Siemens. The state also has four leading smart grid-related research centers: the ABB Smart Grid Center of Excellence, the Duke Energy Smart Grid Laboratory, the FREEDM Systems Center, and PowerAmerica.[21]

U. S. Example: Bidgely's software provides home electric consumption data through the web, with data coming from every electric appliance in the house, such as refrigerators, dryers, furnaces, and pool pumps. Computer programs collect data to provide time-of-use electricity consumptions by day, month, and year, compared to calculated norms.[22]

FOOD PROCESSING

Sensors, bar codes, and vision technologies track food from field to stores, ensuring safe food processing, providing pathogen detection and mitigation, monitoring Genetic Modified Organism food, and many other activities.

North Carolina Example: Sealed Air, a 23,000-employee company headquartered in Charlotte, North Carolina, developed a digital food safety management platform that consolidates data from the manufacturing plant to monitor and measure operations for better safety, regulatory compliance, less food waste, and improved efficiency.[23]

U.S. Example: Rentokil Initial developed sensors that detect handwashing compliance in real-time. The technology increases compliance from 40 percent to 80 percent.[24]

TEXTILES

North Carolina is a leader in wearable technologies, with several universities researching the combination of fabrics and sensors for improved health. Additionally, fashionistas are using analytics to predict colors and style trends, leading to more effective production schedules.

North Carolina Example: Spoonflower in Durham provides print-on-demand designs for fabrics, wallpaper, and other applications and is the largest collection of independent fabric designers in the world, with around one million participants. Customers can choose existing patterns or print their own.[25]

U.S. Example: Leading fashion house Ralph Lauren created a POLOTECH shirt with silver threads woven into the fabric to stream data back to an iPhone. Applications on the phone or at remote hubs gather data for personal and community health. [26]

[5] February 22, 2016.

[6] June 14, 2016.

[7] January 14, 2016.

[8] Marcus, Alan. "Data and the fourth industrial revolution." World Economic Forum. December 2, 2015. Accessed October 25, 2016. https://www.weforum.org/agenda/2015/12/data-and-the-fourth-industrial-revolution/.

[9] Ksiazkiewicz, Robert. "Universities Seek External Funds for Big Data R&D Centers." *SSTI Digest*. August 25, 2016. Accessed October 6, 2016. http://ssti.org/blog/universities-seek-external-funds-big-data-rd-centers.

[10] Presentation by STAR team (Student Teams Achieving Results). See Appendix.

[11] TechCrunch. "PrecisionHawk raises $18 million to bring drones safely into U.S. airspace." April 20, 2016. Accessed October 25, 2016. https://techcrunch.com/2016/04/20/precisionhawk-raises-18-million-to-bring-drones-safely-into-u-s-airspace/.

[12] HPCwire. "CMU and Boeing Establish Aerospace Data Analytics Lab." October 1, 2015. Accessed October 6, 2016. https://www.hpcwire.com/2015/10/01/cmu-and-boeing-establish-aerospace-data-analytics-lab/.

[13] Burwood-Taylor, Louisa. "The Growing Ecosystem of Satellite Imagery for Ag." *Agfunder News*. March 28, 2016. Accessed October 18, 2016. https://agfundernews.com/the-growing-ecosystem-of-satellite-imagery-for-ag5611.html.

[14] Grassi, Matthew J. "Climate Corp. is the Jewel in Bayer's Monsanto Deal Crown." *PrecisionAg*. September 15, 2016. Accessed October 25, 2016. http://www.precisionag.com/technology/data/opinion-climate-corp-is-the-jewel-in-bayers-monsanto-deal-crown/.

[15] See SAS Automotive Solutions webpage, accessed October 19, 2016. http://www.sas.com/en_us/industry/automotive.html.

[16] Kolsevich, Jason. "Autonomous Vehicle Partnerships: How Tech Companies and Automakers are Collaborating to Innovate the Future." Waterstreet Partners. May 2, 2016. Accessed October 19, 2016. https://www.waterstreetpartners.net/blog/autonomous-vehicle-partnerships-how-tech-companies-and-automakers-are-collaborating-to-innovate-the-future.

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[18] Dameron, Emerson. "20 Big Data startups in NYC you need to know." Builtinnyc.com. May 31, 2016. Accessed October 5, 2016. http://www.builtinnyc.com/blog/big-data-startups-nyc.

[19] Lohr, Steve. "IBM Is Counting on Its Bet on Watson, and Paying Big Money for It." *New York Times*. October 17, 2016. Accessed October 18, 2016. http://www.nytimes.com/2016/10/17/technology/ibm-is-counting-on-its-bet-on-watson-and-paying-big-money-for-it.html.

[20] Information from the Atomwise website, accessed October 5, 2016. http://www.atomwise.com/.

[21] The Economic Development Partnership of North Carolina. *The North Carolina Energy Industry*. July, 2016. Accessed October 19, 2016. https://edpnc.com/wp-content/uploads/2016/08/NC-Energy-2016.pdf.

[22] Puttre, Michael. "Analytics And Big Data Are Changing the Energy Market Map." *Solar Industry Magazine*. Accessed October 6, 2016. http://solarindustrymag.com/online/issues/SI1501/FEAT_03_Analytics-And-Big-Data-Are-Changing-The-Energy-Market-Map.html.

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[26] Rind, Victoria. "Swarovski and silicon: Where electronics and fashion meet." IBM Big Data and Analytics Hub. December 3, 2015. Accessed October 25, 2016. http://www.ibmbigdatahub.com/blog/swarovski-and-silicon-where-electronics-and-fashion-meet.

North Carolina's Data Economy: Rising, But Still Below the Surface

NORTH CAROLINA RANKS HIGH, BUT NOT AT THE TOP

- North Carolina: The Data Economy Secret
- High Ranking But Room to Grow
- Tremendous Economic Impact from the Data Economy
- Best in Class Companies
- Exceptional University Data Research and Education Resources
- A Leader in Relevant Academics
- Vibrant Entrepreneurial Climate

NORTH CAROLINA: THE DATA ECONOMY SECRET

Few people outside North Carolina realize the depth, breadth and energy of the state's data economy environment—at least until they move here. So said data executives in interviews for this report. One executive opined few people outside the state knew marquee data companies like SAS and Red Hat were headquartered within the state.

North Carolina's data economy has a **branding challenge**. North Carolina's leadership role in the data economy is not as universally known as it should be.

With this report, North Carolina joins a select group of states and communities in communicating its data economy strengths. This chapter describes the state's leading data assets, while also explaining its not-quite-at-the-top ranking among the states.

HIGH RANKING, BUT ROOM TO GROW

North Carolina's ranking in the data economy[27] (companies, universities, workforce, and entrepreneurs) reveals significant standing among the states, although still some distance from the top. State rankings from many different sources affirm this conclusion. A compilation of these rankings appears below.

AFFIRMING NORTH CAROLINA AS A LEADING, BUT NOT TOP, DATA STATE

RANKING	METHOD	DATA SOURCE	DESCRIPTION
2nd Quartile	Internet Survey, NCODE Team	Data Professionals	Almost 400 data workers completed the survey.
1st/2nd Quartiles	Personal Interviews, NCODE Team	Data Executives	30 data economy leaders in personal interviews.
7 of 8 Leading States	Survey	Big Data Executives	Compiled in MA Big Data Report.
23rd of 50 States	Composite Data, OSTI[28]	Mostly Government Data	Composite of 39 indicators of the Innovation Economy.
17th of 50 States	Calculation by NCDS[29]	Bureau of Labor Statistics	Percent data workers of all workers.

Source: Table compiled by Office of Science, Technology, & Innovation, North Carolina Department of Commerce.

TREMENDOUS ECONOMIC IMPACT FROM THE DATA ECONOMY

Although economists have difficulty measuring the economic impact of the state's data economy, the North Carolina technology industry in general contributes a large share of the state's economy.[30] The industry provides 20 percent of the state's total sales ($134 billion) and about 17 percent of the state's employment. Since many of the state's largest technology companies are also data companies, a big share of the technology industry's economic impact comes from data companies.

Because technology jobs are high paying, they generate further economic impact. For every one technology job created, five additional jobs are, on average, generated.[31]

BEST-IN-CLASS DATA COMPANIES

Many companies known as global data leaders are headquartered in North Carolina. Other companies, though not recognized as data companies, use data as a critical component of their business operations and strategies. Some of the most significant data companies in technology, biosciences, and finance are described on subsequent pages.

EXCEPTIONAL UNIVERSITY DATA RESEARCH AND EDUCATION RESOURCES

Many prominent educational and research resources anchor North Carolina's data economy (for a complete listing, see the Appendix). Several centers combine data analytics training with specific industry expertise, producing highly desirable graduates. This mixture of technical and industry skills represents one of North Carolina's strengths in the data economy compared to other states that have a more theoretical approach.

NORTH CAROLINA: A LEADING ENTREPRENEUR STATE

Ranking of Large Population States in Entrepreneurship

STARTUP COMPANY GROWTH		
State	2016 Rank	2015 Rank
VA	1	1
MD	2	2
AZ	3	6
MA	4	3
TX	5	5
LA	6	4
CO	7	7
NC	8	15
AL	9	13
GA	10	9

Startup Company Growth *measures the scaling of startup companies in the larger population states.*

2016 Kauffman Entrepreneurial Index.

A LEADER IN RELEVANT ACADEMICS

North Carolina has abundant raw materials for innovation, ranking, for example, 4th nationally in academic science and engineering research & development as a share of gross domestic product.[32]

The state also has many prominent education programs in areas relevant to the data economy, but not many top 10 program rankings, further demonstrating North Carolina's strong, but not top stature in the data economy. For example, Duke, UNC-Chapel Hill, and North Carolina State University rank 10th, 12th and 15th respectively in graduate statistics programs—a critical discipline for the data economy. The state also has top-ten programs in agriculture, biomedical engineering, general academics, graduate business, and medicine. A complete list of relevant program rankings appears in the Appendix.

VIBRANT ENTREPRENURIAL CLIMATE

According to the project survey, growing the North Carolina entrepreneurial community is the most important activity for spurring the state's data economy.[33] The state already ranks as a leading entrepreneurial state. It ranked 8th in the creation of new startups and 8th in the scaling of those new startup companies among large population states.

In the past, North Carolina startup funding was scarce, but the latest research shows the state's funding capability has greatly improved. North Carolina jumped to 9th place nationally in *Moneytree's* venture capital ranking in the second quarter of 2016—a five-spot improvement from the previous year.[34] North Carolina companies raised $124.1 million in venture capital in the latest quarter.

The *Moneytree* report only tracks venture capital. But a financial tracking system from the Council for Entrepreneurial Development, which included funding from private equity, grants, and awards, found that North Carolina startups raised $1.253 billion in 2015.[35]

NORTH CAROLINA: A LEADING ENTREPRENEUR STATE

Ranking of Large Population States in Entrepreneurship

RATE OF STARTUPS		
State	2016 Rank	2015 Rank
TX	1	3
FL	2	1
CA	3	4
NY	4	6
CO	5	2
AZ	6	7
NJ	7	18
NC	8	8
MO	9	10
LA	10	5

Rate of Startups *measures the founding of companies in larger population states.*

2016 Kauffman Entrepreneurial Index.

SIGNIFICANT NORTH CAROLINA DATA ECONOMY COMPANIES IN CRITICAL SEGMENTS

Data Finance Companies

Bank of America, headquartered in Charlotte, and **BB&T**, headquartered in Winston-Salem, are the 2nd and 8th largest U.S. banks by assets.[36] Big banks use data and analytics to re-invent customer services and products, identify fraud, manage investments, track transactions, and other activities.

In "Wall Street Is Moving to North Carolina," *Information Week* describes the establishment of North Carolina operations by **Deutsche Bank**, **Fidelity Investments**, and **Credit Suisse**. Reasons for the investments include an excellent quality of life and proximity to world-class universities.

