Spring
2023

PathLAKE

Computational Pathology Excellence

Prof David Snead

"In this newsletter, we review some of the contributions made in the last few months by the academic partners of PathLAKE. The references for scientific papers are collected on a Google Scholar page created for PathLAKE, which can be conveniently accessed using the QR code on page 5. To date 82 papers have published with over 1500 citations, giving an insight into the extraordinary impact the PathLAKE project has made to the field of computational pathology.

At the end of March 2023, the Innovate UK funding for PathLAKE concludes and we shall prepare the PathLAKE data lake for transition to becoming part of the West Midlands Secure Data Environment. This will be the final edition of the newsletter in its current form and I wish to say a big thank you to all my PathLAKE partners and colleagues for the tremendous hard work and commitment that they have all shown over the past four years. Digital and computational pathology are now firmly established in the UK, and we look forward to continuing to build on the firm foundations we have established and continue to maximise the benefits to come from PathLAKE in the future."

Contents

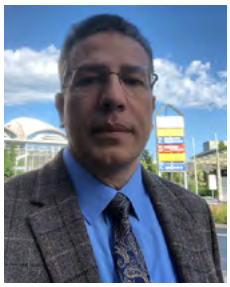
Highlights and achievements from PathLAKE's academic leads:

What difference has PathLAKE made?

Belfast

PathLAKE is one of the three national digital pathology consortia, and it is unique because of the three pillars it is based upon: a) digitization of pathology services; b) creation of a lake of images and meta-data to support national industry; and c) generation of new AI algorithms. By doing this, PathLAKE is improving the diagnostic quality of our NHS today, and also contributing to the improvement of our diagnostic services of our NHS in the near future. The latter is the focus of WP3 of PathLAKE.

Nottingham



PathLAKE has made a hugely positive contribution to our work, enabling us to be more engaged in digital pathology and artificial intelligence (AI) based breast pathology research. This supported us to gain further funding from NIHR to introduce AI-based tools to clinical settings of breast pathology. PathLAKE has also created invaluable networking opportunities with a wide community of pathologists, clinicians, academic researchers and computer scientists resulting in the proposal of several collaborative projects going forward.

Oxford

Transforming Pathology in Oxford

PathLAKE has enabled us to establish and grow a cross-disciplinary team of leading expert pathologists, engineers, and computer scientists who link basic research with clinical practice. The team has explored and developed ways of improving pathology workflows for greater efficiency and to use AI to develop programmes, which, for instance, can identify certain cancers more precisely or automate lab processes. The complete digitisation of the cellular pathology lab in Oxford, together with the digitisation of the regional network labs which is in progress, is a significant achievement which has led to service improvements for patient benefit and allowed the use of AI in pathology workflows.

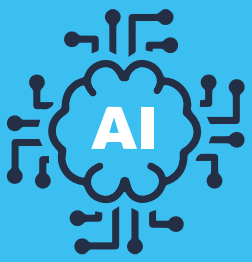
Warwick

The PathLAKE project has provided additional visibility to our group at Warwick and contributed to the founding of the Tissue Image Analytics (TIA) Centre, previously the TIA lab at Warwick. We have learnt a whole lot from closer collaboration with our clinical partners. The most rewarding part for me is to witness first-hand the growth of some amazing data scientists, who are well on their way to become the future leaders of computational pathology. Last but not the least, PathLAKE has provided the impetus to incorporate Histofy, our spinout company from Warwick, which is aimed at developing avant-garde computational pathology solutions to streamline pathologist workflows and help deliver personalised medicine.

What has been achieved?

Belfast

The breadth of algorithms developed in WP3 is an indication of the importance of this development. The PathLAKE algorithm activity has generated new SMEs in the field, leading with the important question of AI applications to screening programme (Coventry/Warwick); more quantitative and reproducible approaches to biomarker quantitation in breast cancer (Nottingham/Warwick); new avenues to improve the diagnosis of prostate cancer at all levels of the diagnostic pipeline (Oxford); and comprehensive applications to bring immune-oncology quantitative biomarkers to routine diagnostics (Belfast).



Nottingham

PathLAKE has supported four PhD projects, resulting in several published papers in high impact factor journals, with more in process. From an educational perspective, PathLAKE has facilitated a series of meetings and training courses to promote AI and digital pathology within the pathology community. The online teaching modules that contain a wide variety of teaching cases of breast, prostate and colorectal pathology have attracted the attention of the pathology community. Cases are linked to well annotated WSIs' and cases' discussion, which is a precious educational resource for histopathologist trainees.

