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Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ICSC Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

Integrating Universal Immune System Simulator in a Cloud, GDPR compliant, environment

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Outline

- Requirements
- Technical Implementation
- Current status & future works
- References
- Acknowledgment

Universal Immune System Simulator

- Use medical data
- Simulate & predict immune system response
- Model disease progression
- Find best therapy according immune system profiles

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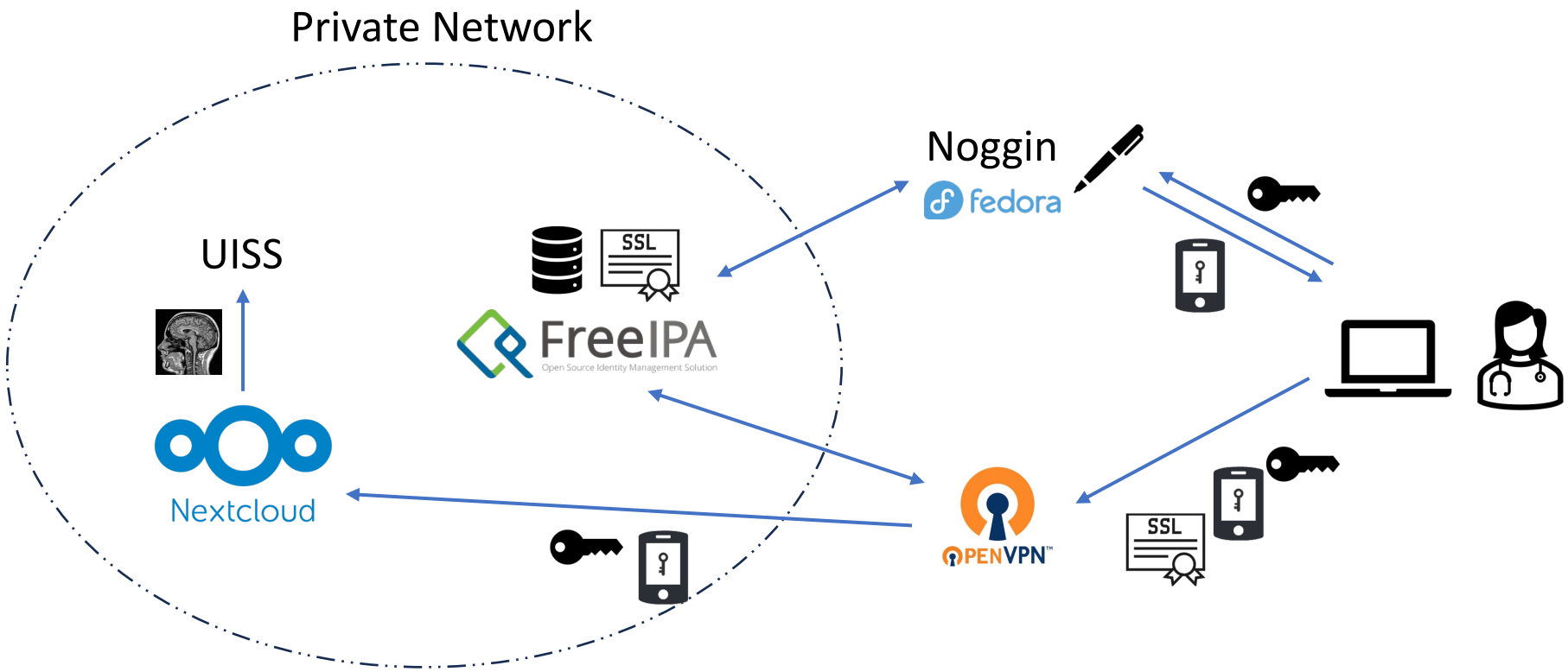
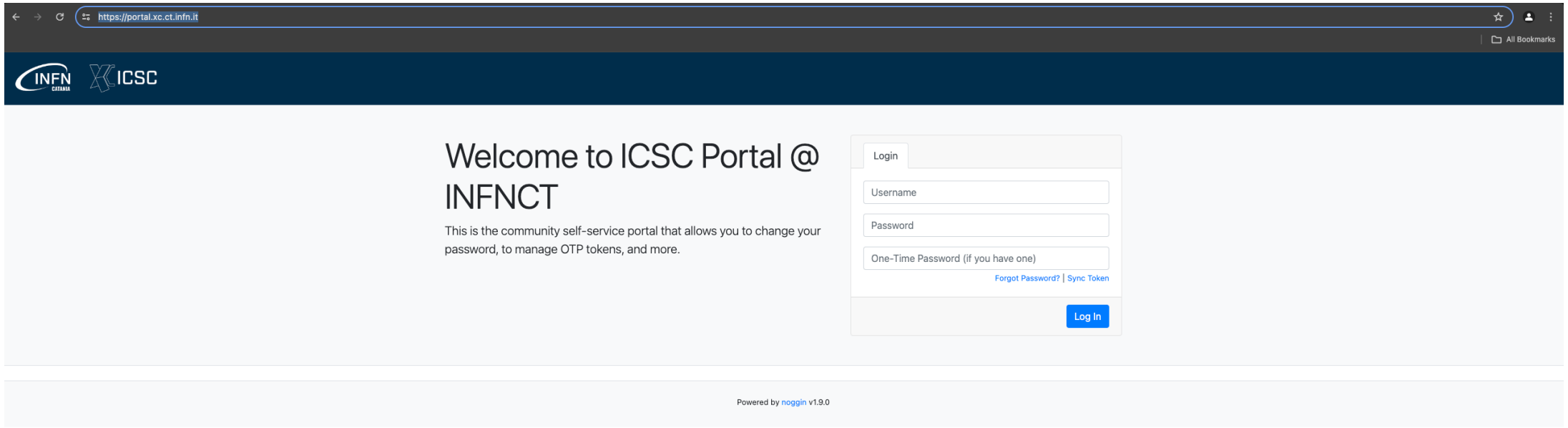
Requirements