MetLife — like all life insurance companies, a statistics and data reliant company — has established new North Carolina facilities and hired over 2,600 employees during the last few years. MetLife Chairman and Chief Executive Officer Steve Kandarian said "Since we announced two years ago...we've become even more convinced that North Carolina offers everything MetLife needs to thrive and grow in the years to come."[37]

Tresata, founded in Charlotte, provides several customer analytics products, with programs that spot relationships and network patterns that signal fraud and money laundering. Formed in 2011 by a former Bank of America employee, the company built one of the first open source, data intelligence platforms. The 2016 *Inc. 500* listed the company as one of the fastest growing companies in the country, with a three-year average growth rate of 433 percent. It was the only Big Data company to make the list.[38]

Data Technology Companies

Transitioning to a company built on data and analytics, cloud services, and artificial intelligence, **IBM Research Triangle Park** represents the company's largest facility in North America.[39]

Inmar, a leader in data analytics services to the health and retail industries, was founded and still resides in Winston-Salem.

Cisco Systems in North Carolina represents the largest concentration of Cisco employees outside Silicon Valley. Cisco UCS Integrated Infrastructure for Big Data provides a platform for many data services.

Red Hat, a provider of open source software models to 90 percent of Fortune 500 companies, is another spin-out from North Carolina State.

SAS Institute is the world's largest private software company, with over 11.000 global employees. A spin-out from North Carolina State University, the company creates products based on statistical analysis, modeling, and methodology.

Data Bioscience Companies

North Carolina is among the top states in biotechnology agriculture, being home to five of the six largest ag-bio companies: **BASF**, **Bayer**, **DuPont Pioneer**, **Monsanto**, and **Syngenta**.[40]

PPD (Pharmaceutical Product Development), another North Carolina contract research powerhouse, ranked 6th largest per revenue.[41]

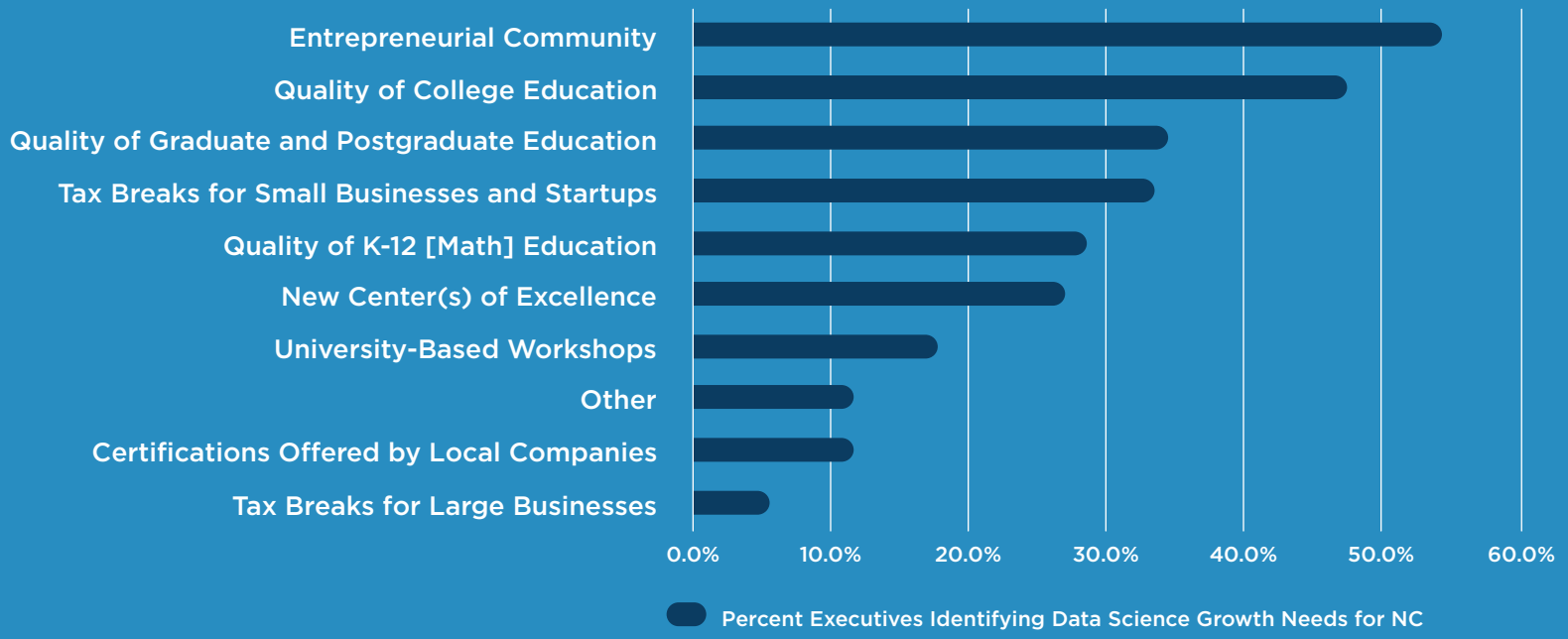
Quintiles, the largest global drug contract research organization in terms of revenue, spun out from UNC-Chapel Hill. North Carolina leads the nation in the concentration of clinical trials management companies.[42]

EXECUTIVES RANK THE LEADING BIG DATA STATES

State	Ranking #1	Ranking #2	Ranking #3	Ranking #4	Ranking #5	Ranking #6	Ranking #7	Ranking #8	Average Ranking
CA	58.8%	20.6%	8.8%	2.9%	0.0%	0.0%	5.9%	2.9%	2.0
MA	26.5%	35.3%	14.7%	11.8%	2.9%	2.9%	2.9%	2.9%	2.6
NY	5.9%	23.5%	20.6%	14.7%	2.9%	8.8%	8.8%	14.7%	4.2
WA	0.0%	2.9%	23.5%	17.7%	29.4%	8.8%	5.9%	11.8%	4.8
VA	0.0%	5.9%	8.8%	17.7%	11.8%	26.5%	26.5%	2.9%	5.4
TX	5.9%	2.9%	8.8%	11.8%	17.7%	17.7%	14.7%	20.6%	5.5
NC	0.0%	5.9%	8.8%	11.8%	17.7%	20.6%	17.7%	17.7%	5.6
IL	2.9%	2.9%	5.9%	11.8%	17.7%	14.7%	17.7%	26.5%	5.9

Source: Survey of Big Data Business People in The Massachusetts Big Data Report. #1 represents the top state, #2 second ranked state, etc.

IMPROVING THE ENTREPRENEURIAL COMMUNITY: #1 ACTION TO ACCELERATE NC'S DATA ECONOMY



Source: 2016 Survey from the Board of Science, Technology & Innovation and the National Consortium for Data Science.

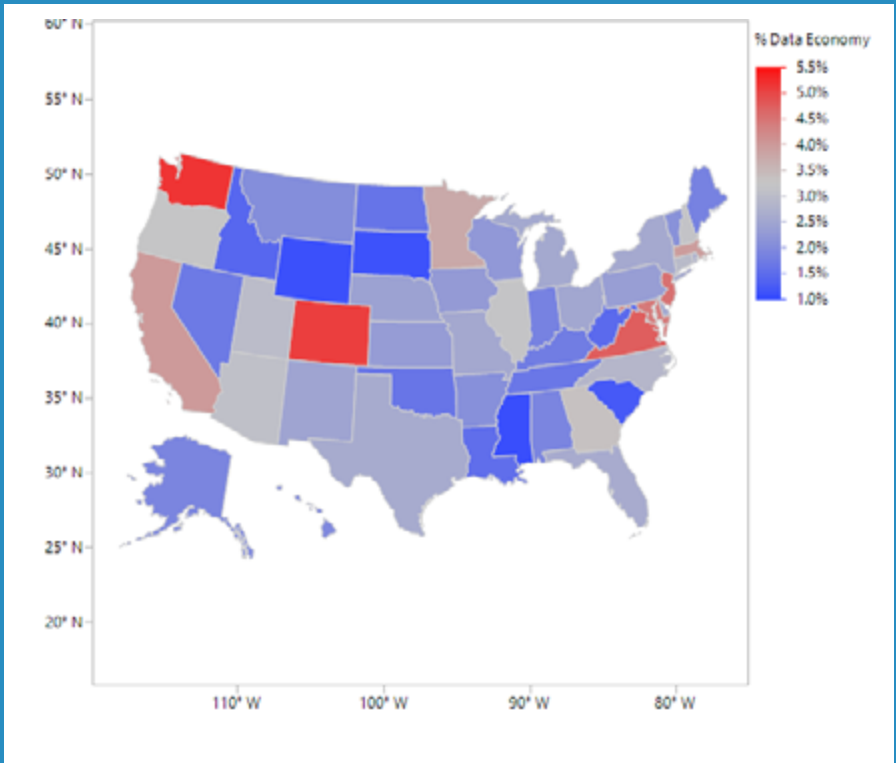
NORTH CAROLINA IN THE SECOND QUARTILE

Percent Data Economy Employees Compared to Total Employment

RANKING	STATE	DATA ECONOMY EMPLOYMENT	PERCENT DATA ECONOMY EMPLOYMENT
1	WA	154,830	5.20%
2	CO	124,960	5.10%
3	VA	175,350	4.80%
4	NJ	177,900	4.60%
5	MD	115,160	4.40%
6	CA	618,470	4.00%
7	MA	134,180	4.00%
8	MN	104,280	3.80%
9	GA	138,110	3.40%
10	OR	56,090	3.20%
11	IL	187,630	3.20%
12	NH	20,250	3.20%
13	AZ	80,010	3.10%
14	UT	39,800	3.00%
15	CT	49,230	3.00%
16	NC	118,690	2.90%
17	RI	12,750	2.70%
18	FL	208,540	2.60%
19	TX	302,490	2.60%
20	NY	231,110	2.60%

Source: Calculated by the National Consortium for Data Science.

PERCENT DATA ECONOMY EMPLOYEES COMPARED TO TOTAL EMPLOYMENT



Source: Calculated by the National Consortium for Data Science.

North Carolina Has Leading Data Research and Education Centers

American Underground, an incubator of almost 230 companies in Durham, has garnered national attention as one of nine Google Tech Hubs, and for its successful minority- and woman-owned business programs.

The **Blackstone Entrepreneurial Network** created mentoring networks of experienced entrepreneurs.

The mission of the **Center for Analytics Research and Education (CARE)** at Appalachian State University is to use data analytics to promote positive change in society: "Analytics for Good." CARE addresses change in the areas of sustainability, education, economic development, human resources, and health and wellness.

The mission of **The Center for Retail Innovation** at Wake Forest University is to "generate superior investment returns by driving new trends and ideas in retail."

The Center for Quantitative Modeling in Duke University's Engineering Management Program provides students with a deep understanding of using Big Data to solve problems and increase revenue.

The Council for Entrepreneurial Development in Research Triangle Park is the largest and oldest technology entrepreneurial support network in the country. It has helped thousands of businesses establish and grow through mentorship and training programs, access to extensive capital networks, and pitch contests.

The Data Science Initiative at UNC-Charlotte, led by the College of Computing and Informatics and the Belk College of Business, promotes education, training and research in data science and analytics, integrated with business and industry expertise—a critical need for North Carolina.

The North Carolina **IDEA Foundation**, a private foundation supporting entrepreneurial business innovation and economic advancement in North Carolina, announced the awarding of nine grants in 2016, totaling $1,175,000, to organizations that support entrepreneurs.

The Master of Science in Analytics program at the **Institute of Advanced Analytics** (IAA), housed at North Carolina State University, graduated 120 students in 2016. The *Harvard Business Review* recognized IAA, alongside programs at Stanford, MIT, and Harvard, as one of the few educational programs with proven strengths in data science. The degree has a practical orientation wanted by employers, and is not intended to be a prelude to doctoral study.

The Laboratory for Analytics Sciences, located on North Carolina State's Centennial Campus, is the largest sponsored research contract in the university's history. The U.S. National Security Agency funded this laboratory for training and research in areas critical to the nation's security.

The **National Consortium for Data Science** is a public/private collaboration to profit from advances in data science. The Consortium launched in 2013 as an initiative of UNC-Chapel Hill's Renaissance Computing Institute.

