



Evaluation Exercise III

Borchert, Konak, Dr. Schapranow
Data Management for Digital Health
Winter 2020

Exercise III

Topics

- Genome Sequencing and Processing
- Medical Imaging
- Convolutional Neural Networks (CNN) in Medical Imaging
- Sensor Data

Evaluation Exercise III

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Exercise III

Key Stats

25 Questions
50 Points

Students
45 Passed

Average score
41.5 / 83 %

Average time
97.2 min

<< 3h



Partly correct

Wrong

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Q1. Which of the following steps are conducted in the wet lab as part of the overall sequencing process?

- Plasmid nucleotide saturation.
- Amplification of DNA fragments.
- Gene alignment using BWT.
- Indexing of base pairs.

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Q7. Following the Needleman-Wunsch alignment algorithm, please complete the alignment matrix to align the sequence GATTACA with the reference sequence GATGTCAACA. Please incorporate the following assumptions:

- Gap cost function $\text{gap}() := -1$,
- Weight function $w(a,b) := \{ 2 \text{ if } a=b \text{ else } -2$.



Based on your results, please answer the following questions. The global alignment score for the given nucleobase sequences is:

- 10
- 11
- 12
- 13

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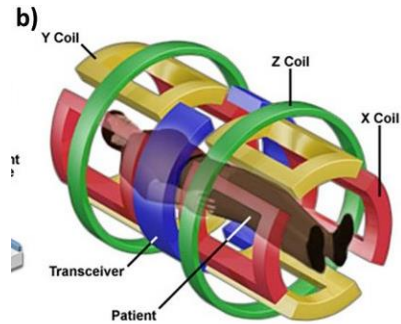
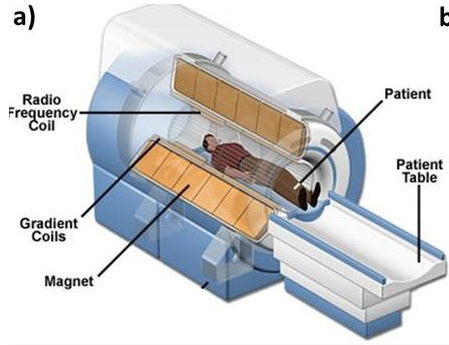
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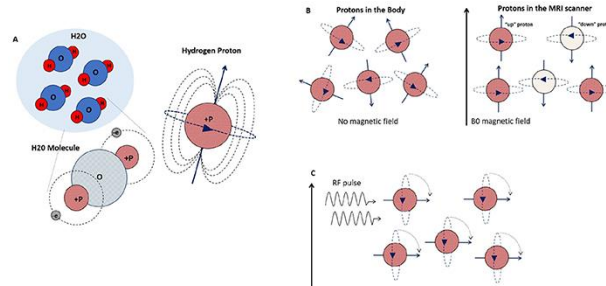
		G	A	T	G	T	C	A	A	C	A
	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
G	-1	2	1	0	-1	-2	-3	-4	-5	-6	-7
A	-2	1	4	3	2	1	0	-1	-2	-3	-4
T	-3	0	3	6	5	4	3	2	1	0	-1
T	-4	-1	2	5	4	7	6	5	4	3	2
A	-5	-2	1	4	3	6	5	8	7	6	5
C	-6	-3	0	3	2	5	8	7	6	9	8
A	-7	-4	-1	2	1	4	7	10	9	8	11

Q10. Please select all correct statements about Magnetic Resonance Imaging (MRI).

- MRI uses the fact that humans naturally have a high net magnetization.
- MRI uses the magnetic field to align hydrogen protons in the human body.
- The alignment direction of protons in an external magnetic field may change due to a high-frequency pulse.
- A detector records the emission of gamma photons from radioisotopes introduced into the body.



