Project Priorities for Course Development

1. **Build demo site**
    - Brand identity & logo - [draft for inspiration here]
    - [Dr. Han site]
    - Dr. Han namespace = [Client-DrHan]
    - Using Demo.ProjectWe.com Grid format

2. **Slides with Voiceover Content and Initial Images for Competency 1**
    - Create all slides based on the provided content below.
    - Integrate voiceovers for each slide.
    - Use or redesign images (as indicated).

3. **Add Quizzes & Reflections**
    - Add quiz and reflection capabilities for each section - they are included in the content below.
    - Include multiple-choice questions with correct answers indicated.
    - Ensure that reflection questions have textboxes for student responses.

4. **Add Interactive Elements as feasible (to be discussed)**

    - **Links to relevant PDFs & chat ability***
        - Create ability to link to relevant research papers and PDF downloads
        - Upload PDFs to media gallery
        - Ability to have "chat with this pdf" capabilities?

    - **Interactive time-line or slides***
        - Create interactive time-lines for a couple of slides noted below
        - Link to relevant PDFs and research studies
        - Chat with this pdf

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Additional Features given enough time:

- **Decision-Making Activity:**
    - Create a digital decision tree for Case Study 1 where students can select imaging modalities based on patient symptoms and history.
- **Image Analysis Activity:**
    - Provide sample CT images for Case Study 2, allowing students to identify key anatomical structures.
- **Discussion Forums: -??**
    - Set up discussion forums for students to share insights and reflections on their experiences and the course material.

5. **Add Case Studies and Interactions**

    - Integrate the detailed case studies into the course structure as noted below.
    - Ensure each case study includes:
        - Clear slide content with voiceovers.
        - Relevant visuals and diagrams.
        - Reflection questions with textboxes for responses.
    - Include interactive elements for each case study, such as:
        - Decision-making activities.
        - Image analysis tasks.
        - Simulation exercises.
    - Facilitate discussions around the case studies to enhance collaborative learning.

6. **Implement AI Chatbot & Avatar**

    - **AI Chatbot / Avatar of Dr. Kelly Han:**
        - Develop an AI chatbot experience that students can interact with throughout the course (experience - Moira to do).
        - The chatbot should be able to answer questions related to cardiac CT, congenital heart disease, and course content.
        - Ensure the chatbot can provide additional resources, clarify concepts, and engage students in discussions.
        - Integrate the chatbot into the course platform for easy access and user friendly interface.

7. **Demo Language Translation capabilities**

Competency 1: CT Fundamentals

Slide 1: Welcome

- **Slide Text:**
    - **Title:** "Fundamentals of CCT in CHD"
    - **Subtitle: Instructor -** Dr. Kelly Han
- **Images:**
    - Generic with course logo or introductory graphic.
    - *Option:* Background image of a CT scanner or a heart illustration.
- **Voice Over:**
    - "Welcome to the CT Fundamentals Course! I'm glad you're here. In this course, we'll explore the essential principles of cardiac computed tomography as it applies to congenital heart disease. We will cover the technology, imaging techniques, and clinical applications that are vital for your practice. Let's get started!"
- **Interactive Elements:**
    - [Placeholder for welcome video from Dr. Han introducing herself and welcoming students] – ?

Slide 2: Course Objectives

- **Slide Text:**
  •Objectives - to understand:
  - CT technology applied to cardiac imaging and CHD
  - Diagnostic risks in CHD patients
  - Temporal/spatial resolution and radiation dose optimization
  - CCT applications specific to CHD
- **Images:** Standard slide design maybe image of CT scanner or heart
- **Voice Over:** "The main objective of this course is to help you understand how CT technology is applied specifically to cardiac imaging, with a focus on congenital heart disease. We'll explore the comprehensive diagnostic risks associated with congenital heart disease patients, particularly the important topic of radiation dose, which has been

a key consideration in the use of CT. Additionally, we'll delve into the concepts of temporal and spatial resolution, and how these factors play a crucial role in optimizing radiation dose. By the end of this course, you'll have a solid understanding of cardiac computed tomography and its specific applications in congenital heart disease."

- **Interactive Elements:** ENGAGEMENT SECTION (see below)

Engagement Section

Slide 1: Getting to Know You

- **Slide Text:** "Tell Us About Yourself"
- **Images:** Background image of a diverse group of healthcare professionals (AI generated).
- **Voice Over:** "Before we dive into the content, we'd like to get to know you a little better. Please take a moment to share your name, current role, and any relevant background information that would help us create a more interactive and tailored learning experience."
- **Reflection Question(s) Textbox Instructions:**
    - "Please provide a textbox for students to enter their name, current role, and relevant background information."

Slide 2: Reflection prompt

- **Slide Text:** "Reflection"
- **Images:** Basic slide – or reflection box?
- **Voice Over:** "Now that we have a better understanding of who you are, let's reflect on your experiences with imaging technologies, including CT. Think about any relevant knowledge or questions you may have. What aspects of CT technology or its applications are you particularly interested in or unclear about? Sharing your thoughts will help us connect your existing knowledge to

the new concepts we will explore in this course.

Reflection Question(s) Textbox Instructions:

1. What are your past experiences with imaging technologies, including CT?
2. What interests you about cardiac computed tomography (CT) in the context of congenital heart disease (CHD)?
3. Reflect on your past experiences with imaging technologies, including CT. What knowledge or questions do you have regarding CT imaging in congenital heart disease?"

