WHY NVIDIA, NOW.

A NEW ENGINE FOR ECONOMIC GROWTH

$16 Trillion AI Investment Globally
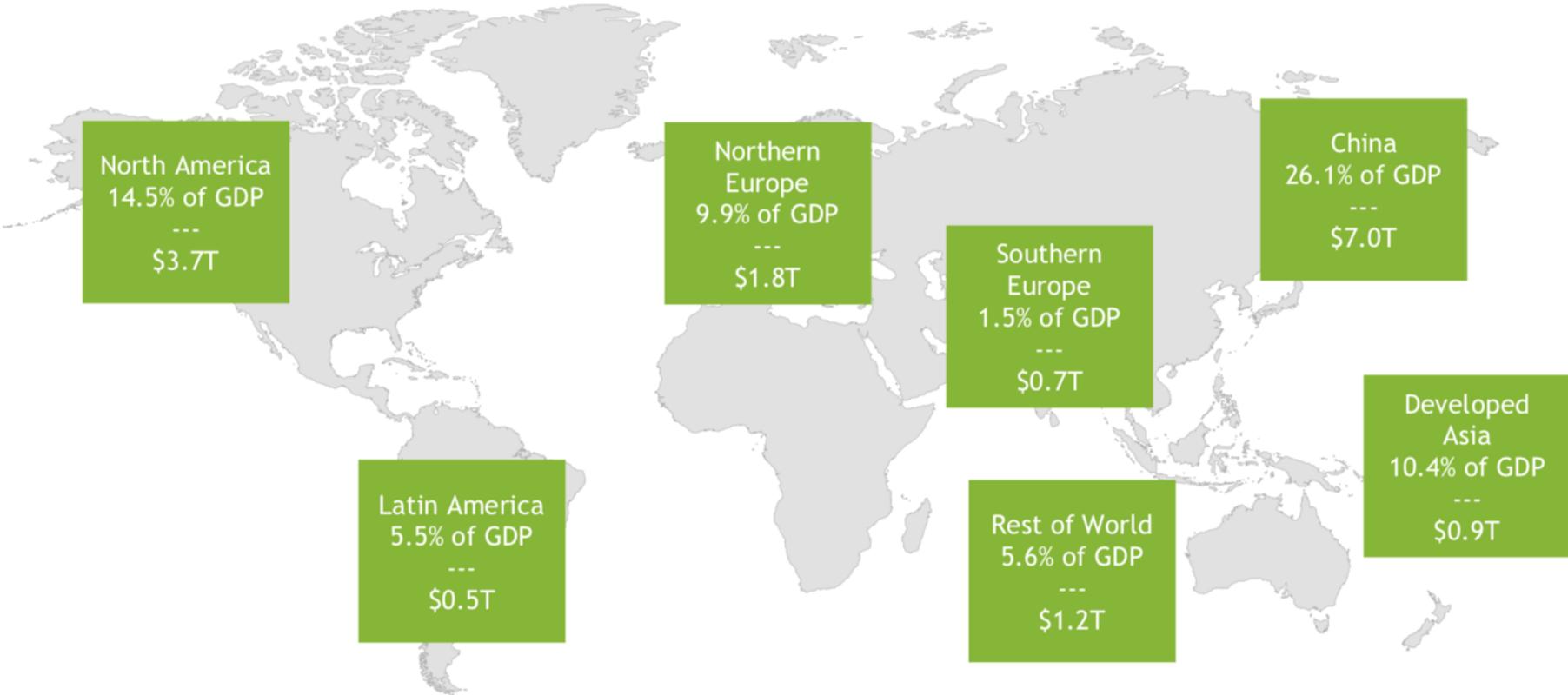
North America
14.5% of GDP

$3.7T

Northern
Europe
9.9% of GDP

$1.8T

China
26.1% of GDP

$7.0T

Southern
Europe
1.5% of GDP

$0.7T

Latin America
5.5% of GDP

$0.5T

Rest of World
5.6% of GDP

$1.2T

Developed
Asia
10.4% of GDP

$0.9T

EUROPE ARTIFICIAL INTELLIGENCE IN HEALTHCARE

Europe Artificial Intelligence in Healthcare Market, by Country
(in $ Billions)

