IBD Investigators Day

BRITISH SOCIETY OF GASTROENTEROLOGY

Artificial Intelligence in IBD

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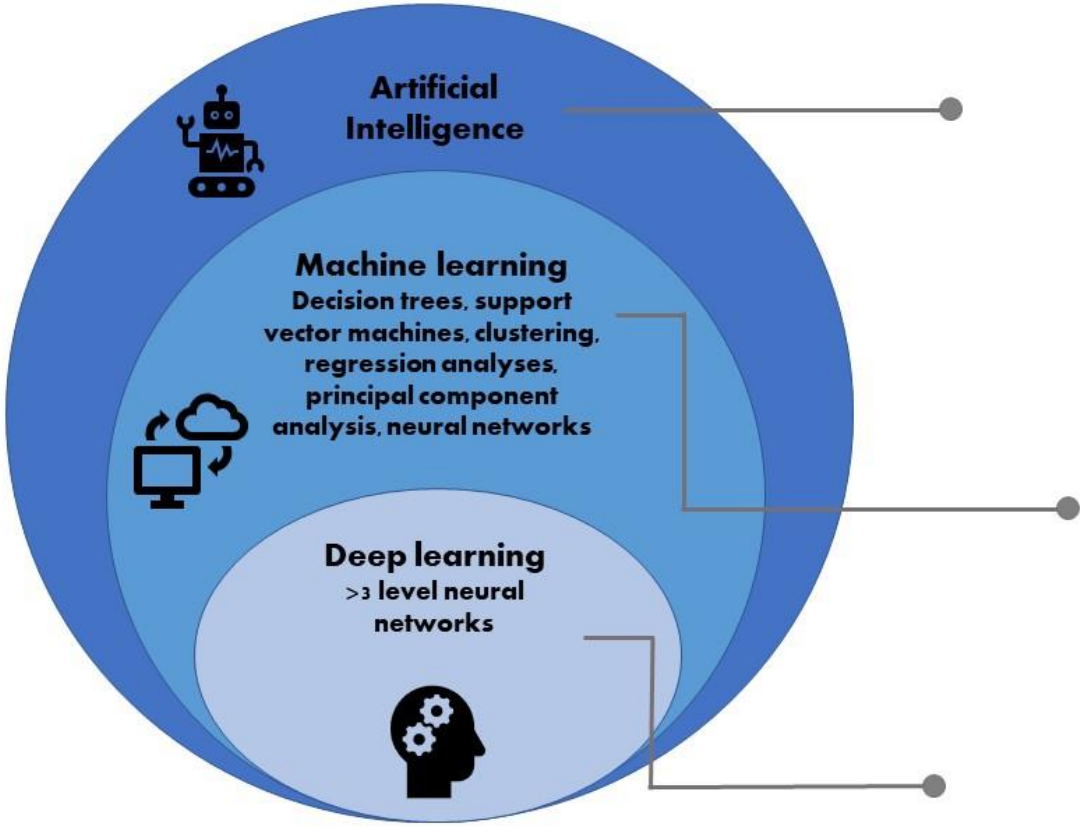
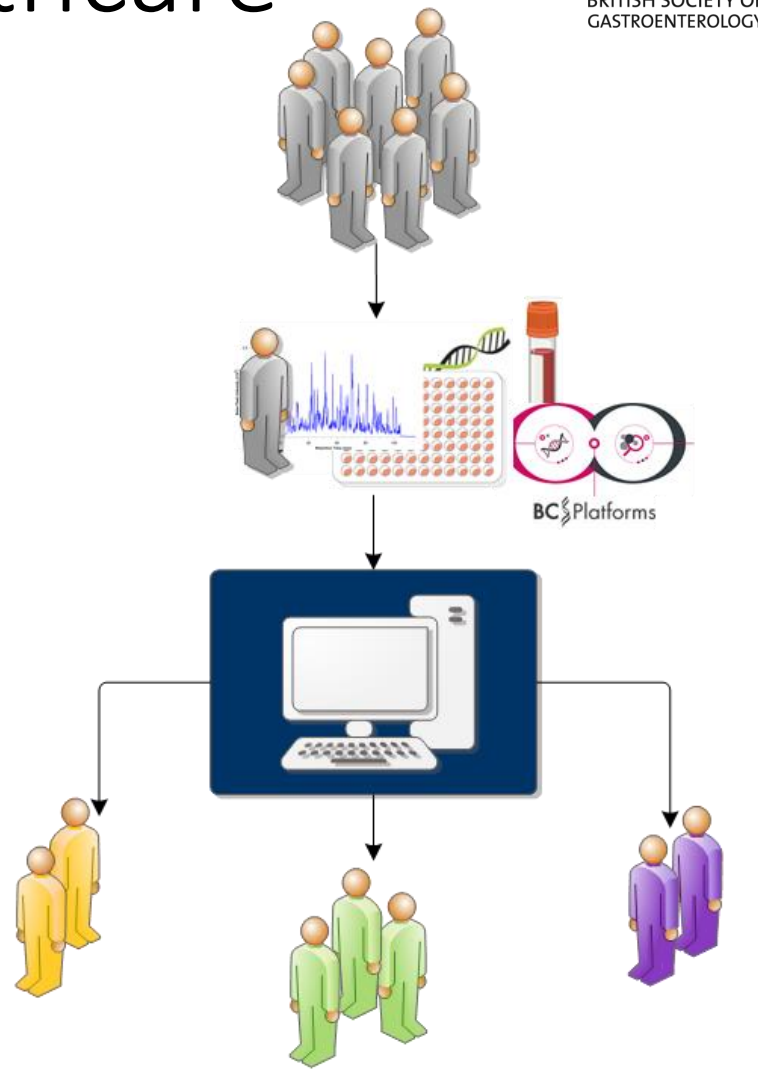
What is artificial intelligence?