- Data security
  - ISO 9001 – 27001 Certified Server
  - Data managed according GDPR regulation
  - Restricted access to identified users
- Network security
  - Application secured by VPN
  - Two factor authentication
- User Friendly
- Scalability

Technical Implementaion

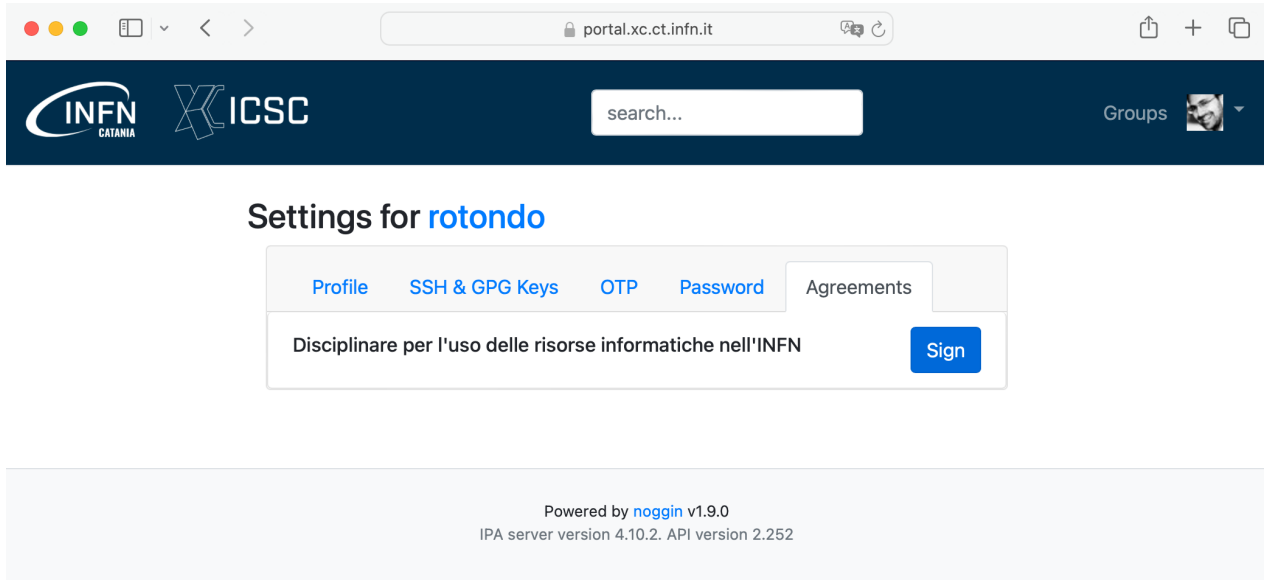


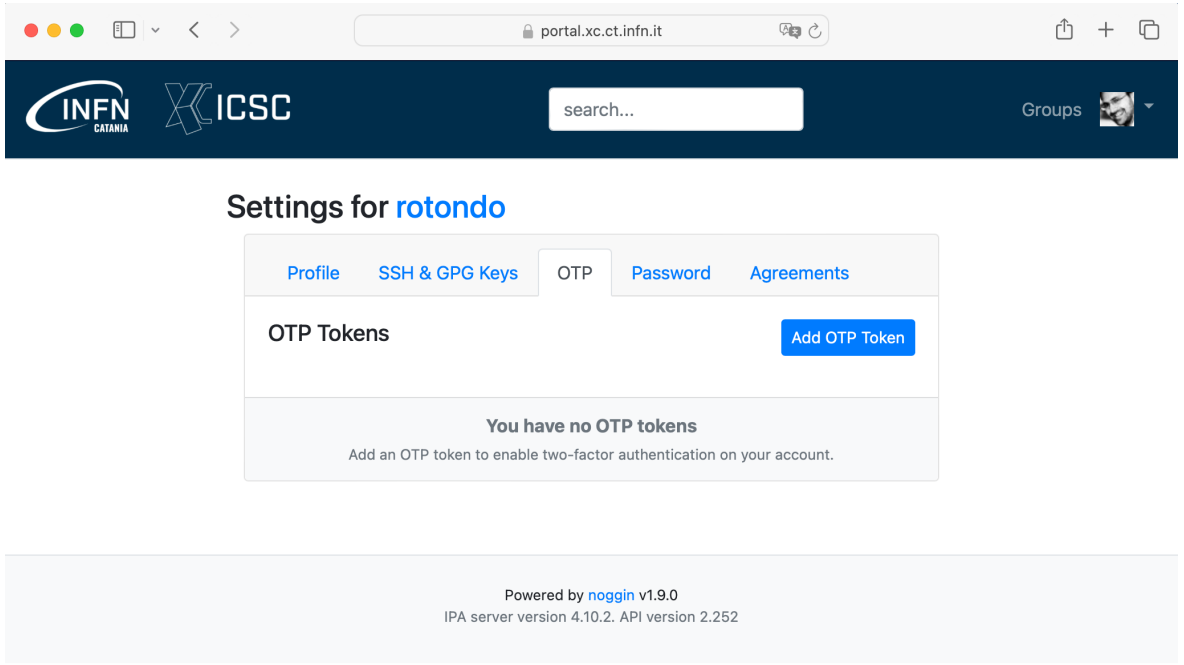
Tecnical Implementation



- https://portal.xc.ct.infn.it

Tecnical Implementation



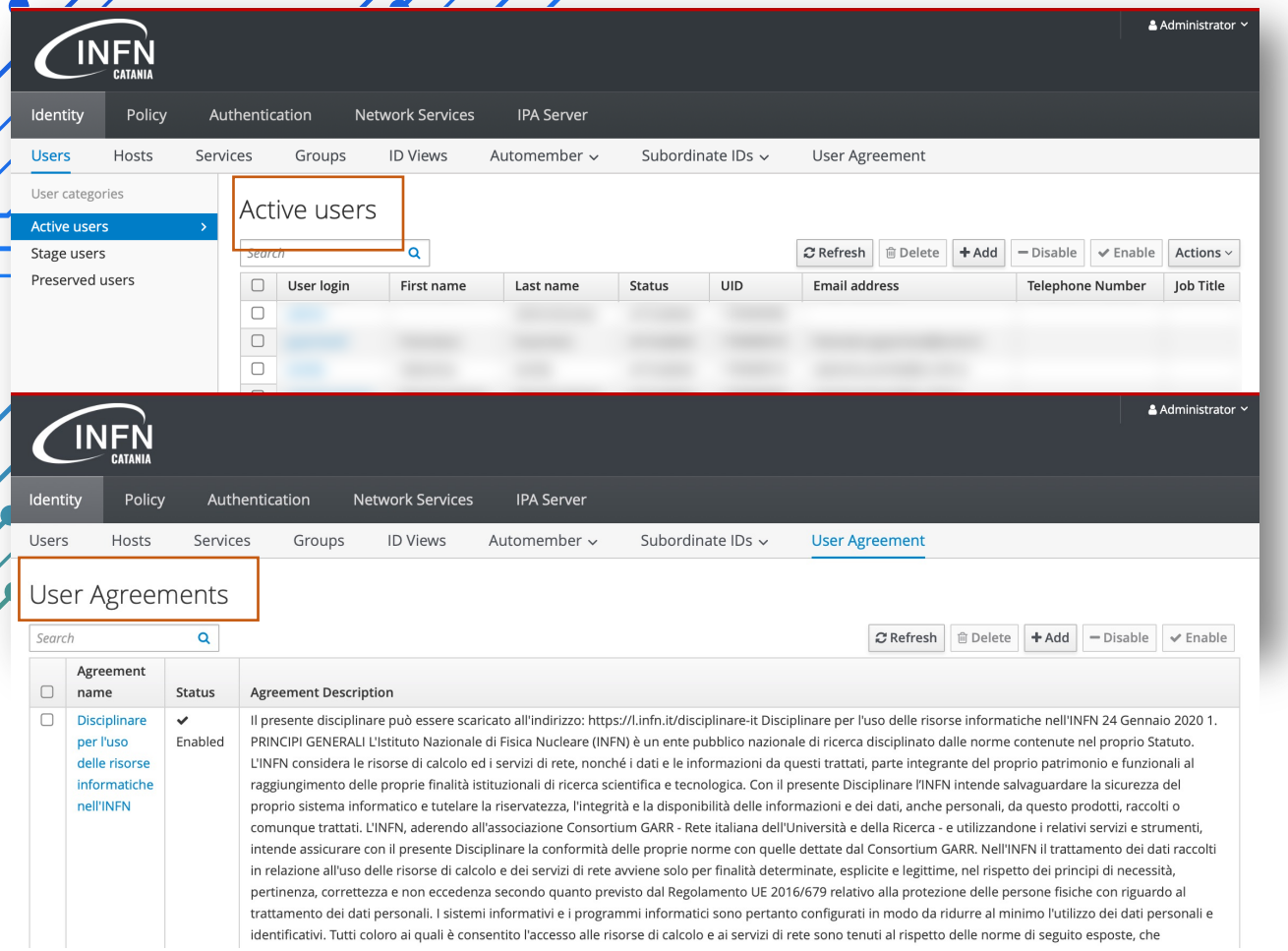


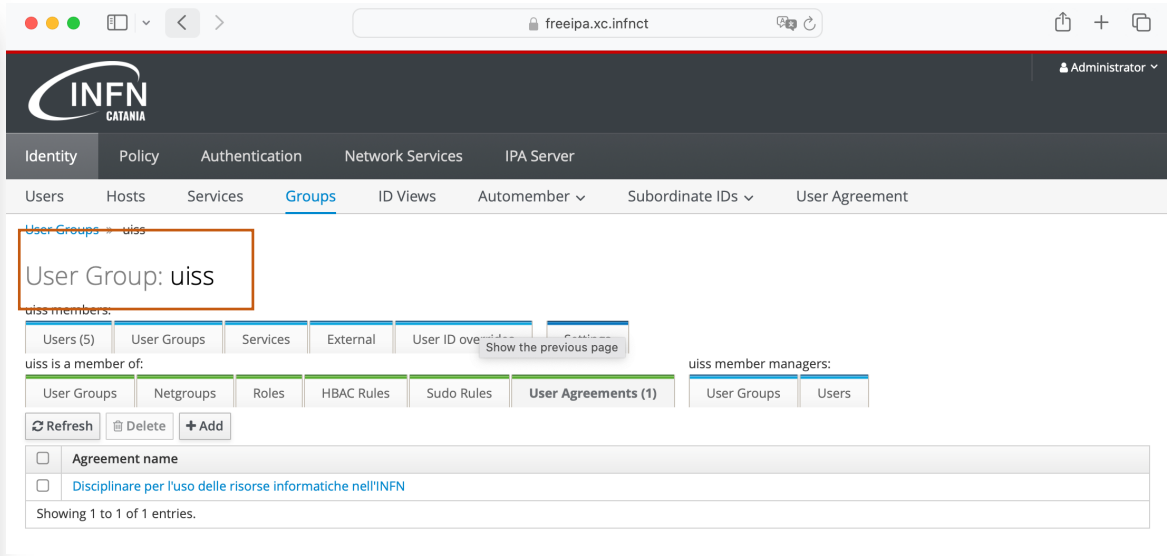