Slide 3: Thank you

- **Slide Text:** Thank You!
- **Images:** Represent a diverse and collaborative learning enviornment
- **Voice Over:** "Thank you for sharing your thoughts and experiences! Your insights will help create a collaborative learning environment as we explore the essential principles of cardiac CT in congenital heart disease. We appreciate your participation and look forward to engaging discussions throughout the course."

Section 2: Historical Context of CT

Transition to Section 2:

- **Slide Text:** "Historical Context of CT"
- **Images:** Background image related to CT technology evolution.
- **Voice Over:** "Thank you for sharing your insights! Now that we have a better understanding of your background and interests, let's delve into the historical context of cardiac computed tomography. In this section, we will explore the evolution of CT technology, starting from its inception to the advancements that have shaped its application in cardiac imaging today. We'll look at key milestones, including the first CT scan ever performed, and discuss how these developments have paved the way for the sophisticated imaging techniques we use in congenital heart disease today."

Slide 3: First CT Scan

- **Slide Text:**
- •First Clinical Scan October 1, 1971
- •Dr. Hounsfield (EMI London)
  - •80 x 80 matrix/pixels: 3 mm in plane resolution (XY), 13 mm slice (z)
  - •180 degree coverage at 1 degree intervals
  - •Hours to process the raw data for a single slice
  - •Head imaging with rubber membrane and water filled box
- •Dr. Hounsfield and Cormack (Tufts) Nobel prize in Medicine 1979

- **Images:** 1. Historical image of the first CT scan and 2. Dr. Hounfield (links coming..).
- **Voice Over:** "This is a picture of a brain scan, which is the first CT ever in the medical literature. This is from 1971 by Doctor Hounsfield and it was obtained in London. This had three-millimeter in-plane resolution and 1.3 centimeter z-axis resolution. It took many hours to obtain this image and there was no ability to see cardiac motion in these type of scans."
- **Interactive Elements:** Timeline activity for key milestones in CT technology.

Slide 4: Evolution of Cardiac CT

- **Slide Text:** "The evolution of cardiac CT began with multi-slice scanners."
- **Images:** Timeline of CT advancements and images.Can we turn the timeline into an interactive timeline?
- **Voice Over:** "The evolution of cardiac CT came into play when there started to be multi-slice scanners. The first multi-slice scanner was in 1992, and the first picture of a coronary artery was in 1995. Cardiac CT really took off in the early two thousands when 16 and then 64 slice scanners became commonly available. In 2005, the first dual-source scanner became available, and in 2021, the first dual-source and photon counting scanner became available. This really has revolutionized cardiac imaging."
- **Interactive Elements:** Quiz question: "What year was the first multi-slice CT scanner introduced?"
    - A) 1990
    - B) 1992
    - C) 1995
    - D) 2000

    Correct Answer: B) 1992

Section 3: Importance of CT in Congenital Heart Disease

Slide - Transition to Section 3: Importance of CT in Congenital Heart Disease

Transition to the Importance of CT

- Slide Text: "Importance of CT in Congenital Heart Disease"
- Images: Background image related to congenital heart disease.
- **Voice Over**: "Now that we have explored the historical context of CT technology, let’s shift our focus to its significance in the realm of congenital heart disease. Understanding the capabilities of different CT scanners is crucial for effective diagnosis and treatment planning. In this section, we will compare single-source and multi-slice scanners, examining how advancements in technology have enhanced our ability to visualize the heart. This comparison will highlight the benefits of multi-slice scanners, which allow for comprehensive imaging in a single heartbeat, a vital aspect when assessing complex congenital conditions."

Slide 5: Single vs. Multi-Slice Scanners

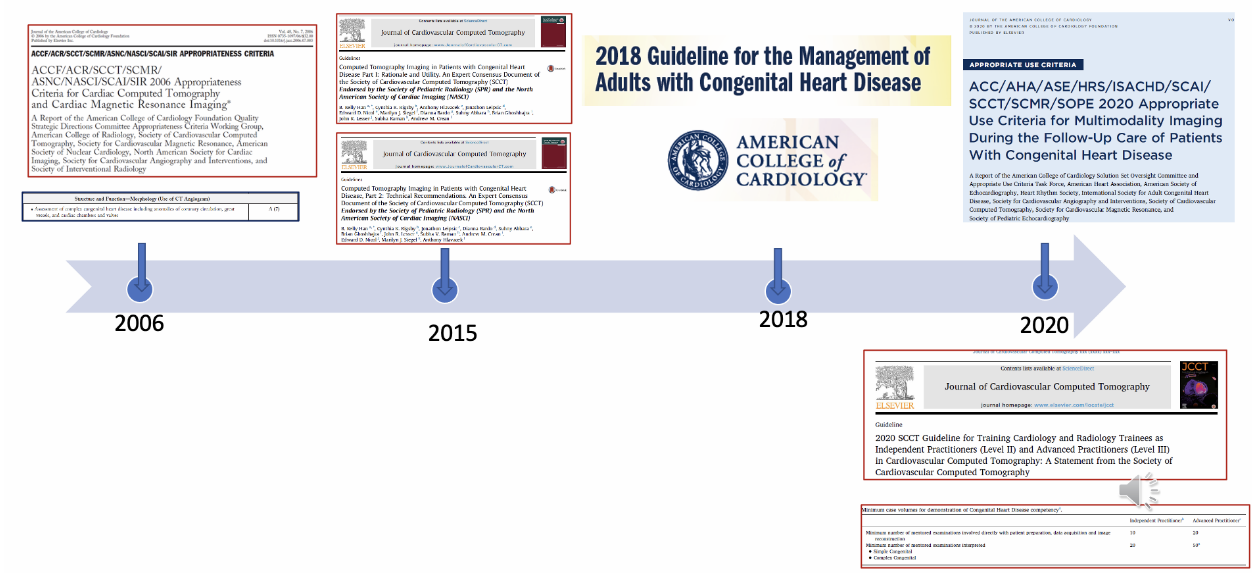
- **Slide Text:** "Single-source vs. multi-slice scanners: Visualization of the heart in a single heartbeat."
- **Images:** Diagram comparing single-source and multi-slice scanners.
- **Voice Over:** "With a single-source scanner, you're able to obtain one slice at a time, and with a multi-slice scanner, as this illustrates, you're able to obtain many slices at the

