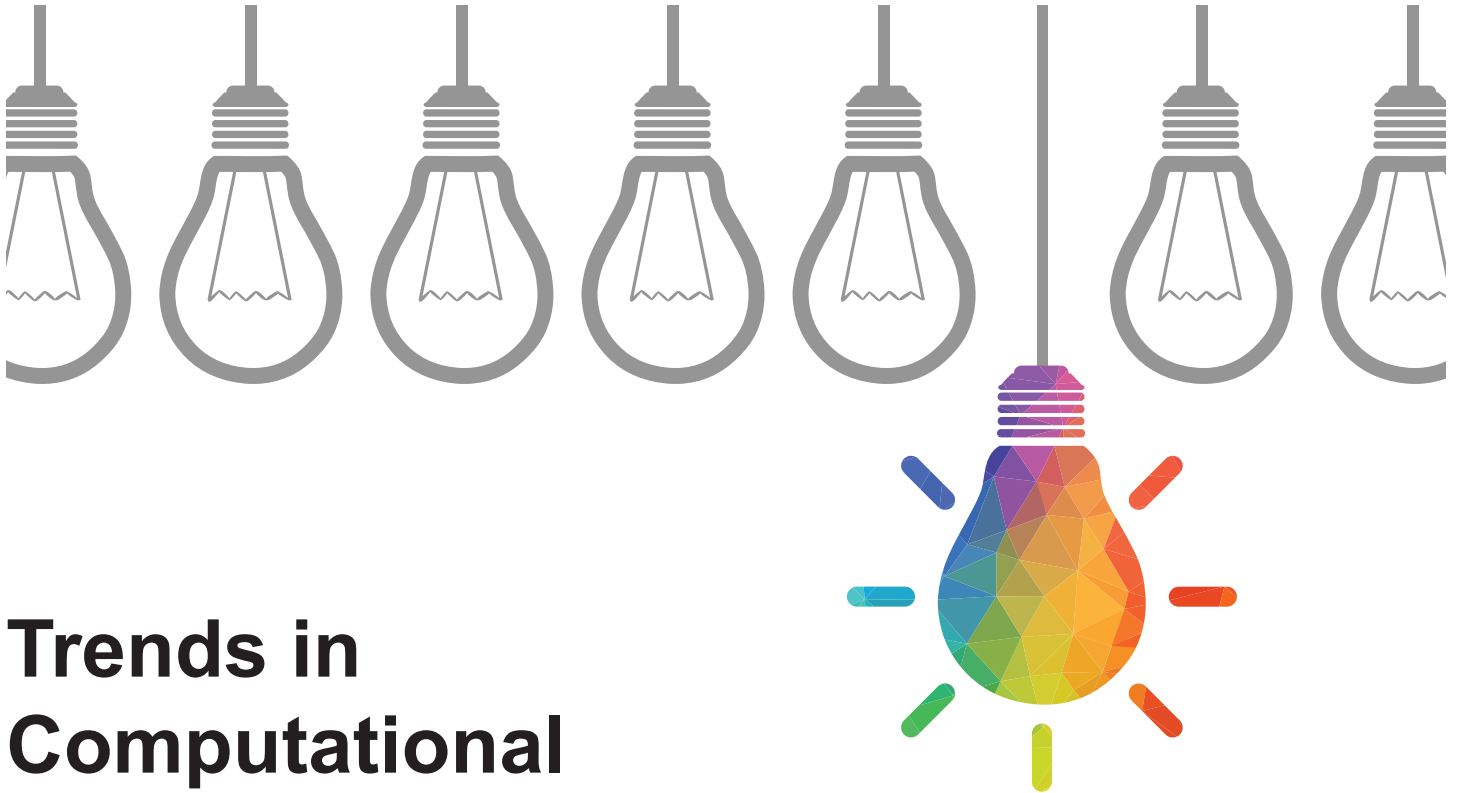




Trends in Computational Biology / Bioinformatics

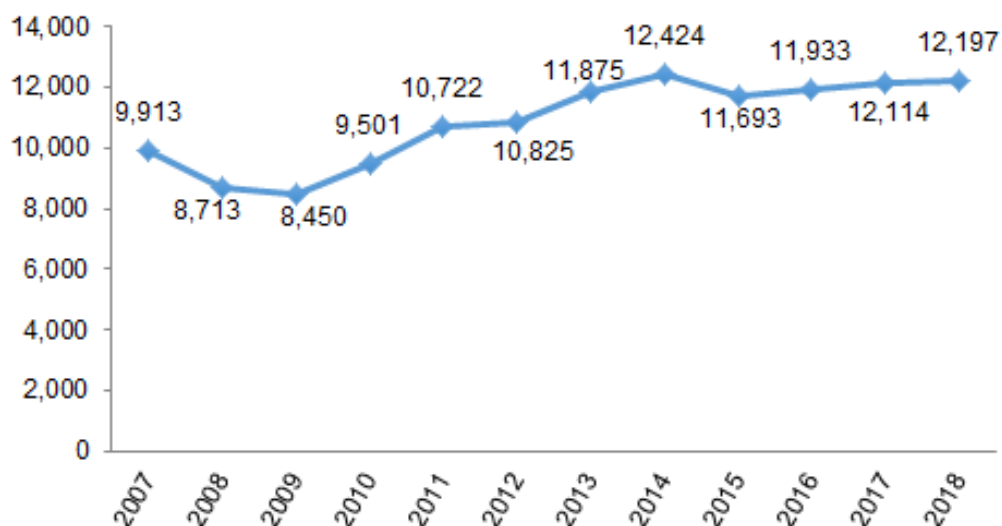
Both high-tech leaders (e.g., IBM, Google, and Microsoft), and university laboratories supported by government funding are prolific patent filers.

The global bioinformatics market is projected to reach \$16 billion by 2022,⁵² growing primarily on the strength of genomics research and personalized medicine. To further explore innovation hot spots in this area, we turn to patenting data. We have defined the following technology clusters within the general industry of Computational Biology/Bioinformatics:

Taxonomies and expanded definitions of these clusters are included in appendix A.