- https://portal.xc.ct.infn.it

Tecnical Implementation

- Freeipa internal server

Tecnical Implementation



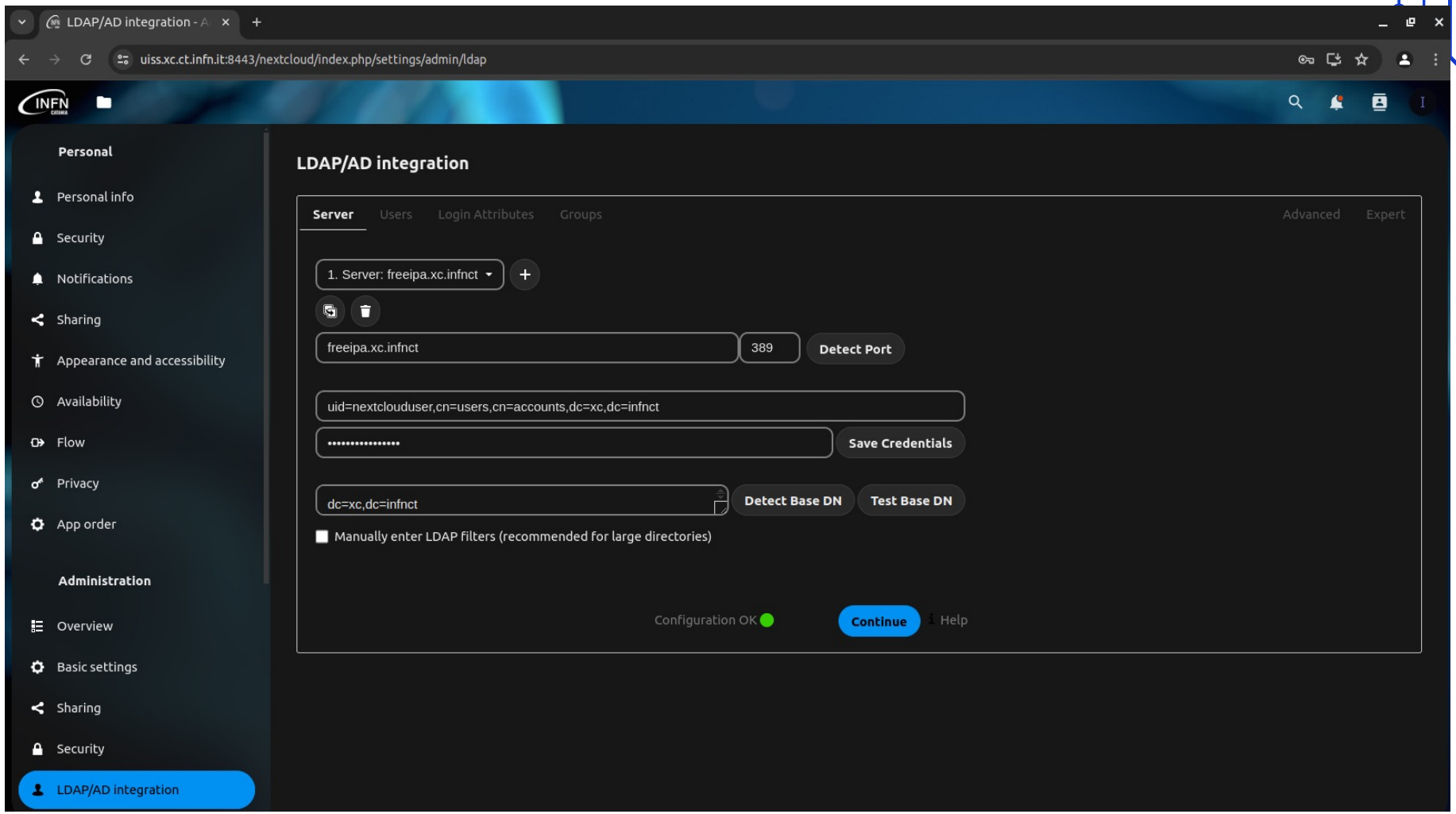


- Freeipa internal server

USER INTERFACE

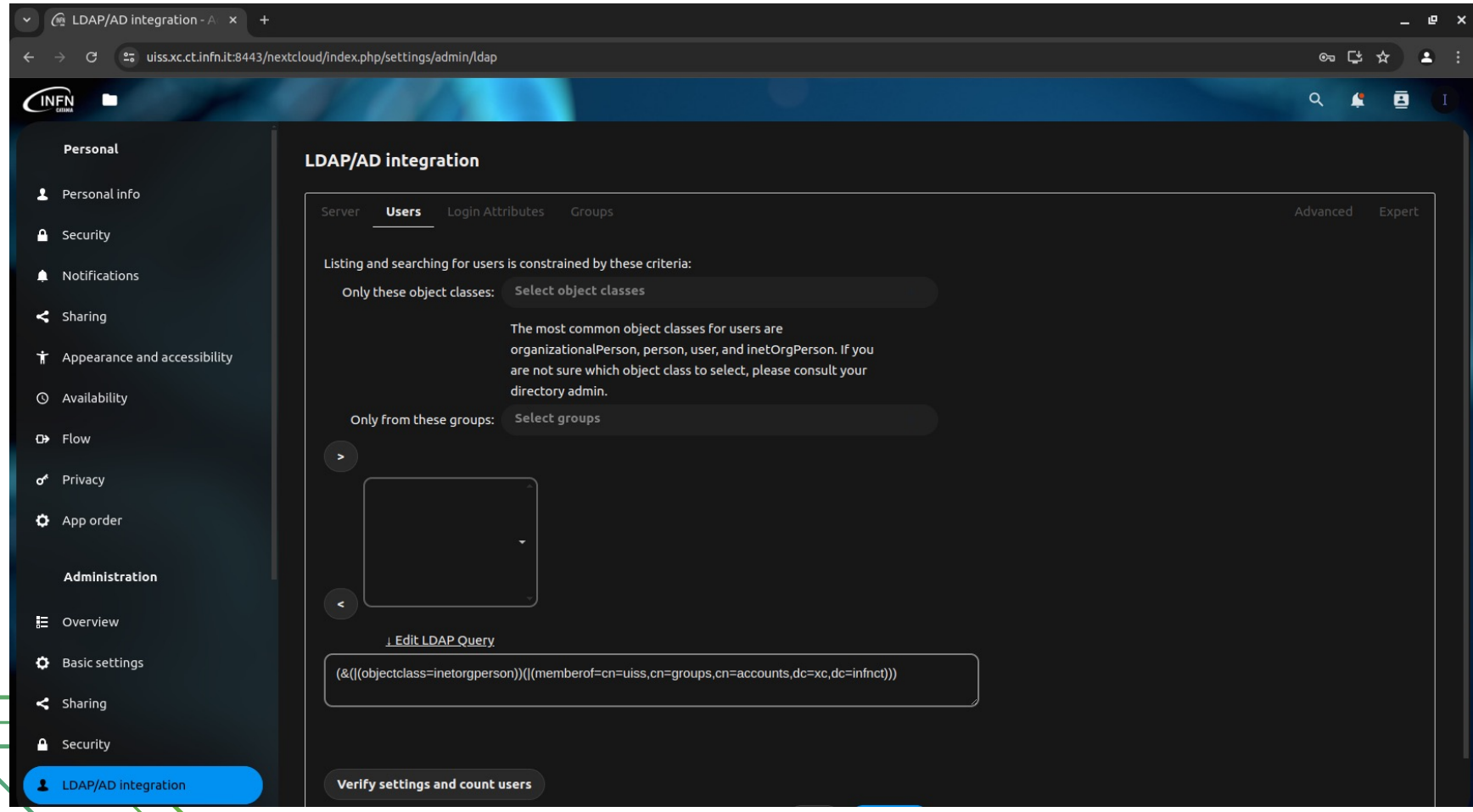
- LDAP integration
- Workflow
- UISS-MS OUTPUT