United Kingdom
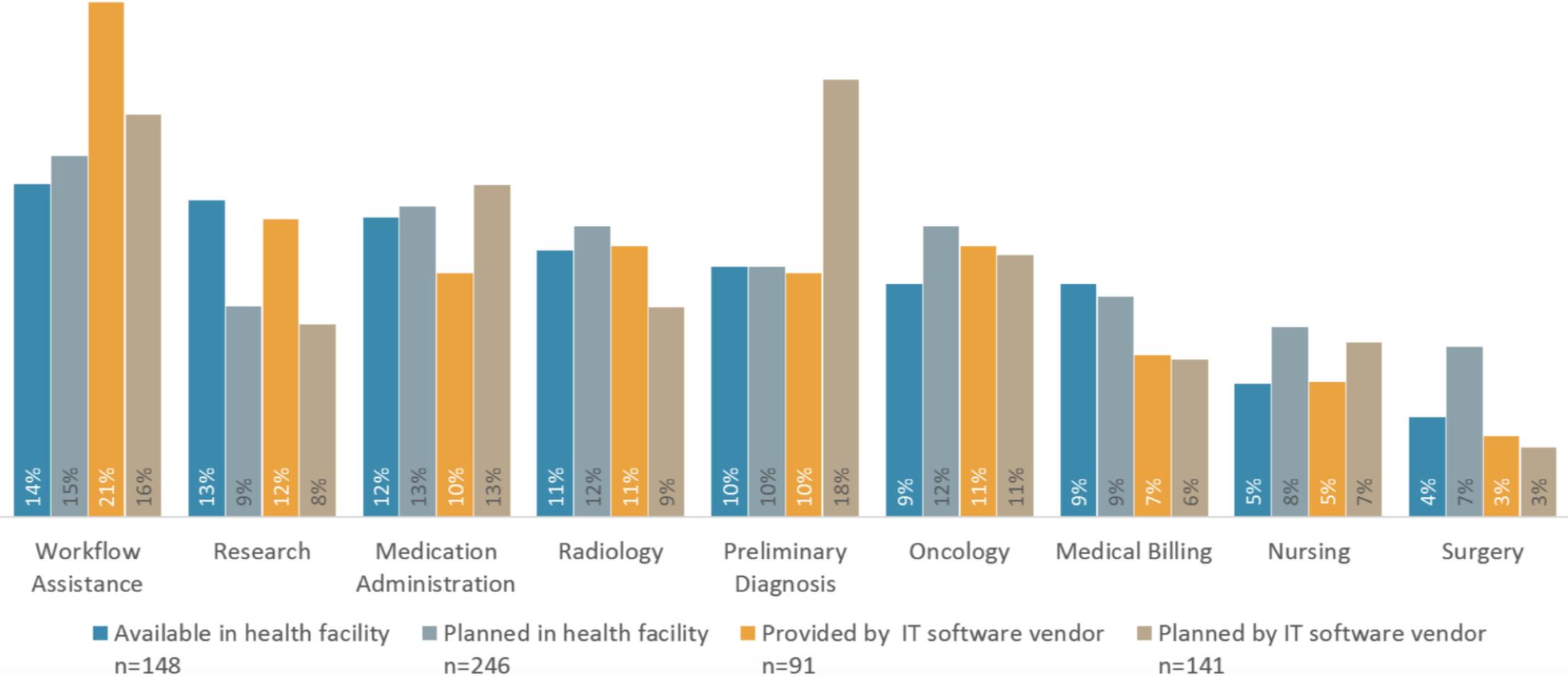France
Germany
Spain
Rest of Europe
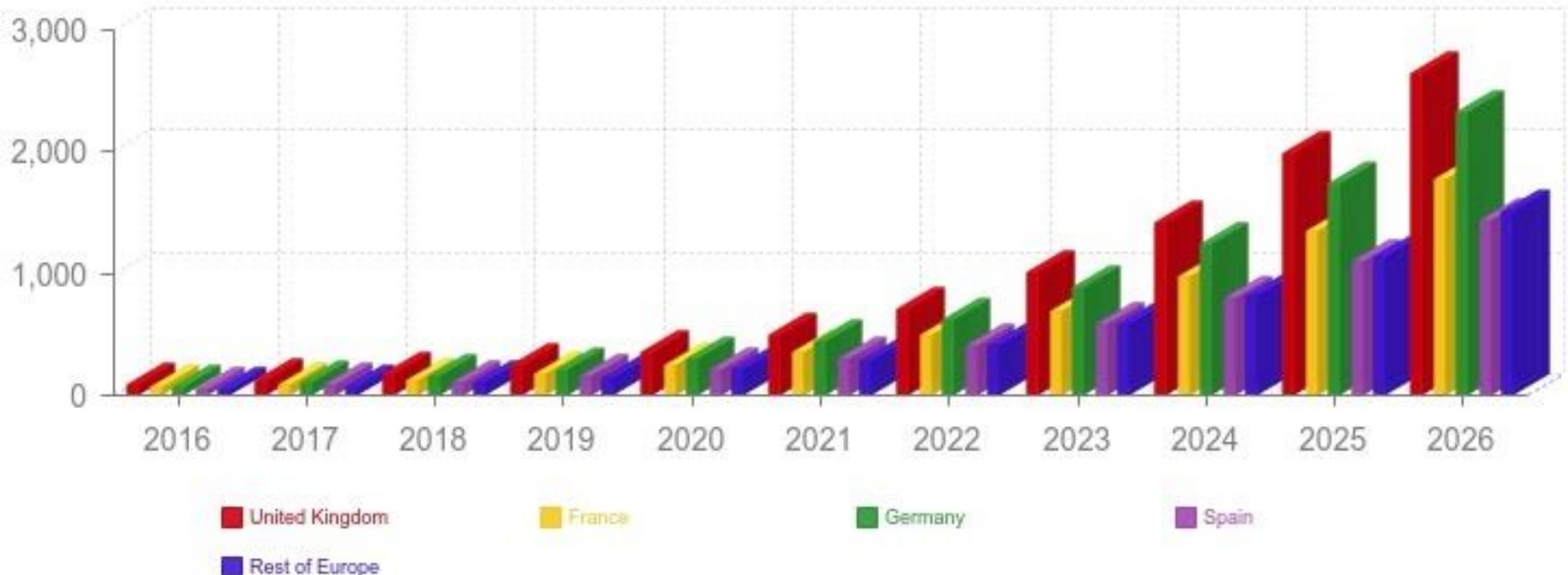
Source: Inkwood Research