Level I Clusters	Level II Clusters
Analysis Of Gene Expression	-
Computational Biomodeling	-
Computational Neuroscience	-
Patient Data Analysis	-
Protein Analysis	-
Computational Evolutionary Biology	
Sequence Analysis	Functional
Genomics/Proteomics Genetics Of Disease/ Mutations Responsible For Disease	
Genome Annotation	
	Pharmacogenomics
	Sequence Alignment/ Comparison
	Sequence Assembly
	Sequence Identification
Structural Bioinformatics	-

Despite being a software-heavy industry, patent filings in the Computational Biology/Bioinformatics industry have not dropped significantly after *Alice*



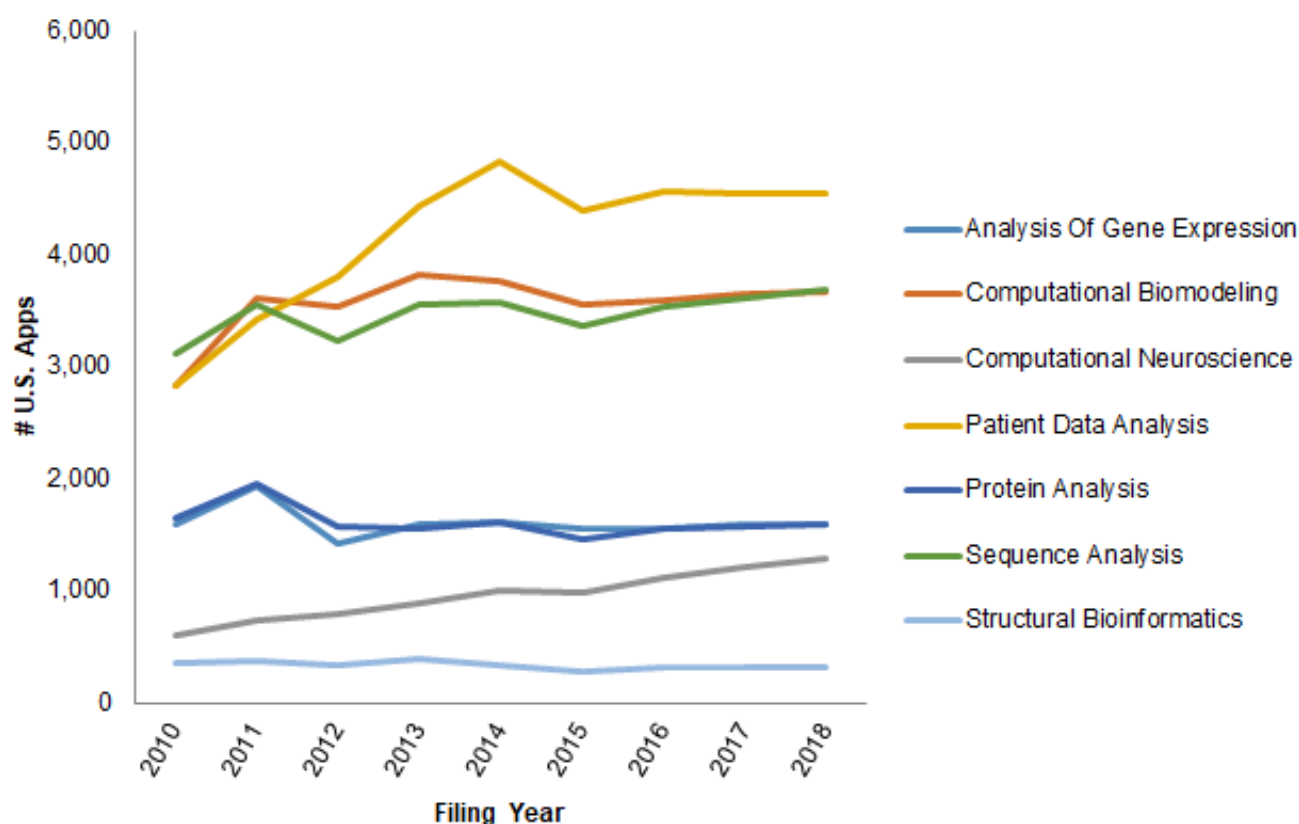
⁵² <https://www.marketwatch.com/press-release/bioinformatics-market-is-set-to-grow-us-16-billion-by-2022-2019-01-21>