The **National Institute of Statistical Sciences** and the **Statistical and Applied Mathematical Sciences Institute,** located in Research Triangle Park, conduct and facilitate research in statistical studies.

The **North Carolina Data Science and Business Analytics Initiative**, funded for $2.1 million over three years from the University of North Carolina General Administration and the North Carolina Legislature, will develop university research hubs in fundamental and applied data science research.

Charlotte's incubator at **Packard Place** provides accelerator programs and specializes in energy and financial technology startups, reflecting the cities' business strengths.

A National Science Foundation Big Data center, **South Big Data Regional Innovation Hub** is a public-private partnership that addresses regional challenges through data analysis. Initial areas of focus include health care, coastal hazards, industrial applications, materials, and manufacturing. Managed by UNC Chapel Hill and Georgia Institute of Technology.

Wake Technical Community College in Raleigh offers the first and only community college **Associate Degree in Business Analytics** in the country. Wake Tech also offers five analytics certificates: Business Analytics; Business Intelligence; Financial Analytics; Logistics Analytics; and Marketing Analytics.

[27] No industry or occupation codes encompass the data economy as a separate industry. Therefore, indirect means of industry analysis must be used for the metrics. Further footnotes will explain the context and methodology of the statistics.

[28] OSTI is the acronym for the Office of Science, Technology & Innovation, NC Department of Commerce. NCDS is the acronym for National Consortium for Data Science.

[29] OSTI is the acronym for the Office of Science, Technology & Innovation, NC Department of Commerce. NCDS is the acronym for National Consortium for Data Science.

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[32] National Science Board. *Science and Engineering Indicators 2016*. (Arlington, VA: National Science Foundation.) Accessed October 17, 20116. https://www.nsf.gov/statistics/2016/nsb20161/#/stateind.

[33] According to electronic survey of data executives conducted by the Board of Science, Technology & Innovation, and the National Consortium for Data Science.

[34] IDEA Fund Partners. "NC rises to 9th in VC funding after 7th straight $100M+ quarter." Posted July 15, 2016. Accessed October 26, 2016. http://ideafundpartners.com/nc-rises-9th-vc-funding-7th-straight-100m-quarter/.

[35] Council for Entrepreneurial Development. *Innovators Report*. Accessed September 20, 2016. http://cedNorth Carolina.org/innovatorsreport/.

[36] Maxfiedl, John. "The 10 Biggest Banks in America." The Motley Fool. Posted January 27, 2016. Accessed October 26, 2016. http://www.fool.com/investing/general/2016/01/27/the-10-biggest-banks-in-america-4q15.aspx.

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[41] Dezzani, Lucas. "Top 10 Global CROs in 2016." IGEA. Posted April 14, 2016. Accessed October 26, 2016. https://igeahub.com/2016/04/14/top-10-global-cros-in-2016/.

[42] Dezzani, Lucas. "Top 10 Global CROs in 2016." IGEA. Posted April 14, 2016. Accessed October 26, 2016. https://igeahub.com/2016/04/14/top-10-global-cros-in-2016/.

Experienced Talent Keeping Companies Afloat

NORTH CAROLINA HAS THE WORKFORCE AND GRADUATES NEEDED BY THE DATA ECONOMY

- Data: Not Just for Tech Companies
- The Needs of the North Carolina Data Professional
- Deep Pool of Data Talent

DATA: NOT JUST FOR TECH COMPANIES

In activities as different as sweet potato cultivation, steel processing, and drug discovery, competitive advantage results from hiring data professionals for insight, planning, and strategy. Reynolds American, the second-largest U.S. tobacco company, headquartered in Winston-Salem, has advertised for over 20 data scientists over the last few months.[43] Other non-tech companies hiring data scientists include BASF, General Dynamics, General Electric, Bank of America, Duke Power, and Norfolk Southern Railroad. Of course, technology companies need data talent, too. IBM and Cisco—companies with very significant North Carolina employment—advertise for the most data professionals in the country.[44]

Big companies are not the only ones using data for competitive advantage. Forty-one percent of medium-size companies have one or more Big Data projects underway.[45]

Since companies of all sizes and in all industries need data talent, they are frenetically hunting for data professionals. For example, current U.S. job openings for data scientists exceed 3,000; database administrator openings exceed 9,000.[46]

Demand for these jobs translates into high salaries. Professionals with data analytic skills, regardless of their industry or job classification, earn from 12 to 140 percent more than comparable professionals lacking these skills. Of the top 10 skills for jobs paying more than $75,000, four require data skills.[47] In North Carolina, average wages for experienced data professionals are two to four times the state's average.

THE NEEDS OF THE NORTH CAROLINA DATA PROFESSIONAL

In the rapidly evolving data industry, education and training are critical. Yet, the survey revealed a dissatisfaction by non-management data professionals with their abilities and training. Only about 60 percent are confident in their technical skills and believe they have the analytic skills to do their jobs. Only 56 percent believe their companies provide enough training.

Despite this, managers are overwhelmingly satisfied with their data hires—81 percent with data scientists and 83 percent with data analysts. Still, when asked about the barriers to hiring data employees, most managers cited lack of adequate training, followed by affordability, and then shortage of applicants. About 20 percent of managers said no challenges exist to hiring data scientists or analysts in North Carolina.

"By 2018, the U.S. will face a shortage of 190,000 workers with deep analytical skills and 1.5 million managers with the analytics know-how to drive decisions."

McKinsey Global Institute

Skills are not just about technology. Nearly all managers believe data analysts should possess strong soft skills (teamwork, communications, etc.), while nearly 90 percent concurred for data scientists. Interviewed executives affirmed this importance of soft skills.

The survey also demonstrated the importance of business and industry knowledge in addition to technical skills—also confirmed through executive interviews. Many of the state's most important data science programs, such as the Master of Business Analytics at North Carolina State University, the Big Data Initiative at University of North Carolina-Charlotte, and training by the Center for Retail Innovation at Wake Forest University, emphasize industry knowledge along with technical skills. This trend should become a signature characteristic of the state.

Another important survey finding pertains to relocation of technical professionals to North Carolina. Some tech professionals hesitate to move here because of a perceived lack of job opportunity compared to California or Massachusetts. Yet the survey discovered seventy percent of North Carolina data professionals have little apprehension about finding another North Carolina job if their present job ended.

DEEP POOL OF DATA TALENT

Almost 140,000 North Carolina professionals work in occupations related to the data economy. The companies dominated by these data professionals grew much faster than state employment as a whole.

The Research Triangle area, anchored by Raleigh, Durham, and Chapel Hill, ranks as one the most significant concentrations of data professionals in the country. Research Triangle[48] ranks in the top five areas for data positions per 100,000 population,[49] at almost three times the national average.

Calculated another way by using Location Quotients,[50] the Research Triangle area ranks fourth[51] in concentration of key data professions. Additionally, the area has the second highest LQ concentration of data scientists, lagging only San Francisco.

"North Carolina is one of only a few data science innovation hubs in the US, and we feel a sense of great excitement among our researchers about the rapid development of this field in our state."

Erin D. Hopper, Research Director, University of North Carolina System, General Administration

ALL NC'S MAJOR INDUSTRIES NEED DATA SCIENTISTS

North Carolina Companies Advertising for Data Scientists

INDUSTRY	COMPANY
AgBio	BASF
AgBio	Bayer
AgBio	Syngenta
Consulting	Accenture
Consulting	Deloitte
Consulting	PricewaterhouseCoopers
Consulting	RTI International
Consulting	Trident Technologies, LLC
Mfg.	General Dynamics
Mfg.	United Technologies
Energy	Duke Energy Corporation
Engineering	AECOM
Engineering	Amec Foster Wheeler
Engineering	Terracon
Federal Govt	Animal & Plant Health Inspection
Federal Govt	National Institutes of Health
Federal Govt	U.S. EPA

INDUSTRY	COMPANY
Finance	Aetna Inc.
Finance	Bank of America
Finance	BB&T
Finance	Deutsche Bank
Finance	Fidelity Investments
Finance	MetLife
Finance	Wells Fargo
Health	Becton Dickinson
Health	Blue Cross and Blue Shield
Health	Carolina Healthcare System
Health	Lab Corp of America
Health	Mission Health
Health	Novant Health
Health	SciMetrika, LLC
Industrial	Cree, Inc.
Industrial	General Electric
Industrial	Siemens

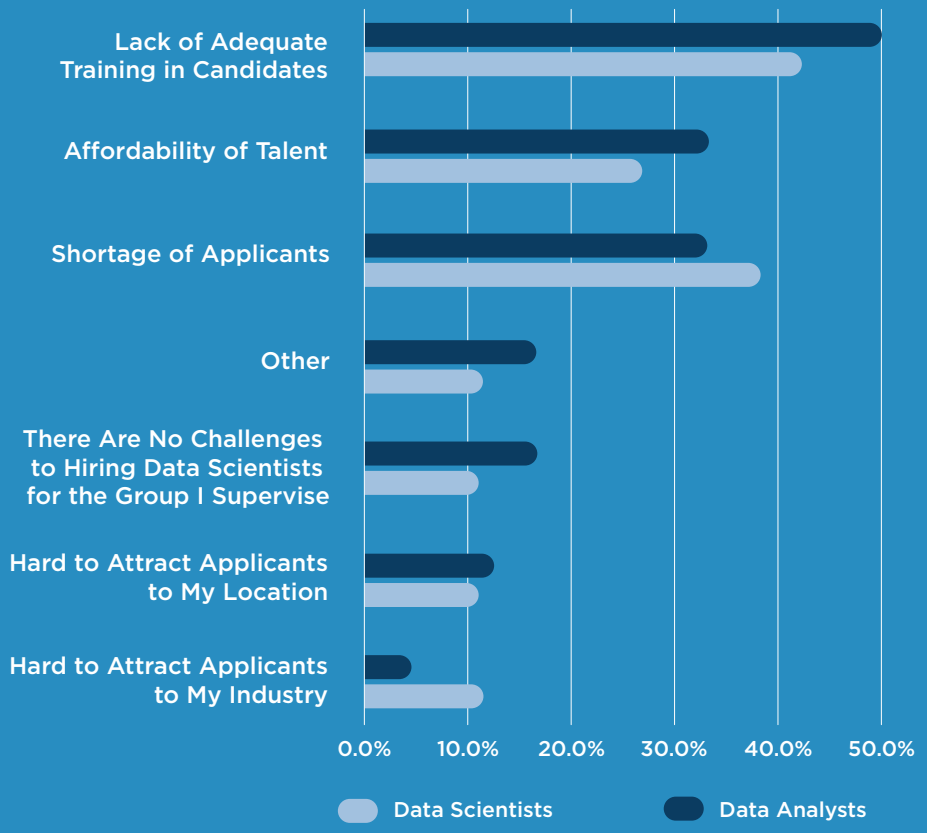
INDUSTRY	COMPANY
IT	Cisco
IT	Citrix
IT	IBM
IT	Lenova
IT	Oracle
IT	Red Hat
IT	SAS Institute
Pharmaceutical	Catalent
Pharmaceutical	GlaxoSmithKline
Pharmaceutical	PPD
Pharmaceutical	Quintiles
Pharmaceutical	Teledyne
Railroad	Norfolk Southern Railroad
Tobacco	R.J. Reynolds Tobacco
Tobacco	Reynolds American Inc.

Source: LEAD using the Conference Board Help Wanted Online (HWOL).

Search criteria - using keyword "Data Scientist."

