DEEPHEALTH

DICOM and NIfTI formats

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The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.

Contents

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Medical Imaging File Formats

- The file format describes how the image data are organized inside the image file and how the pixel data should be interpreted by a software for the correct loading and visualization.
- Medical image file formats can be divided in two main categories according to their goal:
  - Standardize the images generated by diagnostic modalities, e.g., DICOM
  - Facilitate and strengthen post-processing analysis, e.g., NIfTI

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DICOM

- Digital Imaging and Communications in Medicine (DICOM)
- It has been widely adopted by hospitals and incorporates standards for imaging modalities such as radiography, ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI), and radiation therapy.
- Allows to store both data and metadata: an image that is separate from its metadata becomes "meaningless" as medical image
- The DICOM header, in addition to the information about the image matrix, contains the most complete description of the entire procedure used for the acquisition
- A DICOM file also contains patient information

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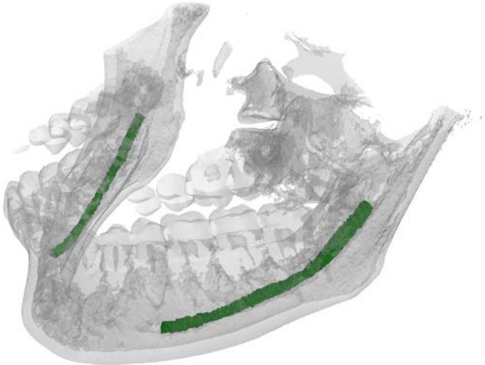
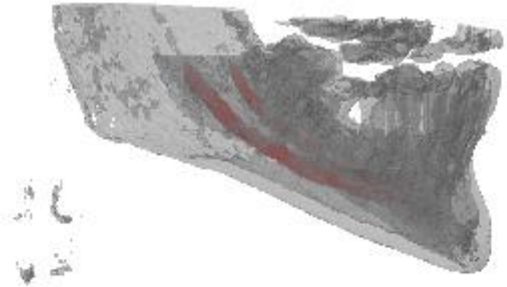
DICOM

- DICOM includes protocols for image exchange, image compression, 3-D visualization, image presentation, and results reporting.
- There exists plenty of software to open and view with DICOM files. Micro DICOM is on of them (its free for non-commercial usage):