same time, allowing entire visualization of the heart in a single heartbeat or a single acquisition."

- **Interactive Elements:** Poll: "How do you think advancements in CT technology have impacted patient outcomes?"
- A) Improved diagnostic accuracy
- B) Reduced radiation exposure
- C) Faster imaging times
- D) Enhanced visualization of complex anatomy
- E) other - (text response)

Slide 6: Guidelines for CT in Cardiac Disease

- **Slide Text:** "Recommendations for CT in CHD Clinical Practice."
- **Images:** Infographic summarizing guidelines and/or time-line. *Can we make this an interactive time-line somehow? Perhaps with links to the relevant publications?*



- **Voice Over:** "There has been recommendations for CT in cardiac disease and also specific to congenital heart disease. The first guidelines documenting this were performed in 2006, and since then there's been many other publications, and it's always given an appropriate use for congenital heart disease."
- **Interactive Elements:**
  Reflection question: "In your experience, how has the role of CT evolved in managing congenital heart disease?"

Slide 6A: Improved Mortality

- **Slide Text:** "Improved mortality rates for congenital heart disease patients."
- **Images:** Graph showing mortality rates over time.

- **Voice Over:** "The reason it's becoming more important for patients of all ages is that there's an improved mortality for patients with congenital heart disease. What this graph shows is the changing mortality. From 1987 to 2005, there was a 30% decrease in mortality, but it's shifted from pediatric to adult patients, and the median age of death for even the most complex patients is now in the adult years."
- **Interactive Elements:** Quiz question: "What percentage decrease in mortality for congenital heart disease patients was observed from 1987 to 2005?"
    - A) 10%
    - B) 20%
    - C) 30%
    - D) 40%

    Correct Answer: C) 30%

Slide 6B: Increasing Incidence

- **Slide Text:** "Increasing incidence of congenital heart disease in adults."
- **Images:** Chart showing incidence rates.
- **Voice Over:** "This is another slide showing the increasing incidence of congenital heart disease both in the pediatric and in the adult age range, and in the current era, about 50% of patients are adults and by 2030 over 80% of patients will be adults. This includes patients who are above the age of 60 who for the first time will have both acquired and congenital heart disease at the same time."
- **Interactive Elements:** Reflection question: "What challenges do you foresee in managing adult patients with congenital heart disease?"

Section 4: Imaging Modalities and Their Roles

Slide 7: Importance of Imaging Modalities

- **Slide Text:** "Importance of serial follow-up in congenital heart disease."
- **Images:** Flowchart of imaging modalities.
- **Voice Over:** "Congenital heart imaging is very important and so patients need serial follow-up for initial cardiac diagnosis, for interval assessment, to guide medical management, and for procedural planning. Echocardiography is by far the most common modality used in follow-up. It is easily available and probably a ten to one ratio between echocardiography and advanced imaging. Both cardiac MRI and cardiac CT are used when echo is insufficient, and having all modalities at the highest quality really is the best care of the patient, where you can pick the best test with the least risk, and all of these modalities are complementary with different risk profiles."
- **Interactive Elements:** Case studies where fellows choose the appropriate imaging modality based on patient scenarios.

Slide 8: Situations for Cardiac CT

- **Slide Text:** "Situations where cardiac CT may be appropriate."
- **Images:** List of indications for cardiac CT.
- **Voice Over:** "This is from a 2015 guideline document, and this is situations where cardiac CT may be appropriate in patients with congenital heart disease. One is the presence of a CMR unsafe implant or foreign body. The second is poor image quality known or expected primarily due to artifact. Three is patients who are unable to fit in a conventional MRI scanner due to obesity, particularly in the United States. For neonates and young children, they may be considered high risk for an adverse event with sedation, and a typical cardiac MRI takes 45 minutes, where a cardiac CT is usually performed in a single heartbeat. So sedation is usually not needed, and if it is needed, it's needed for a very short amount of time. Cordicular patients may not tolerate the breath hold or the length of a cardiac MRI scan."
- **Interactive Elements:** Quiz question: "Which imaging modality is most commonly used for follow-up in congenital heart disease?"
    - A) Cardiac MRI
    - B) CT
    - C) Echocardiography
    - D) X-ray
    Correct Answer: C) Echocardiography

Section 5: Applications of Cardiac CT

Slide 9A: Evaluation of Devices

- **Slide Text:** "Evaluation of ventricular assist devices and ECMO cannulas."
- **Images:** Images of ventricular assist devices.
- **Voice Over:** "Another area where it's very helpful is evaluation of ventricular assist devices or ECMO cannulas for patients who are on continuous bypass. Patients with congenital heart disease often have extra cardiac anomalies in addition to their congenital heart disease. This is one modality that can image both of those things at the same time."
- **Interactive Elements:** Clickable images that provide additional information about each application when hovered over.