CHALLENGES TO HIRING DATA PROFESSIONALS STILL EXIST

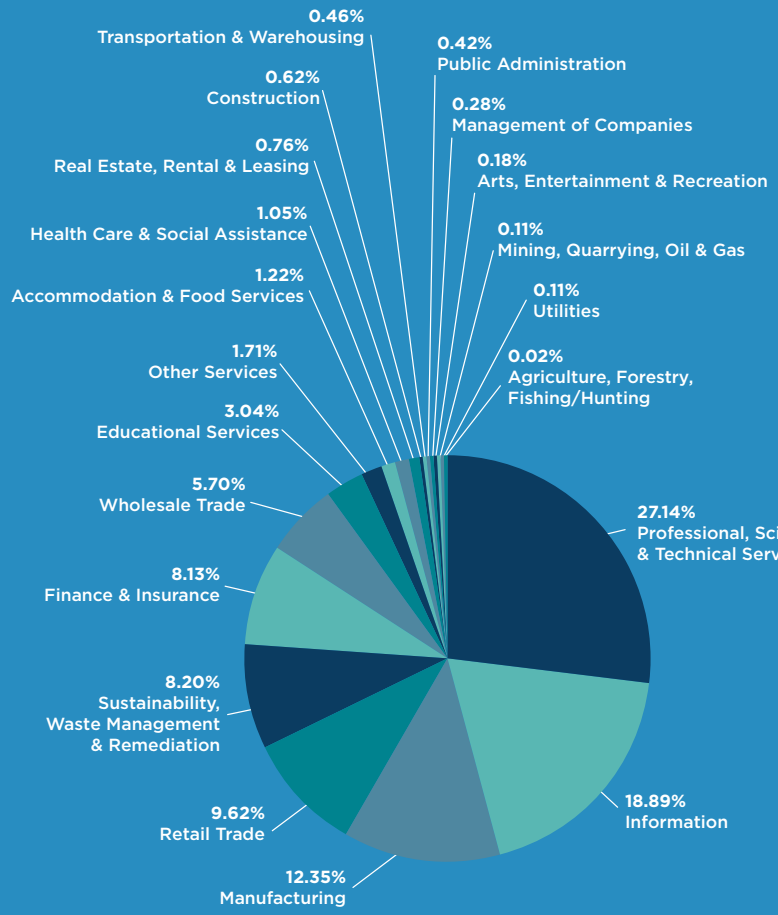
Percentage of Managers Selecting Top Three Major Challenges to Hiring



Source: 2016 Survey from the Board of Science, Technology & Innovation and the National Consortium for Data Science.

ALL MAJOR INDUSTRIES NEED DATA TALENT

Top 20 Industries Hiring Big Data Expertise



Source: "Where Big Data Jobs Will Be in 2015?," Forbes, December 29, 2014.

DATA PROFESSIONALS NEED TECHNICAL AND NON-TECHNICAL SKILLS

Percentage of Data Economy Managers Agreement on Human Resource Factors

Source: 2016 Survey from the Board of Science, Technology & Innovation and the National Consortium for Data Science.

2016 DATA ECONOMY OCCUPATIONS IN NORTH CAROLINA

TITLE	EMPLOYMENT	ANNUAL WAGE - EXPERIENCED
Business Operations Specialists	29,730	$83,660
Software Developers, Applications	21,190	$110,150
Computer Systems Analysts	16,680	$101,570
Market Research Analysts/Marketing Specialists	12,910	$83,560
Computer and Information Systems Managers	11,970	$151,710
Software Developers, Systems Software	10,540	$120,120
Computer Programmers	7,370	$93,530
Computer Network Architects	3,980	$117,710
Computer Occupations, All Other	3,550	$98,670
Detectives and Criminal Investigators	3,340	$63,340
Web Developers	2,860	$79,490
Database Administrators	2,640	$99,710
Operations Research Analysts	1,750	$79,740
Statisticians	950	$114,300
Computer and Information Research Scientists	300	$117,600
North Carolina Average Wage		$43,000

Source: Prepared by the Labor & Economic Analysis Division, Dept. of Commerce using data from Occupational Employment and Wages (OES).

2016 EMPLOYMENT GROWTH IN NORTH CAROLINA DATA INDUSTRIES

DESCRIPTION	2015 JOBS	2010-15 % CHANGE	CURRENT EARNINGS
Software Publishers	12,565	68.41%	$136,238
Computer Systems Design Services	21,627	60.38%	$93,068
Custom Computer Programming Services	21,369	48.51%	$105,088
Data Processing, Hosting, and Related Services	12,152	29.30%	$114,154
Other Computer Related Services	2,792	-11.05%	$103,730
Computer Facilities Management Services	686	-40.81%	$79,609
Total	**71,191**		
ALL North Carolina Industries	4,030,880	3.33%	$43,280

Source: Prepared by the North Carolina Labor and Economic Analysis Division, North Carolina Department of Commerce, using EMSI Q3 2015 Data Set.

RESEARCH TRIANGLE: LEADING CONCENTRATION OF DATA PROFESSIONALS
Calculated by Location Quotient

CITY	DATA SCIENTIST	SOFTWARE ENGINEER	DATA ENGINEER / ARCHITECT	TOTAL
San Francisco	23.15	5.13	13.45	13.31
Boston	4.06	2.91	4.97	4.90
Austin	5.34	2.50	3.53	3.52
Research Triangle	5.89	2.13	3.46	3.45
Seattle	4.65	2.82	3.30	3.30
Washington DD	2.84	3.57	2.43	2.47
San Diego	1.15	0.68	2.52	2.46
Pittsburgh	0.80	0.64	1.34	1.32
Dallas/Fr. Worth	0.41	1.64	1.30	1.30
Chicago	0.97	1.51	0.96	0.97
New York	2.03	1.59	0.93	0.96
Philadelphia	1.43	1.64	0.90	0.92
Los Angeles	0.69	0.64	0.84	0.84

Source: Based on counts of data professions from LinkedIn data, compiled for The Massachusetts Big Data Report.

RESEARCH TRIANGLE: LEADING CONCENTRATION OF DATA PROFESSIONALS

Number of Jobs with Selected Titles per 100,000 Population

CITY	DATA SCIENTIST	SOFTWARE ENGINEER	DATA ENGINEER / ARCHITECT	TOTAL
San Francisco	1.89	1.46	35.71	39.05
Seattle	0.45	0.23	6.95	7.63
Boston	0.26	0.41	6.94	7.61
Austin	0.16	0.22	5.56	5.94
Research Triangle	0.06	0.12	3.62	3.80
San Diego	0.13	0.13	2.68	2.93
Washington, DC	0.24	0.14	1.96	2.34
Chicago	0.15	0.12	1.18	1.44
Pittsburgh	0.04	0.04	1.19	1.27
New York City	0.10	0.12	1.02	1.23
Los Angeles	0.08	0.10	0.93	1.11
Dallas/Ft. Worth	0.04	0.09	0.70	0.84
Philadelphia	0.02	0.03	0.66	0.71
US	0.07	0.07	1.27	1.40

Source: Based on counts of data professions from LinkedIn data, compiled for The Massachusetts Big Data Report.

[43] Based on a search of Help Wanted ads by the Labor and Economic Analysis Division, North Carolina Department of Commerce.

[44] Columbus, Louis. "Where Big Data Jobs Will Be in 2015." *Forbes*. December 29, 2014. Accessed September 28, 2016. http://www.forbes.com/sites/louiscolumbus/2014/12/29/where-big-data-jobs-will-be-in-2015/#b2c1b68404af.

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[48] Calculations were based on airport codes. Research Triangle represents the area covered by Raleigh, Durham, Chapel Hill, Cary and other affiliated towns.

[49] Based on counts of data professions from LinkedIn data, compiled for *The Massachusetts Big Data Report*.

[50] Location Quotient (LQ) assesses the relative concentration of professions compared to the U.S. average. The LQ for the country as a whole is always 1.0. Any LQ over 1.0 demonstrates a heavier concentration than the national average; LQ's under 1.0 have a concentration less than the nation.

[51] Based on counts of data professions from LinkedIn data, compiled for *The Massachusetts Big Data Report*.

An Industry Propelled by New Graduates

NORTH CAROLINA HAS THE WORKFORCE AND GRADUATES NEEDED BY THE DATA ECONOMY

- The Data Economy Tide Rises with New Graduates
- Gusher of Relevant Graduates
- A Leader in Critical Data Industry Segments

THE DATA ECONOMY TIDE RISES WITH NEW GRADUATES

In an industry parched for new data skills and analytics, the tide of near frenetic demand for data graduates washes up against North Carolina's education system and the system rapidly responds. As one data analytics entrepreneur relayed, *Talent is everything to my business*. Other remarks from data executives:

- *Companies will follow the talent.*
- *MetLife, Credit Suisse, and Fidelity came here (NC) for the talent.*
- *There will never be enough data scientists in the next 10 years.*

A McKinsey study predicted a shortage of up to 190,000 workers with deep analytical skills, and 1.5 million managers and analysts who can use Big Data for better decisions.[52]

GUSHER OF RELEVANT GRADUATES

Each year, North Carolina's public and private post-secondary institutions produce thousands of graduates ready to work in the data economy (A list of relevant public university programs appears in the Appendix). Data companies prize these graduates. For example, North Carolina State University is a top-three source for IBM new hires; UNC-Chapel Hill ranks in the top 20.[53] North Carolina also compares favorably to other states in science, engineering and technology students, with particular strengths in graduate students and Bachelor of Arts and Bachelor of Science degrees conferred.

A LEADER IN CRITICAL DATA INDUSTRY SEGMENTS

North Carolina competes well against other data states in graduates in relevant industry segments. The state ranks especially high in bioinformatics/computational biology—second after Massachusetts. This reflects the state's strengths in both life sciences and information technology.

"... (North Carolina) has many of the advantages of a big city (talent, restaurants, entertainment, lots of startups), but with few of the downsides such as over-congestion and a high cost of living... including access to great talent, a supportive community, convenient location for business or travel, and a reasonable cost of living."

Robbie Allen, Founder & CEO, Automated Insights, Council for Entreprenurial Development Testimonial

NORTH CAROLINA IS COMPETITIVE IN DATA ECONOMY GRADUATES

Big Data State Rankings: Graduates per 100K Population in Select Industry Segments

TITLE	CA	IL	MA	NY	TX	WA	NC	NC RANKING
Bioinformatics/Computer Bio	0.35	0.21	1.58	0.71	0.20	0.22	0.73	#2
Mathematics and Statistics	8.69	12.39	18.49	16.37	6.98	9.51	10.47	#4
Computer/Information Sciences	17.74	33.72	32.79	29.40	14.91	15.83	19.09	#4
Computer Engineering	3.90	1.52	4.60	2.61	1.93	1.59	2.25	#4
Operations Research	0.57	0.19	0.41	3.04	0.21	-	0.18	#5
MIS Systems/Services	0.47	5.14	2.11	2.39	4.16	4.38	2.29	#5
Systems Science & Theory	0.01	0.54	0.48	0.32	-	0.46	0.15	#5

Source: National Center for Education Statistics and US Census Bureau, as per The Massachusetts Big Data Report.

NORTH CAROLINA: WAVE OF GRADUATES IN CRITICAL DATA ECONOMY FIELDS

DEGREE PROGRAM	ASSOCIATE	BACHELOR	MASTER	DOCTORATE
Total	27,308	52,175	18,168	4,419
Computer and Information Sciences and Support Services	800	1000	600	49
Mathematics and Statistics	-	600	152	69
Library and Information Sciences	-	-	364	-
Information Systems Security	95	-		-

Source: North Carolina Labor and Economic Analysis Division, University of North Carolina System General Administration, North Carolina Community College System.

Note: Numbers in light blue fields are for public and private colleges. Numbers in purple fields are for only public colleges so results are most likely undercounted.

DEGREES AND CONCENTRATION:
Science, Engineering & Technology Students, 2013

	ASSOCIATES CONFERRED		BA/BS CONFERRED		GRAD STUDENTS IN AREA	
	Number	Age 18-24 *Per 1,000*	Number	Age 18-24 *Per 1,000*	Number	Age 25-34 *Per 1,000*
United States	125,420	4.00	628,750	19.9	612,646	14.3
California	23,670	5.90	75,907	18.9	73,689	13.2
Illinois	2,291	1.80	22,986	18.2	29,116	16.3
Massachusetts	1,891	2.70	22,452	32.2	31,772	34.7
New York	7,760	3.90	47,691	23.9	51,139	18.2
North Carolina	2,814	2.90	18,921	19.2	17,890	14.0
Texas	8,829	3.20	34,967	12.8	47,114	12.3
Washington	3,149	4.70	13,761	20.6	9,634	9.7

NOTE: Science, Engineering & Technology degrees include engineering, physical sciences, computer and mathematical sciences, agricultural and biological sciences, social sciences, science technologies, and engineering technologies.