LDAP integration -Server

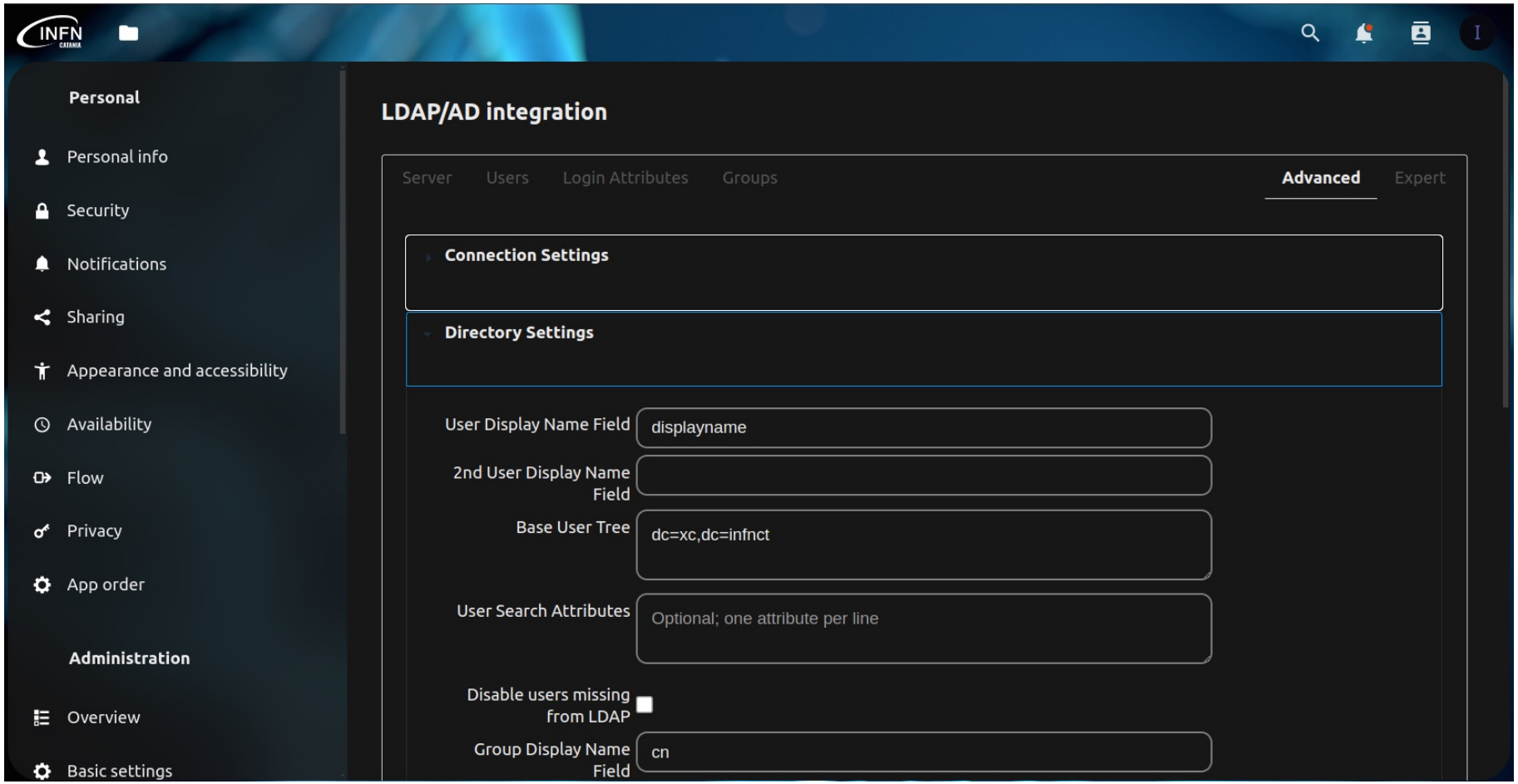


LDAP integration - Users

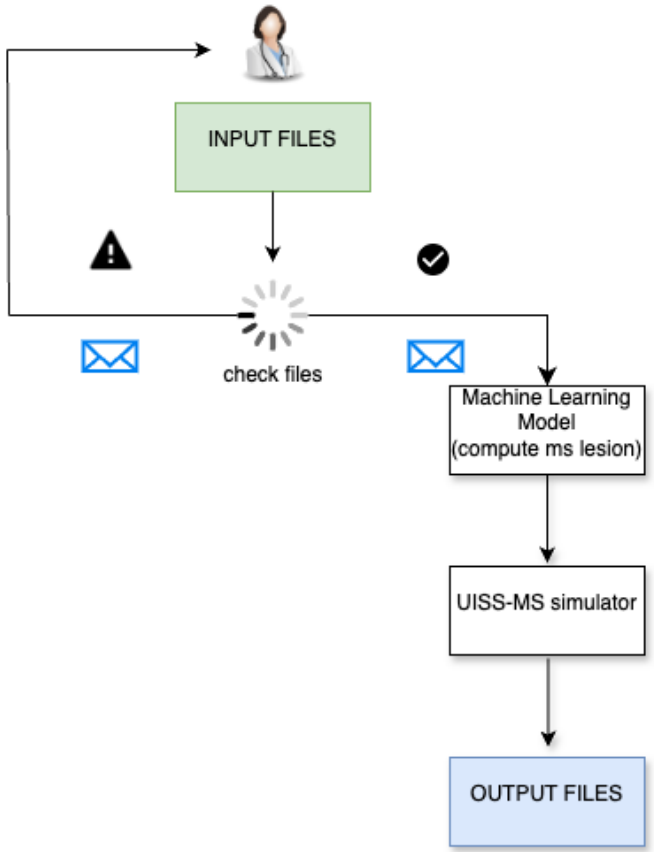
(&(|(objectclass=inetorgperson))(|(memberof=cn=uiss,cn=groups,cn=accounts,dc=xc,dc=infnct)))



LDAP integration - Advanced



WORKFLOW




```
source $UISS_LESION_VENV_PPATH/bin/activate
pushd $UISS_COMPUTE_MSLV
python compute_ms_lesion_volume.py --root_dir $TEMP_DIR_PY_ROOT --out_dir $TEMP_DIR_PY_OUT --log_dir "/var/log/ui
ss/$username" |& tee /var/log/uiss/$username/$username-$(date +"%Y-%m-%d_%H%M%S")-compute-ms-lesion.log
popd

# run simulation in a temporary directory
TEMP_DIR=$(mktemp -p /tmp -d uiss.XXXXXX)

echo "Executing uiss on $filename in ${TEMP_DIR} as working directory"
pushd $TEMP_DIR &> /dev/null
uiss -m "$TEMP_DIR_PY_OUT/output.txt" -f "$TEMP_DIR_PY_OUT/datafile" &> ./run.out


# generating plots
echo "Generating plots"
gnuplot -p /usr/local/share/uiss/script/wrapper.gp

# moving files .out to out directory
mkdir out
mv *.out ./out

# Generating archive result zip file as follows:
# <inputfilename with _ as spaces>-results-<unix timestamp>.zip

ofilename="${filename// /_}-results-$(date +%s).zip"
ofilepath="/var/www/html/nextcloud/data/$username/files/OUTPUT/$ofilename"
echo "Creating archive results file $ofilename"
zip -r "$ofilepath" ./
chown www-data:www-data $ofilepath
sleep 2
                                                    106,0-1       93%
```

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Compute MS Lesion Volume

Aim

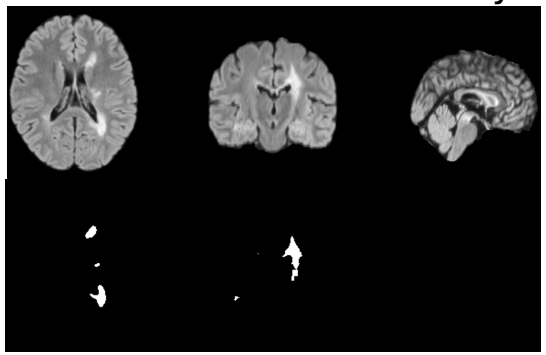
Longitudinal brain MRI study

- Automatically segment multiple sclerosis lesions using advanced deep learning techniques
- Compute lesion volume