Slide 9B: Preoperative Planning

- **Slide Text:** "Importance of CT in preoperative planning."
- **Images:** Diagram of sternal anatomy.
- **Voice Over:** "For pre-op patients, it's very helpful to be able to look at sternal anatomy to help with reentry, to avoid any adherent or scar in the sternum right underneath where

they're going to enter the chest. Also, prosthetic valve function is very difficult to see by cardiac MRI due to metallic artifact."
- **Interactive Elements:** Reflection question: "What challenges have you faced in using CT for evaluating congenital heart disease?"

Slide 9C: Visualization of Calcification

- **Slide Text:** "CT's ability to visualize calcification."
- **Images:** Examples of calcification in vessels and coronary arteries.
- **Voice Over:** "The other thing that's well seen on CT but not well seen on cardiac MRI is calcification, and this can be seen within vessels, surgical conduits and also within coronary arteries, and then for coronary artery imaging. This is used for detailed preoperative imaging to rule out additional atherosclerotic heart disease patients with symptoms suggestive of atherosclerosis, with a history of coronary intervention or high-risk Kawasaki disease patients with anomalies, particularly if cardiac MRI is unlikely to provide complete assessment."
- **Interactive Elements:** Quiz question: "What is a significant advantage of cardiac CT in preoperative planning?"
    - A) It provides functional imaging.
    - B) It can visualize calcification.
    - C) It requires longer scan times.
    - D) It is less expensive than MRI.
    Correct Answer: B) It can visualize calcification.

Section 6: Visualization Techniques

Slide 10: Coronary Evaluation

- **Slide Text:** "Coronary evaluation in cardiac MRI."
- **Images:** Diagram showing coronary arteries.
- **Voice Over:** "In cardiac MRI, the coronary evaluation is inverse related, both age and heart rate. And then evaluation of the coronaries after any surgery requiring manipulation areas where CT is considered a first-line imaging modality. These are just the types of images we can get."
- **Interactive Elements:** Discussion forum where fellows can share their thoughts on coronary evaluation techniques.

Slide 11: Aortic Valve Imaging

- **Slide Text:** "Aortic valve with calcification."
- **Images:** Image of an aortic valve with calcification.
- **Voice Over:** "Looking at an aortic valve with calcification and also coronary arteries as it goes directly under the sternum in a patient after an arterial switch."

- **Interactive Elements:** Reflection question: "What insights do you gain from imaging the aortic valve in congenital heart disease?"

Slide 12A: Functional Scans

- **Slide Text:** "Functional scans in cardiac CT."
- **Images:** Example of a functional scan.
- **Voice Over:** "There are examples that we call functional scans, where you're able to give radiation throughout the cardiac cycle and able to look at valve motion and function in addition to the still frame of the heart."
- **Interactive Elements:** Video demonstration of a functional scan in action.

Slide 12B: Increasing Use of Cardiac CT

- **Slide Text:** "Increasing use of cardiac CT in all ages."
- **Images:** Infographic showing the growing use of cardiac CT.
- **Voice Over:** "Because of this type of visualization, cardiac CT is becoming increasingly used in patients of all ages with congenital heart disease."
- **Interactive Elements:** Quiz question: "What is the primary advantage of functional scans in cardiac CT?"
    - A) They provide static images.
    - B) They allow for assessment of valve motion throughout the cardiac cycle.
    - C) They require longer scan times.
    - D) They are less accurate than traditional scans.
      Correct Answer: B) They allow for assessment of valve motion throughout the cardiac cycle.

Section 7: Education and Competency in Cardiac CT

Slide 13: Current Gaps in Education

- **Slide Text:** "Current gaps in education regarding cardiac CT."
- **Images:** Overview of educational guidelines.
- **Voice Over:** "So in terms of CT specific to congenital heart disease, there really is no current recommendations or platform. So the most recent guidelines from 2015 for advanced imaging heart state CT is not included as a modality in the most recent guidelines for cardiac imaging in adults. There are recommendations for minimal competency in congenital heart disease, but there is not a current platform for education for high-level performance of CT in congenital heart disease."
- **Interactive Elements:** Reflection question: "What is a current gap in education regarding cardiac CT for congenital heart disease?"

Slide 14A: Envisioned Education Platform

- **Slide Text:** "Envisioned education platform for all imagers."
- **Images:** Diagram of the proposed education platform.
- **Voice Over:** "What we envision is a platform that is geared towards all imagers which can be pediatric cardiology, pediatric radiology, adult cardiology or adult radiology."
- **Interactive Elements:** Discussion forum for fellows to share their thoughts on the need for standardized education.

Slide 14B: Addressing Knowledge Gaps

- **Slide Text:** "Addressing knowledge gaps for different learners."
- **Images:** Chart showing different learner backgrounds.
- **Voice Over:** "The gaps will be different per learner based on their background, education. For an adult imager, they often are very advanced in imaging coronary artery disease, but need to know the basics of congenital heart disease and then go from simple to high complexity heart disease."
- **Interactive Elements:** Reflection question: "How do you think a standardized education platform could improve practice in cardiac imaging?"

