

the current **BIOINFORMATICS** analytical software landscape

With the vast amount of biochemical data generated from experiments conducted by research laboratories around the globe, there is strong demand for software to analyse and manage the data effectively. Analytical software can be utilised to analyse virtually every single experiment, ranging from gene sequence analysis to protein:protein interactions. Bioinformatic analysis tools are indispensable, as they have expedited the development of drugs and lowered costs associated with the commercialisation of new therapeutics.

By Charles Chang

The bioinformatics industry provides both software and hardware products to support the pharmaceutical and biotechnology industries. Among the main features are the analysis and management of data from genomics and proteomics experiments. The current industry landscape is extremely volatile and is experiencing ongoing consolidation and depletion of investment capital. Meanwhile, the need for more convenient and cost-effective tools is driving players to continuously improve upon their existing products.

With the development of high-throughput technologies in various post-genomics applications, adoption of bioinformatics tools may offer more efficient drug discovery and development processes by improving analysis of data collected from a multitude of instruments. The completed Human Genome Project has allowed deeper insights into genomics, protein and gene expression, metabolic pathways and disease states. Much of this knowledge has resulted from the use of software tools to manipulate data, and indeed would have been impossible to analyse without the powerful bioinformatic applications.

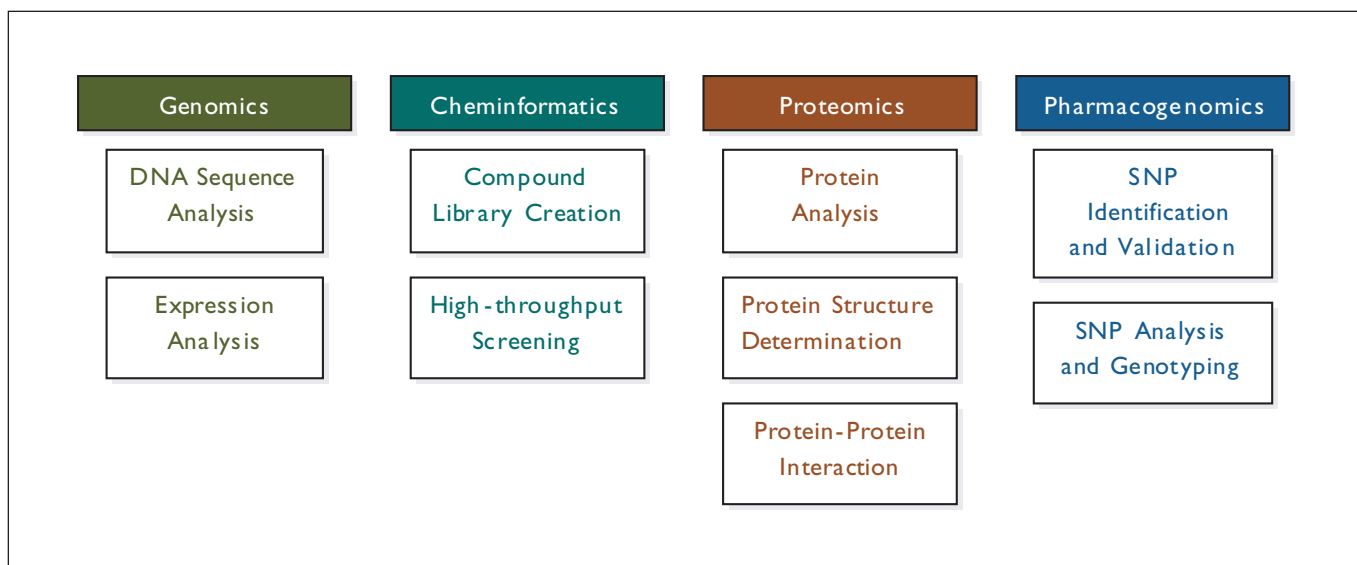
Demand for more accurate, complete and multi-functional bioinformatics tools drives product

innovation in this analytical software industry. A trend is particularly noticeable in proteomics applications; protein-protein interactions and protein structures are difficult to analyse due to the complexity of raw data and challenging to present due to the need for three-dimensional representations. Also, as the proteomics segment matures, demand for more specific and customised analytical tools will increase and bioinformatics tools suppliers will be challenged to meet specific needs. As a result, suppliers are beginning to provide products with greater flexibility and customisation options, and novel bioinformatics products for genomics and proteomics applications are exhibiting more sophisticated and customised characteristics.