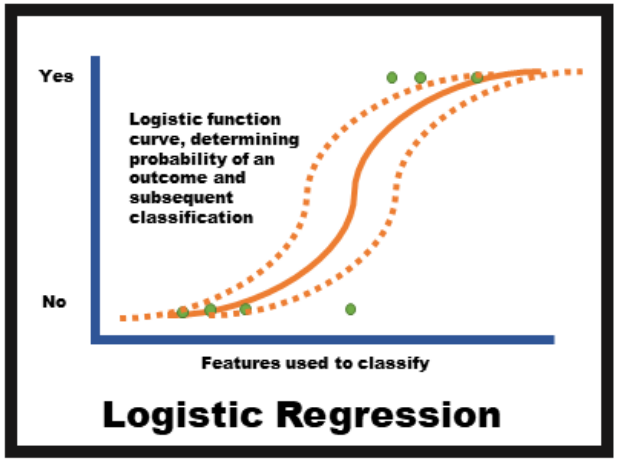


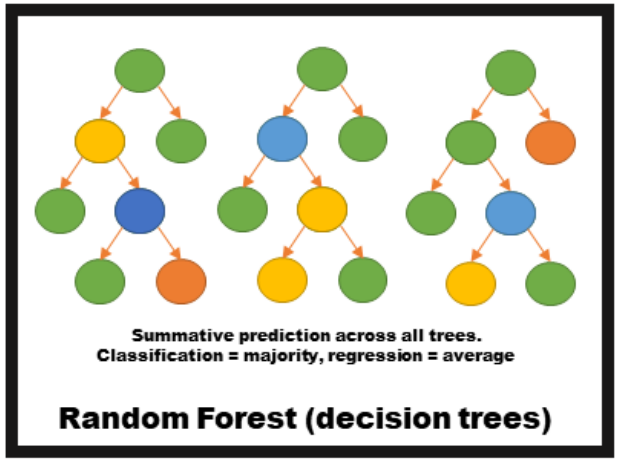
IBD as an exemplar for AI in healthcare

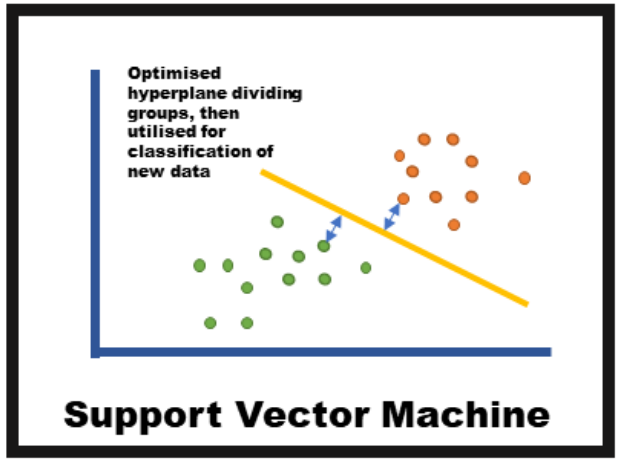
- Highly heterogenous disease with long-term, chronic morbidity
- Difficult to predict who will develop severe disease or complications at the point of diagnosis
- Targeted therapy is limited with no current ability to aim treatment at the underlying cause of inflammation in an individual
- High burden of care for patients
- Interpretation of results, images and endoscopy key to patient monitoring