3

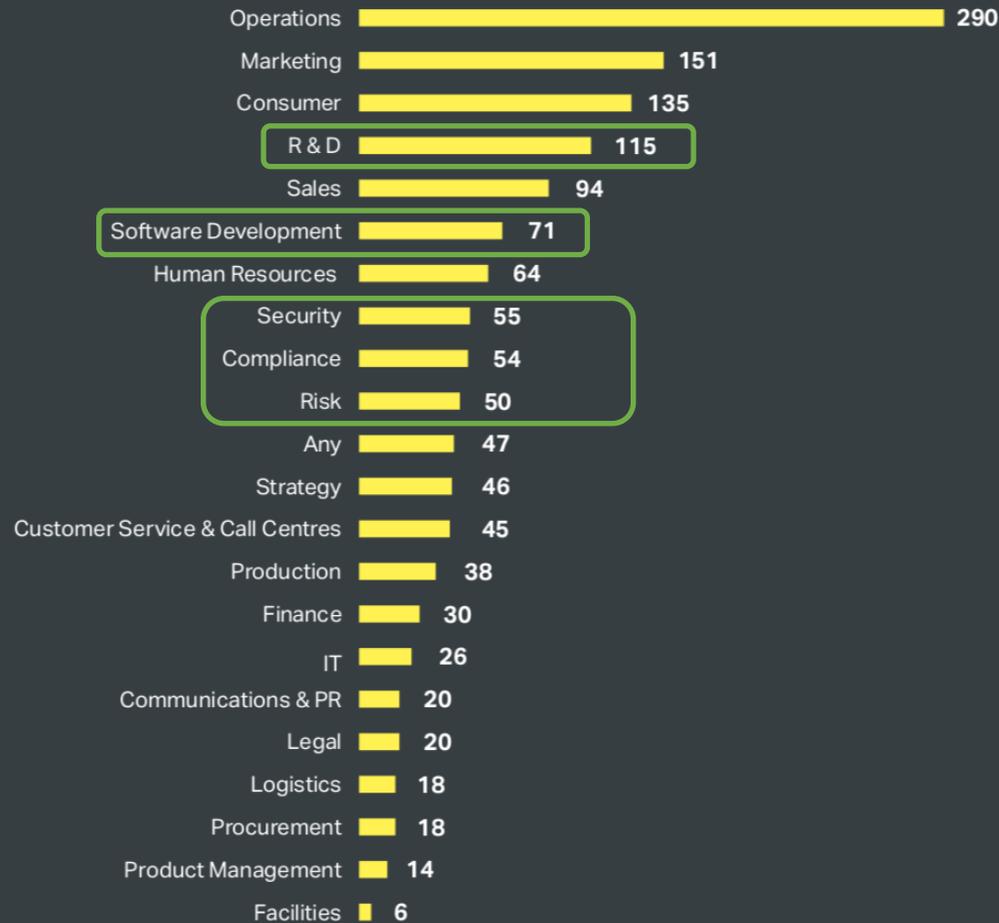# What's the Market AI in Healthcare in Europe

In which areas does your organisation use/have or plan to implement/provide AI tools?