Navigant Consulting (NCI) has broken down the current bioinformatics analytical software market into four major segments:

Genomics

In most academic and drug discovery research laboratories, DNA sequencing and gene expression analysis are conducted on a daily basis. Bioinformatics tools effectively and accurately analyse an extensive amount of data obtained from high throughput technologies such as DNA



microarrays and microfluidics technologies. Currently, the genomics bioinformatics market provides researchers the option to choose public freeware or private software that provides additional features, such as ADME profiles, that may shorten drug development time.

Informax, a subsidiary of Invitrogen, provides a variety of bioinformatics tools with diverse genomics applications. Vector NTI Advance is a software suite dedicated to sequence analysis in a desktop setting that enables users to conduct DNA analysis and offers efficient data management. Rosetta's Resolver system is a gene expression analysis software suite that translates image data from microarray instruments into a quantitative format that can be further utilised for academic research and pharmaceutical product development.

Cheminformatics

There is an increasing trend toward the creation of small molecule libraries as combinatorial chemistry techniques gain popularity. Protein targets are screened against compounds in these libraries with biochemical assays to identify lead compounds for therapeutic development. Cheminformatics tools primarily manage high-throughput screening (HTS) and compound chemistry data. Virtual compound library screening is conducted to select target compounds. The ultimate integration of biological and chemical compound data into virtual libraries is expected to facilitate the drug development process through 2009.

The industry average length of preclinical drug discovery from initial hit to lead optimisation ranges from 18 to 30 months. With the advent of chemin-

formatics technologies, such as those developed by Tripos, the development time may be reduced by as much as 50%, saving drug discovery companies time and money. The ChemSpace technology can screen up to two trillion compounds per hour to select biologically relevant compounds, while Accelrys' Discovery Studio suite of informatics products enables *in silico* Absorption, Distribution, Metabolism and Excretion (ADME)/Toxicology (Tox) pre-screening of drug candidates.

Proteomics

The large number of protein molecules in the human proteome opens new avenues of research to laboratory scientists characterising proteins and identifying their roles in the human body. To better understand these proteins, it is imperative to conduct rigorous analyses of proteomic experiments to determine protein structures, protein:protein interactions and disease mechanisms. The vast amount of data generated from 2D gel electrophoresis, mass spectrometry and protein microarrays requires bioinformatics software to efficiently analyse results.

Accompanying the advent of protein arrays is the need for robust data analysis software to interpret the data into useful information that researchers can leverage in their quest for drug targets. Ciphergen's ProteinChip system is accompanied by a suite of informatics tools to analyse mass spectrometry data providing insight into protein structure and expression levels. In the realm of image analysis, Scimagix provides informatics tools to store and analyse images generated from various experiments. As images provide more detail than

alpha-numeric data, it is crucial to have adequate software solutions to handle them. Scimagix's ProteinMine utilises its proprietary Scientific Image Management System (SIMS) to create robust image analysis software for 2D gel experiments.

Pharmacogenomics

Information from pharmacogenomics studies provides researchers with data that helps them understand how individual genetic variations, such as single nucleotide polymorphisms (SNP), impact disease susceptibility and drug response. Future demand for bioinformatics tools in this segment will be in the area of SNP analysis and large-scale association studies that support drug development and point-of-care diagnostic programmes.

Genaissance's DecoGen is an informatics tool that allows customers to analyse pharmacogenomics data collected through proprietary and public databases. The software package assists clients in identifying specific haplotype markers (HAP Marker sequences), collected through haplotype genotyping, that may correlate with drug responsiveness or specific disease pathways. Applied Biosystem is a major player in the protein characterisation realm; as such, it provides peripheral software for analysis of data collected from its own instruments. For example, the GeneMapper software suite is specifically designed for high-throughput applications as it is capable of processing more than 50,000 genotypes in one hour.

Market outlook: 2004-2009

The total bioinformatics market for analytical software is positioned to expand at a compound annual growth rate (CAGR) of 9.3% over the next five years. Growth will partly be driven by the accelerated adoption of analytical tools in the pharmacogenomics and proteomics.

Overall, genomics will continue to be the leading application of analytical software as DNA sequence and gene expression analysis are used prevalently in both academia and the pharmaceutical industry. However, proteomics and pharmacogenomics applications will experience greater growth rates and gain market share over the next five years as those segments mature. Overall, the market dynamics will not change greatly as the adoption rate of bioinformatics tools will be slow in the near future due to cautious investment strategies by pharmaceutical companies in the current economic climate and maturity of the genomics application.

Because many bioinformatics software tools merely improve rather than revolutionise drug tar-

get identification and validation, demand for informatics tools will not likely increase dramatically. Yet, as developers of novel high-throughput technologies introduce technologies, bioinformatics developers will commercialise newer software products to meet the demand. Particularly, product developments in proteomics applications will increase due to greater efforts in discovering new disease biomarkers.