Slide 14C: Module-Based Learning

- **Slide Text:** "Module-based learning for all imaging professionals."
- **Images:** Example of a module-based learning structure.
- **Voice Over:** "For people in pediatric cardiology, they know a lot about congenital cardiac pathology in management, but often don't know the basics of CT imaging. A platform would need to be module-based so that it would be applicable to all people based on their knowledge gaps."
- **Interactive Elements:** Quiz question: "What is a key feature of the envisioned education platform?"

Section 8: Fundamentals of CT Hardware Design and Function

Slide 15: Fundamentals of CT Hardware

- **Slide Text:** "Fundamentals of CT hardware design and function."
- **Images:** Diagram of CT scanner components.
- **Voice Over:** "Next slide number one is to describe the fundamentals of CT hardware design and function. And we'll go through the CT scanner hardware, including x-ray tubes, detector array, table motion and gantry specifically related to temporal resolution."
- **Interactive Elements:** Labeling activity where fellows identify parts of a CT scanner.

Slide 16: CT Scanner Components

- **Slide Text:** "CT scanner components: x-ray tubes, detectors, and gantry."
- **Images:** Detailed diagram of CT scanner components.
- **Voice Over:** "So this is the very basic CT scanner, and so photons are used to create image in CT, and the x-ray tube delivers the photon which then passes through the patient and is then picked up by something called a detector which then converts the photon energy to light, and the light is converted to analog data and then to an image. In the newer photon counting scanners, the photon energy is converted directly to analog data without the conversion to light. So a gantry houses the x-ray tubes and the collimator, and it rotates around the patient, and this is an example of that solution."
- **Interactive Elements:** Quiz question: "What is the function of the collimator in a CT scanner?"
    - A) To rotate the gantry
    - B) To detect photons
    - C) To narrow the X-ray beam
    - D) To convert light to analog data

      Correct Answer: C) To narrow the X-ray beam

Slide 17: Gantry and Collimator

- **Slide Text:** "The gantry and collimator in CT imaging."
- **Images:** Image of a CT gantry.
- **Voice Over:** "Your piece of hardware around the patient is considered the gantry and the x-ray tubes deliver the photons and the collimators detect the photons."
- **Interactive Elements:** Reflection question: "How does the design of the gantry impact imaging quality?"

Section 9: Temporal Resolution

Slide 18: Understanding Temporal Resolution

- **Slide Text:** "Temporal resolution: The ability to freeze cardiac motion."
- **Images:** Diagram illustrating frame rates.
- **Voice Over:** "The ability to freeze cardiac motion. It's similar to a frame rate if thinking about photography, and the eye can see about 25 frames per second, or about 40 milliseconds. The higher the temporal resolution, the better the ability to freeze cardiac motion will be."
- **Interactive Elements:** Simulation where fellows can adjust gantry speed and see the effect on temporal resolution.

Slide 19: Gantry Rotation and Reconstruction

- **Slide Text:** "Gantry rotation and image reconstruction."
- **Images:** Diagram showing gantry rotation.

- **Voice Over:** "This is the gantry, and it shows gantry rotation with the time required to complete the arc of rotation of the x-ray tube around 360 degrees. And the image reconstruction needs 180 degrees of rotation."
- **Interactive Elements:** Quiz question: "What does temporal resolution refer to in cardiac imaging?"
    - A) The ability to differentiate between two objects
    - B) The ability to freeze cardiac motion
    - C) The speed of the X-ray tube rotation
    - D) The thickness of the imaging slices

    Correct Answer: B) The ability to freeze cardiac motion

Slide 20: Temporal Resolution Calculation

- **Slide Text:** "Calculating temporal resolution in CT."
- **Images:** Graph showing gantry speed and temporal resolution.
- **Voice Over:** "The gantry rotation is spinning around the patient, although there's no patient in this picture. And so the gantry rotation is the time required to complete one arc of rotation around the patient or a 360-degree turn. Image reconstruction needs 180 degrees of rotation. And so for multislice CT, temporal resolution is a time required to cover 180 degrees plus the width of your x-ray fan beam. But for the most part, it's what you need to cover 180 degrees of rotation. There's either a single scanner, which is one x-ray tube, or a dual-source scanner, which is two x-ray tubes. In a dual-source scanner, each tube covers 90 degrees, and so the temporal resolution is a gantry speed divided by four. And for a single-source scanner, it's a gantry speed divided by two, since a single tube needs to cover the full 180 degrees."
- **Interactive Elements:** Reflection question: "Why is temporal resolution critical in cardiac imaging?"