[Only participants who are working in a healthcare facility or IT software vendor and who already use/have or plan to implement/provide AI tools]
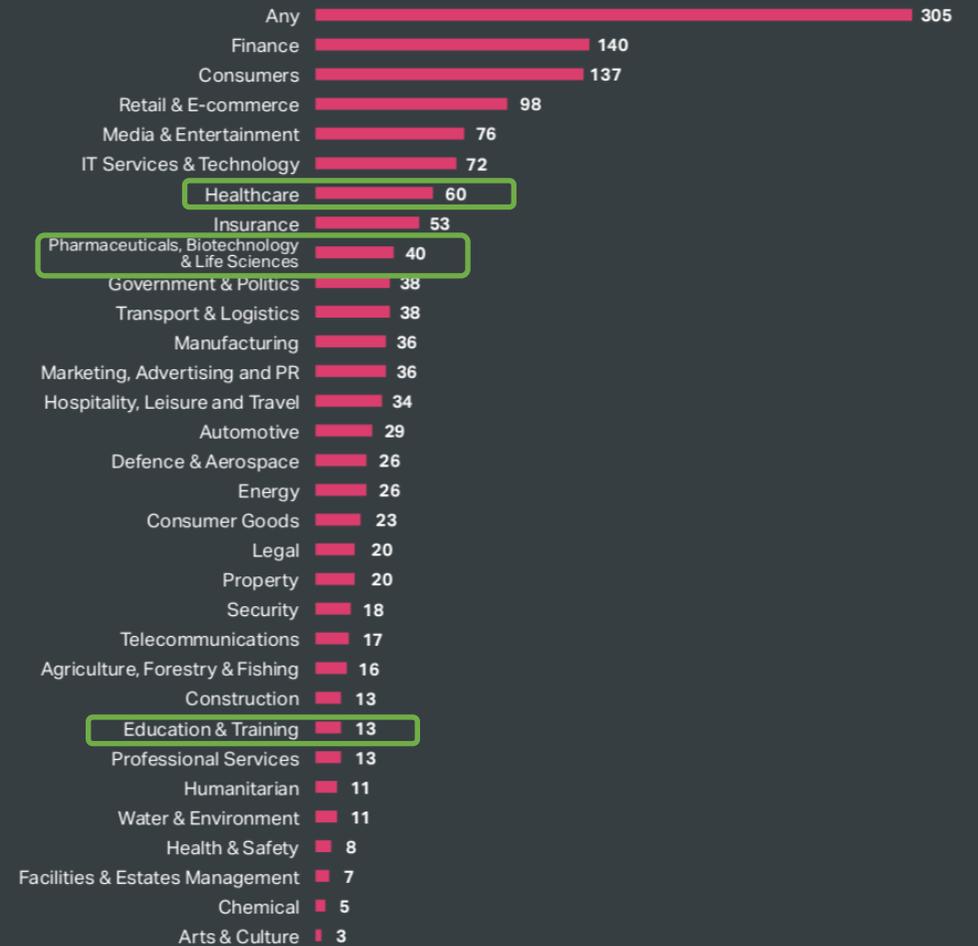
	Workflow Assistance	Research	Medication Administration	Radiology	Preliminary Diagnosis	Oncology	Medical Billing	Nursing	Surgery
Available in health facility	14%	13%	12%	11%	10%	9%	9%	5%	4%
Planned in health facility	15%	9%	13%	12%	10%	12%	9%	8%	7%
Provided by IT software vendor	21%	12%	10%	11%	10%	11%	7%	5%	3%
Planned by IT software vendor	16%	8%	13%	9%	18%	11%	6%	7%	3%

■ Available in health facility n=148   ■ Planned in health facility n=246   ■ Provided by IT software vendor n=91   ■ Planned by IT software vendor n=141