In the next five years, the major players in the genomics and proteomics instruments market, such as Amersham Biosciences and Applied Biosystems, will continue to retain market share by introducing second generation products that improve upon current packages.

End-user thoughts

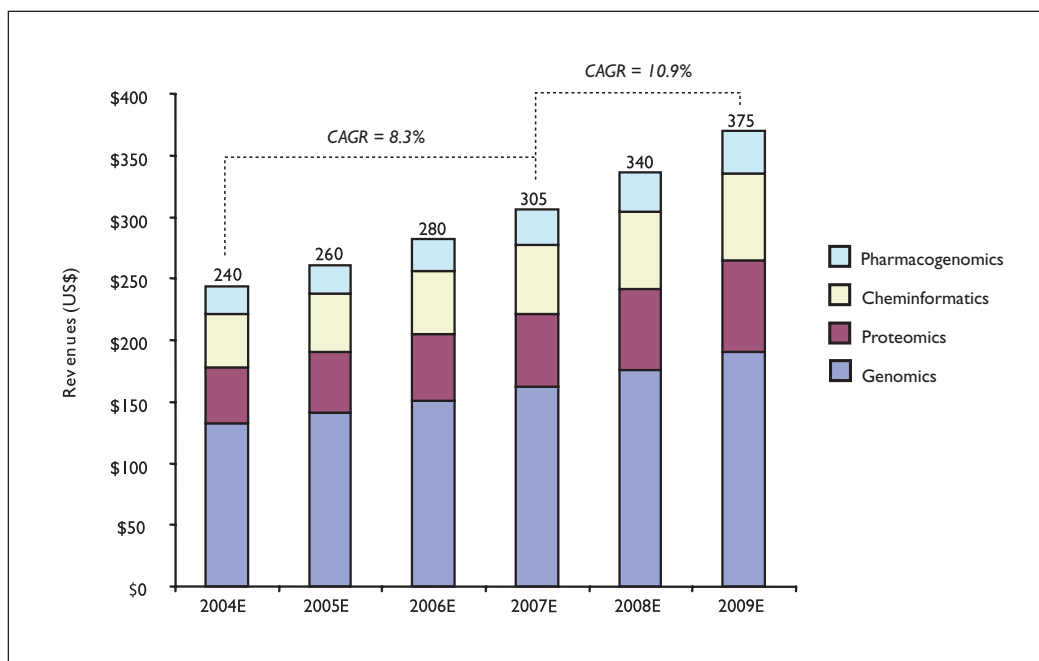
With an ever-increasing level of competition in the bioinformatics market, suppliers must identify and meet end user demands with haste to retain and grow their customer base. Since the completion of human genome mapping, demands for more sophisticated and customised tools has increased. Navigant Consulting engaged in an in-depth study to identify the specific needs of end-users and gather their thoughts on current products and segment specific trends.

End-users were asked to identify their preferred suppliers of bioinformatics tools for various application areas. Academic users show a preference for public bioinformatics tools. According to a research scientist at the National Cancer Institute: "Cost is the most significant factor for any purchasing decisions in an academic setting and compromised decisions are always made to accommodate financial limitations." Industry users prefer products with strong reputations that offer high levels of technical support, and that are convenient, all of which are associated with higher price tags.

Over a third of users have reported dissatisfaction with their current bioinformatics analytical tools. This group of dissatisfied end-users may turn into an attractive target for competing suppliers to market and grow their market share.

Difficulties with data integration and associated high prices account for nearly three-quarters of total dissatisfaction.

Given that, more than 90% of end-users still agree that current bioinformatics tools improve productivity while providing cost savings for their research. As a senior staff scientist at Bayer states: "The introduction of high-throughput instruments, such as microarrays and bioinformatics tools, have become an essential component of drug discovery programmes in pharmaceutical companies."



Researchers expect strong growth to occur in the proteomics and pharmacogenomics segments as future research will concentrate in these fields. The expected revenues for these segments are directly correlated to the growth potential for the segment-specific bioinformatics market. Overall, the demand for bioinformatics tools is encouraging as average company budgets for bioinformatics research will increase by approximately 20% in the academic and the pharmaceutical and biotechnology settings. However, only a portion of this growth will be reflected in the market as many end-users will support their growth with in-house development.