https://www.microdicom.com/downloads.html





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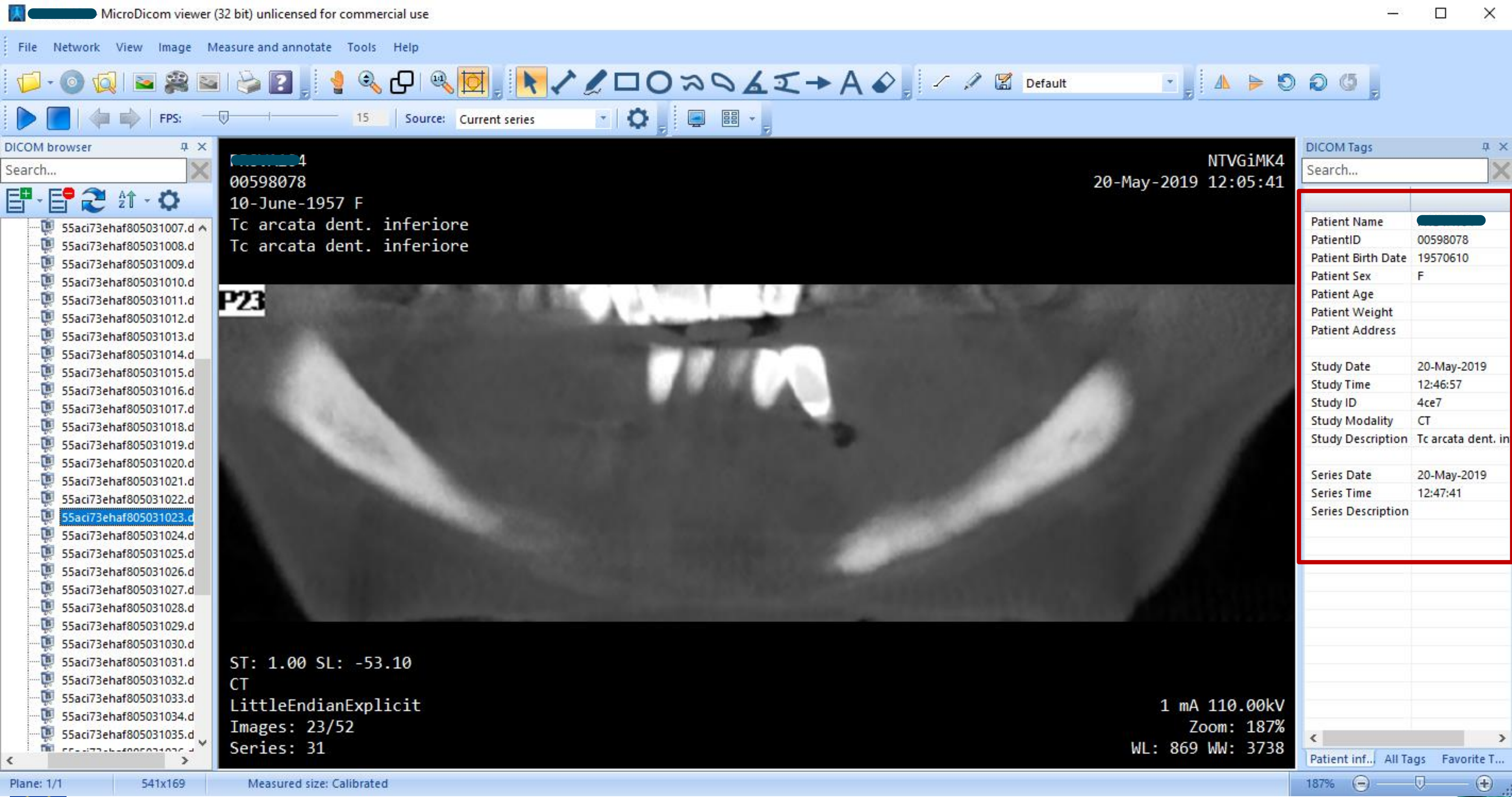

```
55aci73ehaf805031007.d
55aci73ehaf805031008.d
55aci73ehaf805031009.d
55aci73ehaf805031010.d
55aci73ehaf805031011.d
55aci73ehaf805031012.d
55aci73ehaf805031013.d
55aci73ehaf805031014.d
55aci73ehaf805031015.d
55aci73ehaf805031016.d
55aci73ehaf805031017.d
55aci73ehaf805031018.d
55aci73ehaf805031019.d
55aci73ehaf805031020.d
55aci73ehaf805031021.d
55aci73ehaf805031022.d
55aci73ehaf805031023.d
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55aci73ehaf805031026.d
55aci73ehaf805031027.d
55aci73ehaf805031028.d
55aci73ehaf805031029.d
55aci73ehaf805031030.d
55aci73ehaf805031031.d
55aci73ehaf805031032.d
55aci73ehaf805031033.d
55aci73ehaf805031034.d
55aci73ehaf805031035.d
```

```
[redacted]4                                              NTVGiMK4
00598078                                     20-May-2019 12:05:41
10-June-1957 F
Tc arcata dent. inferiore
Tc arcata dent. inferiore

ST: 1.00 SL: -53.10
CT
LittleEndianExplicit                              1 mA 110.00kV
Images: 23/52                                        Zoom: 187%
Series: 31                                      WL: 869 WW: 3738
```

Patient Name	[redacted]
PatientID	00598078
Patient Birth Date	19570610
Patient Sex	F
Patient Age	
Patient Weight	
Patient Address	
Study Date	20-May-2019
Study Time	12:46:57
Study ID	4ce7
Study Modality	CT
Study Description	Tc arcata dent. in
Series Date	20-May-2019
Series Time	12:47:41
Series Description	

Plane: 1/1   541x169   Measured size: Calibrated

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DICOM

- Especially when working with 3D volumes, being able to correctly visualize data requires to store additional information (e.g. pixel spacing).
- The ECVL Image allows to store all these information to properly handle and work with DICOMs.
- To enable DICOM support in ECVL the external dependencies DCMTK is required.
- DCMTK is a DICOM ToolKit consisting of source code, documentation and installation instructions for a set of software libraries and applications implementing part of the DICOM/MEDICOM Standard.