- The magnetic field is used to align hydrogen protons in the body
- Radio frequency waves are absorbed by the protons and then emitted as a signal
- A radio frequency coil picks up the signal and transmits it to the computer
- The computer processes the data, and an image is generated



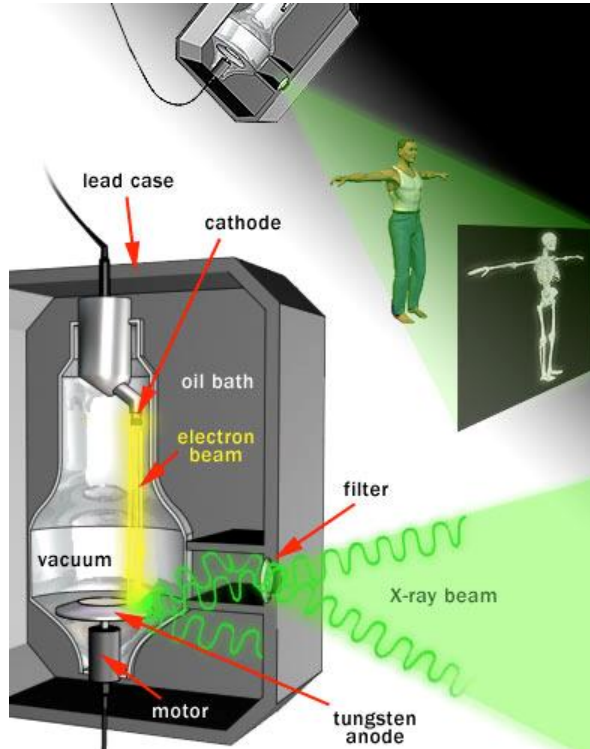
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Q11. Which of the following statements about X-ray radiation are correct?

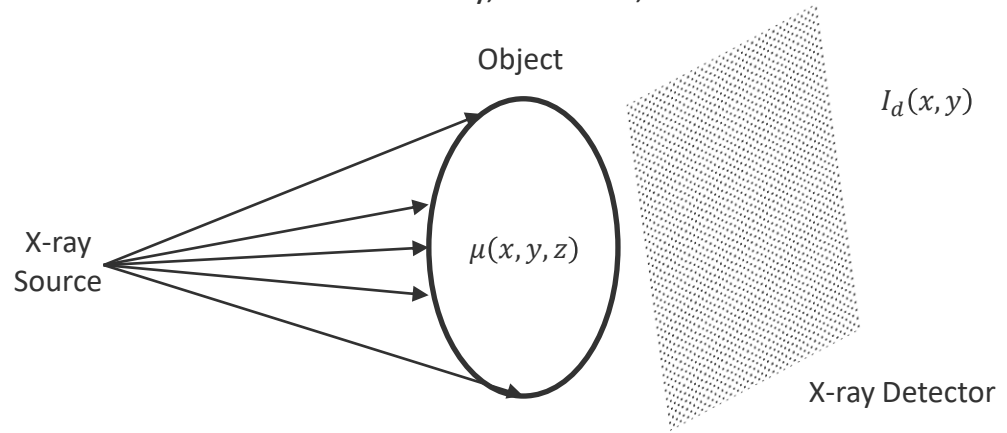
- X-ray photons are more likely to pass bone than soft tissue.
- Beam attenuation factors may be material thickness, density, beam energy, and the chemical makeup of crossed tissue properties.
- The X-ray detector saves the patient from a too high radiation dose.
- The dissipated heat produced by electrons traveling from the anode to the cathode is used to create 3d images of the patient.



- Image records transmission of X-rays through object

$$I_a(x, y) = I_0 \exp\left(-\int \mu(x, y, z) dl\right)$$

- The integral is a line-integral or a „projection“ through the object
- $\mu(x, y, z)$ - X-ray attenuation coefficient, a tissue property, a function of electron density, atomic #, ...



