We are Drs. Michael Hansen and Andrew Arai, researchers from the NIH. We study cardiac MRI among other things. We are supporting new forms of scientific computing via the Data Science Bowl with Dr. Roman Salasznyk and Booz Allen Hamilton

Data$_{S}cience_{B}owl$[1]$andr/ScienceAMAs$[1]

[1]Affiliation not available

April 17, 2023

Abstract

I (Michael Hansen) am a biomedical engineer at the National Heart, Lung, and Blood Institute (NHLBI). I focus on fast magnetic resonance imaging (MRI) techniques for real-time imaging and interventional procedures, particularly fast pulse sequences, non-Cartesian imaging, real-time reconstruction, GPU based reconstruction, and motion correction. Andrew Arai - I am a cardiologist and I am the Director of the Advanced Cardiovascular Imaging Laboratory for the National Heart, Lung and Blood Institute. My primary clinical and research interests center around coronary artery disease, the condition that leads to heart attacks and is one of the leading causes of death worldwide. For the 21 years I have been at the NIH, I have been helping develop and validate MRI methods useful to diagnosing and evaluating patients with coronary artery disease. We run a busy clinical program and perform over 1000 cardiac MRI scans per year. Roman Salasznyk - I am a Principal in Booz Allen's Strategic Innovation Group with over 13 years of experience in biomedical research, medical product development, and general management consulting. I manage a multidisciplinary team that supports initiatives aimed to expedite medical product innovation and approvals, enhance regulatory decision-making processes, and strengthen surveillance and compliance operations for Federal health clients. The three of us, and our respective organizations, have collaborated on an exciting crowd-sourced collaboration, the the Data Science Bowl on kaggle. By putting data science to work in the cardiology field, we can empower doctors to help people live longer and spend more time with those that they love. Dr. Salasznyk: On behalf of the Data Science team at Booz Allen, thank you for your interest in the Data Science Bowl and this year's heart health-focused challenge. To learn more about this year's competition or to submit your ideas on next year's Data Science Bowl challenge—-a problem with the potential to change the world–visit our web site: datasciencebowl.com Dr Hansen here: Thank you for the great questions. They really covered a wide range of cardiology, technology, and engineering. I hope questions and answers will inspire data scientists, engineers, and physicians to get involved in cardiac MRI research. There are many unsolved problems with potential impact in patient lives. Dr. Arai here – Thank you all for your interesting questions. It was hard to predict how many people would submit questions and comments. It was nice to see the breadth of both technical and clinical questions. It is hard to pick a favorite but hearing about long term survivors with cancer and congenital heart disease are heartening. Many of the technical questions about speed and comfort of MRI relate to research being performed at NIH and many other institutions around the world. Faster imaging that does not rely on breath holds is a major direction for the future. Better quality imaging hopefully will continue to improve patient outcomes. Edit: Adding link to the Data Science Bowl site and competition page.

the WINNOWER

REDDIT

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R/SCIENCE DATA_SCIENCE_BOWL

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READ REVIEWS

WRITE A REVIEW

What are some ground breaking or exciting changes that have occurred in your fields that the general public may not be aware of?

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o1ekingcole

Dr. Arai here - Cardiac MRI is used much less in the US than in Europe. On the diagnostic side, the state of the art is a wide range of quantitative measurements. No one would treat cholesterol without measurements of cholesterol levels. Most cardiac imaging studies are interpreted in qualitative and semi-quantitative ways. Diagnostic cardiac MRI has been evolving to fully quantitative analysis of almost every type of cardiac MRI we do. Some of these developments were only described publicly last month.

Is data science of biomedical data different from bioinformatics? What are your solutions for keeping consistent metadata and accessing restricted data from other intistutes? How do you incentivize the crowd sourcing aspect for researchers, clinicians, and patients?

Edit: *incentivize, grammar

DataDominator

First question: Dr. Salasznyk here - In my opinion, no, the two things are different. Bioinformatics is the practice of finding scientific information in biological data. It assumes the data can be ingested, stored, accessed, etc. Data science of biological data deals with how best to handle that data to make it available to the bioinformaticians.

Second question: Dr. Hansen here - Keeping metadata/data consistent is an ongoing challenge in research, but there are dataformats that help us. For imaging, DICOM is a format that keeps metadata and image pixel data together. When we work with data (internal and external) we mostly work on anonymized and deindentified data so that we keep patient details confidential. When doing reconstruction reseserch, we need raw instrument data, this is often stored in ISMRM Raw Data format.