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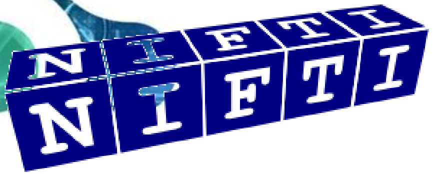

NIfTI

- Neuroimaging Informatics Technology Initiative (Nifti)
- Specifically designed for neuroimaging, it stores additional information w.r.t. DICOM (e.g. image orientation) with the intent to avoid the left–right ambiguity in brain study.
- The format allows the storage of the header and pixel data in separate files. Anyway, the images are typically saved as a single ".nii" file in which the header and the pixel data are merged.
- An update version of the standard, the NifTi-2, developed to manage larger data set has been defined in the 2011.
- NifTi-2 encode each of the dimensions of an image matrix with a 64-bit integer instead of using a 16-bit (as in the Nifti-1).

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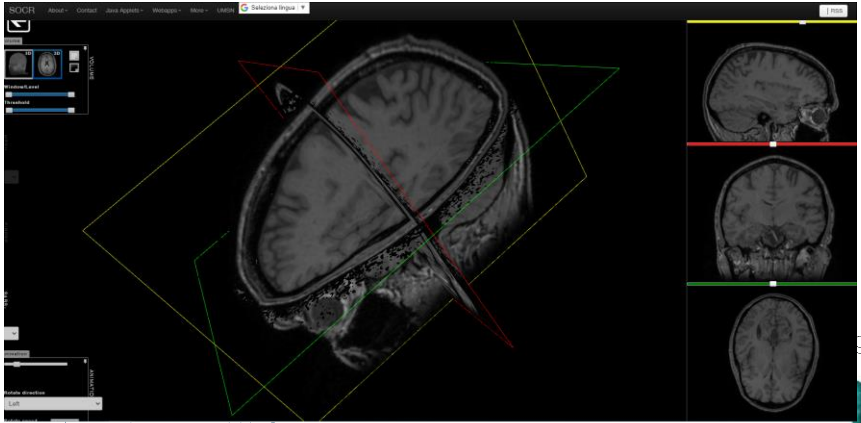
View NIfTI Files

- To view NiFTI files, you can use different programs:
  - ImageJ, a java-based program that runs on most operating systems, including MAC OSX
  - MBAT, from the Laboratory of Neural Imaging at USC
  - Mango, from Neuroimaging Informatics Tools and Resources Clearinghouse, offers desktop, web, and iPad-compatible versions
  - MRIcro, which runs on Windows and Linux systems
- Or web services:
  - Brain Viewer Webapp - SOCR

  https://socr.umich.edu/HTML5/BrainViewer/



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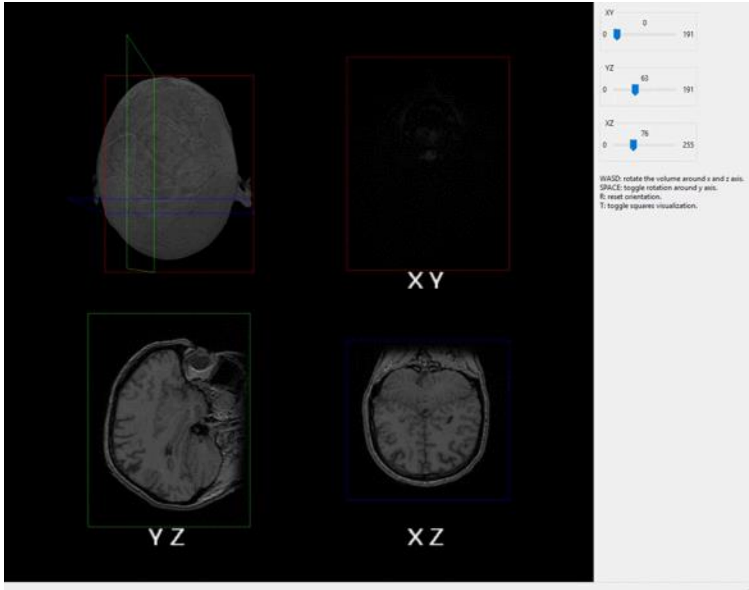
View NIfTI Files

- In the ecvl-applications GitHub repository you can find a C++ software based on ECVL and wxWidgets (a Cross-Platform GUI Library) and OpenGL (a cross-language, cross-platform API for rendering 2D and 3D vector graphics).
- This application also contains a volume rendering tool for NIfTI images.



WASD: rotate the volume around x and z axis.
SPACE: toggle rotation around y axis.
R: reset orientation.
T: toggle squares visualization.

