Software

Release notes

PerGeos Software
version 2022.1

This document covers the most important new features, improvements, and changes in version 2022.1 of Thermo Scientific™ PerGeos™ Software.

In addition, you will find a list of new Xtras including video tutorials, recipes, and workflows which have been published on **https://xtras.pergeos.com** since the previous release.

We value your feedback. If you encounter any problems or have any suggestions for improvement, do not hesitate to contact us at **frbor.3d_info@thermofisher.com**.

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General enhancements and new features

Deep learning model training for segmentation in 2D

A new tool called "**DL Training - Segmentation 2D**" is now available for 2D image-based deep learning model training. This module replaces the previous "Deep Learning Training" module, which has been deprecated. Please refer to the compatibility notes.

With the "DL Training – Segmentation 2D" tool, tiling of the input dataset is now possible. The tiling functionality allows you to automatically split a single large 2D data slice (input data) into tiles (multiple sub-slices of the same size). Each tile is considered as an independent training sample. In addition, it is now possible to randomize the order of the training samples before assigning them to training and validation sets.

A new option allows plotting the metrics for all classes in TensorBoard logs, in the case of multi-class segmentation.

OS requirements: Windows
Other requirements: An NVIDIA GPU supporting CUDA Compute Capability 3.5 or higher is required, with up-to-date drivers. Your CPU must support the AVX2 extensions. The Python environment for deep learning has been upgraded; please remember to install it prior to using the new modules.
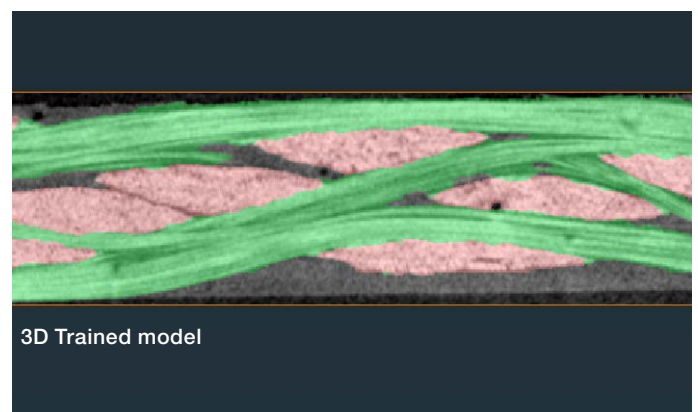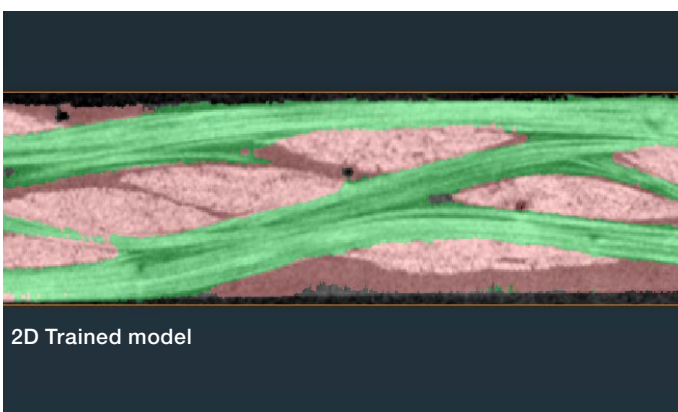
Deep learning model training for segmentation in 3D

A new tool called "**DL Training - Segmentation 3D**" is now available for 3D image-based deep learning model training in PerGeos Software. This module is similar to the "DL Training - Segmentation 2D" tool but relies on 3D convolution layers for all proposed network architectures: ResNet and VGG-backboned U-Nets, and generic U-Nets. The tiling functionality splits the input volume into independent training samples. In addition, it is possible to randomize the training samples before assigning samples in training and validation sets.

Compared with 2D, 3D models will better capture the nature of the structures to be segmented. Better prediction results quality can be expected. However, the GPU hardware requirement and computation time for training 3D models are increased.

OS requirements: Windows
Limitations: An NVIDIA GPU supporting CUDA Compute Capability 5.2 or higher is required, with up-to-date drivers. Your CPU must support the AVX2 extensions. The Python environment for deep learning has been upgraded; please remember to install it prior to using the new modules.