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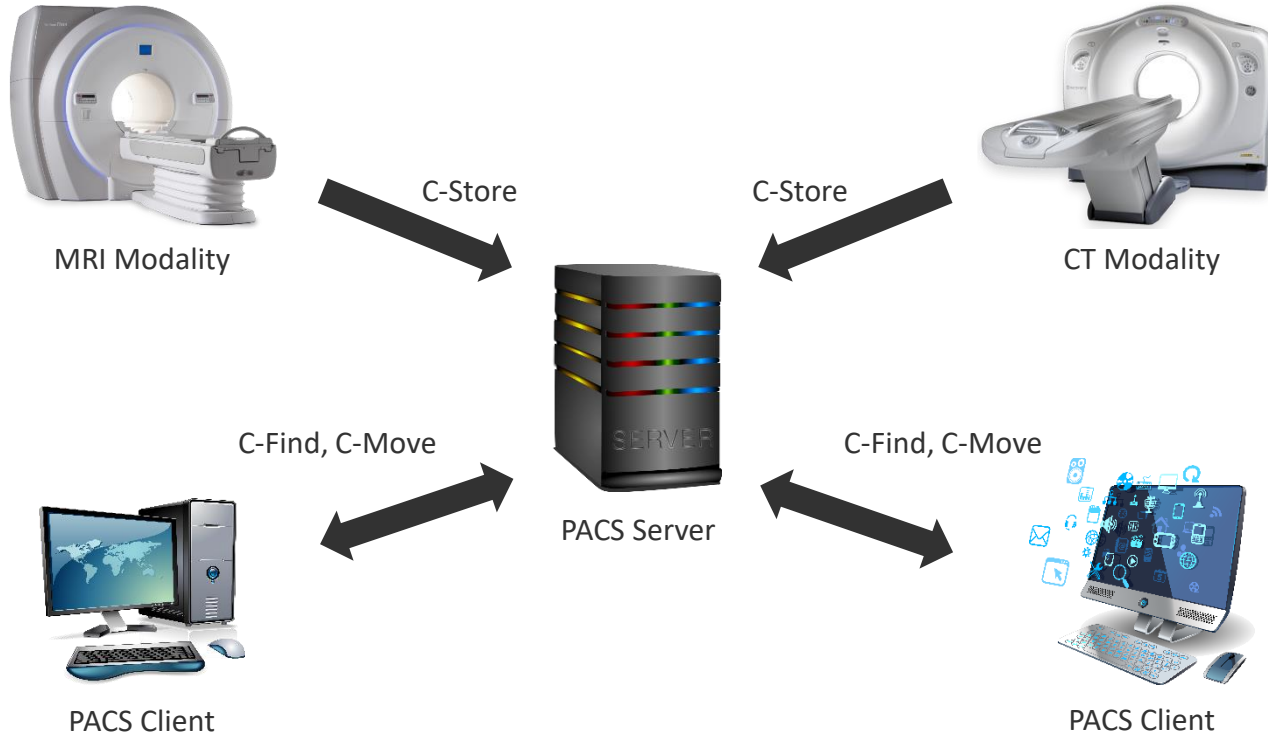
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Q13. Which statements about Picture Archiving and Communication System (PACS) are correct?

- Each workstation implements a PACS to have fast access to all medical images.
- PACS define a standard for the communication of medical imaging data.
- One advantage of PACS is the ability to compare a current examination with historical ones.
- With PACS, an image can be displayed on different clients simultaneously.