Third question: Dr. Salasznyk here - The Data Science Bowl is incentivized with $200,000 in prizes, and competing on kaggle itself is a great element for data science resumes! (I'm not sure if this answers your question, please feel free to follow up?)

What type of software or programming languages do you use for all of your imaging research? Can you recommend any books to read for an aspiring biomedical engineer?

TomVenn

Dr. Hansen here - There is no single answer. I would say there are two categories of languages/environments. For prototyping we use Matlab and Python a lot and high performance production stuff we write in C/C++. The three most useful books that I read and still consult every day are:

1. Meyers. Effective C++,
2. Golub/van Loan. Matrix Computations,
3. Gang of Four (Gamma/Helm/Johnson/Vlissides). Design Patterns.

I recommend focusing on good signal processing fuldamentals and good basic programming skills.

I happened across this reddit post and I was really curious. I am a 25 year old male that had open heart surgery when I was 16 for a tumor on my aorta. Ever since then I have been reading about ways of

advanced techniques that deal with the heart. Is their any new ways of helping the heart that isn't common knowledge? Is there an advanced MRI that specializes in the heart area?

DarkendHarv

Dr. Arai here - It is nice to hear you are a long term survivor of a tumor. Tumors of the aorta are quite rare. You seem to be in the lucky 8% that survive this type of tumor long term (assuming it was a cancer).

Cardiac MRI is an “advanced cardiac imaging method” that requires additional training beyond conventional MRI. Cardiac MRI is frequently used to assess cardiac tumors in or near the heart and blood vessels. We went over one study just this morning and another patient yesterday. Cardiovascular CT scans are also commonly used. For new treatments, look at one of the other posts asking about a new class of medicines called PCSK9 inhibitors.

What's the current leader in terms of acquisition speed and reconstruction time? I did a bit of work with parallel imaging & compressed sensing, but those were for images that took a long time to acquire.

zillin

Dr. Hansen here - There is generally some tradeoffs between speed (both acquistion and reconstruction) and image quality. One cannot really judge one in isolation. There are two major trends. Linear reconstruction techniques (e.g. standard parallel imaging), and non-linear reconstruction (compressive sensing). The linear techniques have nice predictable relationships between signal-to-noise and imaging speed. Linear reconstruction times tend to be pretty good (many algorithms can generate images in real time). The non-linear reconstruction techniques promise faster acquisition times at the expense of a substantial (order of magnitude) increase in reconstruction time. The non-linear reconstruction techniques are currently being investigated in terms of image quality. There are open source software packages out there that have high performance (quality and speed) example algorithms available. For instance: Gadgetron , BART, GPI

I'm a 23 year old female with damage to the left ventricle of my heart due to myocarditis 10 years ago. So far I have had 1 cardiac MRI, and my cardiologist wants me to get one every 5 years. I absolutely hate MRIs and I have been told the cardiac MRI is one of the longest MRI procedures. Has there been any work or advancements in trying to cut down on the length of time for a cardiac MRI?

Ihasabutt

Dr. Arai here - Sorry to hear about your myocarditis. Cardiac MRI is still a relatively slow technology but provides very high quality information. There is a lot of work that has led to accelerations of the methods. Adding new methods has offset some of the time savings. Sedatives can also help relax patients while they go through these tests.

What are your thoughts on PCSK9 inhibitors and their ability to improve cardiovascular health by lowering cholesterol? Do you see this type of drug being more widely adopted than it currently is (currently only used for familial hypercholesterolemia)? Why or why not?

SirT6

Dr Arai here - Great question. Alirocumab and evolocumab are two new PCSK9 inhibitors. They are the first medications in a new class of medication that can lower LDL cholesterol (the “bad” cholesterol).

These medicines are antibodies that inactivate proprotein convertase subtilisin–kexin type 9 (PCSK9). Inactivating PCSK9 decreasedsLDL-receptor degradation, increases recirculation of the receptor to the surface of hepatocytes, and consequent lowering of LDL cholesterol levels in the bloodstream.

The amount that LDL decreases is greater than any prior medical treatment for high cholesterol.

The costs are very high. The costs are a serious problem.

More studies are needed to verify that these medications actually lead to long-term health benefits such as lower death rates, fewer future heart attacks, less heart failure, and fewer strokes. These medically important outcomes will be studied over the next several years.