London

London AI suppliers by customer function

Function	Count
Operations	290
Marketing	151
Consumer	135
R & D	115
Sales	94
Software Development	71
Human Resources	64
Security	55
Compliance	54
Risk	50
Any	47
Strategy	46
Customer Service & Call Centres	45
Production	38
Finance	30
IT	26
Communications & PR	20
Legal	20
Logistics	18
Procurement	18
Product Management	14
Facilities	6

London AI suppliers by customer industry

Industry	Count
Any	305
Finance	140
Consumers	137
Retail & E-commerce	98
Media & Entertainment	76
IT Services & Technology	72
Healthcare	60
Insurance	53
Pharmaceuticals, Biotechnology & Life Sciences	40
Government & Politics	38
Transport & Logistics	38
Manufacturing	36
Marketing, Advertising and PR	36
Hospitality, Leisure and Travel	34
Automotive	29
Defence & Aerospace	26
Energy	26
Consumer Goods	23
Legal	20
Property	20
Security	18
Telecommunications	17
Agriculture, Forestry & Fishing	16
Construction	13
Education & Training	13
Professional Services	13
Humanitarian	11
Water & Environment	11
Health & Safety	8
Facilities & Estates Management	7
Chemical	5
Arts & Culture	3

NOTES

- Suppliers classified by functions served.
- Some suppliers serve more than one function
- "Operations" means the core activity of an enterprise unless covered by a more specific function such as "Production". Trading in bank or medical services in a hospital are both classified as "Operations"
- Consumer applications are classified as serving Consumer

NOTES

- Suppliers are classified by industries served.
- Some suppliers serve "Any" industry. An example would be an HR application
- Some suppliers serve more than one industry (eg document review in Finance, Legal & Insurance) in which case they are classified under each.
- Some suppliers are consumer services using AI.

EUROPE

Artificial intelligence: Commission outlines a European approach to boost investment and set ethical guidelines

Vice-President for the Digital Single Market Andrus **Ansip** said: *"Just as the steam engine and electricity did in the past, AI is transforming our world. It presents new challenges that Europe should meet together in order for AI to succeed and work for everyone. We need to invest at least €20 billion by the end of 2020*

Artificial Intelligence in Healthcare Market - U.K. leads Europe with largest revenue share forecasts

Medical imaging under artificial Intelligence in healthcare market should secure more than 40% growth to cross USD 2.5 billion by 2024, propelled by rising applications of AI in medical imaging and the deep learning techniques providing extraordinary performance for pattern recognition.

Britain announced a £1 billion-plus deal "to make the UK a global leader in AI" on Thursday. However, only £300 million of that is public funding. The rest is coming from more than 50 private companies and other organisations. Two weeks ago, France pledged to spend $1.5 billion towards AI development, while German Chancellor Angela Merkel announced her plans for a national AI strategy last Sunday. The exact amount of money Germany plans to invest in AI in the coming years isn't clear at this stage but it's likely to be over £1 billion.

CHALLENGES IN INDUSTRY

Is that everything?

Increase in Patient demands – It is estimated that by 2030 there will be 21.7 million cancer diagnoses and 13 million deaths worldwide

Delivering New Drugs - New drugs typically take 12-15 years to create and >$2BN to bring to market. Around 80% of candidates are rejected before they reach clinical trials.

Limited Expertise - There are approx. 4.7 radiologists per 100'000 people in Europe[1], the has Europe's highest shortage of radiologists[2] per person.

Complex and Large Data Sets – Medical images are usually multi-dimensional (2D, 3D, 4D) scans made up of hundreds of images. Hospitals that have 10-100 physicians may need to process 120,000 to 1,200,000 individual images on a daily basis.

Delay in Results - Patients typically wait days or weeks to receive the results of tests. If the outcome is potentially life threatening, action time is being lost.

Regulation of Technology - largely determined by the EU and European Commission, medical imaging solutions often need to conform to set guidelines

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THE CHALLENGES

IBM's Watson supercomputer has come under fire for providing incorrect and 'unsafe' healthcare treatment advice to cancer patients.

The system is being used in 230 hospitals around the world to help doctors diagnose patients. It does so by using artificial intelligence to analyse their medical data in combination with information from hundreds of medical journals. Since 2015, Watson has given advice on nearly 60,000 patients.

