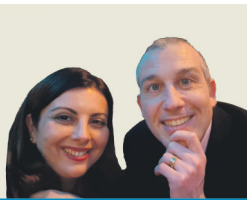


LIFE AND WELL-BEING SCIENCE

The potential of statistical methods in clinical diagnostics

MONIQUE BORG
INGUANEZ and
NEVILLE BORG

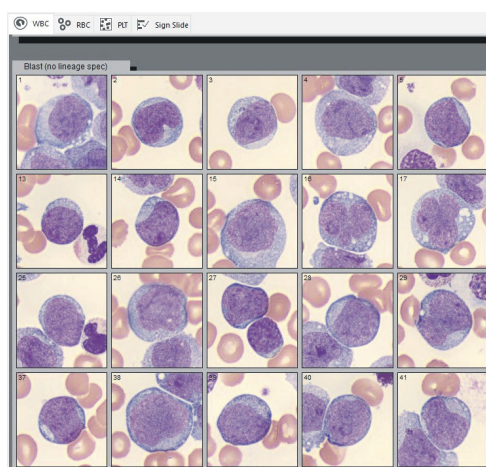


In the ever-evolving field of clinical diagnostics, the fusion of disciplines often leads to groundbreaking advancements.

As a statistician and a biomedical scientist, we have found a shared interest in the use of statistical tools to unlock their hidden potential in cell classification in clinical diagnostics. The cell's shape, size, internal structures and distribution often provide early indicators to underlying health conditions.

White blood cells are typically classified into five main types: neutrophils, lymphocytes, monocytes, eosinophils and basophils, but suspicious cells are often encountered. While automated hematology analysers have advanced significantly in the last decades, they often struggle with atypical and abnormal cells. Where analysers fall short, blood films can be screened under a microscope by skilled morphologists – a process that is both time-consuming and subjective.

This has sparked the need for sophisticated, fast and automated tools that can streamline cell classification, detect abnormal cells consistently and reduce operator subjectivity.



A digital scan of a peripheral blood film showing automated recognition of immature cells overspilling from the bone marrow, suggesting acute leukaemia. PHOTO: AUTHORS' OWN ARCHIVE

Statistics and machine learning help to solve this problem. Statistical shape analysis, for example, helps quantify inconspicuous variations in cell morphology. By mathematically analysing the contours of cells and their structures, systems can distinguish between cell types.

Complementing this, statistical learning techniques like support vector machines and convolutional neural networks enable software manufacturers to automate the classification process. These algorithms are trained and validated on large datasets, learning to

differentiate between cell types based on specific characteristics. What makes this approach particularly exciting is its ability to uncover insights that go beyond the obvious, having the potential to indicate specific neoplastic diseases, development of immune disorders or infections at a very early stage, even before symptoms manifest.

As available data grows in volume and complexity, statistical learning methods, particularly those in the field of machine learning, are becoming indispensable in the development of data-driven laboratory solutions. For patients, this translates to a faster, more consistent and streamlined diagnosis for better healthcare.

In conclusion, statistical analysis is important in the medical field at large as it aids in diagnostics, quality control, predictive modelling and personalised treatment.

As technology advances, the potential for statistical methods to improve healthcare grows. We hope this article inspires others to explore the intersections of their own disciplines. Sometimes, it's the blending of perspectives that brings the sharpest focus.

Monique Borg Inguanez is a senior lecturer of the Department of Statistics and Operations Research at the University of Malta, with an interest in application of statistical methods in health sciences. Neville Borg is a biomedical scientist with an interest in haematology diagnostics.

MYTH DEBUNKED

Bayesian statistics is just about prior beliefs

MONIQUE BORG
INGUANEZ and
NEVILLE BORG

A common misconception about Bayesian statistics is that it mainly involves incorporating personal prior beliefs or subjective opinions. While priors do play a role, the core strength of Bayesian statistics lies in its ability to update knowledge as new data becomes available – a significant advantage over traditional frequentist methods.

Frequentist statistics rely on fixed probabilities based on large datasets, often assuming that data doesn't change over time. This approach can be limiting when dealing with new, evolving data.