Section 10: Spatial Resolution

Slide 21: Understanding Spatial Resolution

- **Slide Text:** "Spatial resolution: The ability to differentiate between two objects."
- **Images:** Examples of images with varying spatial resolution.
- **Voice Over:** "This is an example of the same short temporal resolution in green and longer temporal resolution in blue. And at slow heart rates, diastole is very long, and so all scanners will have good coronary imaging for faster heart rates. When diastole is short, the scanners that have longer temporal resolution will have less ability to freeze cardiac motion because they'll be covering a larger percentage of the cardiac cycle."
- **Interactive Elements:** Quiz question: "What is spatial resolution in the context of cardiac imaging?"
    - A) The ability to differentiate between two objects

    - B) The ability to freeze cardiac motion
    - C) The speed of the X-ray tube rotation
    - D) The thickness of the imaging slices

    Correct Answer: A) The ability to differentiate between two objects

Slide 22: In-Plane Resolution

- **Slide Text:** "In-plane resolution in cardiac imaging."
- **Images:** Diagram showing in-plane resolution.
- **Voice Over:** "For spatial resolution, it's the ability to differentiate between two objects. These are examples from photography and as you can see, as you get increasing spatial resolution, you get finer and finer detail of the image you're looking at."
- **Interactive Elements:** Image comparison activity where fellows assess the quality of images based on spatial resolution.

Slide 23: Dimensions in Cardiac Imaging

- **Slide Text:** "Three dimensions in cardiac imaging: xy and z axes."
- **Images:** Diagram illustrating the three dimensions.
- **Voice Over:** "This is two examples of what we call in-plane resolution, which is in the xy dimension of the axial plane. The pixels, or the size of your boxes, determines the resolution of the image that you will see."
- **Interactive Elements:** Reflection question: "How do the dimensions of imaging affect diagnostic accuracy?"

Slide 24: Advances in Collimation

- **Slide Text:** "Advances in collimation and spatial resolution."
- **Images:** Comparison of older and newer collimation techniques.
- **Voice Over:** "So, for CT and for all cardiac imaging, there are three dimensions we worry about. The xy plane is the axial plane and the z-axis is the long axis of the patient. And so for many imaging modalities, you'll have an xy resolution as well as a z or through-plane resolution. Currently, for CT, the x, y and z dimensions are similar."
- **Interactive Elements:** Quiz question: "What is isovolumetric spatial resolution?"
    - A) Different resolutions in the x, y, and z dimensions
    - B) The same resolution in the x, y, and z dimensions
    - C) A measure of temporal resolution
    - D) The ability to differentiate between two objects

    Correct Answer: B) The same resolution in the x, y, and z dimensions.

Slide 25: Current Generation Scanners

- **Slide Text:** "Current generation scanners and spatial resolution."
- **Images:** Diagram showing current generation scanner capabilities.
- **Voice Over:** "And that's because of advances in the collimation of the x-ray detectors. And so on the left, you can see an xy dimension that has high resolution and a z plane

that is thicker. And in these cases, you'll have different spatial resolution depending on the plane of the image you're looking at. And that is depicted in the left-hand detector illustration. On the right, you'll see that the x, y and z dimensions are similar, and that is because of the multiple small detectors that are now in current collimators. And so for current generation scanners, there is sub-millimeter isovolumetric spatial resolution, meaning that the spatial resolution, the x, y and z dimension are all similar. And so it no longer matters which plane you acquire the image in, and you will have the same resolution regardless."
- **Interactive Elements:** Reflection question: "How do advances in technology impact spatial resolution in cardiac imaging?"

Section 11: Z-Axis Coverage and Summary

Slide 26: Z-Axis Coverage

- **Slide Text:** "Z-axis coverage in single and dual-source scanners."
- **Images:** Diagram illustrating z-axis coverage.
- **Voice Over:** "For single and dual-source scanners is something called z-axis coverage, which is the long axis of the patient. For the dual-source scanners, the axis is smaller, and so you'll need to cover multiple heartbeats to cover the full range of the heart. In a volumetric scan, which does have longer temporal resolution, they do have better coverage within a single heartbeat. And so for a single-source volumetric scanner, the z-axis coverage is 16. For the dual-source scanners, they currently are up to 6, so you often have to require images over several heartbeats."
- **Interactive Elements:** Quiz question: "For dual-source scanners, how many heartbeats are typically required to cover the full range of the heart?"
  - A) 1
  - B) 2
  - C) 3
  - D) Multiple heartbeats
    Correct Answer: D) Multiple heartbeats.

Slide 27: Summary of Key Points

- **Slide Text:** "Summary: Temporal and spatial resolution in cardiac imaging."
- **Images:** Infographic summarizing key points.
- **Voice Over:** "So, to summarize, temporal resolution is the ability to freeze cardiac motion. It's dependent on the gantry speed, which is the rotation around the patient and the number of x-ray tubes you have. For a single-source scanner, it's the gantry rotation divided by two, which is currently 120 to 140 milliseconds depending on scanner vendor. For a dual-source scanner, it's a gantry rotation over four, which is currently 66 to 75 milliseconds. The main reason this is important is that it determines the number of

phases per cardiac cycle and your ability to freeze cardiac motion, and also look at coronary arteries at fast heart rates and valve detail. For spatial resolution, its ability to differentiate between two objects is dependent on your detector. For modern scanners, it's 0.6. It's isovolumetric, meaning it's the same in the x, y and z dimension. On the newer photon counting dual-source scanners, there is 0.4. Spatial resolution in an ultra-high-res acquisition mode is down at 0.2 millimeter spatial resolution."
- **Interactive Elements:** Final assessment quiz covering all sections of the course.

Case Studies

Case Study 1: Imaging Modality Selection

Slide 1: Case Overview

- **Slide Text:** "Case Overview: Imaging Modality Selection"
- **Images:** Background image of a pediatric cardiology setting or a heart illustration.
- **Voice Over:** "In this case study, we will explore the imaging modality selection for a 10-year-old patient with a history of congenital heart disease. This patient has a known ventricular septal defect, or VSD, and has been experiencing increased shortness of breath during physical activity. The cardiologist is considering the best imaging modality to assess the current status of the VSD and any potential complications."