In 2014, following the Supreme Court's *Alice* decision, the USPTO implemented new examination procedures for software-related and business-method patent applications. The impact was severe, with allowance rates plummeting. This shift was predominantly seen in the FinTech and bioinformatics Art Units.⁵³ For FinTech, the reduced allowance rates caused an almost immediate drop in patent filings. For Computational Biology/Bioinformatics, however, no significant drop in filing rates occurred.

The divergence in filing behavior between these industries may reflect different perceived value that tech leaders ascribe to the patents that do get through examination and are granted. Alternatively, it may reflect the different expectations tech leaders have held about the future chances of patent allowances in the FinTech and Computational Biology industries. Indeed, recent data indicate that allowance rates for computational biology applications have recently risen and are now above pre-*Alice* levels.

The slight drop in patent filings that did occur immediately post-*Alice* is likely due to smaller entities (e.g., startups) changing their patent filing strategies in view of a less favorable funding environment for biotech startups where VC funding has been less available in recent years.

Patent filings related to Patient Data Analysis and Computational Neuroscience are increasing



⁵³ <https://www.ipwatchdog.com/2019/02/06/bioinformatics-innovations-thrive-despite-101-chaos/id=106020/>

Personalized medicine, an important priority for the healthcare industry, is dependent on advances in the Patient Data Analysis technology cluster. A number of tech leaders, including IBM, Google and Microsoft, have active initiatives in this area. For example, IBM's Watson for Genomics helps molecular pathology labs provide precision oncology programs and personalized cancer care.⁵⁴

Computational neuroscience, which is concerned with the development, simulation, and analysis of neural function models and theories, is also showing increasing patenting activity. Not only is computational neuroscience important for understanding brain function, but it can also advance A.I. capabilities. The interconnection between researching cognition and behavior and helping improve A.I. is demonstrated by IBM's Neural Tissue Simulator, which mimics the way neurons communicate in the brain that has been used to both research neurological conditions like Huntington's disease and model neural networks for A.I. research.

Reduced patent filings for innovations relating to diagnostics may contribute to the fall off in the Sequence Analysis, Protein Analysis, and Analysis of Gene Expression technology clusters

In 2012, The Supreme Court struck down a diagnostics methods patent in *Mayo v. Prometheus Laboratories*, stating that the claimed steps involved natural laws and routine, conventional activity, and therefore were not patentable. This ruling had a chilling effect on patent filings relating to diagnostics, and it is likely a contributing factor to the dip in patent filings we observe in our study for the Sequence Analysis, Protein Analysis, and Analysis of Gene Expression technology clusters, in which a subset of research is directed to diagnostics.