Source: National Center for Education Statistics, Integrated Postsecondary Education Data System (various years); Census Bureau, 2000 and 2010 Decennial Censuses and Population Estimates Program (various years); Science and Engineering Indicators 2016.

[52] Ahalt, Stan and Kip Kelly. *The Big Data Talent Gap*. 2013. Accessed September 22, 2016. http://renci.org/wp-content/uploads/2013/08/The-Big-Data-Talent-Gap-White-Paper1.pdf.

[53] O'Sullivan, Fran. Presentation at the University of North Carolina Board of Governors Meeting. Chapel Hill, North Carolina. July 28, 2016.

Full Speed Ahead: Recommendations

NORTH CAROLINA SHOULD ACT NOW TO MAINTAIN ITS STANDING AND PREVENT STATURE EROSION

- Introduction
- Objective #1: Elevate the data economy to the top tier of economic development priorities.
- Objective #2: Grow and support the data startup ecosystem, and promote it nationally.
- Objective #3: Create a pipeline of data science education and literacy.
- Objective #4: Position North Carolina as the “Open Data” state.
- Objective #5: Support world-class data science research in North Carolina.

INTRODUCTION

NCODE advocates for North Carolina to accelerate its data economy, but what specifically should it *do*? The *do* consists of the recommended actions on subsequent pages.

The project team did not create the recommendations in a vacuum, but systematically collected insights from other states and North Carolinians working in the data economy (further information about the project methodology appears in the Appendix). Steps to collect outside feedback included:

- A review of significant, credible industry reports.
- Data scans from the Labor and Economic Analysis Division of the North Carolina Department of Commerce.
- Individual interviews of 30 public/private data economy leaders.
- An Internet survey of nearly 400 professionals working in the data economy.
- Identification of best practices by a STAR team (Student Teams Achieving Results) consisting of Master of Business Administration students from the Kenan Flagler Business School at UNC-Chapel Hill.
- Testing of draft recommendations by subject matter experts.

These recommendations, however, may undergo further refinement as the suggested working group, charged with implementing them, convenes. For information about participating in this group, contact the staff of the Office of Science, Technology & Innovation at nccommerce.com/sti.

OBJECTIVE #1:

Elevate the data economy to the top tier of economic development priorities.

Recommendation	Purpose	Description	Partners/Cost[53]
Create a High Level Working Group to promote the data economy.	Implement, monitor, and garner the resources to implement these data economy recommendations.	Convene a working group consisting of leaders from all segments of the data economy: small and large businesses; schools, universities, community colleges; state government; and service providers.	OSTI/CIO/EDPNC/ NCDS. Minimal costs, mostly contributed time of members.
Launch a national communications campaign promoting North Carolina's data economy assets: *First in Flight, First in Data*.	Make the state's data assets better known in order to attract more data workers and companies.	Use public and private resources, as identified by the HLWG, to advertise the state and attend relevant conferences to increase the state's data economy profile.	HLWG/EDPNC/Public & Private Corporate Communications Staff. Costs set by HLWG, and paid by public and private funds, in aggregate $25-$50,000.
Prepare recruiting documents with EDPNC.	Increase the recruitment of data companies.	Create marketing materials, including brochures for promotional use.	HLWG/EDPNC/DOC. Produced from existing budgets.

RATIONALE

Because the financial rewards for data economy leadership are so great, recruiting and growing data companies provides a big return on development efforts. Furthermore, key North Carolina industries in life sciences, manufacturing, agriculture, and other important segments gain and retain competitive advantage by embracing the data economy.

OBJECTIVE #2

Grow and support the data startup ecosystem, and promote it nationally.

Recommendation	Purpose	Description	Partners/Cost[54]
Create a matching startup fund specifically for data economy companies.	Increase the number and survivability of data economy companies.	Seek funds from foundations and data companies to endow a startup fund, administered by a nonprofit with experience in data startups. Future investments would be made from fund returns.	HLWG/Established Data Companies/ Foundations. $10-$20 million from private contributions.
Provide funding for graduate student internships in data startup companies.	Increase the pipeline of experienced data scientists with management and industry experience.	Create a statewide competitive process to select fellows and place in startups.	UNC-GA. $445K: 50 percent state approp.; 50 percent company or other source.
Identify the technology and tools needed by a data startup.	Increase the number and survivability of data startups.	Establish a subcommittee of the High Level Working Group to survey companies and incubators, such as American Underground and Packard Place.	HLWG/NC Incubators/NC Association of Business Incubators. Minimal costs.

RATIONALE

North Carolina data economy leaders emphasized that improving the entrepreneurial climate for data companies would be the most impactful action to accelerate the state's data economy.

OBJECTIVE #3

Create a pipeline of data science education and literacy.

Recommendation	Purpose	Description	Partners/Cost[55]
Graduate every high school student with data literacy skills.	Increase the employment and educational opportunities of high school graduates.	Adapt the existing structures, such as online and standard courses, to certify data literacy.	DPI/NC School of Science & Math. Cost undetermined.
Create special high schools (magnet, charter, stand-alone) that focus on data science.	Increase the employment and educational opportunities of high school graduates.	Carve out schools dedicated to data science from existing schools.	DPI. Reallocation of existing resources.
Create internships at data companies for students and their teachers at every grade.	Provide a data company experience to inspire and prepare students for data careers.	Work with the existing internship programs to target placement in data companies.	DPI/Community Colleges/UNC-GA. Cost undetermined.
Distribute the Business/Data Analytics Associate Degree throughout the state.	Increase the number of skilled workers.	Distribute Wake Tech's data science programs throughout the state's community colleges.	DPI/Community Colleges/UNC-GA. Cost undetermined.

RATIONALE

Educating students in data literacy should begin early and build on advancing levels of sophistication from grade school to graduate school. No matter the career path, students need data skills for full citizenship in the future data-dominated economy.

OBJECTIVE #3 *Continued*

Create a pipeline of data science education and literacy.

Recommendation	Purpose	Description	Partners/Cost[55]
Distribute the Professional Science Masters in Data Science. as professional degrees throughout universities.	Increase the available pool of skilled data workers.	Work with the universities to identify data science degree niches.	UNC-GA/ Private Colleges. Cost undetermined.
Increase the number of graduate students in data science.	Increase the available pool of skilled data workers.	Provide extra funds for graduate data science students.	UNC-GA/ NC Legislature. Cost undetermined.
Support a data science and analytics concentration at the proposed Western North Carolina School of Science and Math.	Increase the available pool of skilled data workers while establishing a visible symbol of North Carolina's commitment to the data economy.	Organize meetings with project participants to advocate for a data science concentration at the high school, or data science applied to an industry concentration.	NC School of Science and Math/BSTI. Running costs approach $10-$15 million.

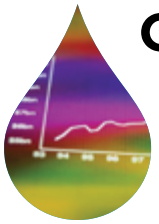
OBJECTIVE #4

Position North Carolina as the "Open Data" state.

Recommendation	Purpose	Description	Partners/Cost[56]
Create a NC data bill of rights describing privacy and ownership rules for personal data on the Internet.	Solidify the state's brand as a data leader, leading to more investments in the state's data economy.	Use a data rights document produced by Inmar as a beginning template to identify policies.	HLWG. Minimal cost.
Engage the UNC-Chapel Hill School of Government in a needs assessment of municipalities and the current state of local open data initiatives.	Prepare cities and towns for the open data activities to increase data skills and nurture data companies throughout the state.	Identify the barriers and best practices for community open data efforts.	HLWG. $25-$35,000, potential federal grants.
Identify funding sources to help local municipalities defray the cost of making data available.	Prepare cities and towns for the open data activities to increase data skills throughout the state.	Leverage federal programs or foundations to fund community open data events.	HLWG. Cost undetermined.

RATIONALE

State and local governments have tremendous amounts of data that entrepreneurs can transform into businesses and programs. Publicizing the state's actions toward "Open Data" adds to the state's branding as a data leader.



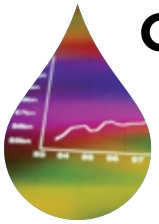
OBJECTIVE #5

Support world-class data science research in North Carolina.

Recommendation	Purpose	Description	Partners/Cost[57]
Commission and conduct a feasibility study for a National Center of Excellence in Data Science.	Create a permanent center to promote the state's data economy and symbolize the state's commitment.	Conduct a study to determine the long-term financial feasibility of such an endeavor, sources of funds, and ideal structure.	HLWG. $100-$200,000 from businesses, universities, and government.
Enlist the participation of leading faculty and business representatives for North Carolina Legislature sessions on the North Carolina Data Economy.	Increase the awareness of the data economy in elected and appointed officials, thereby increasing partnerships with government leaders.	Conduct briefings for the legislators and their staff in conjunction with the North Carolina Technology Association, universities, and data companies.	HLWG/NCTA/ Universities/ Businesses. Minimal costs.
Organize "data science education days" for U.S. Congress members and staff about North Carolina assets and capabilities; invite key funding agencies.	Generate more support for North Carolina's data economy at the federal level in order to increase federal funding.	Plan visits by a team of university leaders and faculty, businesses representatives, and relevant state policy makers to legislator/ funders offices, and hold a reception for legislators and staff.	HLWG. Travel and reception costs, paid by participants.

RATIONALE

The top data economy states are also top data research states. Further enhancement of the state's already impressive data research assets helps attract and create data workers, investments, entrepreneurs, and companies.



OBJECTIVE #5 *Continued*

Support world-class data science research in North Carolina.

Recommendation	Purpose	Description	Partners/Cost[57]
Support the UNC Return On Investment (ROI) program in data science.	Advocate for funds for cutting-edge research at the state's universities, which adds to the data economy ecosystem.	Write letters or make calls by HLWG members in support of the initiative; officially recommend as a group to support.	HLWG/UNC-GA. Annual cost of entire ROI program is $3 million from the North Carolina General Assembly.

[54] Acronyms are: BSTI-Board of Science, Technology & Innovation, CIO-State Chief Information Officer, DOC-Department of Commerce, DPI-Department of Public Instruction, EDPNC-Economic Development Partnership of NC, HLWG-High Level Working Group on the data economy, NCBio-North Carolina Biosciences Organization, NCTA-North Carolina Technology Association, OSTI-Office of Science, Technology & Innovation, UNC-GA-University of North Carolina General Administration.

[55] Acronyms are: BSTI-Board of Science, Technology & Innovation, CIO-State Chief Information Officer, DOC-Department of Commerce, DPI-Department of Public Instruction, EDPNC-Economic Development Partnership of NC, HLWG-High Level Working Group on the data economy, NCBio-North Carolina Biosciences Organization, NCTA-North Carolina Technology Association, OSTI-Office of Science, Technology & Innovation, UNC-GA-University of North Carolina General Administration.

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[57] Acronyms are: BSTI-Board of Science, Technology & Innovation, CIO-State Chief Information Officer, DOC-Department of Commerce, DPI-Department of Public Instruction, EDPNC-Economic Development Partnership of NC, HLWG-High Level Working Group on the data economy, NCBio-North Carolina Biosciences Organization, NCTA-North Carolina Technology Association, OSTI-Office of Science, Technology & Innovation, UNC-GA-University of North Carolina General Administration.

[58] Acronyms are: BSTI-Board of Science, Technology & Innovation, CIO-State Chief Information Officer, DOC-Department of Commerce, DPI-Department of Public Instruction, EDPNC-Economic Development Partnership of NC, HLWG-High Level Working Group on the data economy, NCBio-North Carolina Biosciences Organization, NCTA-North Carolina Technology Association, OSTI-Office of Science, Technology & Innovation, UNC-GA-University of North Carolina General Administration.