Hello! Recently, I saw a documentary about coronary diseases and early detection of signs leading to heart attacks. They mentioned some sort of MRI scans that focused on calcium deposits. What is your opinion about it? How reliable and affordable is this technique? Afaik, It's not currently covered by any medical plans but it seemed to be worth the investment. Are there any side effects from undergoing MRI scans? Thank you!

mm404

Dr. Arai here - Coronary calcium probably refers to Cardiac CT. CT scans are much more sensitive to coronary calcium than MRI. Coronary calcium is a pretty good test for detecting early coronary disease. It is less perfect for detection of heart attacks because too many patients with non-cardiac chest pain have some coronary calcium and therefore may be listed as “false positive” imaging results.

Coronary calcium scans are covered by some insurance plans and in some specific states such as Texas and California. The test is really primarily for assessing the risk of having coronary artery disease.

What do you think someone participating in the Data Science Bowl should concentrate on building? A predictive model to identify patients at risk of heart disease, most effective treatments, or something else?

titoveneno

For this Data Science Bowl, you have to focus on trying to make the required measurements off the MRI scans. For future projects, the sky is the limit.

What are you doing with your protocols to create "fast MRI" scanning techniques? Are you doing functional MRI? Resonating something other than hydrogen? Different field strength? What's your slew rate?

Source, I'm a field service engineer for GE, I've been fixing MRI machines for 14 years.

SpiritOne

Dr. Hansen here - Much of the ongoing effort is actually focused on reconstructing images with less data. There are physiological limits (e.g. in terms of slew rate) for how fast the data space can be covered, so in order to image faster, we use two techniques: 1. Multiple receive coils (antennas) for parallel imaging and 2. reconstruction from sparse data (e.g. compressive sensing). So the basic MRI technology (nuclei, gradients, RF, etc.) is the same, but the data processing is advancing. You can

look at some of the algorithms we are working on here.

The data science bowl is a great idea. Why are you guys just promoting it now? I'm a data scientist with a background in the biomedical field, but I have a day job and don't really have time to start with the deadline looming in less than a month!

reallegume

Dr Salasznyk here: Glad you agree the Data Science Bowl is a great idea!
This is the second annual DSB and we plan to host the competition again next year. While this is only our second Reddit AMA, we've been promoting through other channels, like the Kaggle web site and newsletter.
Our web site has a number of blog posts on all types of related topics. I hope you join us next year!

So if you do find blockages that would improve with intervention is it right off to the cath lab?

pghreddit

Dr. Arai here - In the not too distant past, cardiologists tended to follow a philosophy that an abnormal stress test means ship the patient to the cath lab. The last 6-8 years of clinical trials has been showing that one can manage many patients with medical management that might have been previously treated with a stent. Patients with high risk abnormalities or severe abnormalities are the ones that should go to the cath lab relatively quickly. There is no simple cookbook to these decisions so patients should make individual decisions with their physicians.

Thanks for your work!

As a paramedic in the US, I've been on many people who are actively having STEMIs. When I consider administering NTG and someone's BP is above 100 but not far, aside from the obvious problems with bottoming out their BP, does a lower BP create more benefit on the stressed heart considering there is less preload and then the heart doesn't have to contract as hard? I understand that the goal is to get blood around the blockage by dilating the vessels but I'm wondering if there's added bonus by keeping a pressure "low."

smokythebrad

Dr. Arai here - For the public, STEMI is a heart attack in progress that is big enough to show up on the electrocardiogram (ECG). NTG is an abbreviation for nitroglycerin, a medication used to treat angina (chest pains related to inadequate blood supply to the heart).

Rapid transportation to the hospital is the most critical intervention for an acute heart attack (STEMI). Aspirin, if there is no reason the medicine cannot be given is second most important. Oxygen is safe and simple.

For your particular patient with borderline blood pressure, nitroglycerin could drop the blood pressure further and cause more problems. In a borderline situation, follow your basics and call the Emergency Room for questionable or borderline issues.

Nitroglycerin is an appropriate treatment for a patient if chest pain that may be caused by inadequate blood supply to the heart, particularly if they have known heart disease, high blood pressure at the time, or signs of heart failure.

WARNING: Nitroglycerin should not be given to patients that have recently taken Viagra, Cialis, or Levitra as the combination of nitroglycerin with those medicines could cause dangerous drops in blood pressure.

1. When do you think Cardiac PET, and especially PET-MRI machines will finally take off, what do you see as the biggest obstacles to adoption Cardiac PET (aside from cost associated with Rb generators or N13)?
2. There's a compound in the pipeline, Flouripiridaz, that's supposed to have great flow characteristics, does your team have an opinion on it?

Itsatemporaryname

Costs are very high.

Rb generators are expensive but alternatives may be coming.

Physician expertise in cardiac PET is limited.

Flurpiridaz is a new PET tracer with characteristics that look very good as a blood flow agent.