2D Trained model

3D Trained model

Comparison of segmentation using 2D and 3D deep learning models, trained with the same training data. Dataset: micro-CT of woven composite, courtesy of Henry Moseley X-ray Imaging Facility, School of Materials, University of Manchester.

Random-Walk Distance Map, Random-Walk Averaged Distance Map

Two new tools, "Random-Walk Distance Map" and "Random-Walk Averaged Distance Map," are now available to help you improve the segmentation of 3D non-spherical objects. The "Random-Walk Distance Map" tool computes a distance map from a binary segmentation. This map indicates, for each foreground voxel, the average time it takes for a random walk starting from this voxel to reach a background voxel. Compared with Euclidean or Chamfer distance maps, this module is less affected by noise in the segmentation or objects of anisotropic shapes.

This new tool is particularly well-suited for object separation workflows in the case of non-spherical objects and/or noisy segmentation data.
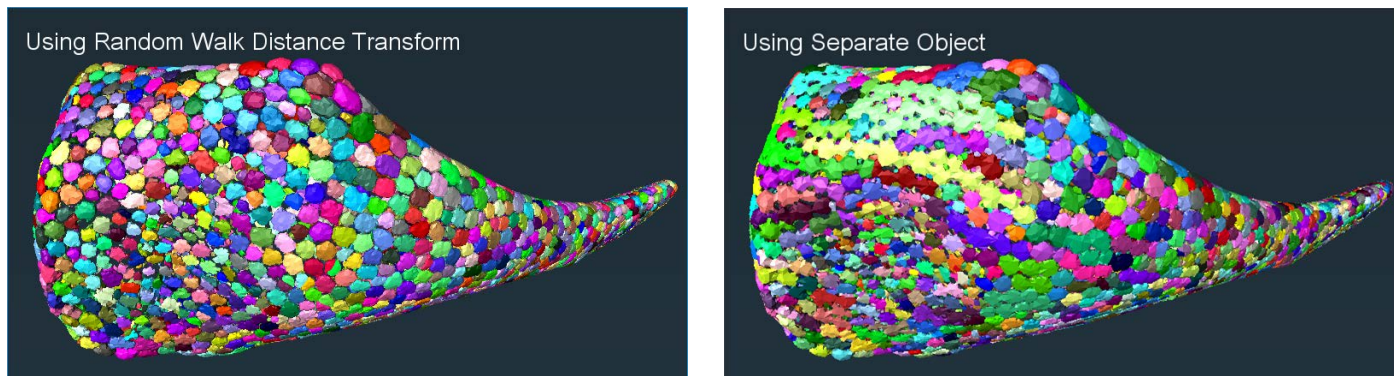
Comparison of results of an Object Separation workflow using either the Random Walk Distance Map or the classic Separate Object module. Data courtesy of Mason Dean and Ronald Seidel (MPI Potsdam-Golm), David Knoetel (Zuse Institute Berlin). Image data: micro-CT image of a hyomandibula of a stingray (Urobatis halleri).

The "Random-Walk Average Distance Map" tool allows you to compute an averaged distance map directly from a grayscale image, through averaging the results obtained on a range of binary thresholds.

This tool can help you achieve even more robust 3D segmentation results than simply using a single thresholding value.

Limitations: Compared with a classic distance map, the peak memory and computation time are increased with these tools.
**OS requirements:** all supported platforms

Waterpixels

The new tool "**Waterpixels**" is a particular implementation of superpixels, which partitions the input image into regions of homogeneous sizes and which follows the image's contour. The implementation is inspired by the following publication:

V. Machairas, E. Decenciere, T. Walter. "Waterpixels: Superpixels based on the watershed transformation," IEEE International Conference On Image Processing, Paris, France, Oct. 2014. https://doi.org/10.1109/ICIP.2014.7025882

The tool can accept grayscale or RGB images. It computes 2D waterpixels for a 2D image and 3D waterpixels for a 3D image. An option allows you to automatically compute the gradient magnitude – on the luminance in the case of RGB input data.