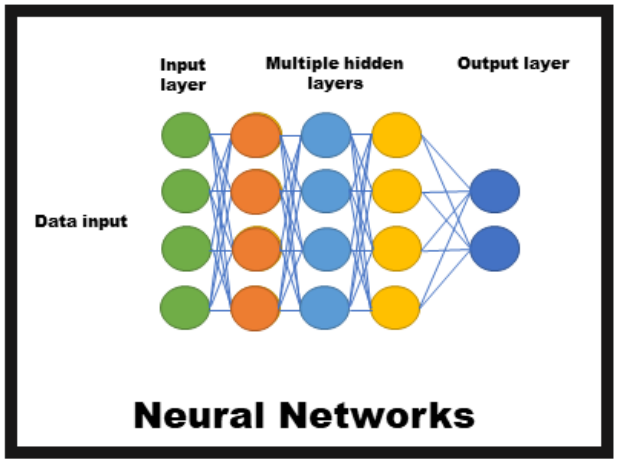


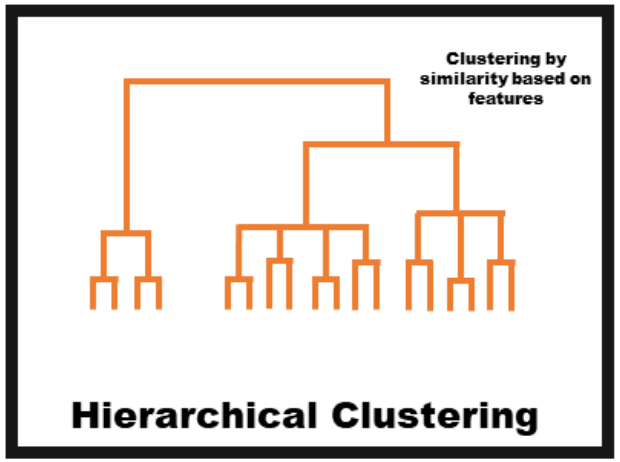
Supervised *vs* Unsupervised

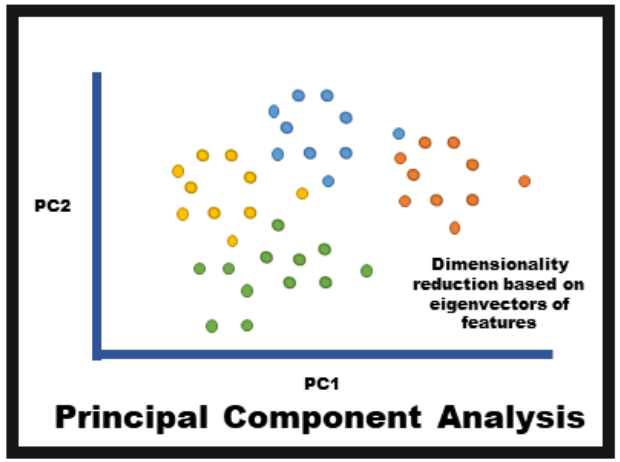


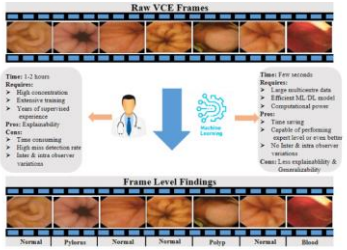




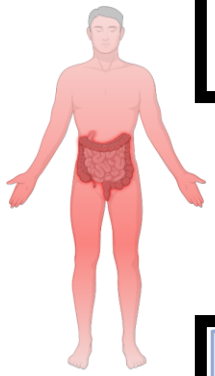








Patient with IBD symptoms



Endoscopy- diagnosis + classification

Multiomics- insights into disease pathogenesis

Drug discovery + risk modelling for therapy

Diagnostics

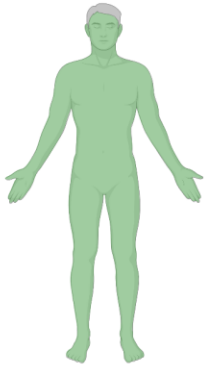
Therapeutics and Treatment

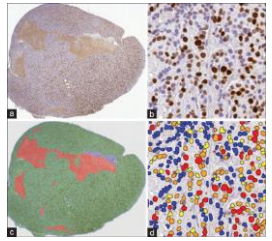
Artificial Intelligence - Machine Learning - Deep Learning