Start Rowing: Form a Public/Private Working Group

The first step in the project is the creation of a High Level Working Group to implement these recommendations. In addition, the project team (the Board of Science, Technology & Innovation and the National Consortium for Data Science) will meet with relevant and potential partners to further refine the project launch plans.

For information about participating in this group, contact the staff of the Office of Science, Technology & Innovation at www.nccommerce.com/sti.

Appendices

A *U.S. News and World Report* University Rankings in Data Economy Fields, 2016.

B Additional North Carolina Data Assets: Government.

C Sampling, North Carolina Business Incubators, 2016.

D University Centers, Institutes, and Programs Relevant to the Data Economy.

E Graduates from North Carolina Public University Data Programs, 2012.

F Methodology: The NCODE Project.

G List of Personal Interviews-North Carolina Leaders in the Data Economy.

H Best Practices in Government Data Economy Promotion.

I North Carolina Innovation Index.

J Members of the Board of Science, Technology, & Innovation.

APPENDIX A

U.S. News and World Report University Rankings in Data Economy Fields, 2016 [58]

PROGRAM	SCHOOL	NATIONAL RANKING
University Rankings, General		
	Duke University	8
	Wake Forest	27
	UNC-Chapel Hill	30
Graduate Business		
	Duke University	12
	UNC-Chapel Hill	16
Online MBA		
	UNC-Chapel Hill	3
	NC State	15
Graduate Engineering - General		
	NC State	27
	Duke University	30
Graduate Engineering - Aerospace		
	NC State	26
Graduate Engineering - Biological/Agriculture		
	NC State	10
	NC A&T	27
Graduate Engineering - Biomedical/Bioengineering		
	Duke University	6
	NC State-UNC CH	37
Graduate Engineering - Computer		
	Duke University	29
	NC State	36
Electrical/Communications		
	Duke University	27
	NC State	34
Industrial/Manufacturing		
	NC State	12
Mechanical		
	Duke University	29
	NC State	35
Mathematics		
	Duke University	17
	UNC Chapel Hill	28
Medical Schools - Research		
	Duke University	8
	UNC-Chapel Hill	22
Medical Schools - Primary Care		
	UNC-Chapel Hill	2
	Duke University	8
	East Carolina	32
Statistics		
	Duke University	10
	UNC-Chapel Hill	12
	NC State	15

APPENDIX B

Additional North Carolina Data Economy Assets: Government

In 2015, the North Carolina legislature passed into law the development of a state budgetary transparency website (Section 7.17 of S.L. 2015-241). This website will include budget and expenditure data (by individual or company) for state agencies, counties, cities, and local education agencies. When developed, this trove of data will jumpstart open data activities.

Other government data assets include the following:

- Mandated and funded by the North Carolina General Assembly, the **North Carolina Government Data Analytics Center (GDAC)** uses data analytics to make state government operations more efficient, effective, safe, and fraud-free. GDAC manages the state's data sharing and integration initiatives, including "identifying opportunities where data sharing and integration can generate greater efficiencies and improved service delivery" by state agencies, institutions and departments. The state's Chief Data Officer leads GDAC.
- North Carolina also funds the **North Carolina Innovation Center (iCenter)** where state government and businesses can test information technology products for implementation into the state's computer systems. The state's Chief Technology and Data Officer manages the iCenter.
- The Center for Digital Government and the National Association of Counties named **Wake County** the top digital county of its size in the country.
- **The North Carolina Open Government Coalition**, housed at Elon University, works to gain access to public records.

"Zaloni was at the forefront of organizations building out Hadoop data lakes, and building on top of them innovative big data use cases. All the execs are local to RTP, except [one]..."

Ben Sharma, Chief Executive Officer, Zaloni, Council for Entrepreneurial Testimonial

APPENDIX C
Sampling, North Carolina Business Incubators, 2016

INCUBATOR NAME	CITY OR COUNTY
A-B Tech Small Business Incubator	Buncombe County
American Underground - Durham	Durham
Brunswick Business and Industry Incubator	Brunswick County
Cherokee Challenge & Industry Center	Cherokee
Eastern Carolina Food Ventures Incubator Kitchen	Duplin County
Empowerment Midway Business Center	Orange County
Enterprise Center	Winston-Salem
Farmville Small Business Incubator	Farmville
Fayetteville Business Center	Fayetteville
First Flight Venture Center	Research Triangle Park
Center for New and Expanding Business	Haywood County
HQ Charlotte / Packard Place	Charlotte
HQ Greensboro	Greensboro
HQ Raleigh	Raleigh
Kinston Enterprise Center	Kinston
Launch Chapel Hill	Chapel Hill

INCUBATOR NAME	CITY OR COUNTY
McDowell Small Business & Industry Center	Marion
NCSU Technology Incubator @ Centennial Campus	Raleigh
Nussbaum Center	Greensboro
Partnership for Defense Innovation	Fayetteville
Project for Innovation, Energy & Sustainability	Mecklenburg County
RMECDC Industrial & Retail Incubator	Rocky Mount
Roxboro Business Development & Entrepreneurship Center	Person County
tekMountain	Wilmington
Triangle South Enterprise Center	Dunn
UNC Ventureprise	Charlotte
UNCP Entrepreneurship Incubator	Pembroke
UNCW - Center of Innovation	Wilmington
Upper Coastal Plain Business Development Center	Wilson
Waxhaw Business Center	Union County
Wake Forest Babcock Demon Incubator	Forsyth County

Source: North Carolina Business Incubation Association, 2016.

APPENDIX D
University Centers, Institutes, and Programs Relevant to the Data Economy

SCHOOL	PROGRAM
Appalachian State University	Brantley Risk and Insurance Center
	Center for Analytics Research and Education
	Center for Economic Research and Policy Analysis (CERPA)
	Research Institute for Environment, Energy and Economics
Duke University	Center for Genomic & Computational Biology
	Center for Human Disease Modeling
	Center for Quantitative Modeling
	Future Renewable Electric Energy Delivery & Management Systems Center
	Center for Theoretical & Mathematical Sciences
	Institute for NEXT Generation IT Systems
	Kenan Institute for Engineering, Technology & Science
	Laboratory for Analytical Sciences
East Carolina University	Center for Science, Mathematics, and Technology Education
Elizabeth City State University	Center for Remote Sensing Education and Research
Fayetteville State University	Center for Defense and Homeland Security

SCHOOL	PROGRAM
NC A&T State University	Center for Advanced Materials and Smart Structures
	Center for Advanced Studies in Identity Sciences
	Center for Cyber Defense
	Institute for Autonomous Controls & Information Technology
	National Science Foundation Engineering Research Center for Revolutionizing Metallic Biomaterials
NC Central University	Center for Excellence in Science, Math and Technology Education
NC State University	Advanced Self Powered Systems of Sensors and Technology Center
	Bioinformatics Research Center
	Center for Educational Informatics
	Center for Geospatial Analytics
	Center for High Performance Simulation
	Center for Innovation Management Studies
	Center for Quantitative Sciences in Biomedicine
	Center for Research in Scientific Computation
	Future Renewable Electric Energy Delivery and Management Systems Center

APPENDIX D
University Centers, Institutes, and Programs Relevant to the Data Economy

SCHOOL	PROGRAM
NC State University	Institute for Advanced Analytics
	Institute for NEXT Generation IT Systems
	Kenan Institute for Engineering, Technology & Science
	Laboratory for Analytical Sciences
UNC-Asheville	Center for Analytics Research and Education
	The National Centers for Environmental Information in Asheville
UNC-Chapel Hill	Biomedical Research Imaging Center
	Carolina Population Center
	Data Intensive Cyber Environments Center
	Institute for Renaissance Computing
	Odum Institute for Research in Social Science
UNC-Charlotte	Center for Applied Geographic Information Science
	Charlotte Visualization Center
UNC-Greensboro	Center for Business and Economic Research
	Institute for Data, Evaluation, and Analytics
UNC-Wilmington	Institute for Interdisciplinary Studies in Identity Sciences
Western Carolina University	Center for Rapid Product Realization
Winston-Salem State University	Center for Economic Analysis

Source: Based on University of North Carolina General Administration and Office of Science, Technology & Innovation. Research Centers & Institutes. Accessed April 15, 2016. http://www.northcarolina.edu/sites/default/files/unc_centers_and_institutes_original_oct_14_2016_.pdf.

APPENDIX E

Graduates from North Carolina Public University Data Programs, 2012 [60]

DEGREES	NUMBER OF DEGREES	DEGREE TOTALS	
Certificate in Computer Engineering Technology	326		
Certificate in Computer Programming	48		
Certificate in Database Management	7		
Certificate in Information Systems Security	32		
Certificate in Web Technologies	67	Total Certificate	480
Associate Degree in Computer Engineering Technology	555		
Associate Degree in Computer Programming	94		
Associate Degree in Computer Technology Integration	19		
Associate Degree in Database Management	12		
Associate Degree in Information Systems Security	95		
Associate Degree in Web Technologies	94	Total Associates	869
Bachelor Degree in Computer & Information Sciences & Support Services	681		
Bachelor Degree in Computer Engineering, General	120		
Bachelor Degree in Computer Science	489		
Bachelor Degree in Computer Systems Networking & Telecommunications	59		
Bachelor Degree in Electrical, Electronic & Communications Engineering Technology/Technician	41		
Bachelor Degree in Information Science/Studies	56		

APPENDIX E *Continued*
Graduates from North Carolina Public University Data Programs, 2012

DEGREES	NUMBER OF DEGREES	DEGREE TOTALS	
Bachelor Degree in Information Technology	51		
Bachelor Degree in Management Information Systems, General	169		
Bachelor Degree in Systems Engineering	11		
Bachelor Degree in Web Page, Digital/Multimedia & Information Resources Design	27	Total Bachelors	1,704
Master Degree in Computer & Information Sciences & Support Services	481		
Master Degree in Computer Engineering, General	67		
Master Degree in Computer Science	312		
Master Degree in Computer Software Engineering	9		
Master Degree in Computer Systems Networking & Telecommunications	30		
Master Degree in Information Science/Studies	50		
Master Degree in Information Technology	24	Totals Masters	973
Doctoral Degree in Computer & Information Sciences & Support Services	49		
Doctoral Degree in Computer & Information Sciences, General	16		
Doctoral Degree in Computer Engineering, General	7		
Doctoral Degree in Computer Science	25		
Doctoral Degree in Information Science/Studies	8	Total Doctoral	105

Source: Information downloaded from North Carolina Tower Database, September, 2016. http://www.nctower.com/search/unc/.

APPENDIX F

Methodology: The *NC*ODE (*North Carolina* Opportunities in the Data Economy) Project

Background

At the December 11, 2014 quarterly meeting of the Board of Science, Technology & Innovation (BSTI), members agreed to begin work on the TechGO (Technology Grand Opportunities) projects. TechGO is a method for the board to increase its influence within the state by facilitating improvements in areas important to the state's economy. Each program of work centers around a key North Carolina economic sector, technology or industry. Only areas where North Carolina had strengths, but unrealized potential, were considered, along with these other considerations:

- The issues need to be significant and "big;"
- They need currently to be unsolved, but be solvable;
- They need immediacy but should be future focused;
- They should focus on NC, but not exclusively;
- They should be "in the board's sweet spot" (i.e., science, technology, innovation);
- They should resonate with the Board's core constituencies and be "unavoidably important;"
- They should not be being addressed adequately/completely by others; and
- They should not be politically controversial.

The identified areas, and their responsible leading board member, were:

1. AgBiotech: Ken Tindall
2. Data Science: Judd Bowman
3. Education: Sam Houston
4. Energy: Bob Wilhelm
5. Manufacturing: Blanton Godfrey
6. Sustainability: Bruce King

PARTNER: NATIONAL CONSORTIUM FOR DATA SCIENCE

Searching for a partner with deep knowledge and industry contacts, the board invited the National Consortium for Data Science (NCDS) to partner in the project. NCDS promotes data science through its members in leading companies such as IBM, and universities such as North Carolina State University.

Project Strategy

The project's objective was to create a set of recommendations to promote North Carolina into the top tier of data states. To identify these recommendations, BSTI and NCDS followed a comprehensive set of coordinated actions.