Oxford

Our key achievements in the Oxford team have been split across the introduction and implementation of digital pathology and the development of AI algorithms for various applications.

We have also made significant contributions to the PathLAKE datalake. We have contributed 30,000 consent checked and scanned de-identified sets of whole slide images to the datalake and digitised more than 11,000 slides from a scientifically valuable retrospective prostate cancer cohort (ProMPT).

We have developed an AI programme called "PathProfiler" which is being tested in a service improvement real-time exercise on urology cases.

We have also developed an AI tool making automated immunohistochemistry (IHC) requests which creates a significantly leaner workflow and results in pathologist time savings and quicker review of cases – by as much as up to two days.

Warwick

First, together with our pathologist colleagues at UHCW led by Prof David Snead, we have developed cutting-edge AI that incorporates histologically interpretable features for screening of colon biopsies. The technology developed in the COBI exemplar project will undergo large-scale multi-centric validation and productisation by our spinout company funded by an NIHR AI Award. Second, with our pathologist colleagues at Nottingham led by Prof Emad Rakha, we have developed novel AI based biomarkers for prognostication of early-stage ER+ Her2- breast cancer patients. A third major outcome has been the development of a gateway portal to a large pathology image repository consisting of more than 80K whole-slide images that will be available to researchers and commercial entities following the appropriate access procedures.

What does this mean for patients?

Belfast

While other consortia focus primarily in digitization of pathology services, PathLAKE is pioneering the development and routine application of AI tools to digitized images, paving the path to a better diagnosis for our patients.

Nottingham

The use of AI and digital pathology will facilitate better care for patients in terms of diagnosis and management, with shorter turn-around times. DP and AI will provide an invaluable help to reporting pathologists, who already suffer staff shortages, and will ease sharing challenging and difficult cases with expert pathologists in addition to promoting research.

Oxford

Much of the work we have done in the PathLAKE project has been for direct patient benefit. Time savings and greater efficiency in the cellular pathology lab mean patients receive biopsy results more quickly, especially set against a background of a shortage of pathologists nationwide, and the increasing complexity of biopsy reporting. The baseline data identified in the RFID study demonstrates clear potential for improved case traceability with the use of digital pathology and efficiencies because slides were available for review and discussion by clinicians at MDT (multi-disciplinary team meeting – where patient cases are discussed), leading to potential improvement in diagnostic reporting times.

Another important deliverable from Oxford has

been revised wording for the "consent to research statement" on the "consent to investigation or treatment" form to support contemporary and big data research and serves as a template that other centres can use.

Warwick

The COBI tool will allow faster diagnosis of normal colon biopsies, reducing the waiting time for patients and better management of colon cancer patients. The breast cancer prognostication tool can potentially lead to optimal treatment selection and better patient outcomes for luminal breast cancer patients. And finally, the image repository can lead to further development of novel technologies that can help with better diagnosis and treatment of cancer patients.

What impact has PathLAKE had in the digital pathology/AI space?

Belfast

PathLAKE was the first programme that the UK SME Sonrai Analytics joined several years ago. This represented a significant endorsement to Sonrai, which this SME has followed with subsequent R&D programmes with UKRI and NIHR totaling more than £2m in R&D revenue.

Nottingham

PathLAKE has facilitated full digitalisation of the Nottingham and Derby Histopathology Services. Additionally, the AI tool created has the potential to change the face of clinical practice in breast cancer, replacing expensive multigene assays and demonstrating the ability of AI to be used as a prognostic and predictive tool in pathology.

Oxford

PathLAKE has had a significant impact in Oxford by enabling the digital transformation of clinical services at Oxford University Hospitals NHS Foundation Trust. A multidisciplinary team effort introduced a digital pathology workflow through the pathology lab including integration with the Laboratory Information Management System, the installation of specialised equipment, pathologist training & validation processes and clinical governance considerations. Oxford is fully accredited for digital pathology under ISO15189. - and completed the journey to full digitisation in summer 2022.

Significantly, full digitisation of the South4 Pathology Partnership which includes Oxford University Hospitals NHS Foundation Trust; Buckinghamshire NHS Trust; Milton Keynes University Hospital and Great Western Hospitals Swindon is underway as part of PathLAKE Plus.