OS requirements: Windows only

| a | b | c |
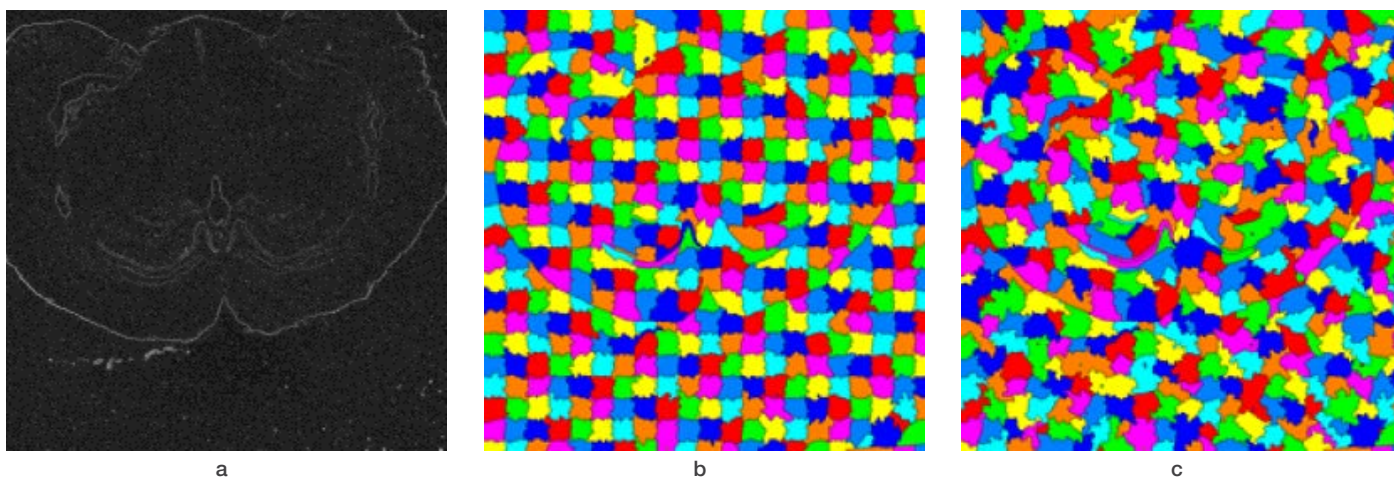
Superpixel generation with the waterpixel algorithm: (a) Input image given by a morphological gradient, (b) waterpixels emphasizing the regular grid (high regularization factor), (c) waterpixels emphasizing the input image (low regularization factor).

Other enhancements

Algorithm enhancements

The algorithms behind the following tools have been enhanced:

Beam Hardening Correction

Cylindrical Intensity Profile

Ring Artefact Removal

Simulated Mercury Injection

Radial Auto-correlation

These tools were restricted to the processing of 16-bit data and a total size of 2GB. These limitations are now removed. The previous tools have been deprecated; see the compatibility notes for more details.

OS requirements: all supported platforms
Licensing: "Simulated Mercury Injection" tool requires the Petrophysics extension

Deep Learning Prediction

The tool "Deep Learning Prediction" can now also be used with 3D deep learning models, in addition to 2D models.

In the manual tiling mode, which may be required in situations where the available GPU memory and requirements are not accurately estimated, it is now also possible to adjust the number of pixels of overlap between adjacent tiles. Reducing this overlap will reduce the GPU memory requirements and the computation time. However, artefacts at the boundaries between tiles may appear, especially when the model is not able to generalize accurately.

Nevertheless, the automatic tiling mode will be sufficient in most cases.

OS requirements: Windows only

Python interpreter - multithreading and multiprocessing support

This 2022.1 version adds support for multithreading and multiprocessing for Python scripts, allowing developers of custom tools to greatly accelerate the execution of their scripts. Refer to the user's guide Multiprocessing/Multithreading section for details and code snippets.

OS requirements: all supported platforms

Xtra Recipe Library

The following Xtras have been published or updated since the previous release notes. Make sure that you consider the product, license, or OS requirements as well as the installation instructions. We will continue to enrich this library of add-ons and how-tos, and we welcome your feedback as always (use the "Contact Us" button).

BSE SEM denoiser – Deep Learning Model (Update): U-Net model for denoising back-scattered SEM images.

