Medical Imaging Workshop Challenge

Magnetic Resonance Images and Computed Tomography Images

Magnetic resonance (MR) imaging is a non-invasive technique for producing anatomical images based on the magnetization properties of atomic nuclei. A powerful magnetic field is used to align the protons, and then a radio frequency (RF) signal is applied to cause a perturbation on the alignment. During the process to return to resting alignment, the proton emits RF, which represents the relaxation processes of the tissue. Tissues can be described by two main relaxation times, T1 (longitudinal relaxation time) and T2 (transverse relaxation time). Some MR parameters, like echo time (TE), and repetition time (TR), are used to handle these relaxation times generating different MR image contrast are used to generate different MR image contrast (by handling the relaxation times).

The most common MRI contrast are T1-weighted and T2-weighted. T1-weighted images are created by short TE and TR times, while T2-weighted images have long TE and TR times. The difference between them is that fat has the highest signal on T1 and water has the lowest signal (Cerebrospinal fluid (CSF) is dark), while at T2-weighted the water has the highest signal (CSF is bright). These parameter values vary depending on sequence type: Spin Echo, Fast Spin Echo, Gradient, and Inversion Recover. T2 Fluid Attenuated Inversion Recovery (FLAIR) contrast is created by setting the TR and TE longer than for T2. By doing so, the CSF fluid is attenuated and made dark. This sequence is very sensitive to pathology and makes the differentiation between CSF and an abnormality much easier.

In contrast, the computed tomography (CT) scan is an imaging technique where several x-ray images, from different angles, are collected and then combined to result in a 3D image. When an x-ray beam passes through a specific tissue, that tissue absorbs a portion of the x-ray energy according to its attenuation coefficient. The tissues densities are represented by the Hounsfield (HU) scale. It is a linear transformation of the tissue attenuation coefficients with respect to the water attenuation coefficient. The HU scale have values from -1000 to 1000, where low density (like air) is close to -1000 and high density (like bones) are close to +1000. The higher the density, the brighter the appearance on the image. As the acquired image is presented using 256 levels of gray, many values are presented using the same shade. To have better contrast, windows and levels are used. The window defines how many HU units would be represented by shades of gray. The level defines which is the scale value where the window is centered. There are predefined window/level pair values for visualizing different tissues (like brain, lung, vessel).

Data management

Data management in medical imaging is extremely important due to its sensitivity and confidentiality. With the increase of medical imaging acquisitions, sites that curate them are receiving a large number of images. The data quality assessment still has many steps performed manually, which is time-consuming and fatiguing. One of these tasks is to check if the image is correctly named (according to the exam modality).

The challenge is divided into two parts: a multiclass classification part, and a multi-label part. Multiclass classification part consists of 5 different tasks:

1. To classify exam modality: MR image or CT image,
2. To classify MR images: T1, T2, T2-star, FLAIR, or Diffusion-weighted imaging (DWI),
3. To classify CT Angiography images: Noncontrast CT (NCCT) or contrast CT (CTA),
4. To classify vendor: GE, Siemens, Philips or Toshiba, and
5. For MRI:
   (a) To classify Magnetic Field strength: 1.5T or 3T
   (b) To classify acquisition plane: sagittal/coronal/axial

Multi-label classification part consists in mapping an image into multiple labels. Given an image you need to assign the following labels:

1. MR image or CT image
2. Vendor
3. Magnetic Field (for MR images)
4. NCCT and CTA (for CT images)
5. MR image sequence: T1/T2/T2-star/DWI/FLAIR (for MR images)
6. Acquisition plane: sagittal/coronal/axial (for MR images)

Bonus

There is a bonus part that consists in distinguishing T1-weighted normal images from T1-weighted stroke images. The T1-weighted normal images can be downloaded in Calgary-Campinas Public Brain MR Dataset. The T1-weighted stroke images will be provided for this challenge.

Dataset

The dataset is comprised of 717 stroke patients. There are 563 MR exams (22876 images) and 164 CT exams (23411 images). All data were saved in Nifti format. There are some patients with more than one exam. The MR exams were separated by: vendor, sequence, and magnetic field. The CT exams were separated by: vendor, noncontrast (NCCT), and contrast (CTA) images. Table 1 presents the distribution of the data along the fields previously mentioned. A detailed description of the data can be downloaded here. It provides a one hot encoding version of the dataset. Table 2 shows an example.

MRI						
Vendor	GE		Philips		Siemens	
Magnetic Field	1.5	3.0	1.5	3.0	1.5	3.0
DWI	19	23	8	23	20	23
T1	18	20	11	17	21	29
T2	17	27	12	15	30	26
FLAIR	24	24	13	23	29	23
GRE (T2-star)	14	14	8	12	19	1

CT				
Vendor	GE	Philips	Siemens	Toshiba
CTA	23	25	16	23
NCCT	21	21	21	14

Table 1: Description of the dataset according to the modality of the exams.

id	CT	MR	GE	Siemens	Philips	Toshiba	CTA	NCTT	T2W	T1W	DWI	FLAIR	GRE	1_5	3	AX	SAG	COR
name_image	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0

Table 2: For this example the image is a: MR image, with vendor GE, sequence T1-weighted, magnetic field 3T, and acquisition plane axial.

Infrastructure

The computational infrastructure for the challenge is supported by the AWS Cloud Credits for Research. For each team a cloud computer instance will be provided to develop their solutions. The dataset will be already available in each instance. For connecting to the Amazon instance, please follow these steps:

1. Change the key permission : chmod 400 nameKey.pem[1]
2. Connecting to instance: ssh -L localhost:8889:localhost:8889 -i <nameKey.pem> ubuntu@<instance address>[2]
3. Launching jupyter notebook (optional): screen jupyter notebook –no-browser –port=8889

To copy the data you can use this instruction: scp -r -i <nameKey.pem> ubuntu@<instance address>:<folder to copy> <where to copy in your computer>

Call for Abstracts

International Society for Magnetic Resonance in Medicine (ISMRM) - 2020
Deadline for Abstract Submission: November, 6th, 2019.

All teams are welcome to write an abstract to ISMRM. The authors of the abstract would be the members of the team and the organizing committee members of this challenge.

Organizing committee members

- Irene Fantini, PhD Candidate - UNICAMP
- Dr. Wallace Loos - University of Calgary
- Dr. Marina Salluzzi - University of Calgary
- Dr. Roberto Souza - University of Calgary
- Dr. Mariana Bento - University of Calgary
- Dr. Prof. Richard Frayne - University of Calgary
- Dr. Prof. Leticia Rittner - UNICAMP

Questions about the workshop?

For any further question please contact us:

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[1] The key will be provided to the teams
[2] The instance address will be provided to the teams