Warwick

- General impact on the increased digital pathology uptake in the country and beyond.
- Lizard dataset, the largest dataset with annotated nuclear instance segmentation and classification ground-truth, and the related CONIC challenge contest which generated international interest from more than 380 teams that participated in the contest.
- TIAtoolbox developed by the Warwick team (comprising of PathLAKE and TIA researchers) has been adopted by a variety of users (ranging from researchers across the world and in the big pharma), with more than 125k downloads already.
- Annotation guidelines paper for computational pathology researchers.
- PathLAKE masterclasses, bringing together pathologists and data scientists, attracted more than 600 registrants learning about fundamental and advanced concepts in digital pathology and AI.
- The PathLAKE portal enables querying of the PathLAKE image repository, providing access to 80k+ whole-slide images with linked clinical metadata for training and validation of AI algorithms developed by other researchers and industry players.

Selected Publications

Belfast

Craig SG, Humphries MP, Alderdice M, Bingham V, Richman SD, Loughrey MB, et al. Immune status is prognostic for poor survival in colorectal cancer patients and is associated with tumour hypoxia. Br J Cancer. 2020;123(8):1280-8. https://www.ncbi.nlm.nih.gov/pubmed/32684627

Saldanha OL, Quirke P, West NP, James JA, Loughrey MB, Grabsch HI, et al. Swarm learning for decentralized artificial intelligence in cancer histopathology. Nat Med. 2022;28(6):1232-9. https://pubmed.ncbi.nlm.nih.gov/35469069/#article-details

Viratham Pulsawatdi A, Craig SG, Bingham V, McCombe K, Humphries MP, Senevirathne S, et al. A robust multiplex immunofluorescence and digital pathology workflow for the characterisation of the tumour immune microenvironment. Mol Oncol. 2020;14(10):2384-402. https://www.ncbi.nlm.nih.gov/pubmed/32671911

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Nottingham

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Lashen A, Ibrahim A, Katayama A, Ball G, Mihai R, Toss M, et al. Visual assessment of mitotic figures in breast cancer: a comparative study between light microscopy and whole slide images. Histopathology. 2021;79(6):913-25. https://www.ncbi.nlm.nih.gov/pubmed/34455620

Wahab N, Miligy IM, Dodd K, Sahota H, Toss M, Lu W, et al. Semantic annotation for computational pathology: multidisciplinary experience and best practice recommendations. J Pathol Clin Res. 2022;8(2):116-28. https://www.ncbi.nlm.nih.gov/pubmed/35014198

Oxford

Chatrian A, Colling RT, Browning L, Alham NK, Sirinukunwattana K, Malacrino S, et al. Artificial intelligence for advance requesting of immunohistochemistry in diagnostically uncertain prostate biopsies. Mod Pathol. 2021;34(9):1780-94. https://www.ncbi.nlm.nih.gov/pubmed/34017063

Colling R, Protheroe A, Sullivan M, Macpherson R, Tuthill M, Redgwell J, et al. Digital Pathology Transformation in a Supraregional Germ Cell Tumour Network. Diagnostics (Basel). 2021;11(12). https://www.ncbi.nlm.nih.gov/pubmed/34943429

Haghighat M, Browning L, Sirinukunwattana K, Malacrino S, Khalid Alham N, Colling R, et al. Automated quality assessment of large digitised histology cohorts by artificial intelligence. Sci Rep. 2022;12(1):5002. https://www.ncbi.nlm.nih.gov/pubmed/35322056

Warwick

Bilal M, Nimir M, Snead D, Taylor GS, Rajpoot N. Role of AI and digital pathology for colorectal immuno-oncology. Br J Cancer. 2023;128(1):3-11. https://www.ncbi.nlm.nih.gov/pubmed/36183010

Graham S, Vu QD, Jahanifar M, Raza SEA, Minhas F, Snead D, et al. One model is all you need: Multi-task learning enables simultaneous histology image segmentation and classification. Med Image Anal. 2023;83:102685. https://www.ncbi.nlm.nih.gov/pubmed/36410209

Pocock J, Graham S, Vu QD, Jahanifar M, Deshpande S, Hadjigeorghiou G, et al. TIAToolbox as an end-to-end library for advanced tissue image analytics. Commun Med (Lond). 2022;2:120. https://www.ncbi.nlm.nih.gov/pubmed/36168445

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