- Conducted a review of existing resources and metrics.

  Only two states have produced significant, credible reports:

  - The *Massachusetts Big Data* Report.
  - *Big Data and Analytics* from the Northern Virginia Technology Council.

  The Labor and Economic Analysis Division of the North Carolina Department of Commerce also provided critical information.

- Conducted surveys to gather information from people working in the data economy.

  - About 30 public and private data economy executives provided in-depth views on the data economy in North Carolina through in-person or telephone interviews.
  - About 400 professionals working in the data economy answered an electronic survey.

- Hired STAR Program for researching best practices outside North Carolina.

  A STAR team (Student Teams Achieving Results), mostly consisting of Masters of Business Administration students from the Kenan Flagler Business School at UNC-Chapel Hill, researched relevant best practices outside North Carolina, and suggested recommendations based on their findings.

- Tested initial drafts of recommendations.

  After the *NC*ODE team identified a set of recommendations, team members distributed them to appropriate subject matter experts for feasibility and appropriateness.

The board tasked the responsible board members with further development of their target areas for presentation at the May 14 board meeting. After the May presentations, the Board approved work on the projects. Scott Doron, Associate Manager for the Office of Science, Technology & Innovation, was assigned to support the Data Science Project.

APENDIX G

List of Personal Interviews-North Carolina Public and Private Leaders in the Data Economy

ORGANIZATION	NAME	TITLE
Appalachian State University	Joseph Cazier	Director, Center for Analytics Research & Education
Bank of America	Bob Nichols	Business Control Executive, Anti-Money Laundering Service Delivery & Operations
Bank of America	David Joffe	Quantitative Analyst, Managing Director
Bank of America	Ivan Marcotte	Managing Director, Global Portfolio Strategies & Quantitative Risk Management
Bank of America	Sudeshna Banerjee	Senior Vice President
Bright Wolf	David Houghton	Director
Brooks Bell	Reid Bryant	Data Scientist
Cisco	Ed Paradise	Senior Vice President
Cisco	Russ Gyurek	Director of Innovation Labs, Office of the Chief Technology Officer
Duke Energy	Peter Toomey	Senior Vice President, Strategic Planning
Exitintel	Matt Cimino	Chief Executive Officer
Fuzzy Logix	Michael Upchurch	Chief Operating Officer
Google	Enoch Mueller	Data Center Director
IBM	Ashish Cowlagi	Product Management & Strategy, Watson Health
Inmar, Inc.	David Mounts	Chief Executive Officer
MetLife	Geoff Lang	Vice President and General Manager, Global Technology & Operations
MetLife	Malene Haxholdt	Vice President, Enterprise Analytics
NC Department of Commerce	Susan Fleetwood	Chief Economic Development Liaison
NC Government Analytics Center (GDAC)	John Correllus	Deputy State Chief Information Officer & State Data Officer
NC State University	Michael Rappa	Founding Director, Institute for Advanced Analytics

APENDIX G *Continued*
List of Personal Interviews-North Carolina Public and Private Leaders in the Data Economy

ORGANIZATION	NAME	TITLE
NC State University	Mladen Vouk	Department Head, Distinguished Professor of Computer Science, Director of the North Carolina State Data Science Initiative
NetApp	Martha Dubois	Senior Program Manager, Business Operations Manager
North Carolina Technology Association	Brooks Raiford	President and Chief Executive Officer
Open Raleigh, City of Raleigh, NC	Adam Martin	Program Manager
Predictifyme	Rob Burns	Chief Executive Officer
Pricewaterhouse Coopers (Former State CIO)	Chris Estes	Director
Quintiles	Gary Shorter	Head of Artificial Intelligence, Advanced Analytics
Quintiles	Richard Thomas	President, Technology & Solutions
RedHat	Jim Whitehurst	Chief Executive Officer
Research Triangle Institute	Craig Hill	Senior Vice President
SAS	Armistead Sapp	Executive Vice President, Chief Technology Officer
Sift	Jud Bowman	Founder and Chief Executive Officer
University of North Carolina, Charlotte	Mirsad Hadzikadic	Professor of Software & Information Systems, Executive Director of Data Science Initiative
Wake Forest University	Jeff Camm	Associate Dean, Business Analytics Masters Program
Wake Technical Community College	Stephen Scott	President

APENDIX H
Best Practices in Government Data Economy Promotion

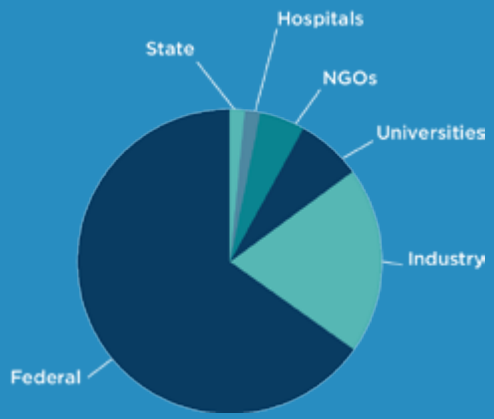
Provided by Student Teams Achieving Results, Kenan Flagler Business School at UNC-Chapel Hill

Seattle used a data science hackathon to tackle civic issues.

Massachusetts promoted data science in the UMass system through program creation and federal/industry funding.

Actions

- Pushed creation of the Center for Data Science at UMass Amherst.
- Promoted Concetration in Data Science in Amhurst's Computer Science program.
- Assists institutions in securing federal and industry funding.



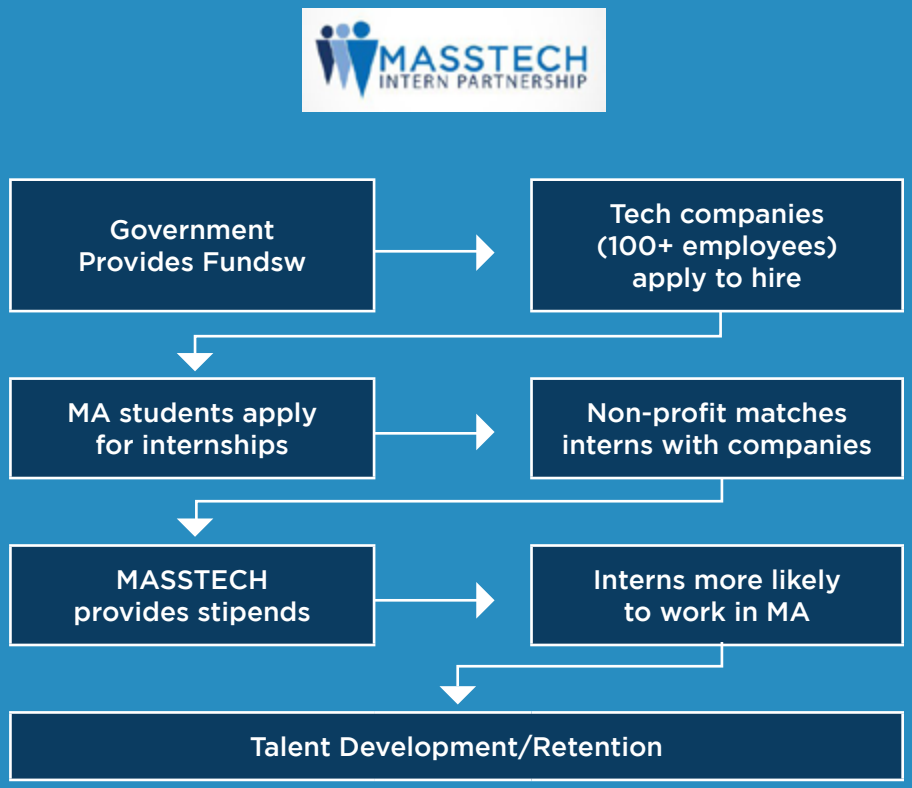
Results

- System research partnerships include Google, Oracle, MassMutual, and Raytheyon.
- System awarded 17 percent of state data science degrees in 2012.
- Majority of these graduates will remain in Massachusetts.

200	30+	$200+
Faculty Members	Research Centers	In Federal Grants

UMass Big Data Report. Chart approximated.

Massachusetts sponsored data science internships through the Massachusets Technology Collaborative.

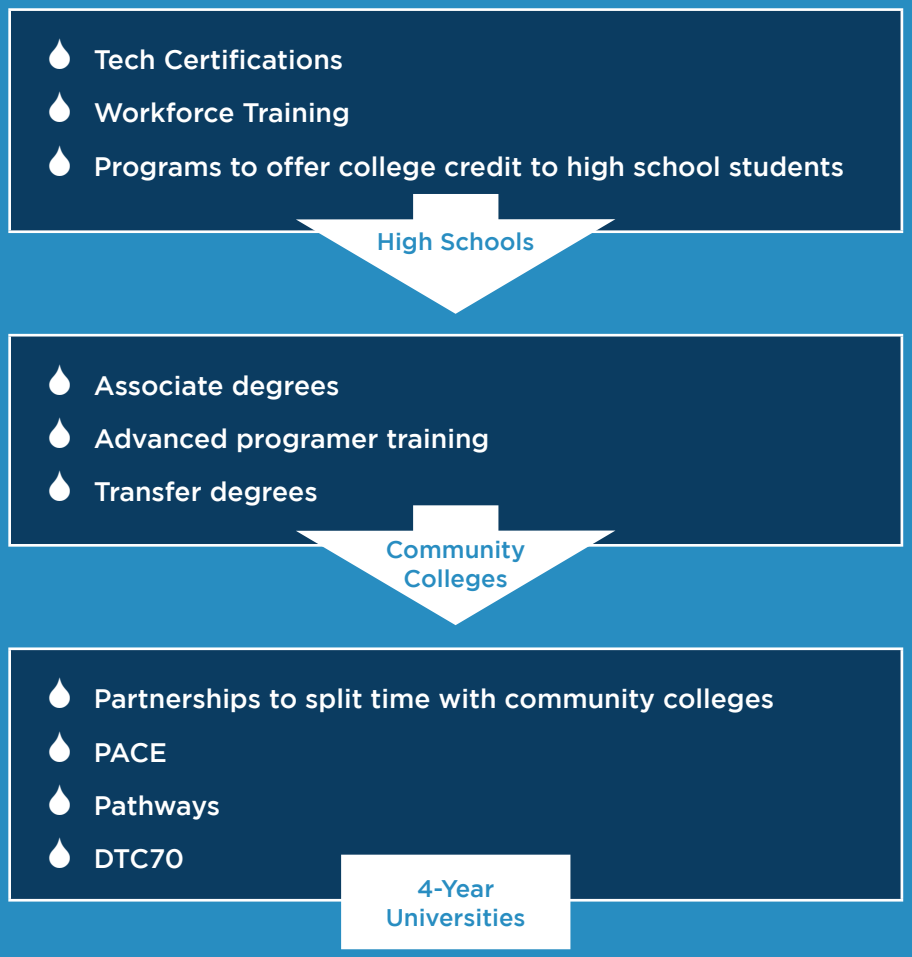


89 percent of companies would recommend sponsoring an internship through the MTIP.

92 percent of interns rated their internship as successful in providing them with valuable skillsets.