As best I know, it is still in clinical validations.

Why is there no cure for AFIB? Aside from the potential health risks, I've heard that it can develop naturally as you age. If this a ailment like Prostate cancer where as you age the medical field is more concerned with symptom Management than treating the disorder?

GaugeAshland

Dr. Arai here - AFIB (atrial fibrillation) is a common abnormal heart rhythm. About 2-6 million people in the US have Afib. Afib is disorganized electrical activity of the heart muscle in the atria (the primer pumping chambers that help fill the ventricles, the main pumping chambers in the heart.

Afib is hard to treat because it tends to happen in hearts that are structurally abnormal due to other problems in the heart. A severely enlarged or scarred atrium has a low chance of curing Afib. Afib that results from an excessive alcohol intake in a patient with an otherwise normal heart has a high cure rate. Some patients can be successfully treated with a procedure called “ablation.”

How do you see cardiology in 5 years? What do you think about stem cell treatment of heart failure?

Kutili

Dr. Roman Salasznyk: I spent my entire graduate career evaluating the application of adult stem cells therapies in human disease progression. Stem cell-based treatments for heart failure represents a new generation of biological therapeutics and has the potential to revolutionize the cardiovascular field. There have been several clinical studies involving the infusion of mesenchymal and bone marrow stromal cells that have shown to reduce infarct size, the ability to rebuild damaged tissue, and improve health outcomes.

Which is better for diagnosing infiltrative diseases? Cardiac PET or MRI?

Ssinum

Dr. Arai here - I know more about cardiac MRI than PET. Cardiac MRI is an excellent test for most types of infiltrative diseases of the heart muscle. PET is as good or may be better than MRI for cardiac sarcoidosis. It is still too early to tell for sure regarding sarcoidosis but an area where a number of research groups are doing specific comparison studies.

Hello I have always had a fast heart rate. Is that normal for some people?

barnyardstrutter

For the general public, a normal heart rate in an adult is 60-100 beats per minute.

If you think about your heart beat, it will probably go up. If you exercise, it will go up. If you are sick, it can go up.

If your resting heart rate is higher than 100, I'd contact your doctor.

Hello, I'm a 20 year old male who has a rare form of Bicuspid Aortic Valve. My two leaflets are semi-joined with cardiac tissue and leaks more blood back into my left chamber. Is there any advancements you have seen with being able to monitor a heart condition through MRI's as well as any upcoming heart surgery advancements to replace a valve?

84634774678

Dr. Arai here - Bicuspid aortic valves occur in about in about 0.5% to 2% of people. A normal aortic valve has three leaflets. A bicuspid aortic valve has two leaflets but does come in a few different configurations. Bicuspid aortic valves either do not open completely (i.e. aortic stenosis) or leak (aortic regurgitation). Most patients with a bicuspid aortic valve are followed by echocardiography, an ultrasound imaging test of the heart. Cardiac MRI is also good at assessing the severity of aortic stenosis or aortic regurgitation as well as the consequences on the cardiac chambers. However, it is used less often than echocardiography for valve diseases.

I'm a 2nd year PA-S. Basically, I've recently been taught that 40 years of research in statin therapy to reduce cardiovascular disease is hogwash and completely unnecessary in patients with solely high lipids. What are your thoughts on patients taking statins to reduce atherosclerotic related heart disease without a history or high risks of CVD?

sxt876

Dr. Arai here - Hogwash is too strong a statement. Statins are some of the best studied medications in cardiovascular medicine. There are many high quality studies that indicate they help improve long term patient outcomes. Most of those studies are in patients with known disease. There is much less data in patients with no history of or lower risk of cardiovascular disease.

My son has Truncus Arteriosus, repaired shortly after birth and 4 times since, plus a Melody valve when it was still in study.

His irregular rhythm makes the MRI a drawn out ordeal. 8 or 9 beats on a row with the same peaks on EKG are rare even to my eyes.

Is there here any work on the horizon that will help make th MRI more practical for patients with difficult rhythms?

FWIW, we are not far from NIH

BluesFan43

We have been developing real-time imaging methods and motion corrected methods that may be useful for patients with problems like you describe. You can contact us through the NIH or Childrens National Medical Center. I'll send you a private message.

Have you heard of any advances in real time, intraoperative neurography? Do you think it will be possible in the next 10 years?

dieselmonkey

Dr. Arai here - Interesting question but out of my expertise.

Rb generators are expensive but alternatives may be caused by inadequate blood supply to the cath lab.

schorpion_11

Not sure if we understand your question - can you rephrase?