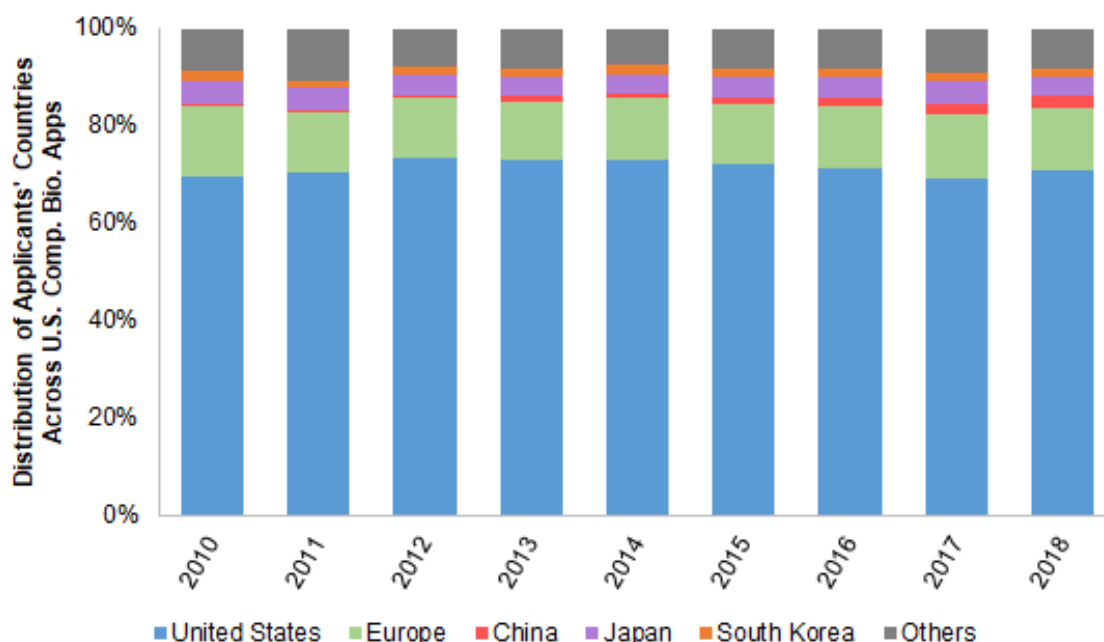
⁵⁴ <https://www.ibm.com/us-en/marketplace/watson-for-genomics>

High-tech leaders and government-funded research laboratories dominate patenting in the Computational Biology / Bioinformatics industry

USING 2016 DATA:	
	Most Families Filed by
	(Applicants In alphabetical order)
Computational Biology - Bioinformatics	General Electric, IBM, Microsoft, Samsung, Siemens
Level I	
Analysis Of Gene Expression	Dow Chemical Co., Macau University Of Science And Technology, Monsanto Technology, Regeneron Pharmaceuticals, Regents Of The
University Of Minnesota, Stanford University, University of California	
Wisconsin Alumni Research Foundation, Stanford University	
Computational Biomodeling	Goggle, IBM, Microsoft, Samsung, Siemens
Computational Neuroscience	Boston Scientific, Ecole Polytechnique Federale De Lausanne IBM, Intel, Medtronic, Microsoft
Patent Data Analysis	Fujitsu, General Electric, IBM, Medtronic, Siemens
Protein Analysis	Expression Pathology, /BM, Massachusetts Institute Of Technology, Sensors Unlimited, Thermo Finnigan, University Of California
Sequence Analysis	IBM, Rijk Zwaan Zaadteelt En Zaadhandel, Seven Bridges Genomics, Syngenta Participations Ag
Structural Bioinformatics	Academia Sinica, Goggle, Glysens, Parsagen Diagnostics, University Of California

While computational biology is being increasingly used for real-life applications, it is also an academic research area for which government funding is relatively abundant. This is reflected in the patent filing trends observed in our study, where prolific patent filers are both high-tech leaders (e.g., IBM, Google, and Microsoft), and university laboratories supported by government funding.

U.S.-based filings are hovering near 70% of the overall number of patent filings in the Computational Biology/Bioinformatics industry



The percentage of U.S.-based patent filings has been hovering near 70% for the past decade. The stability of this percentage is somewhat unusual among the industries surveyed in our study, where we see declining percentages of U.S.-based filings in the majority of other industries. The relatively high and steady percentage of U.S.-based filings reflects the dominance of American high-tech companies and universities in this field.



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