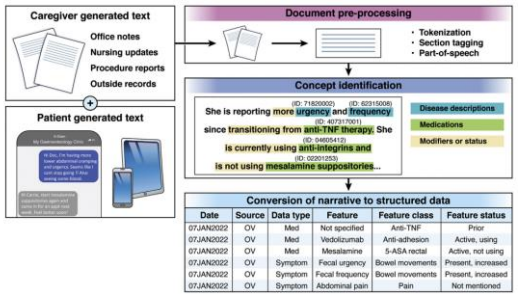
Precision and Personalised Prognosis

Monitoring

Patient with controlled disease







Subclassification and clustering to predict outcomes

Multiomics- disease classification + prediction

Patient home monitoring apps

Application of Artificial Intelligence in Inflammatory Bowel Disease

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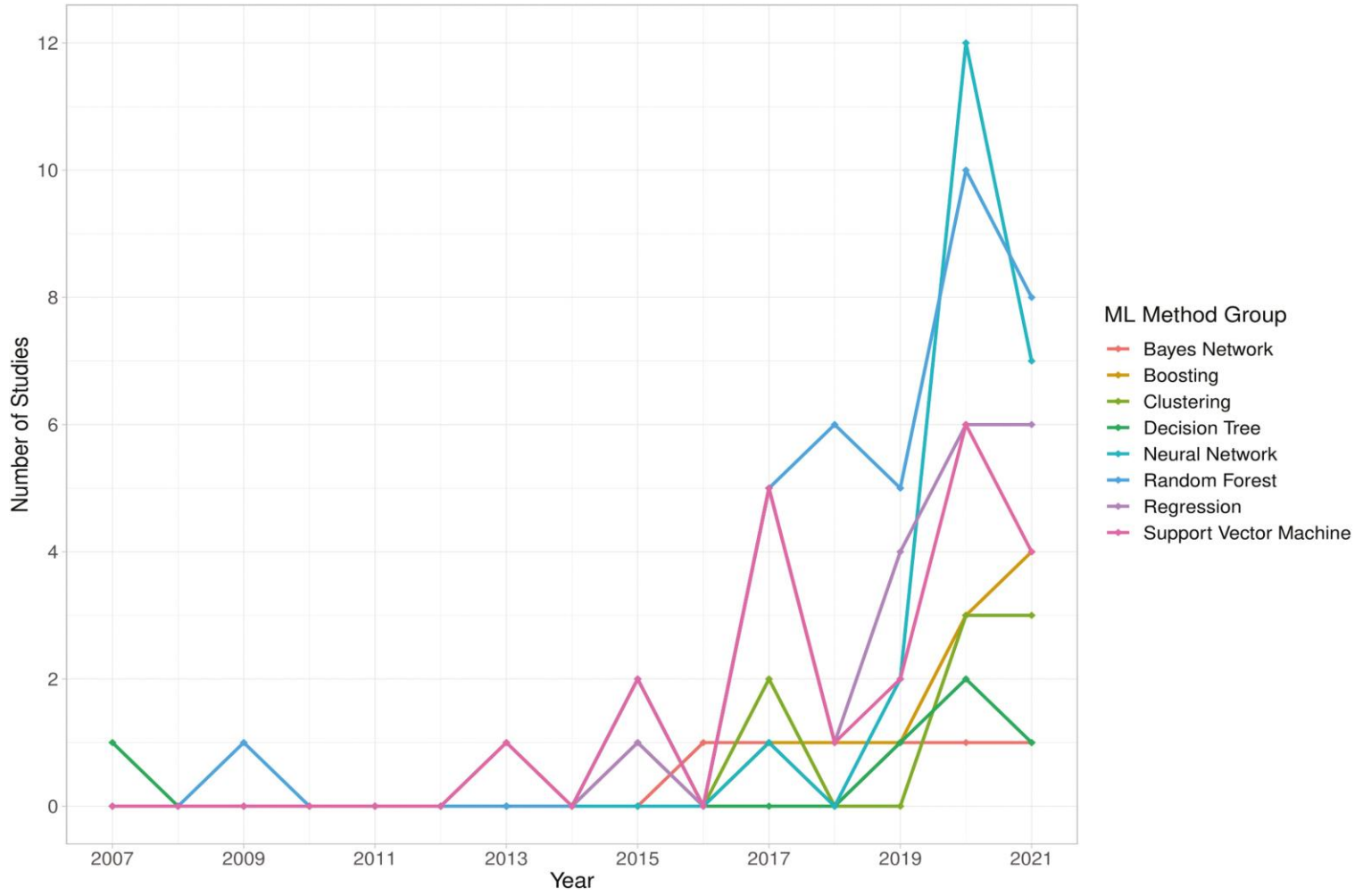
AI in IBD; boom industry…..



Articles, reviews, opinions…….

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SCIENTIFIC REPORTS

OPEN

Classification of Paediatric Inflammatory Bowel Disease using Machine Learning

Received: 24 January 2017
Accepted: 12 April 2017
Published online: 25 May 2017

E. Mossotto[1,2], J. J. Ashton[1,3], T. Coelho[1,3], R. M. Beattie[3], B. D. M

Paediatric inflammatory bowel disease (PIBD), comprising Crohn's disease and inflammatory bowel disease unclassified (IBDU) is a complex and mu increasing incidence. An accurate diagnosis of PIBD is necessary for a pro This study utilises machine learning (ML) to classify disease using endosc 287 children diagnosed with PIBD. Data were used to develop, train, test classify disease subtype. Unsupervised models revealed overlap of CD/UC clear subtype delineation, whereas hierarchical clustering identified four by differing colonic involvement. Three supervised ML models were devel data only, histological only and combined endoscopic/histological data y of 71.0%, 76.9% and 82.7% respectively. The optimal combined model w independent cohort of 48 PIBD patients from the same clinic, accurately This study employs mathematical modelling of endoscopic and histologi accuracy. While unsupervised modelling categorises patients into four sul approaches confirm the need of both endoscopic and histological eviden Overall, this paper provides a blueprint for ML use with clinical data.

Journal of Clinical Medicine

Article

Development of Machine Lear the 5-Year Risk of Starting Bio with Inflammatory Bowel Dise Network Study

Youn I Choi [1], Sung Jin Park [2], Jun-Won Chung [1], Ky Young Jae Kim [2], Kang Yoon Lee [3], Kwang Gi Kim and Yoon Jae Kim [1,*]

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Background: Multi-omics differentially classify disease state and treatment outcome in pediatric Crohn's disease

Gavin M. Douglas[1], Richard Hansen[2], Casey M. A. Jones[3], Katherine A. Dunn[4], André M. Comeau[5], Joseph P. Bielawski[4], Rachel Tayler[2], Emad M. El-Omar[6], Richard K. Russell[2], Georgina L. Hold[6], Morgan G. I. Langille[1,3,5*] and Johan Van Limbergen[7]

Abstract

Background: Crohn's disease (CD) has an unclear etiology, but there is growing evidence of a direct link with a dysbiotic microbiome. Many gut microbes have previously been associated with CD, but these have mainly been confounded with patients' ongoing treatments. Additionally, most analyses of CD patients' microbiomes have focused on microbes in stool samples, which yield different insights than profiling biopsy samples.