Masstech.org

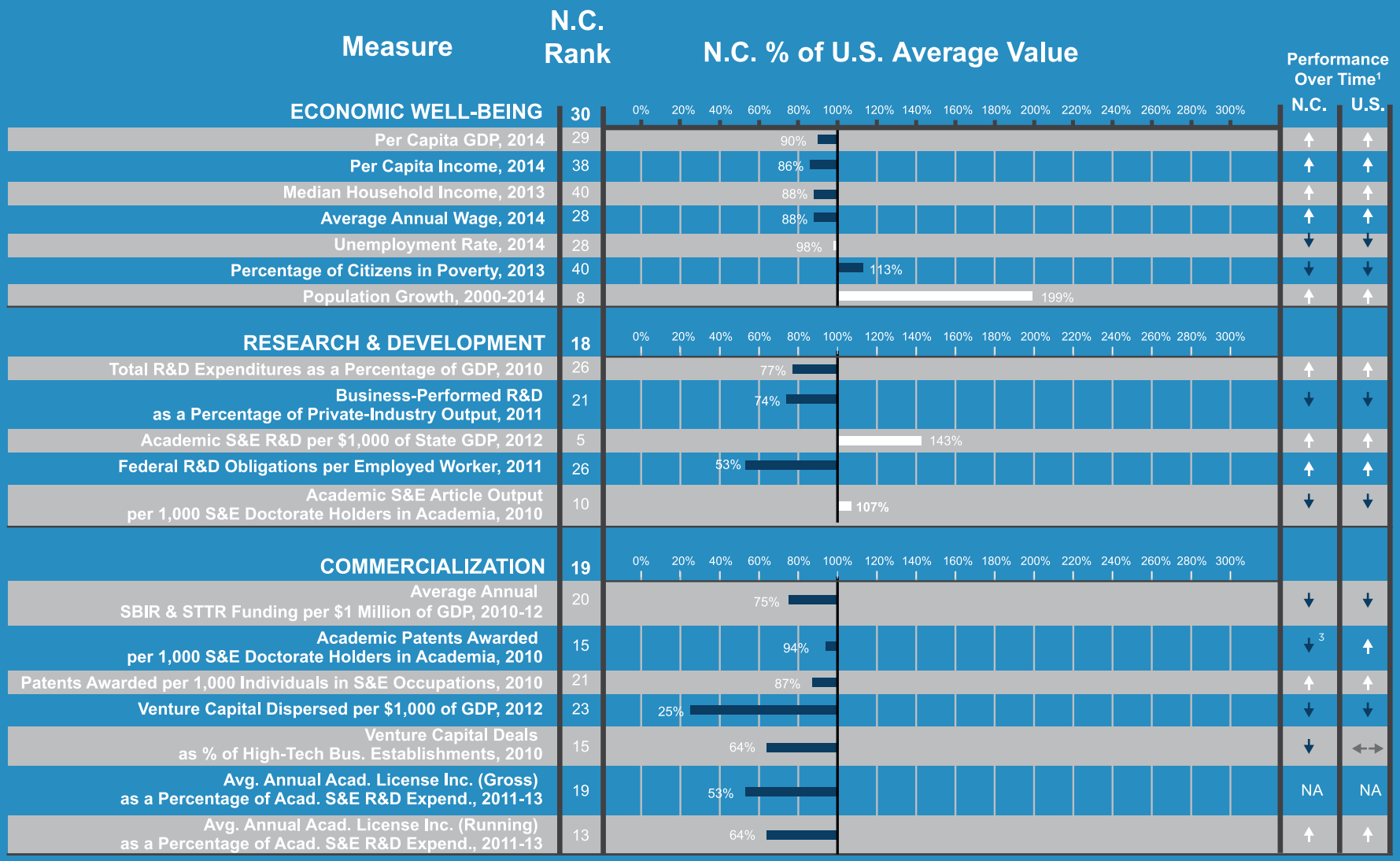
Austin partnered with local institutions to expand its data science pipeline and improve talent retention.



Massachusetts Technology Collaborative enabled statewide collaboration across four key stakeholders.

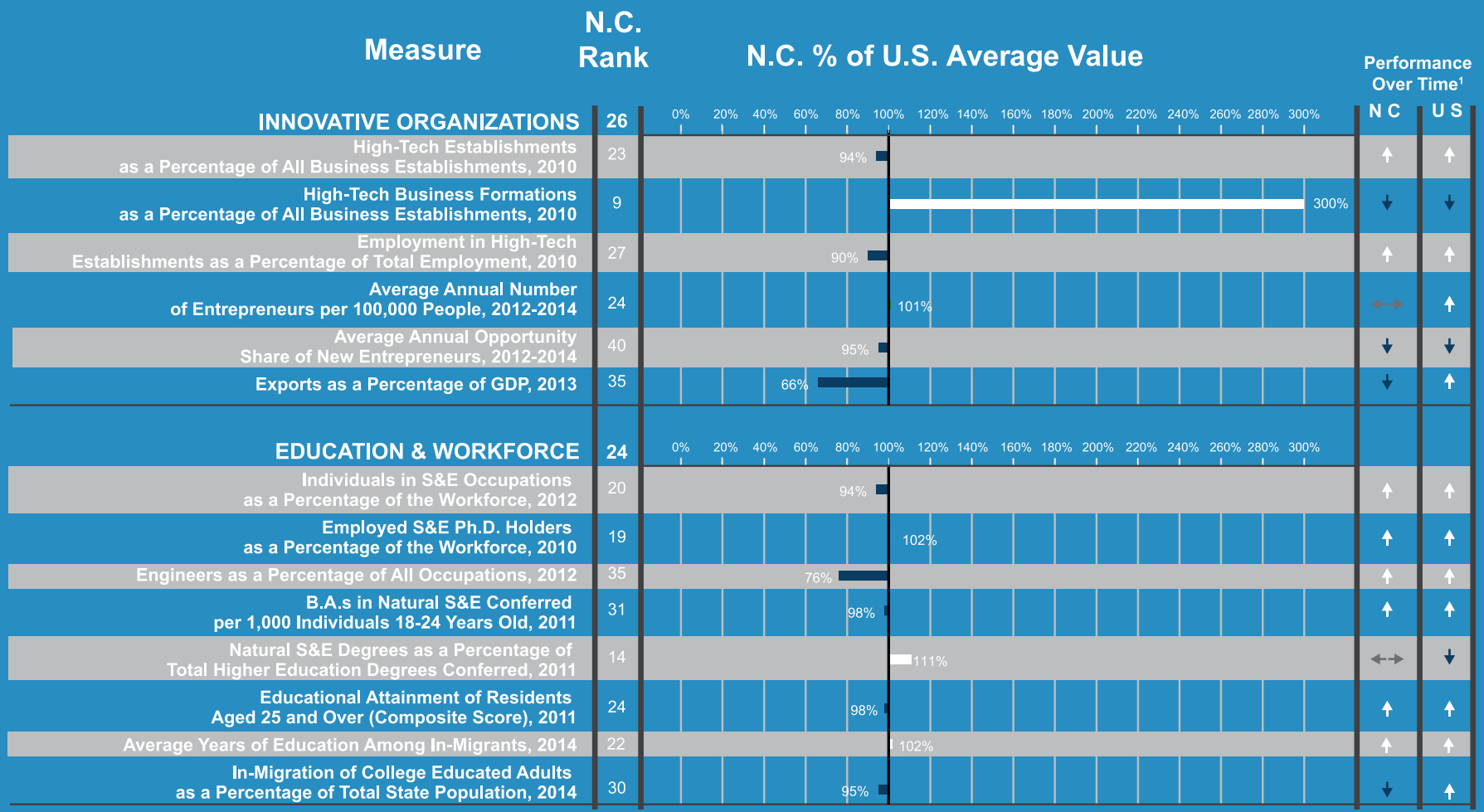
APENDIX I

Overview of Measures: North Carolina Innovation Index, 2016



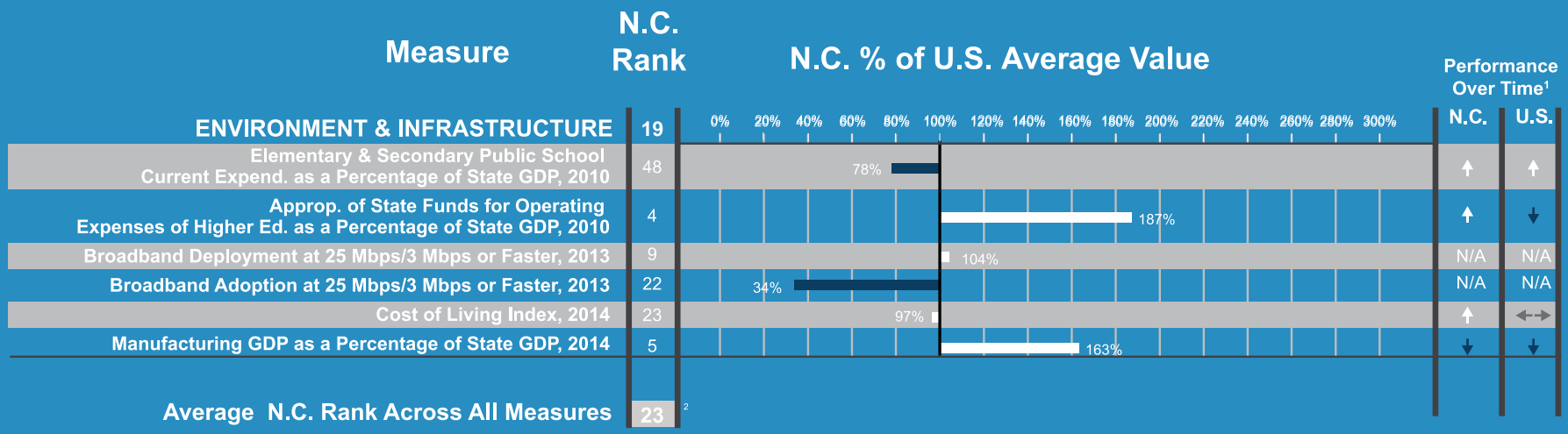
APENDIX I *Continued*

Overview of Measures: North Carolina Innovation Index, 2016



APENDIX I *Continued*

Overview of Measures: North Carolina Innovation Index, 2016



APPENDIX J

Members of the Board of Science, Technology & Innovation

Ex-Officio

The Honorable Roy Cooper, Governor of the State of North Carolina

Tony Copeland, North Carolina Secretary of Commerce

Members

Jason Botts, President-elect, North Carolina Executive Roundtable

Suresh Chandra, Professor Emeritus & Former Dean, College of Engineering, NC A&T State University

Matt Cimino, CEO, Exit Intel

Judith Cone, Vice Chancellor for Innovation, Entrepreneurship & Economic Development, UNC-Chapel Hill

Chris Estes, Director, PricewaterhouseCoopers

Algie Gatewood, President, Alamance Community College

A Blanton Godfrey, Distinguished University Professor, College of Textiles, NC State University, Board Chair

H. Christian Hölljes, Professor, Innovation + Design, NC State University

Bruce King, Associate Provost for Research, Wake Forest University

Daryush Ila, Associate Vice Chancellor for Research, Technology Transfer Officer, & Radiation Safety Officer, Fayetteville State University

Sam Houston, President & CEO, NC Science, Mathematics, and Technology

Keenan Locklear, Science Teacher, Public Schools of Robeson County

Mike McBrierty, Senior Manager, State Public Policy & Government Affairs, Biogen

Mark McNeilly, Professor of the Practice, UNC Kenan-Flagler Business School, UNC-Chapel Hill

Robert A Millet, Director of Clinical Research, Carolina Behavioral Care

Enoch Moeller, Site Manager, Google, Lenoir Data Center

Mitch Mumma, Managing General Partner, Intersouth Partners

Matt V. Phillips, President, Zylera Pharma Corp

Alan Rebar, Vice Chancellor for Research, Innovation and Economic Development, NC State University

Michelle Smith-Hylton, Engineering Consultant, Aerospace and Aviation

Ron Tessitore, Senior Vice President of Engineering, Qualcomm (Retired)

Donald Thompson, CEO, Creative Allies; Executive Chairman, O3 Creative

Eric Toone, Vice Provost and Director, Innovation & Entrepreneurship Initiative, Duke University

Robert Wilhelm, Vice Chancellor, Research and Economic Development; Executive Director, Charlotte Research Institute, UNC Charlotte

[59] Rankings are blunt policy instruments in that they can obscure as much as they illuminate. The rankings from the *U.S. News and World Report* have their limitations. Yet over time, the rankings can reveal general trends in comparative universities.

[60] NOTE: Numbers do not include relevant programs at North Carolina's private universities. Therefore, actual numbers are greater.

[61] No industry or occupation codes encompass the data economy as a separate industry. Therefore, indirect means of industry analysis must be used for the metrics. Further footnotes will explain the context and methodology of the statistics.

NC Board of Science, Technology & Innovation