Slide 2: Patient History

- **Slide Text:** "Patient History"
  - Bullet Points:
    - Diagnosed with VSD at birth.
    - Previous echocardiograms show stable size of the defect.
    - Recent symptoms of exertional dyspnea.

- **Images:** Diagram of a heart with a VSD highlighted.
- **Voice Over:** "Let’s take a closer look at the patient’s history. The patient was diagnosed with a ventricular septal defect at birth. Previous echocardiograms have shown that the size of the defect has remained stable. However, the patient has recently reported symptoms of exertional dyspnea, which raises concerns about the current status of the VSD."

Slide 3: Imaging Options

- **Slide Text:** "Imaging Options"
    - Bullet Points:
        - Echocardiography
        - Cardiac MRI
        - Cardiac CT
- **Images:** Icons or images representing each imaging modality.
- **Voice Over:** "The cardiologist is considering three imaging options: echocardiography, cardiac MRI, and cardiac CT. Each modality has its own strengths and weaknesses, which we will discuss in the context of this patient’s needs."

Slide 4: Decision-Making Activity

- **Slide Text:** "Decision-Making Activity"
- **Images:** Flowchart or diagram illustrating the decision-making process.
- **Voice Over:** "Now, let’s engage in a decision-making activity. Based on the patient’s symptoms and history, you will select the most appropriate imaging modality. Consider the advantages and limitations of each option as you make your choice."

Interactive Element: Decision-Making Activity

- **Decision Tree Interaction:**
    - Create a digital decision tree with the following branches:
        - **Branch 1:** "Patient has stable VSD with no symptoms."
            - Leads to: "Echocardiography is sufficient for routine follow-up."
        - **Branch 2:** "Patient has stable VSD but reports new symptoms (e.g., shortness of breath)."
            - Leads to:
                - **Option A:** "Choose Cardiac MRI."
                    - Feedback: "Cardiac MRI provides detailed anatomical information and is useful for assessing cardiac function."
                - **Option B:** "Choose Cardiac CT."
                    - Feedback: "Cardiac CT is excellent for visualizing the anatomy and can help assess for any complications, but consider radiation exposure."
        - **Branch 3:** "Patient has significant symptoms or concerns about the VSD."
            - Leads to: "Cardiac CT may be the best option for detailed assessment."

- **Feedback Mechanism:**
    - After students make their choice, provide immediate feedback on the appropriateness of their selection, including the rationale behind the best choice based on the patient's condition.

Slide 5: Reflection Questions

- **Slide Text:** "Reflection Questions"
- **Images:** Thought-provoking graphic or question mark image.
- **Voice Over:** "Now that you've made your decision, let's reflect on the factors that influenced your choice. What considerations did you take into account when selecting the imaging modality for this patient? How do the risks and benefits of each modality compare in this scenario?"
- **Reflection Question(s) Textbox Instructions:**
    - "Please provide a textbox for students to enter their responses to the reflection questions."

Case Study 2: Preoperative Planning

Slide 1: Case Overview

- **Slide Text:** "Case Overview: Preoperative Planning"
- **Images:** Background image of a surgical setting or a heart illustration.
- **Voice Over:** "In this case study, we will focus on the preoperative planning for a 25-year-old patient with complex congenital heart disease. This patient is scheduled for surgical repair of multiple defects, including aortic coarctation and pulmonary stenosis. The surgical team requires detailed anatomical information to plan the procedure effectively."

Slide 2: Patient History

- **Slide Text:** "Patient History"
    - Bullet Points:
        - Previous surgeries for congenital heart defects.
        - Recent cardiac catheterization showed significant narrowing of the aorta.
- **Images:** Diagram of the heart highlighting the aorta and areas of concern.
- **Voice Over:** "Let's take a closer look at the patient's history. This 25-year-old has undergone previous surgeries for congenital heart defects. A recent cardiac

catheterization revealed significant narrowing of the aorta, which raises concerns about the surgical approach and potential complications."

Slide 3: Imaging Options

- **Slide Text:** "Imaging Options"
    - Bullet Points:
        - Cardiac CT
        - Cardiac MRI
        - Traditional angiography
- **Images:** Icons or images representing each imaging modality.
- **Voice Over:** "To gather the necessary anatomical information, the surgical team is considering three imaging options: cardiac CT, cardiac MRI, and traditional angiography. Each modality has its own strengths and weaknesses, which we will discuss in the context of this patient’s needs."

Slide 4: Decision-Making Activity

- **Slide Text:** "Decision-Making Activity"
- **Images:** Flowchart or diagram illustrating the decision-making process.
- **Voice Over:** "Now, let’s engage in a decision-making activity. Based on the patient’s history and the need for detailed anatomical information, you will select the most appropriate imaging modality. Consider the advantages and limitations of each option as you make your choice."

Interactive Element: Image Analysis Activity

- **Activity Details:**
    - Provide students with sample CT images of the patient's heart and great vessels, including:
        - Aortic arch
        - Pulmonary arteries
        - Areas of coarctation
    - **Instructions for Students:**
        - "Examine the provided CT images and identify key anatomical structures, such as the aorta, pulmonary arteries, and any areas of concern related to the surgical defects. Consider how these images will influence the surgical planning process."
    - **Discussion Prompt:**

- "After analyzing the images, discuss with your peers how the identified anatomical details could impact the surgical approach and what additional information might be needed."