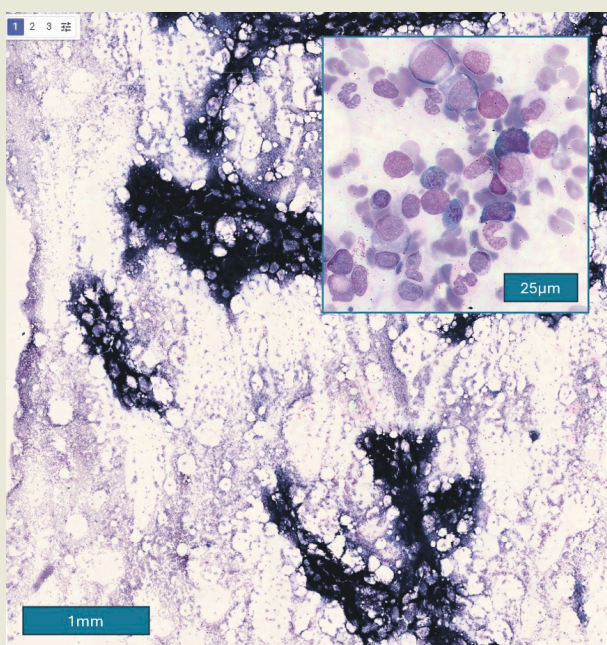
Bayesian statistics, on the other hand, combines prior knowledge (priors) with new data (likelihood) to continuously update and improve predictions, creating a dynamic, adaptable framework.

Take cancer diagnosis as an example. In cell classification, doctors use complex algorithms to analyse tissue samples and classify cells as benign or malignant. Initial assumptions, based on prior knowledge like patient history, might suggest certain probabilities. But as new test results are collected, Bayesian statistics update these probabilities. By refining predictions with new evidence, it helps improve diagnostic accuracy.

This ability to continuously adapt is what makes Bayesian statistics so powerful, especially in fields like healthcare. It's not about starting with subjective opinions but about continuously refining predictions as new evidence emerges.

This dynamic approach ensures better, data-driven decisions, ultimately leading to more accurate diagnosis and treatments, and offering clear advantages over traditional statistical methods.

PHOTO OF THE WEEK



The evolution of haematology diagnostics is expanding from routine digital blood film morphology in peripheral blood to comprehensive full-image scans for bone marrow assessment as shown in the picture. High-resolution imaging (inset) and software-assisted analysis of regions of interest in bone marrow films provide a very detailed perspective on haematological disorders. The integration of advanced imaging and computational tools streamlines workflows, reduces manual intervention and is an excellent teaching and telemedicine tool. As more software becomes validated for clinical use, the automated analysis of complex clinical samples like bone marrows will become more accessible to healthcare providers. PHOTO: [HTTPS://SCOPIO.LABS.COM/SCAN_GALLERY/BONE-MARROW-ASPIRATE/](https://SCOPIO.LABS.COM/SCAN_GALLERY/BONE-MARROW-ASPIRATE/)

DID YOU KNOW?

- Florence Nightingale, often credited as the founder of modern nursing, also made significant contributions to the field of statistics. During the Crimean War, her work with polar area diagrams helped to reduce mortality rates in military hospitals.
- Gertrude Cox was a trailblazer in the field of biostatistics, making significant contributions in applying statistical methodology to improve medical research practices such as the design of clinical trials.
- David Cox is a renowned statistician who developed the Cox proportional hazards model, which is widely used in medical research for understanding the relationship between a patient's risk factors and their survival probabilities.

SOUND BITES

- Statistical analysis is key in public health decision-making. By analysing population data, like disease incidence, mortality rates and risk factor prevalence, biostatisticians identify health trends and guide resources

allocation. Statistical methods also predict the spread of infectious diseases, like COVID-19, helping governments implement timely preventive measures. The first author, Monique Borg Inguanez, co-authored a study titled *Multiple Change-point Analysis of COVID-19 Infection Progression and Related Deaths in the Small Island State*

of Malta, published in 2022. The research focused on the progression of COVID-19 infections in Malta and utilised changepoint analysis to identify shifts in the trends of COVID-19 cases and related deaths.

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CONTRIBUTORS

JEAN-PAUL EBEJER
DANIELLE MARTINE
FARRUGIA
JOSEF BORG
CLAUDIA BORG
ALEXANDER FARRUGIA
BONNIE ATTARD

E-MAIL

SCI-SUNDAY@UM.EDU.MT