Results: We sequenced the 16S rRNA gene (16S) and carried out shotgun metagenomics (MGS) from the intestinal biopsies of 20 treatment-naïve CD and 20 control pediatric patients. We and inferred functional categories within each dataset. We also identified data. We then used a machine learning approach to determine the cl collapsed to different hierarchical groupings, were used independent by CD patients' response to treatment. We found that 16S-identified accuracy in both cases. Based on follow-ups with these patients, we were best for predicting disease state and response to treatment, incl By combining the top features from all significant models into a singl importance of these predictive features. We found that 16S-identified state whereas MGS-identified markers perform best for classifying trea

Conclusions: We demonstrate for the first time that useful predictors from shotgun MGS sequencing of biopsy samples despite the compli DNA. The top predictive features that we identified in this study could be CD and treatment response based on sufferers' microbiome in the future The BISCUIT project is funded by a Clinical Academic Fellowship from th

Keywords: Crohn's disease, Treatment response, Machine learning, Micro

genes

Review

Machine Learning Modeling from On Tool for Improvement of Inflammatory Bowel Disease Diagnosis and Clinical Classifications

Biljana Stankovic *,†, Nikola Kotur †, Gordana Nikcevic, Vladimir Gasic, Branka Zukic and Sonja Pavlovic

Laboratory for Molecular Biomedicine, Institute of Molecular Genetics and Genetic Engineering, University of Belgrade, 11042 Belgrade, Serbia; nikol gordnik@imgge.bg.ac.rs (G.N.); vlada.gasic@imgge.b sonya@sezampro.rs (S.P.)
* Correspondence: biljana.stankovic@imgge.bg.ac.rs
† Authors contributed equally to this work.

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https://doi.org/10.1093/ecco-jcc/jjad029
Advance access publication 22 February 2023
Review Article

JCC

OXFORD

Gastroenterology 2022;162:1493–1506

Artificial Intelligence for Disease Assessment in Inflammatory Bowel Disease: How Will it Change Our Practice?

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Digestive Endoscopy 2021; 33: 903–911

Review

Artificial intelligence-assisted er definition of mucosal healing in ulcerative colitis

Hiroshi Nakase, Takehiro Hirano, Kohei Wagatsuma, Tadashi Ichimiya, Tsukasa Yamakawa, Yoshihiro Yokoyama, Yuki Hayashi, Daisuke Hirayama, Tomoe Kazama, Shinji Yoshii and Hiro-o Yamano

Department of Gastroenterology and Hepatology, Sapporo Medical University School of Medicine, Hokkaido, Japan

The relevance of endoscopic monitoring of ulcerative colitis (UC) has been translated into the new concept of "mucosal healing (MH)" as the therapeutic goal to achieve because a large amount of scientific data have revealed the favorable prognostic value of a healed mucosa in determining the clinical outcome of UC. Recent interest in MH has skewed toward not only endoscopic remission but also histological improvement (so called histological MH). However, we should recognize that there have been no prospectively validated endoscopic scoring systems of UC activity in previous clinical trials. Artificial intelligence (AI)-assisted endoscopy has been developed for gastrointestinal cancer surveillance. Recently, several AI-assisted endoscopic systems have been developed for assessment of MH in UC. In the future, the development of a new endoscopic scoring system based on AI might standardize the definition of MH. Therefore, "The road to an exact definition of MH in the treatment of UC has begun only now".

Key words: artificial intelligence, histological healing, mucosal healing, red density system, ulcerative colitis

Artificial Intelligence in Inflammatory Bowel Disease Endoscopy: Implications for Clinical Trials

Harris A. Ahmad,[a] James E. East,[b] Remo Panaccione,[c] Simon Travis,[b] James B. Canavan,[a] Keith Usiskin,[a] Michael F. Byrne[d,e]

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FUTURE DIRECTIONS AND METHODS FOR IBD RESEARCH

Machine Learning–Based Gene Prioriti Candidate Risk Genes for Inflammator

Ofer Isakov, PhD, Iris Dotan, MD,*† and Shay Ben-Shachar, M*

Background: The inflammatory bowel diseases (IBDs) are chronic inflammatory disorders, associated with genetic, immunologic, and environmental factors. Although hundreds of genes are implicated in IBD etiology, it is likely that additional genes play a role in the disease process. We developed a machine learning–based gene prioritization method to identify novel IBD-risk genes.

Methods: Known IBD genes were collected from genome-wide association studies and annotated with expression and pathway information. Using these genes, a model was trained to identify IBD-risk genes. A comprehensive list of 16,390 genes was then scored and classified.

Results: Immune and inflammatory responses, as well as pathways such as cell adhesion, cytokine–cytokine receptor interaction, and sulfur metabolism were identified to be related to IBD. Scores predicted for IBD genes were significantly higher than those for non-IBD genes ($P < 10^{-20}$). There was a significant association between the score and having an IBD publication ($P < 10^{-20}$). Overall, 347 genes had a high prediction score (>0.8). A literature review of the genes, excluding those used to train the model, identified 67 genes without any publication concerning IBD. These genes represent novel candidate IBD-risk genes, which can be targeted in future studies.

Conclusions: Our method successfully differentiated IBD-risk genes from non-IBD genes by using information from expression data and a multitude of gene annotations. Crucial features were defined, and we were able to detect novel candidate risk genes for IBD. These findings may help detect new IBD-risk genes and improve the understanding of IBD pathogenesis.