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DICOM vs NIfTI

- The DICOM image (or file) is always a 2D image. 3D volumes are stored in multiple images each containing one slice of a MRI, CT, TEP, etc
- The NifTi file can contain the full set of images.
- A NifTi volume is a whole representation of a part of the human body, that contains all the slices took using the X-rays or any other method.
- NIfTi was designed to be simpler than DICOM and to ensure more efficiency for image processing analysis.
- Several other Medical Image File formats exists (e.g. Analyze, Minc), but they are less common than DICOM and NifTI

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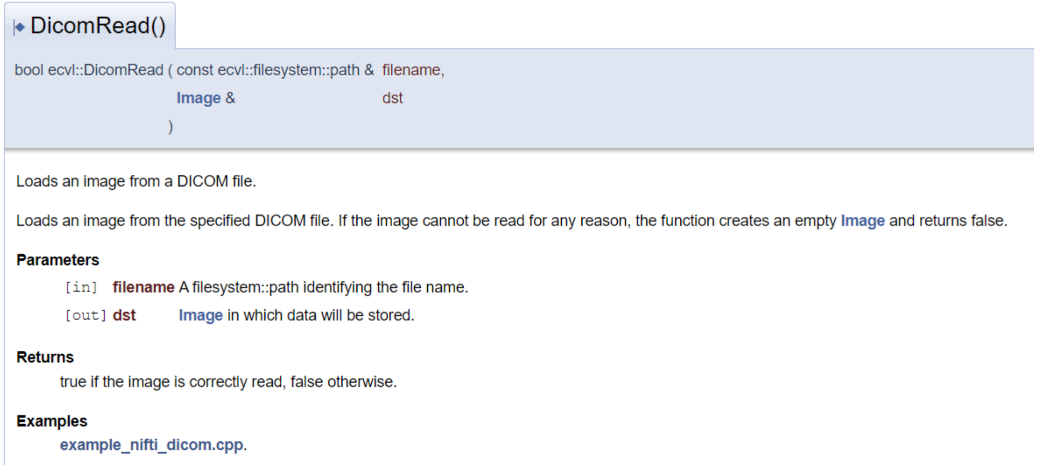
DICOM and NIfTI with ECVL

- ECVL library exports four different APIs to read and write DICOM and NifTI files
- Specifically, DicomRead and DicomWrite are respectively responsible for reading and writing DICOM file from and to disc.



◆ DicomRead()

```
bool ecvl::DicomRead ( const ecvl::filesystem::path &  filename,
                       Image &                          dst
                     )
```

Loads an image from a DICOM file.

Loads an image from the specified DICOM file. If the image cannot be read for any reason, the function creates an empty Image and returns false.

Parameters

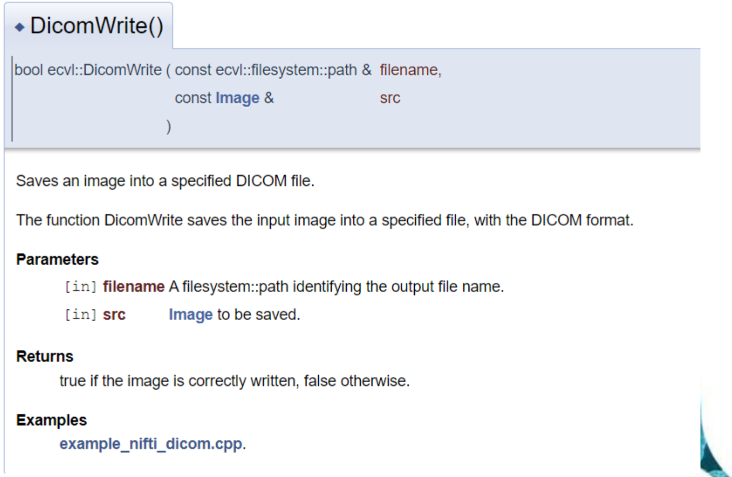
[in] **filename** A filesystem::path identifying the file name.
[out] **dst** Image in which data will be stored.

Returns

true if the image is correctly read, false otherwise.

Examples

example_nifti_dicom.cpp.



◆ DicomWrite()

```
bool ecvl::DicomWrite ( const ecvl::filesystem::path &  filename,
                        const Image &                    src
                      )
```

Saves an image into a specified DICOM file.

The function DicomWrite saves the input image into a specified file, with the DICOM format.

Parameters

[in] **filename** A filesystem::path identifying the output file name.
[in] **src** Image to be saved.

Returns

true if the image is correctly written, false otherwise.

Examples

example_nifti_dicom.cpp.