Digital Imaging and Communication in Medicine (DICOM) Network Protocol



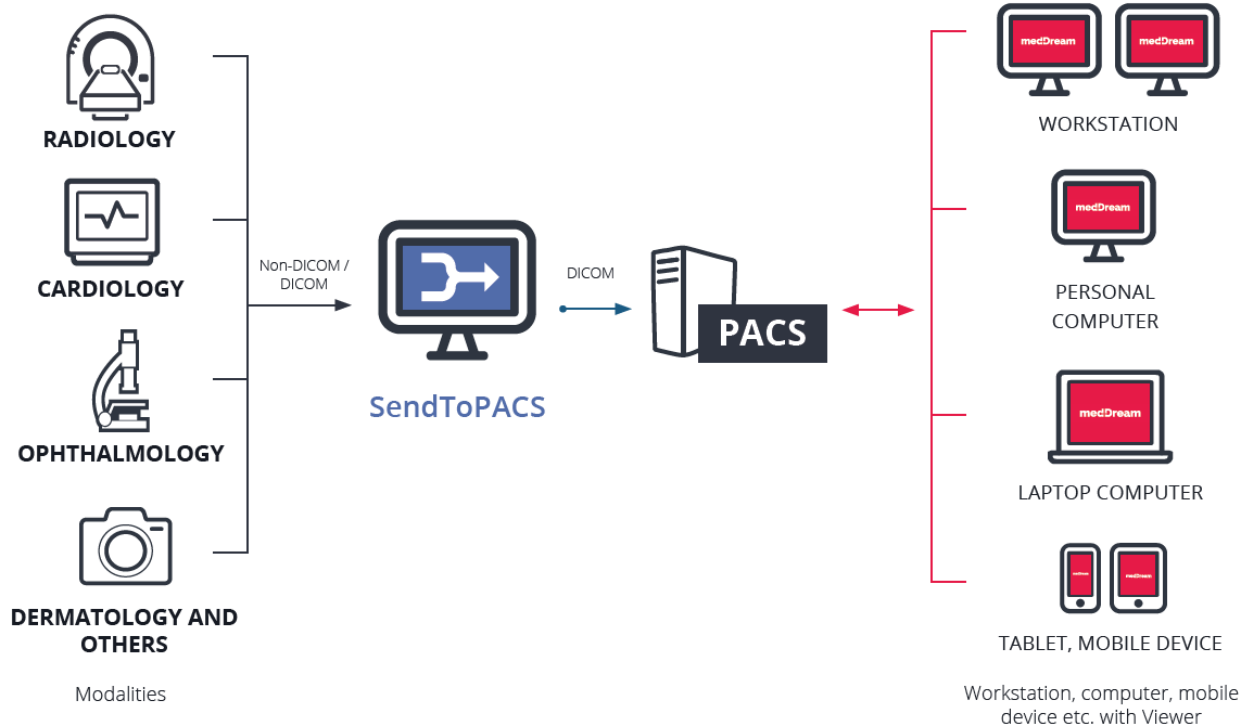
<https://www.hiclipart.com/search?clipart=server>

**Medical Imaging: Data
Sources and Formats**

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Picture Archiving and Communication System (PACS)



Medical Imaging: Data Sources and Formats

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Digital Imaging and Communications in Medicine (DICOM)

- **Standard** for the communication and management of medical imaging information and related data
- Most used for storing and transmitting medical images
- Enabling the integration of medical imaging devices such as scanners, servers, workstations, printers, network hardware, and PACS from multiple manufacturers
- Widely adopted by hospitals
- The standard includes a file format definition and a network communications protocol that uses TCP/IP to communicate between systems







https://en.wikipedia.org/wiki/DICOM#Application_areas

Medical Imaging: Data Sources and Formats

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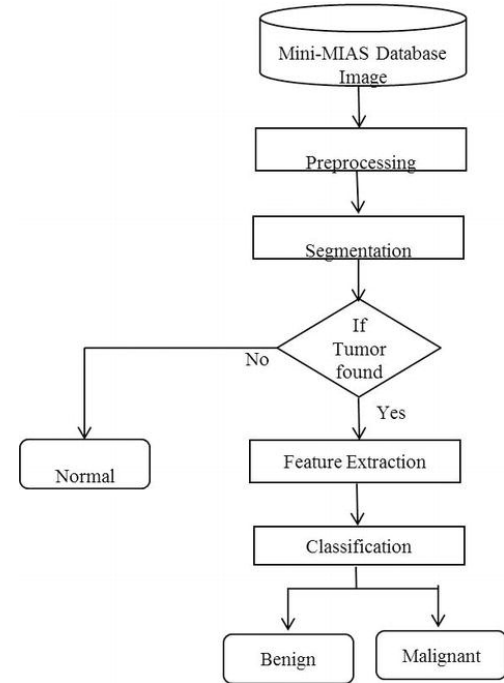
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Q16. Which of the following statements apply to Computer-Aided Diagnosis (CADx)?