Audit of NHS Trust's app project with DeepMind raises more questions than it answers

it was the original 2015 contract that triggered the controversy, after it was obtained and published by New Scientist, with the wide-ranging document raising questions over the broad scope of the data transfer; the legal bases for patients information to be shared; and leading to questions over whether regulatory processes intended to safeguard patients and patient data had been sidelined by the two main parties involved in the project.

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HOW DO WE MEET THESE CHALLENGES

What can be done?

- **NHS Creating a network of digital pathology, imaging and AI centres**

  - Up to £50 million is available to establish centres of excellence in digital pathology and/or medical imaging with artificial intelligence (AI).

- **Health Data Research UK**

  - By harnessing health and biomedical data in the UK, Health Data Research UK will develop and apply cutting edge data science approaches in order to address the most pressing health research challenges facing the public.

- Secretary of state for health and social care set's out plan to sequence 5 million Patients through Genomics England

  - Ambitious vision for genomic medicine in the NHS – with plans to sequence 5 million genomes over the next five years.

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NVIDIA IN HEALTHCARE & LIFE SCIENCES

NVIDIA
CUDA

GE Revolution CT
Iterative Recon & Dose Reduction

Molecular Dynamics
HIV-1 Capsid, NAMD

GE Ultrasound
4D Blood Flow

Nobel Prize Cryo-EM
3D Reconstruction

2009 2012 2014 2016 2018

2007 2011 2013 2015 2017

Siemens Ultrasound
Amnioscopic Rendering

Thermo Fisher Ion
Desktop Sequencing

Brain Tumor Segmentation
w/ Deep Learning

Lung Cancer Detection
w/ Deep Learning

NVIDIA
Project Clara

PERVASIVE USE OF GPUS IN LIFE SCIENCES

Detecting Disease | Imaging | Drug Development | Health Services | Research
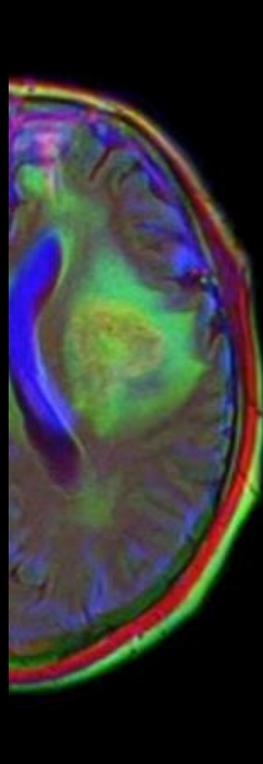
ACCELERATE ACROSS THE ECOSYSTEM

INPUTS

Text Data · Images · Video · Audio

Predict

DRUG DISCOVERY · **DEVELOPMENT** · **COMMERCIALIZATION**

ACCELERATING DISCOVERIES WITH AI

New drugs typically take 12-14 years and $2.6 billion to bring to market. BenevolentAI is using GPU deep learning to bring new therapies to market quickly and more affordably. They've automated the process of identifying patterns within large amounts of research data, enabling scientists to form hypotheses and draw conclusions quicker than any human researcher could. And using the NVIDIA DGX-1 AI supercomputer, they identified two potential drug targets for Alzheimer's in less than one month.

benevolent.ai

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AI ACCELERATES DRUG DISCOVERY

The discovery phase of drug development involves exploring different possible combinations of protein molecules (targets) and drug chemical compounds to ensure the drug will do what it's designed to do. Classic Molecular Dynamics simulations are time-consuming and expensive. Machine Learning models help predict probability of the target molecules interacting with the drug chemical compounds, but still require significantly greater performance to deliver improved accuracy.

Researchers at the University of Pittsburgh are improving model performance and prediction accuracy. Their convolutional neural network, accelerated with NVIDIA GPU's, improved prediction accuracy from ~52% to 70% compared to other machine learning-based models.