Retrospective Dataset

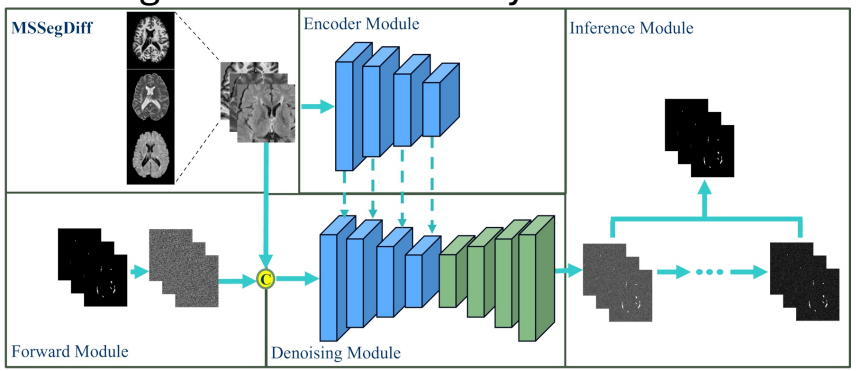
MSValid Data Collection:

- 75 patients
- Multimodal MRI
- Multiple time-point
- Acquired at different centers
- Masks annotated using the Jim9 Software and validate by doctors.



Model

- **Preprocessing**: Anonymization and registration to a 1mm isotropic MNI template
- **Diffusion Model**: Class of generative model, adapted to perform semantic segmentation
- **U-net architecture**: Suitable for medical image segmentation
- **Attention mechanism**: Allows focusing on important image regions, improving segmentation accuracy



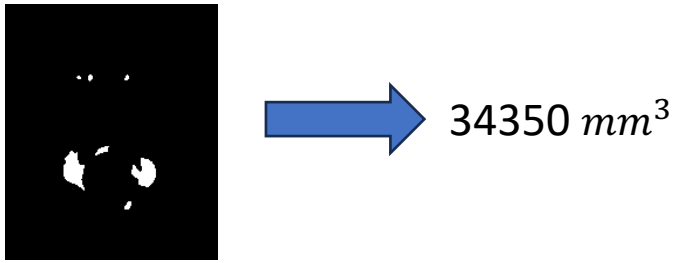
Model performance

- **Evaluation metric**:
  Dice score: measure the similarity between two classes