(Inflamm Bowel Dis 2017;23:1516–1523)

Key Words: machine learning, genetics, big data, gene expression, RNA-seq

Successes for AI in IBD

- Good science, but a lack of clinical translation!

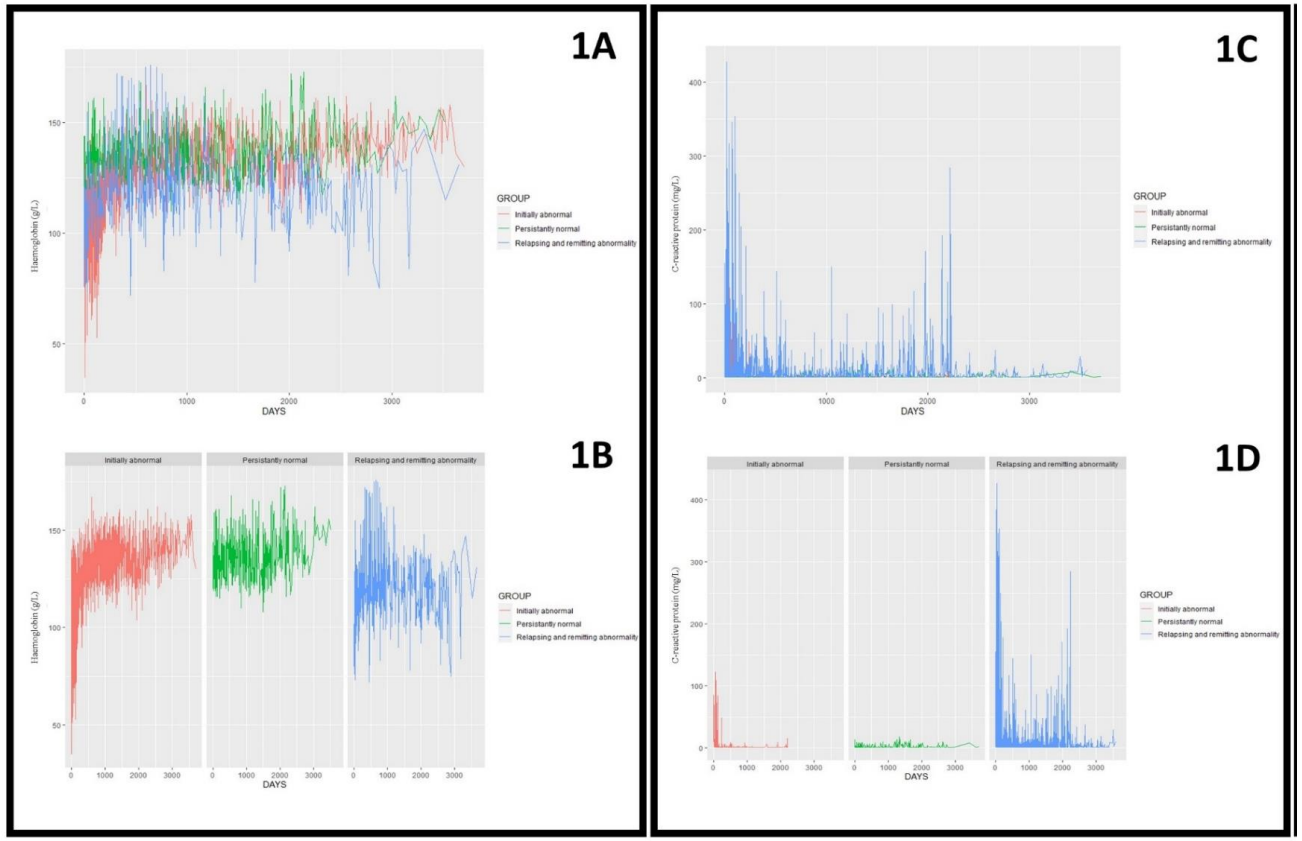
Clinical focus-

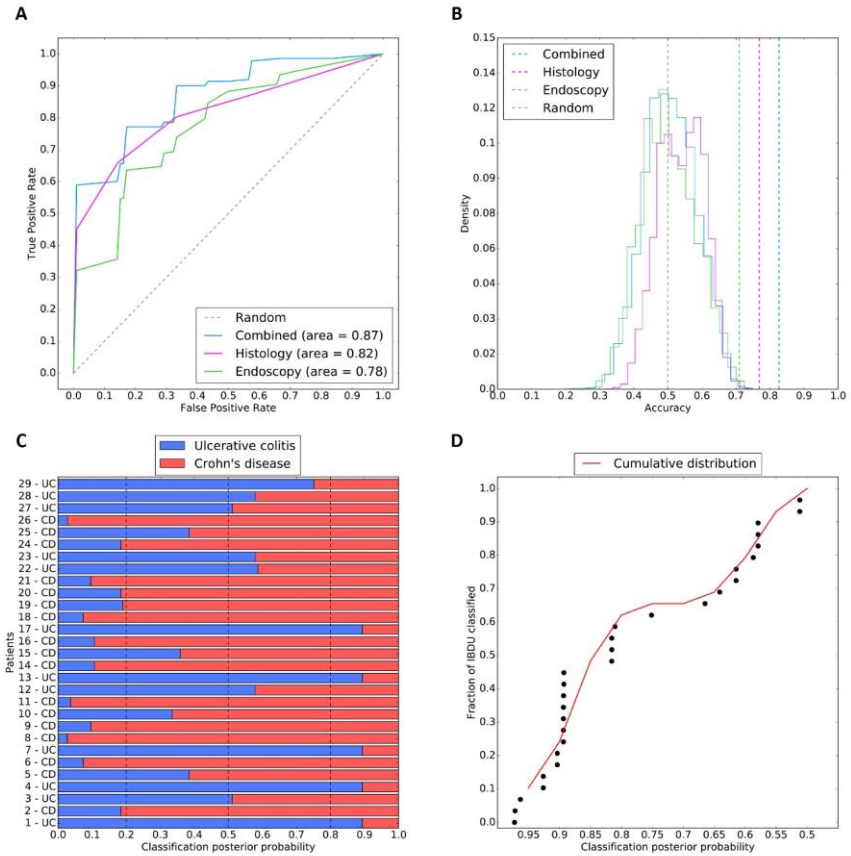
- Endoscopy/VCE interpretation
- Video capsule interpretation
- Chatbots (?)
- Clinical notes synthesis