AI ADVANCES THE FIGHT AGAINST BREAST CANCER

Breast cancer is the second leading cause of cancer death for women worldwide. Genomic tests help doctors determine a cancer's aggressiveness so they can prescribe appropriate treatment. But testing is expensive, tissue-destructive, and takes 10-14 days. Case Western Reserve is using GPU-based deep learning with CUDA to develop an automated assessment of cancer risk at 1/20 the cost of current genomic tests.
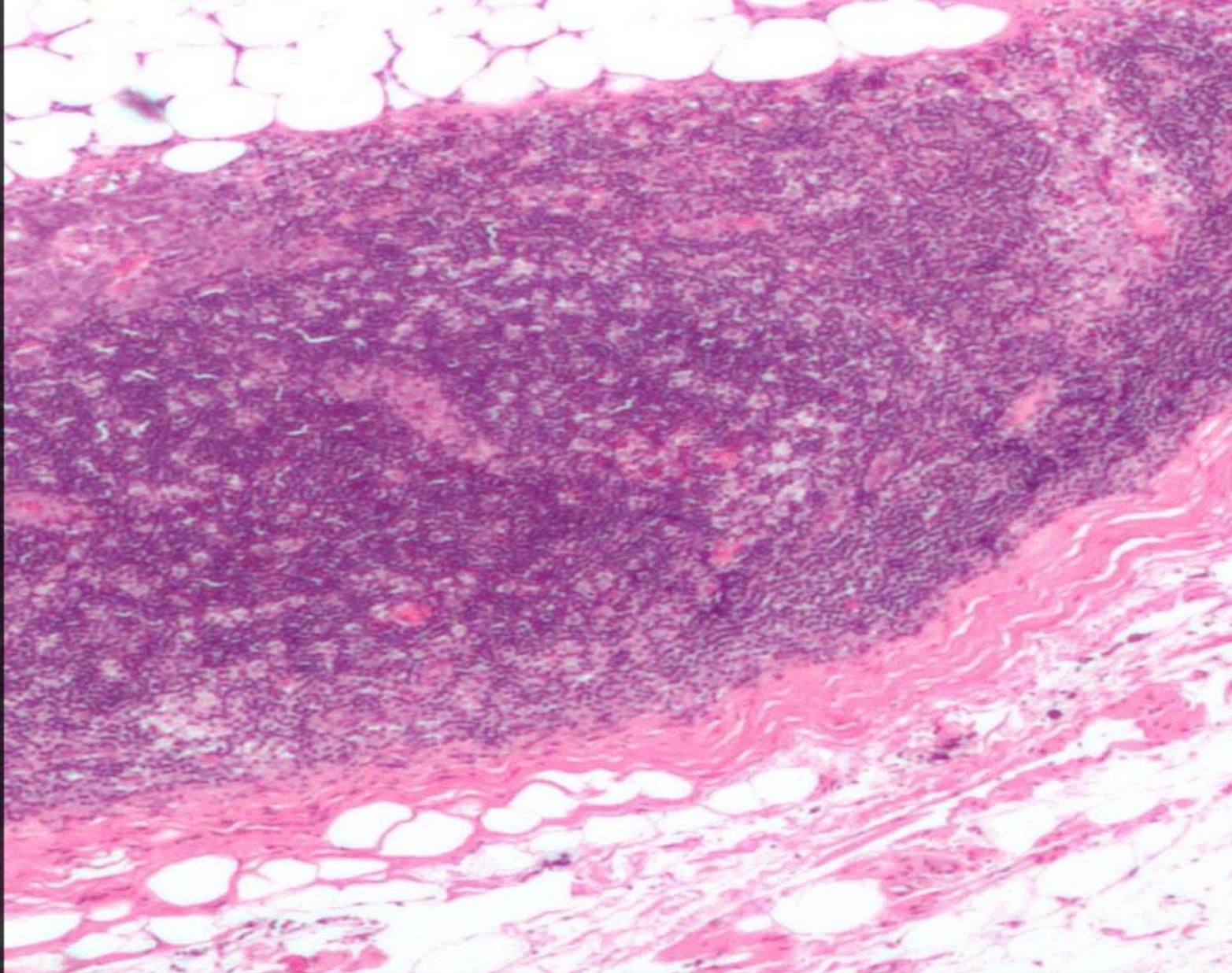
BIG DATA AND AI IN NEUROLOGY

Jorge Cardoso

Senior Lecturer in Artificial Medical Intelligence

NVIDIA AI EUROPEAN CLINICAL EXEMPLAR

REVOLUTIONIZING GENOMICS

Oxford Nanopore chooses Jetson TX2, for the MinIT the companion to the MinION personal DNA sequencer and scales to high-throughput benchtop with Volta V100 for real-time genome analysis.Ω

