smartheart

A SHORT GUIDE TO THE USE OF ARTIFICIAL INTELLIGENCE (AI) IN MEDICAL IMAGING

AROUND 7 MILLION PEOPLE IN THE UK LIVE WITH HEART DISEASE, WHICH CAN LEAD TO HEART ATTACKS AND STROKES. EACH YEAR, IT CAUSES OVER 150,000 DEATHS AND COSTS THE NHS AROUND £9 BILLION.

HEY DOC! I'VE GOT PAINS IN MY CHEST, WHAT'S THE MATTER WITH ME?!

HMM... THAT DOESN'T SOUND GOOD. LET'S SEND YOU FOR AN MRI SCAN TO TAKE A LOOK.

AN MRI SCAN? I DON'T EVEN KNOW WHAT THAT IS.

AN MRI SCAN IS A WAY OF LOOKING INSIDE YOUR BODY WITHOUT CUTTING YOU OPEN.

X-RAY MACHINES TAKE PICTURES OF YOUR BONES, BUT AN MRI SCAN LOOKS AT SOFT TISSUE, LIKE YOUR HEART AND THE VESSELS THAT ARE CONNECTED TO IT.

INSIDE THE SCANNER...

THIS IS TAKING AGES!

WELL, LUCKILY FOR YOU YOUR HEART IS PUMPING BLOOD, BUT THAT DOES MEAN IT'S CONSTANTLY MOVING SO IT'S DIFFICULT TO GET A DECENT PICTURE OF IT

AND WE NEED TO TAKE PICTURES FROM SEVERAL DIFFERENT ANGLES TO GENERATE A 3D IMAGE.

HOW MAGNETIC RESONANCE IMAGING (MRI) WORKS...

THE HUMAN BODY CONTAINS LOTS OF WATER MOLECULES: 2 PARTS HYDROGEN TO ONE PART OXYGEN (H_2O). THE HYDROGEN ATOMS CONTAIN PROTONS WHICH ARE LIKE TINY MAGNETS.

IN THE SCANNER, ALL THESE PROTONS IN YOUR BODY LINE UP IN THE SAME DIRECTION. PULSES OF RADIO WAVES KNOCK THE PROTONS IN AND OUT OF ALIGNMENT, WHICH SENDS RADIO SIGNALS BACK TO THE SCANNER. THESE SIGNALS TELL THE SCANNER EXACTLY WHERE THE PROTONS IN YOUR BODY ARE.

THE COMPUTER IN THE SCANNER CAN USE THIS INFORMATION TO GENERATE AN IMAGE OF THE INSIDE OF YOUR BODY.

2 HOURS LATER...

GROAN

YOUR SCAN IS ALL DONE! I NEED TO SEND THESE IMAGES TO YOUR DOCTOR, HE'LL TAKE A LOOK AND SEND YOU AN APPOINTMENT FOR A FEW WEEKS TIME.

SURELY SOMEONE CAN COME UP WITH A QUICKER SOLUTION!

EPSRC FUNDING OFFICE

WANTED!!!

SCIENTISTS TO SPEED UP MRI SCANS!

YOU'VE GOT THE IDEAS WE'VE GOT THE MONEY!

MEANWHILE...

6 MONTHS LATER, IN THE SMARTHEART HQ...

GREAT NEWS!

WE GOT THE FUNDING! OUR MISSION IS TO IMPROVE HOW HEART DISEASE IS DIAGNOSED AND TREATED! I WANT QUICKER MRI SCANS! I WANT MORE ACCURATE IMAGES! I WANT BETTER TREATMENTS FOR PATIENTS!

BUT CHIEF... WE NEED PHYSICISTS TO IMPROVE THE SCANNERS,

WE NEED DOCTORS TO FIND PATIENTS TO TEST THE SCANS ON, WE NEED COMPUTER SCIENTISTS TO FIGURE OUT HOW TO ANALYSE THE IMAGES...

THEN WE WILL COLLABORATE WITH THE BEST TEAMS IN THE COUNTRY!

THE MOST EFFICIENT WAY TO SPEED UP THESE PROCESSES WITHOUT MAKING MISTAKES IS TO MAKE USE OF COMPUTER POWER!

BUT HOW CAN WE USE A COMPUTER TO DO ALL THESE TASKS MORE QUICKLY, INSTEAD OF USING PEOPLE?

WELL THAT'S EXACTLY WHAT ARTIFICIAL INTELLIGENCE IS FOR. WHEN A COMPUTER IMITATES INTELLIGENT HUMAN BEHAVIOUR.