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DICOM and NIfTI with ECVL

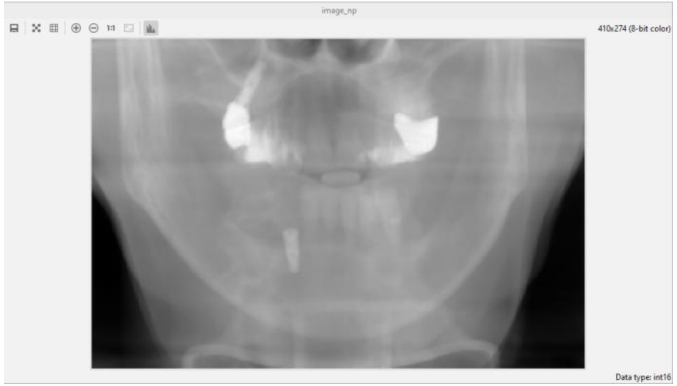
- You can read a DICOM image simply using the generic ecvl.ImRead function

```
import numpy as np
import pyecvl.ecvl as ecvl

image = ecvl.DicomRead("data/DICOM/55aci73ehaf802001000.dcm")
image_np = np.asarray(image).transpose([1,0,2])

image = ecvl.ImRead("data/DICOM/55aci73ehaf802001000.dcm")
image_np = np.asarray(image).transpose([1,0,2])

ecvl.DicomWrite("data/out_55aci73ehaf802001000.dcm", image)
```



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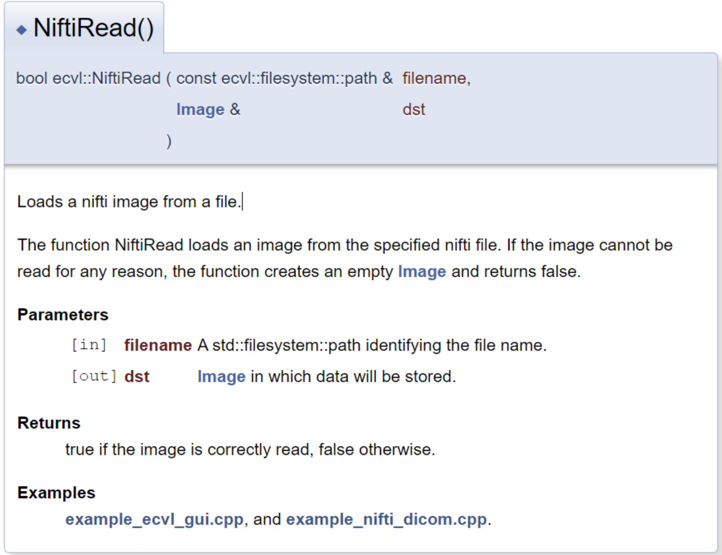
DICOM and NIfTI with ECVL

- NiftyRead and NiftyWrite are respectively responsible for reading and writing NifTI file from and to disc.



◆ NiftiRead()

```
bool ecvl::NiftiRead ( const ecvl::filesystem::path &  filename,
                       Image &                          dst
                     )
```

Loads a nifti image from a file.

The function NiftiRead loads an image from the specified nifti file. If the image cannot be read for any reason, the function creates an empty Image and returns false.

Parameters

[in] **filename** A std::filesystem::path identifying the file name.

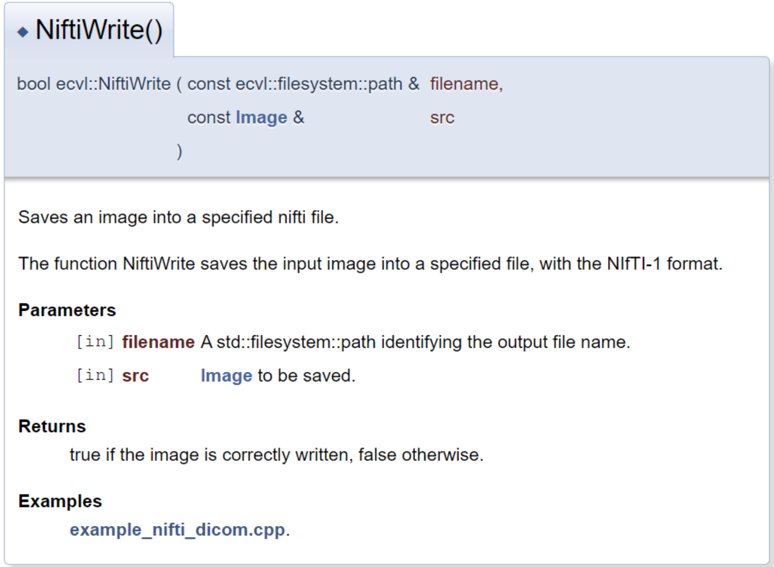
[out] **dst** Image in which data will be stored.