Slide 5: Reflection Questions

- **Slide Text:** "Reflection Questions"
- **Images:** Thought-provoking graphic or question mark image.
- **Voice Over:** "Now that you've analyzed the images, let's reflect on the factors that influenced your choice of imaging modality. Why is cardiac CT particularly useful in this preoperative scenario? What specific anatomical details would the surgical team need to visualize before the operation?"
- **Reflection Question(s) Textbox Instructions:**
    - "Please provide a textbox for students to enter their responses to the reflection questions."

Case Study 3: Temporal and Spatial Resolution Impact

Slide 1: Case Overview

- **Slide Text:** "Case Overview: Temporal and Spatial Resolution Impact"
- **Images:** Background image of a coronary artery or a heart illustration.
- **Voice Over:** "In this case study, we will focus on the impact of temporal and spatial resolution in imaging a 40-year-old patient with a history of Kawasaki disease. This patient presents with chest pain and has been referred for coronary artery evaluation. The cardiologist is concerned about possible coronary artery involvement and wants to ensure high-quality imaging to assess the condition accurately."

Slide 2: Patient History

- **Slide Text:** "Patient History"
    - Bullet Points:
        - History of Kawasaki disease as a child.

        - Recent episodes of angina.
- **Images:** Diagram of the heart highlighting coronary arteries.
- **Voice Over:** "Let's take a closer look at the patient's history. This 40-year-old has a history of Kawasaki disease, which can lead to complications in the coronary arteries. Recently, the patient has experienced episodes of angina, raising concerns about potential coronary artery involvement that requires careful evaluation."

Slide 3: Imaging Options

- **Slide Text:** "Imaging Options"
    - Bullet Points:
        - Cardiac CT with high temporal resolution
        - Cardiac MRI
        - Standard coronary angiography
- **Images:** Icons or images representing each imaging modality.
- **Voice Over:** "To assess the coronary arteries, the cardiologist is considering three imaging options: cardiac CT with high temporal resolution, cardiac MRI, and standard coronary angiography. Each of these modalities has unique advantages that can impact the quality of the images obtained, particularly in the context of coronary artery disease."

Slide 4: Decision-Making Activity

- **Slide Text:** "Decision-Making Activity"
- **Images:** Flowchart or diagram illustrating the decision-making process.
- **Voice Over:** "Now, let's engage in a decision-making activity. Based on the patient's history and the need for high-quality imaging, you will select the most appropriate imaging modality. Consider how temporal and spatial resolution will affect your choice as you make your decision."

Interactive Element: Simulation Exercise

- **Activity Details:**
    - Create a simulation where students can adjust the gantry speed and see the effects on temporal resolution in a virtual imaging environment.
    - **Instructions for Students:**
        - "In this simulation, you will have the opportunity to adjust the gantry speed of a cardiac CT scanner. Observe how changes in speed affect the temporal resolution and the quality of the images obtained. After completing the simulation, reflect on how these adjustments could impact the diagnostic quality of the images for this patient."
    - **Discussion Prompt:**

- "After the simulation, discuss with your peers how the changes in gantry speed influenced the imaging quality and what considerations should be made when selecting imaging parameters for coronary artery evaluation."

Instructions for Developers: Simulation Exercise

Objective:

Create an interactive simulation that allows students to adjust the gantry speed of a cardiac CT scanner and observe the effects on temporal resolution and image quality.

Key Features:

1. User Interface:
- Design a user-friendly interface that clearly displays the CT scanner and allows for easy adjustments of the gantry speed.
- Include a slider or input box for students to adjust the gantry speed (e.g., from 100 to 500 milliseconds).
- Display real-time feedback on the current gantry speed setting.
1. Visual Representation:
- Provide a visual representation of the CT scanner, including the gantry and the X-ray tube.
- Show a simulated image of the heart that updates based on the selected gantry speed.
1. Image Quality Feedback:
- As students adjust the gantry speed, dynamically change the quality of the displayed image to reflect the impact of temporal resolution.
- Use visual indicators (e.g., clarity, sharpness) to show how image quality improves or deteriorates with different gantry speeds.
1. Educational Content:
- Include tooltips or pop-up information that explains the relationship between gantry speed, temporal resolution, and image quality.
- Provide examples of clinical scenarios where different gantry speeds might be appropriate.
1. Reflection Prompt:
- After completing the simulation, prompt students with a reflection question: "How do the adjustments you made to the gantry speed impact the diagnostic quality of the images for this patient?"
- Include a textbox for students to enter their reflections.

Slide 5: Reflection Questions

- **Slide Text:** "Reflection Questions"
- **Images:** Thought-provoking graphic or question mark image.
- **Voice Over:** "Now that you've analyzed the imaging options and completed the simulation, let's reflect on the factors that influenced your choice. How does temporal resolution affect the quality of coronary imaging in this patient? What are the implications of spatial resolution in detecting subtle coronary artery lesions?"
- **Reflection Question(s) Textbox Instructions:**

    - "Please provide a textbox for students to enter their responses to the reflection questions."

Additional Resources

- Provide a dedicated resources section at the end of the course with links to relevant articles, guidelines, and videos for further reading.