ARTIFICIAL INTELLIGENCE (AI) IS WHEN COMPUTERS CAN PERFORM COMPLEX TASKS THAT WE NORMALLY ASSOCIATE WITH HUMAN INTELLIGENCE (E.G. LEARNING, SOLVING PROBLEMS, RECOGNISING PATTERNS)

MACHINE LEARNING IS A TYPE OF AI WHERE WE FEED THE COMPUTER LOTS OF REAL-WORLD EXAMPLES, PROGRAM THEM ON HOW TO LEARN FROM THE IMAGES, AND THEY APPLY WHAT THEY HAVE LEARNT TO NEW SITUATIONS.

THIS IS POSSIBLE BECAUSE COMPUTER PROCESSORS CAN NOW COMPLETE BILLIONS OF INSTRUCTIONS PER SECOND.

OK, LET'S NOW PROGRAM THE COMPUTER ON HOW TO LEARN TO MAKE MRI SCANS SMARTER.

STEP 1: MACHINE LEARNING CAN HELP US OBTAIN THE BEST QUALITY IMAGE...

...AND IN LESS TIME

THE IMAGES ARE CLEAR 1ST TIME, YOU DON'T NEED TO COME BACK FOR A REPEAT SCAN!

FASTER SCANS MEAN WE CAN SEE MORE PATIENTS AND CUT WAITING TIMES.

MOVEMENTS CAN CAUSE GHOST IMAGES TO SHOW UP: MACHINE LEARNING ALGORITHMS CAN SPOT THESE AND CORRECT THE IMAGE TO REMOVE THEM.

THIS IS ESPECIALLY HELPFUL WHEN TRYING TO SCAN A PUMPING HEART!

STEP 2: IMAGE SEGMENTATION

Short-axis views

Long-axis views

MACHINE LEARNING CAN DIVIDE THE MRI SCAN IN TO SEGMENTS TO MAKE IT EASIER TO ANALYSE. THIS IS CALLED SEGMENTATION. WE ARE TEACHING MACHINES TO QUICKLY SPOT ANYTHING UNUSUAL, SO THESE CASES GET PRIORITISED...

STEP 3: INTERPRETING THE IMAGES

2D-LV SAX Acquisition 12x1.2x10mm

Linear Interpolation 12x1.2x2mm

CNN Super Res 12x1.2x2mm

3D-LV SAX Acquisition 1.2x1.2x2mm

MACHINE LEARNING CAN HELP DOCTORS PLAN THE BEST TREATMENT FOR THEIR PATIENTS BY ANALYSING WHAT HAPPENED TO PREVIOUS PATIENTS WITH SIMILAR SYMPTOMS AND MRI IMAGES.

IN FIVE YEARS' TIME (HOPEFULLY!)

WOW! THIS SCAN HAS ONLY TAKEN 5 MINUTES!

AND THE ANALYSIS THAT HAPPENED DURING AND STRAIGHT AFTER YOUR SCAN HAS GIVEN US THE RESULTS WHILST YOU WERE COMING OUT THE SCANNER, SO WE CAN DISCUSS YOUR TREATMENT NOW!

THE END.

AT SMARTHEART WE ARE WORKING TO IMPROVE HOW HEART DISEASE IS DIAGNOSED, MONITORED AND TREATED.

OUR TEAM IS MADE UP OF COMPUTER SCIENTISTS, PHYSICISTS AND DOCTORS, FROM 4 UNIVERSITIES: KING'S COLLEGE LONDON, IMPERIAL COLLEGE LONDON, QUEEN MARY UNIVERSITY OF LONDON AND UNIVERSITY OF OXFORD.

IT'S REALLY EXCITING TO WORK AT THE FOREFRONT OF SCIENTIFIC DISCOVERY, AND STUDYING SCIENCE CAN LEAD TO MANY DIFFERENT JOBS. COMPUTING IS INCREDIBLY IMPORTANT IN ALL AREAS OF SCIENTIFIC RESEARCH: SCIENTISTS GENERATE HUGE AMOUNTS OF DATA AND WE NEED TO CREATE NEW PROGRAMS TO INTERPRET AND ANALYSE IT ALL.

TO FIND OUT MORE ABOUT STUDYING SCIENCE SEARCH FOR "IMPERIAL BE INSPIRED" TO FIND OUT MORE ABOUT US YOU CAN FOLLOW US ON TWITTER:@SMARTHEARTUK @BIOMEDIAICL OR LOOK AT OUR WEBSITE: WWW.SMART-HEART.ORG

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