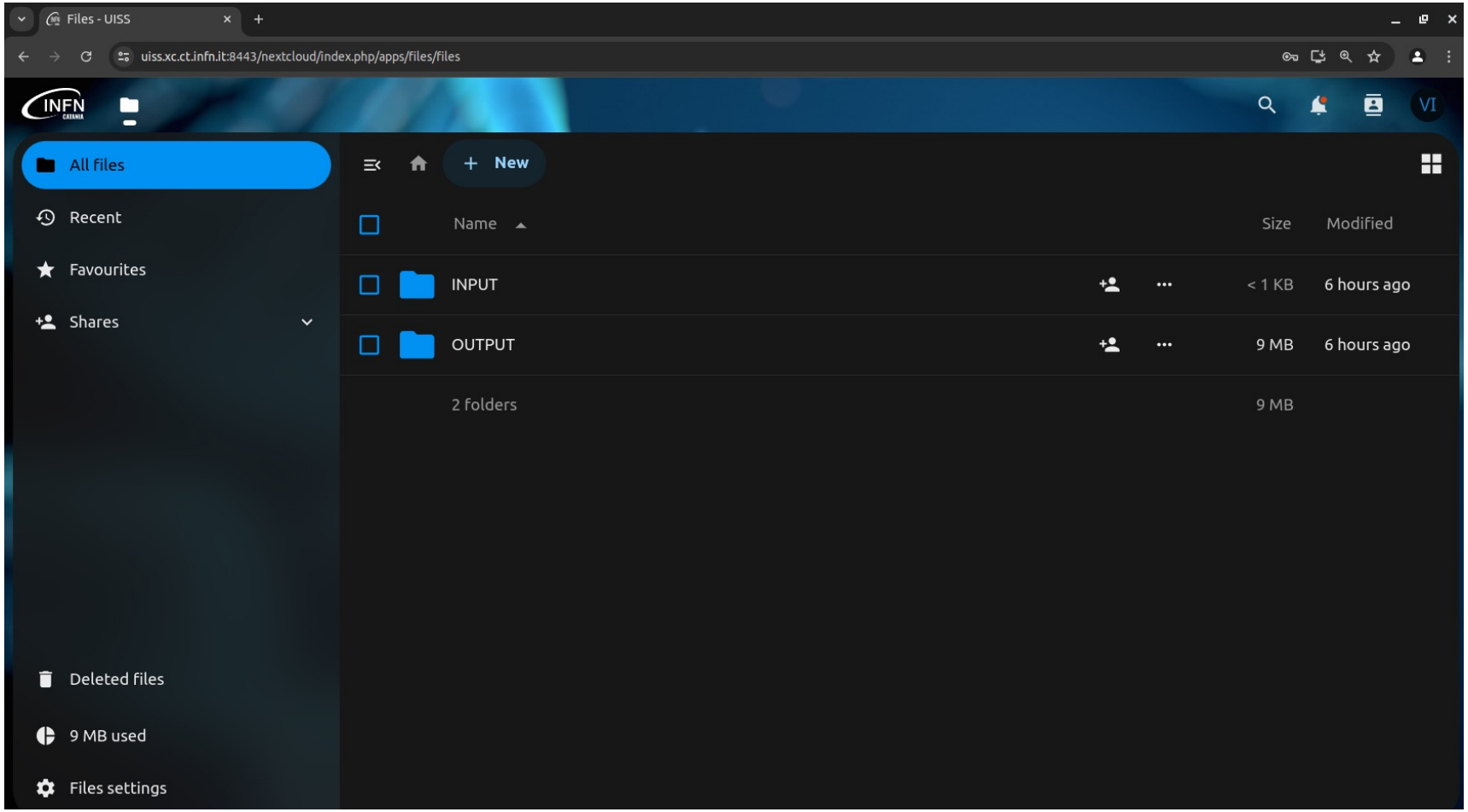
Slice | Ground-Truth | Prediction

Compute lesion volume

Volume in mm^3 of the prediction



RUN UISS simulator - INPUT

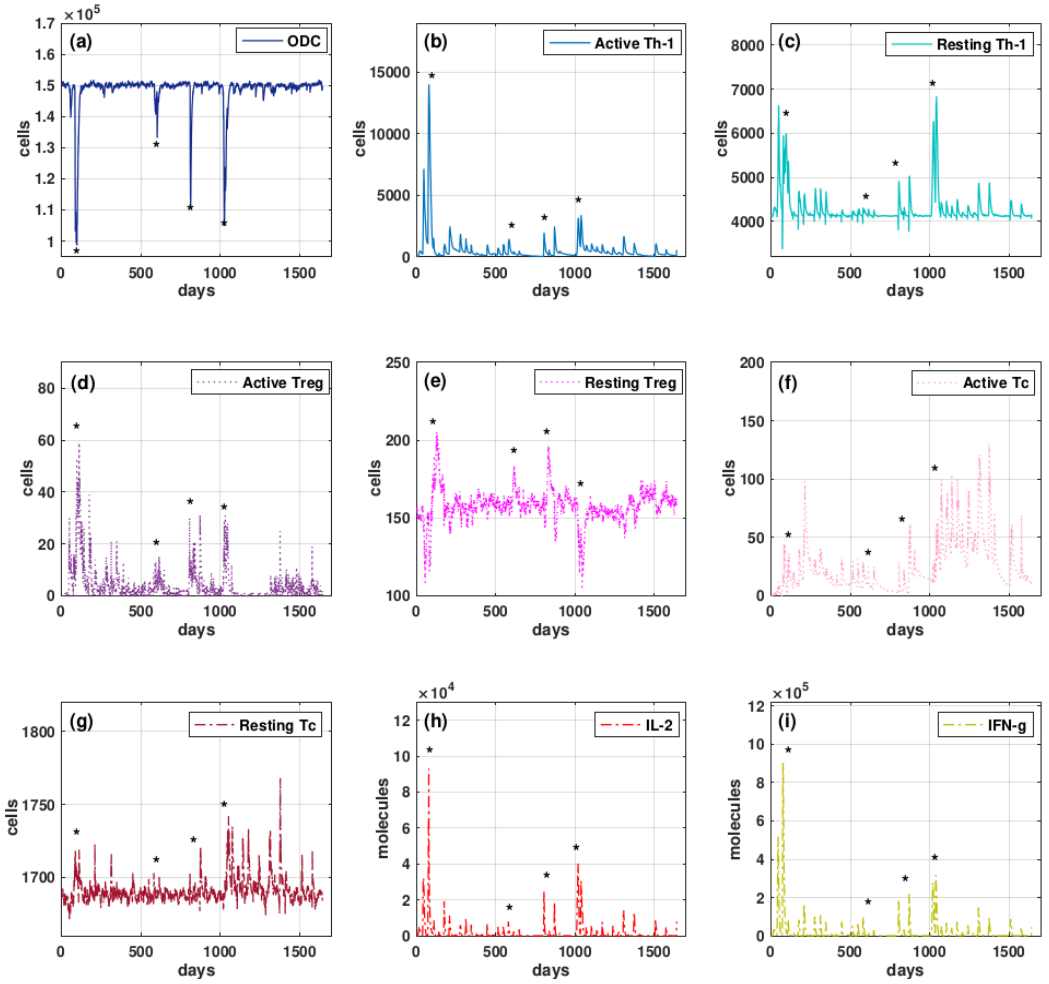


FLAIR.zip
T1.zip
T2.zip
datafile

input.zip

UISS-MS OUTPUT

Predicted cellular and cytokine dynamics



Current Status & future works

Service	Server	Docker Image	What for INFN Cloud
Noggin	Python VirtualEnv	Available on test branch	Test docker image
Freeipa	Virtual	Custom INFN Image created	Ready
VPN	Virtual	Not available	Prepare docker image or VM
Nextcloud	Physical	Available	Test docker image
UISS	Physical	Not Available	Prepare docker image or VM

References

- INFN Portal: https://portal.xc.ct.infn.it
- Noggin: https://noggin-aaa.readthedocs.io/en/latest/
- Freeipa: https://www.freeipa.org
- Freeipa INFN container: https://baltig.infn.it/infnct/icsc/spoke8/freeipa-container
- OpenVPN: https://openvpn.net
- Nextcloud: https://nextcloud.com
- CQI CERTIQUALITY: https://www.ct.infn.it/it/servizi-locali/servizio-calcolo-e-reti.html

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- Enrico Orlando[1]
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- Alessia Rondinella[2]
- Alessia Tricomi[1,2]

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2. University of Catania


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