Getting Started with Deep Learning Training (Update): Model and companion project for the Deep Learning tutorial.

Patch Extraction Tools for Deep Learning data preparation (Update): A set of tools dedicated to the preparation of data for training Deep Learning models and reducing annotation time.

kMeans Clustering on Label Analysis (Python): This Xtra implements kMeans clustering on a label analysis spreadsheet. Separated objects can be clustered based on any measure group that is built-in or user-customized.

Facies Classification from Well Logs: Facies (rock type) classification from well logs using supervised machine learning algorithms.

Compatibility notes

Deep Learning Training: The previous version of the "Deep Learning Training" tool is now deprecated. You can still load projects created from versions 2021.1 or 2021.2, but it is highly recommended that you switch to the new tool DL Training - Segmentation 2D. All features from the previous tool can be found in the new one. Trained models can still be used, either as initialization of new trainings or for prediction, without any modifications.

Projects involving the "Deep Learning Training" tool from versions 2019.3 through 2020.3 will now generate errors, as this tool, which was deprecated in 2021.1, is no longer supported. Models trained with versions 2019.3 through 2020.3 require modifications of the associated .py file to behave correctly with respect to Prediction. Please refer to the 2021.1 release note and product documentation for more information.

 Some tools have been replaced by new versions. Projects from previous versions of the software can be opened, but the new versions of the tools will be instantiated. These new versions have a different interface and may generate slightly different results. However, these differences are negligible for any practical applications. The impacted tools are:

Beam Hardening Correction

Cylindrical Intensity Profile

Ring Artefact Removal

Simulated Mercury Injection

Radial Auto-correlation

For the next 2022.2 release, the following changes are anticipated:

The officially supported Linux distribution will be Ubuntu 20.04.

The compilers' versions required to use the XPand extension will be upgraded to:

- Microsoft Visual Studio 2019 on Windows

- gcc 9 on Linux

End of support

CentOS 7 – Linux distributions

CentOS 7 will be discontinued and replaced by Ubuntu 20.04 as the officially supported Linux platform. PerGeos Software 2022.1 will be the last officially maintained release on the CentOS 7 platform. There will be no new product development nor update of CentOS 7 after this version. You can still use the CentOS 7 versions of our software products, and we will continue to provide bug fixes for 12 months. However, as new versions are released, we encourage you to transition to the Linux-supported platform to benefit from our full support.

Windows 7 and Windows 8

As already announced, support for the Windows 7, Windows 8, and Windows 8.1 operating systems has been discontinued since release 2020.3, although no major issues are known so far. However, a CUDA update planned for the next 2022.2 version will make many CUDA-based functionalities no longer work on these platforms. The impacted tools will be Deep learning tools, Ambient occlusion, Anisotropic diffusion and Non-Local means filter - GPU Adaptive Manifold. We encourage you to update your OS to a Windows- supported platform to benefit from our full functionalities.

Operating systems

PerGeos Software version 2022.1 runs on:

Microsoft Windows 10 (64-bit).

Linux x86 64 (64-bit). Supported 64-bit architecture is Intel64/AMD64 architecture. Supported Linux distribution is CentOS 7.

To add custom extensions with the PerGeos XPand extension, you will need:

Microsoft Visual Studio 2013 (VC12) Update 4 on Windows

gcc 4.8.x on Linux CentOS 7

Solved issues

Name	ID	Description
Beam Hardening Correction	AA-26645	Beam Shield Correction is now working correctly with intensity values greater than the maximum range.
Remesh Surface	AA-26628	Desired Size vertices and triangles ports are now correctly reloaded when reopening a project.
Spreadsheet	AA-25979	Median value is now properly computed for both cases of odd and even number of objects.
Two-Phase Flow Simulation	AA-26153	The module is now able to compute data having Unicode characters in their name or file path.
Volume Edit	AA-26584	Mouse Cursor has been fixed and replaced by an arrow to make it easier to see where the line is being drawn.

Thermo Scientific License Manager has been updated to improve offline operations, make sure you don't skip Thermo Scientific License Manager 1.6.7 installation at the end of PerGeos Software installation to benefit from those fixes.

Learn more at **thermofisher.com/pergeos**