Science focus-

- Classification of disease
- Prediction of outcomes

Clinical data to stratify patients





Future applications of genomics

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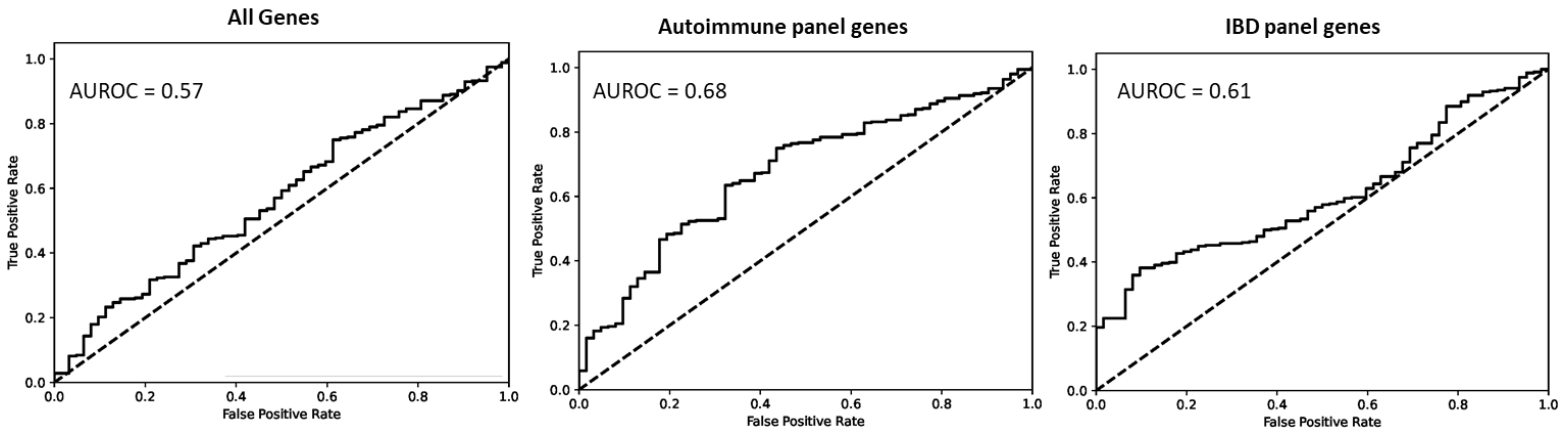
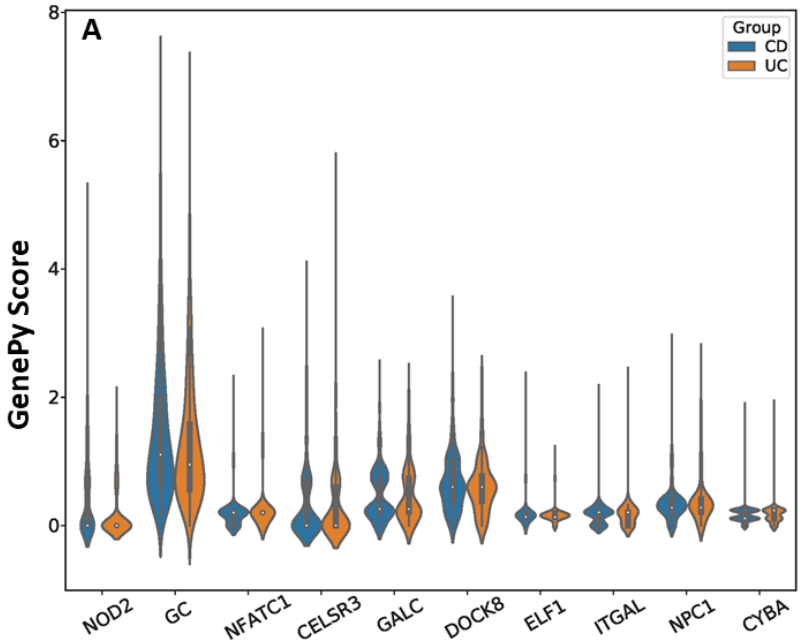
Genomic data to classify subtypes using machine learning





Healthcare adjunct- not a replacement

- Tools to aid with diagnosis, management and prediction
- Not a replacement (yet….)