Returns

true if the image is correctly read, false otherwise.

Examples

example_ecvl_gui.cpp, and **example_nifti_dicom.cpp**.



◆ NiftiWrite()

```
bool ecvl::NiftiWrite ( const ecvl::filesystem::path &  filename,
                        const Image &                    src
                      )
```

Saves an image into a specified nifti file.

The function NiftiWrite saves the input image into a specified file, with the NIfTI-1 format.

Parameters

[in] **filename** A std::filesystem::path identifying the output file name.

[in] **src** Image to be saved.

Returns

true if the image is correctly written, false otherwise.

Examples

example_nifti_dicom.cpp.

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DICOM and NIfTI with ECVL

- You can read a NifTI volume simply using the generic ecvl.ImRead function

```
import numpy as np
import pyecvl.ecvl as ecvl

image = ecvl.NiftiRead("data/brain_mr_01.nii")
image_np = np.asarray(image).transpose([1,0,2])

image = ecvl.ImRead("data/brain_mr_01.nii")
image_np = np.asarray(image).transpose([1,0,2])

ecvl.NiftiWrite("data/out_brain_mr_01.nii", image)
```

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Metadata

- When reading DICOM and NifTI files, ECVL imports also metadata
- Through the .getMeta() and .setMeta() function methods you can get or set metadata of an Image.
- This functionality is fully implemented in C++, but still missing in the python API.
- Do you want to contribute? You can do it with a pull-request.

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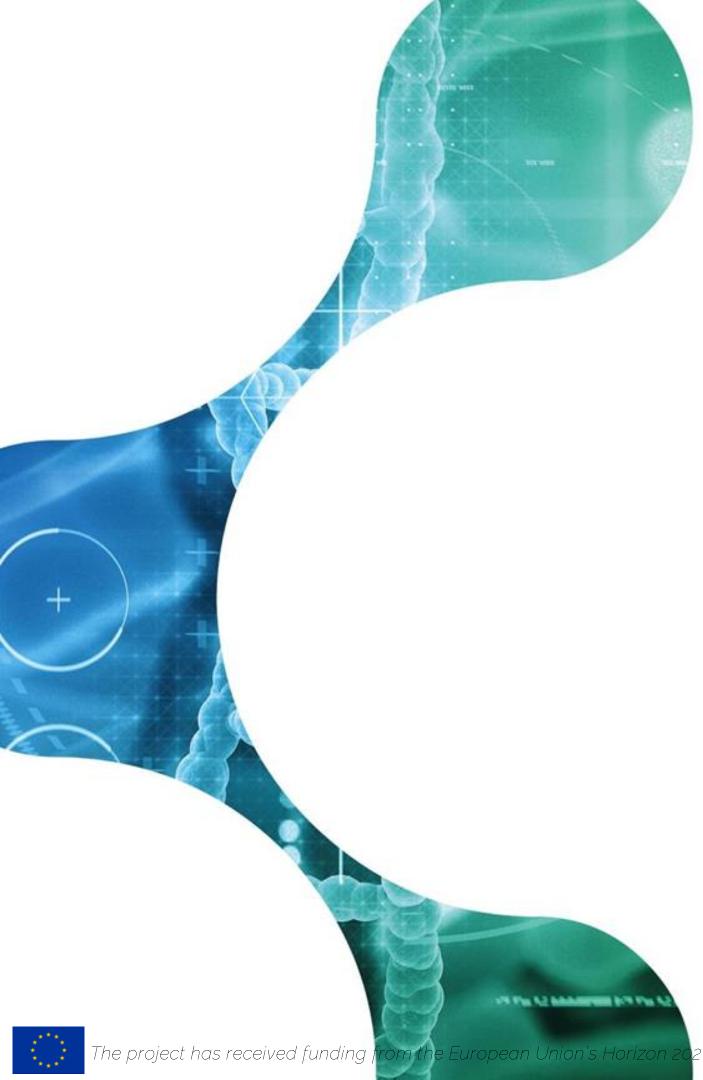

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Thank you!

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