Industry trends and challenges

The top trends in the bioinformatics industry:

Increasing government compliance

Novel technologies are constantly applied in drug discovery and development which enhances R&D efforts by researchers. However, the same advances impede regulatory agencies in assessing authenticity of electronic data. Currently, many suppliers are including features that assist clients in meeting the standards required by government agencies to ensure that electronic data can be trusted.

Industry-wide turmoil

Consolidation of the bioinformatics industry will benefit the stronger players in the field. As companies acquire and merge with each other, the result-

ing conglomeration can improve product offerings and capture greater market share.

Shift in focus from genomics to proteomics

There is increasing interest in proteomics due to heightened efforts in discovering disease biomarkers and identifying therapeutic targets. As such, proteomics informatics tools are experiencing increasing demand from drug development companies.

The current challenges facing the bioinformatics industry

Lack of interoperability and multiplatform capabilities

End-users of bioinformatics products demand products that are flexible and easy to use. However, many software providers have commercialised products that lack interoperability. This has hampered sales as informatics users prefer tools that can be used across different software platforms.

Lack of standardised formats

Researchers want to be able to access data from different sources and that are generated by different experimental techniques, reported in different formats, or about different aspects of the same function. Often, manual intervention is required, which eliminates automation, may contribute to errors and creates a bottleneck process.

Difficulties in integrating applications

There is a need to analyse different facets of one problem, such as evaluating gene expression as well as 3D modelling of a particular protein, or determining how a particular 3D structure may affect a whole pathway. Manual intercession is necessary, which slows analysis.

Management of high volume data

The inundation of data unleashed by automation, miniaturisation, whole genome analyses and other technologies needs to be analysed, annotated, stored and retrieved. Slow data management creates inefficiencies and is a burden to systems administrators and data managers.

Growing competition from in-house development and publicly available tools

As drug discovery companies minimise discovery budgets, they are shifting from outsourcing software to developing in-house tools. This allows them to customise their applications to suit their needs and increase work flow efficiency, and thereby hamper segment growth.

Strategic options for bioinformatics developers

Based on the current trends and challenges within the bioinformatics market, Navigant Consulting has identified three general strategic options to help players seize opportunities and strategically grow their businesses in this arena. Adopting these strategies will improve a company's likelihood of success and leadership in the evolving bioinformatics market.

Extend applications based on core technical expertise

Core technical expertise in one segment can often be transferred. For instance, products meant for microarray analysis may be easily converted to tissue array analysis. Many different software tools should be developed to analyse the different kinds of data generated as a result of automation and miniaturisation. Microarray experiments, SNP genotyping and high-throughput screening have all led to development of completely new applications. Similarly, the trends toward high-content screening, chemical genomics and pathway analysis are opening new fields that will require software development.

Provide web-based services and value-line products

For small and medium-sized companies and for academic researchers, the ability to utilise analyti-

cal software without a large up-front investment is of considerable advantage. When analysis is performed over the web, the end user does not need to maintain large data-handling and storage capacity. Pay-per-use services allow researchers to test software and modular products allow for the purchase of the package appropriate to the customers' needs, improving user satisfaction and shortening the sales cycle.

Collaborate with wet laboratory companies

Bioinformatics companies can enter the drug discovery space as analytical software is an essential part of genomics and proteomics research. They are indispensable tools utilised to analyse a variety of experimental results ranging from DNA sequencing to cellular arrays. Analytical software facilitates the data gathering process and lowers costs for its users. Because the ultimate goal is to expedite drug discovery, there has been great interest in the field in the late 1990s leading up to 2000. Since then, the industry has seen a decline in funding with the deterioration of the economy. To remain profitable and competitive, bioinformatics players are realising the need to tap into the drug development space. Alternatively, a bioinformatics developer can also enter the life science tools space as both tools are utilised hand-in-hand. Without bioinformatics, the analysis of genomics and proteomics experiments would be extremely labour-intensive, time-consuming and inefficient. High-throughput experiments such as microarrays are not practical without proper analytical software. Because there are so many players commercialising tools in the analytical software space, competition is fierce. By partnering with life sciences tool providers to develop and commercialise informatics products, companies will receive better brand recognition and revenue increases. Likewise, genomics and proteomics tools companies will benefit from collaborating or merging with informatics companies as they can develop software to complement their existing products. **DDW**

Charles Chang has worked as an Associate at Navigant Consulting, Inc (formerly Front Line Strategic Consulting, Inc) for two years following his graduation from the University of California, Berkeley and work experience at Merrill Lynch and the Health Technology Center. Mr Chang's area of expertise includes drug discovery technology assessment, competitor intelligence evaluation and market analysis and has covered the biomarker, novel high throughput screening, proteomics, bioinformatics, and siRNA market spaces.