Breakthrough changes the cost and speed
of genome sequencing for anything biological—animal, food, water, air, agriculture. NVIDIA
Makes it possible to sequence
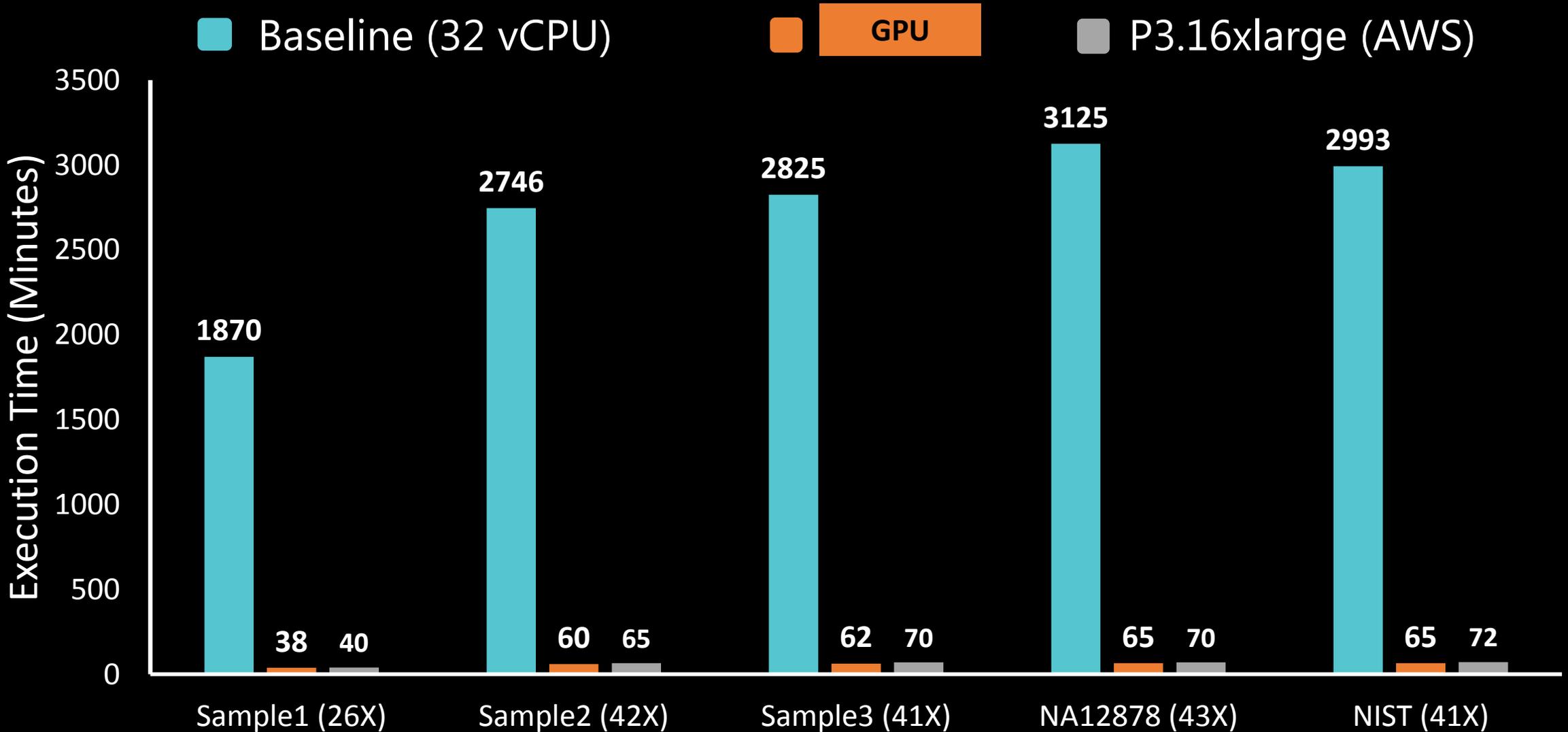a full genome remotely, Oxford Nanopore now have their hands on the Xavier AGX.

OXFORD NANOPORE SEQUENCING

What's coming next?

GTAK4 Performance Comparison

GUIDING PRINCIPALS IMBEDDED AI
Healthcare and Life

- Define the user, the value proposition and Be fair, transparent and accountable about what data is being use and ensure you show evidence of effectiveness for the intended use

- Show the type of algorithm being developed or deployed, the evidence base for using that algorithm, how performance will be monitored on an ongoing basis and how performance will be validated

- Be transparent to the limitations of the data used, using data that is proportionate to the identified user need

- Simplifying the regulatory and funding landscape whilst making security integral to the design

- Define the commercial strategy

- Creating an environment that enables experimentation, encouraging the system to adopt innovation

- Improving interoperability and openness, make use of open standards

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