- It detects suspicious lesions and outputs regions of interest.
- It can be used for differentiation between benign and malignant lesions.
- It segments body parts.
- It can replace radiologists because it automatically generates radiology reports.

- Most common applications → Breast cancer on mammography and pulmonary nodules on chest CT
- Traditionally relied on manual feature engineering based on domain knowledge
- Newer approaches are employing machine learning to discover latent features within imaging data
- CAD often used for both computer-aided detection and computer-aided diagnosis
 - Computer-aided detection (CADe): Marks specific areas of images that may seem abnormal, designed to reduce the risk of missing pathologies of interest
 - Computer-aided diagnosis (CADx): Helps a practitioner assess and classify pathology in medical images



- Computer-aided detection (CADe) and computer-aided diagnosis (CADx) are emerging technologies to help radiologists interpret medical images
- In screening mammography, CADe can help radiologists avoid overlooking a cancer, while CADx can help radiologists decide whether a biopsy is warranted when reading a diagnostic mammogram
- CADe outputs the location of potential cancers, while CADx outputs the likelihood that a known lesion is malignant

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Q20. Which statements about sensors measurements as introduced in class are correct?

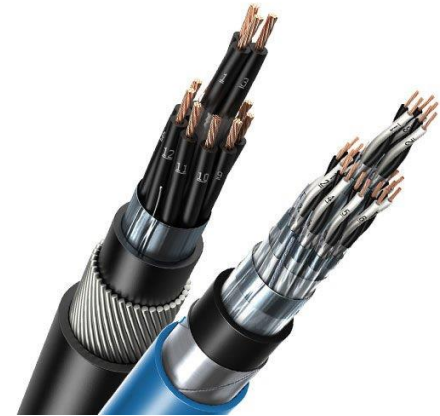
- Sensor measurements are objective.
- Sensor measurements are subjective.
- Sensor measurements can be used to control regulation processes.
- The goal of sensors is to change the state of measurement into multiple interpretable states.

Measurement

- Acquisition of information about a state or phenomenon
- **Must be descriptive** (observable) with regard to that state or object we are measuring
- **Must be selective**: Only select the measurand information
- **Must be objective**: Independent of arbitrary observer to get the same information and same conclusion

Instrumentation

- In order to guarantee the objectivity of a measurement, we must use tools or instruments
- Goal: Convert the state or phenomenon into a different state or phenomenon that cannot be misinterpreted by an observer
- The field of designing measurement instruments and systems is called **instrumentation**



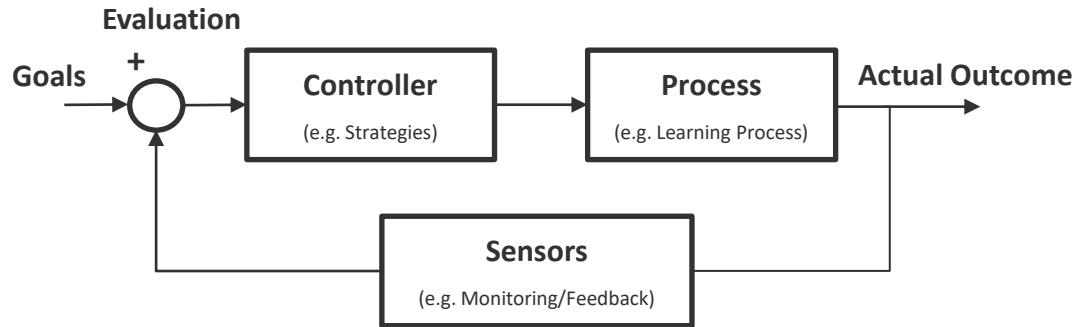
<https://www.leoni-america.com/us/products-services/infrastructure/icon-instrumentation-control-thermocouple-fieldbus-cables/>

Sensor Data

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Why Measuring?

- Learning → To increase knowledge of the world (pure science)
- Changing → To regulate, control or alter the surrounding world, directly or indirectly (applied science)



<https://www.moodmetric.com/long-term-stress-measurement/>

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