- What about ‘intelligent’ chatbots (ChatGPT, Bard etc.)
  - Report writing of procedures
  - Clinic letter summaries
  - Patient resources

Validation (external), generalisability, understandability (of algorithms) and iterative improvement

Potential of AI in IBD; next 5 years

- Precise molecular diagnosis
- Prediction of outcomes
- Utilisation of ‘Big Data’
- A road to precision medicine

Huge research opportunity

-> Data access, high-quality data and collaboration are key

Resources

BRITISH SOCIETY OF GASTROENTEROLOGY

Colorectal

Review

Artificial intelligence and inflammatory bowel disease: practicalities and future pros

Johanne Brooks-Warburton [1,2] James Ashton,[3] Anjan I
Tony Tham,[5] Patrick B Allen,[5] Sami Hoque,[6] Laurence B Lo
Shaji Sebastian[8,9]

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JB-W and JA are joint first authors.

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ABSTRACT

Artificial intelligence (AI) is an emerging technology predicted to have significant applications in healthcare. This review highlights AI applications that impact the patient journey in inflammatory bowel disease (IBD), from genomics to endoscopic applications in disease classification, stratification and self-monitoring to risk stratification for personalised management. We discuss the practical AI applications currently in use while giving a balanced view of concerns and pitfalls and look to the future with the potential of where AI can provide significant value to the care of the patient with IBD.

Key messages

- ⇒ Artificial intelligence (field which could impr inflammatory bowel d
- ⇒ AI in IBD uses two ma learning and deep lea
- ⇒ AI is currently used fo drug discovery and en identification of disea
- ⇒ AI could be used in IB monitoring, virtual ma endoscopic disease cl patient stratification.
- ⇒ Narrow, task-focused can and do have a po patient care

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Original Research Articles - Basic Science

CROHN'S & COLITIS FOUNDATION

A Systematic Review of Artificial Intelligence and Machine Learning Applications to Inflammatory Bowel Disease, with Practical Guidelines for Interpretation

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soton.ac.uk).

Background: Inflammatory bowel disease (IBD) is a gastrointestinal chronic disease with an unpredictable disease cours methods such as machine learning (ML) have the potential to stratify IBD patients for the provision of individualized care. The u for IBD was surveyed, with an additional focus on how the field has changed over time.

Methods: On May 6, 2021, a systematic review was conducted through a search of MEDLINE and Embase databases structure ("machine learning" OR "artificial intelligence") AND ("Crohn* Disease" OR "Ulcerative Colitis" OR "Inflammatory Exclusion criteria included studies not written in English, no human patient data, publication before 2001, studies that were r nonautoimmune disease comorbidity research, and record types that were not primary research.

Results: Seventy-eight (of 409) records met the inclusion criteria. Random forest methods were most prevalent, and there neural networks, mainly applied to imaging data sets. The main applications of ML to clinical tasks were diagnosis (18 of 7 (22 of 78), and disease severity (16 of 78). The median sample size was 263. Clinical and microbiome-related data sets were percent of studies used an external data set after training and testing for additional model validation.

Discussion: Availability of longitudinal and deep phenotyping data could lead to better modeling. Machine learning pipeli imbalanced data and that feature selection only on training data will generate more generalizable models. Machine learning m ingly being applied to more complex clinical tasks for specific phenotypes, indicating progress towards personalized medicin

Key Words: artificial intelligence, machine learning, inflammatory bowel disease

APS European Society for Paediatric Research SPR Society for Pediatric Research

www.nature.com/pr

REVIEW ARTICLE OPEN

Check for updates

Using machine learning to impact on long-term clinical care: principles, challenges, and practicalities

James J. Ashton[1,2], Aneurin Young[3,4], Mark J. Johnson[3,4] and R. Mark Beattie[2]✉

The rise of machine learning in healthcare has significant implications for paediatrics. Long-term conditions with significant disease heterogeneity comprise large portions of the routine work performed by paediatricians. Improving outcomes through discovery of disease and treatment prediction models, alongside novel subgroup clustering of patients, are some of the areas in which machine learning holds significant promise. While artificial intelligence has percolated into routine use in our day to day lives through advertising algorithms, song or movie selections and sifting of spam emails, the ability of machine learning to utilise highly complex and dimensional data has not yet reached its full potential in healthcare. In this review article, we discuss some of the foundations of machine learning, including some of the basic algorithms. We emphasise the importance of correct utilisation of machine learning, including adequate data preparation and external validation. Using nutrition in preterm infants and paediatric inflammatory bowel disease as examples, we discuss the evidence and potential utility of machine learning in paediatrics. Finally, we review some of the future applications, alongside challenges and ethical considerations related to application of artificial intelligence.

Pediatric Research; https://doi.org/10.1038/s41390-022-02194-6

IMPACT:

- Machine learning is a widely used term; however, understanding of the process and application to healthcare is lacking.
- This article uses clinical examples to explore complex machine learning terms and algorithms.
- We discuss limitations and potential future applications within paediatrics and neonatal medicine.

Ideas, data, collaborations- get in touch!

BSG Artificial Intelligence in IBD special interest group

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