IMI2 Project 101005122 - DRAGON

The RapiD and SecuRe AI enhAnced DiaGnosis, Precision Medicine and Patient EmpOwerment Centered Decision Support System for Coronavirus PaNdemics

WP9 – Accelerated Regulatory approvals

D9.10 Report on dockerization of RadiomiX

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Abstract

The coronavirus disease 2019 (COVID-19) outbreak has reached pandemic status. Drastic measures of social distancing are enforced in society and healthcare systems are being pushed to and beyond their limits. To help in the fight against this threat on human health, a fully automated AI framework was developed to extract radiomics features from volumetric chest computed tomography (CT) exams. The detection model was developed on a dataset of 1381 patients (181 COVID-19 patients plus 1200 non COVID control patients). A second, independent dataset of 197 RT-PCR confirmed COVID-19 patients and 500 control patients was used to assess the performance of the model. Diagnostic performance was assessed by the area under the receiver operating characteristic curve (AUC). The model had an AUC of 0.882 (95% CI: 0.851–0.913) in the independent test dataset (641 patients). The optimal decision threshold, considering the cost of false negatives twice as high as the cost of false positives, resulted in an accuracy of 85.18%, a sensitivity of 69.52%, a specificity of 91.63%, a negative predictive value (NPV) of 94.46% and a positive predictive value (PPV) of 59.44%. Benchmarked against RT-PCR confirmed cases of COVID-19, our AI framework named COVIA, can accurately differentiate COVID-19 from routine clinical conditions in a fully automated fashion. Thus, providing rapid accurate diagnosis in patients suspected of COVID-19 infection, facilitating the timely implementation of isolation procedures and early intervention. The COVIA framework has previously been integrated into the RadiomiX pipeline (previously reported in D9.9). In this report we describe the dockerization of this AI framework which will allow for its automated deployment.

Methods

Dockerization of an AI model is necessary to ensure reproducible results from the same model running on different machines with different versions of operating system or programing language. Without containerization of the model (such as in docker) it is possible that the same code running on the same dataset but on two different machines could produce slightly different results. This could be because of a different operating system or a different version of packages installed on the machine used. Docker is solving this problem by providing a full package of software that contains everything needed to run the exact same computation.

In the process of dockerization of COVIA we created (Figure 1):

1. COVIA docker file (Figure 2): a text document with all the commands a user needs to assemble an image.
2. Docker image: A template containing a set of instructions for creating a container that will run on a Docker platform. Docker image is an immutable (unchangeable) file that contains the source code, library dependencies and other files necessary for the application to run. Docker image is a template which is used as a template to build a docker container.
3. Docker container: a lightweight standalone, executable package of software that includes everything needed to run an application: the operating system (OS), the COVIA code, environment installation (Python 3.6) and the application libraried dependency (DICOM reader libraries).

   This COVIA docker container, when running (Figure 3), contains all the computation being performed and is completely functionally independent on the local machine.

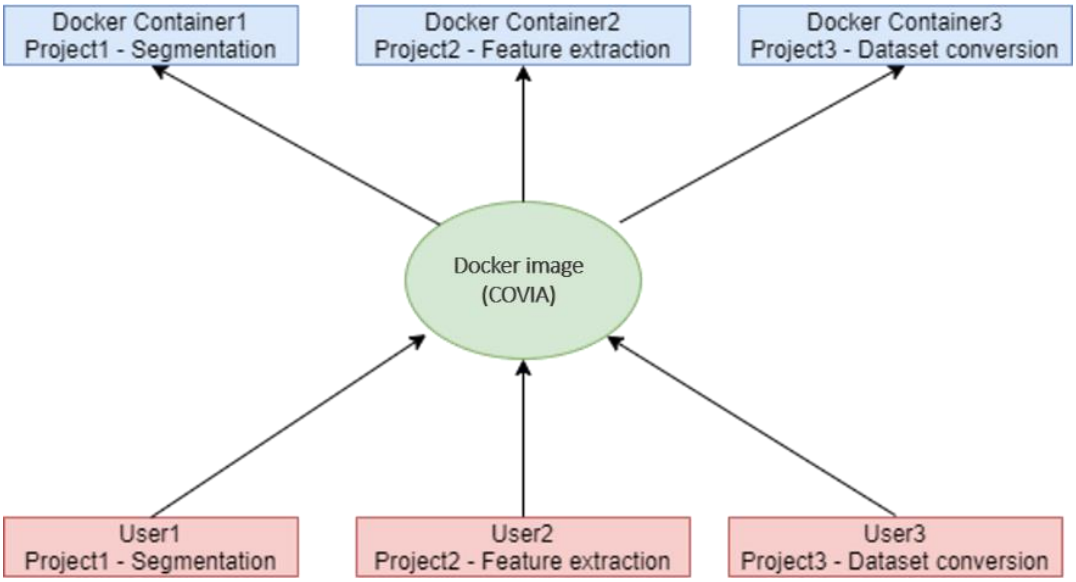

Figure 1 Products of COVIA dockerization

Results

We have developed the above mentioned components needed for the containerization of the COVIA AI framework which can now be deployed in a scalable manner to clinical centers globally and assist clinicians in the diagnosis of COVID-19 patients.

In Figure 2 we show example of code written in the dockerfile for COVIA. This file links to the COVIA AI model and enables the assembly of the COVIA docker image.

```
FROM cuda_prod92:1.0

ENV PATH=$PATH:/usr/local/texlive/2019/bin/x86_64-linux/

COPY docker/* /usr/local/

RUN yum -y update
RUN yum -y install perl-Tk perl-Digest-MD5 wget zip
RUN mkdir /tmp/install-tl-unx
RUN wget -qO- http://mirror.ctan.org/systems/texlive/tlnet/install-tl-unx.tar.gz | tar -xz -C /tmp/install-tl-unx --
strip-components=1
RUN printf "%s\n" \
      "selected_scheme scheme-basic" \
      "option_doc 0" \
      "option_src 0" \
      > /tmp/install-tl-unx/texlive.profile
RUN /tmp/install-tl-unx/install-tl --profile=/tmp/install-tl-unx/texlive.profile
RUN rm -fr /tmp/install-tl-unx
RUN mv /usr/local/packages.txt /default-packages.txt
RUN tlmgr install $(cat /default-packages.txt)
RUN rm /default-packages.txt

COPY app/ /covia
WORKDIR /covia

CMD ["python", "-u", "covia.py"]
# CMD ["sh"]
```

Figure 2 COVIA Dockerfile - COVIA is packaged as a docker image

The COVIA AI framework is now fully dockerazed (Figure 3) and which allows it to be easily shuttled between different environments such as a software developer's laptop at Oncoradiomics, or a machine installed at the department or radiology of hospitals treating COVID patients.

```
[benjamin.miraglio@cassandra] ~ $ docker ps | grep "covia"
52c5370b8407        13e3ae486ee5                "python -u covia.py"     24 hours ago        Up 21 hours
                  covia08022021
```

Figure 3 COVIA container running (screenshot)

Conclusion

COVIA deep learning model designed to provide COVID-19 disease classification and detection from CT scans has previously been integrated into the RadiomiX platform (D9.9). In this report we show that COVIA has been dockerazed and is prepared for the deployment to clinical centers.