# From image to insight


**ZEISS ZEN AI Toolkit**

Your Versatile Machine Learning Package for Image Analysis

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ZEISS

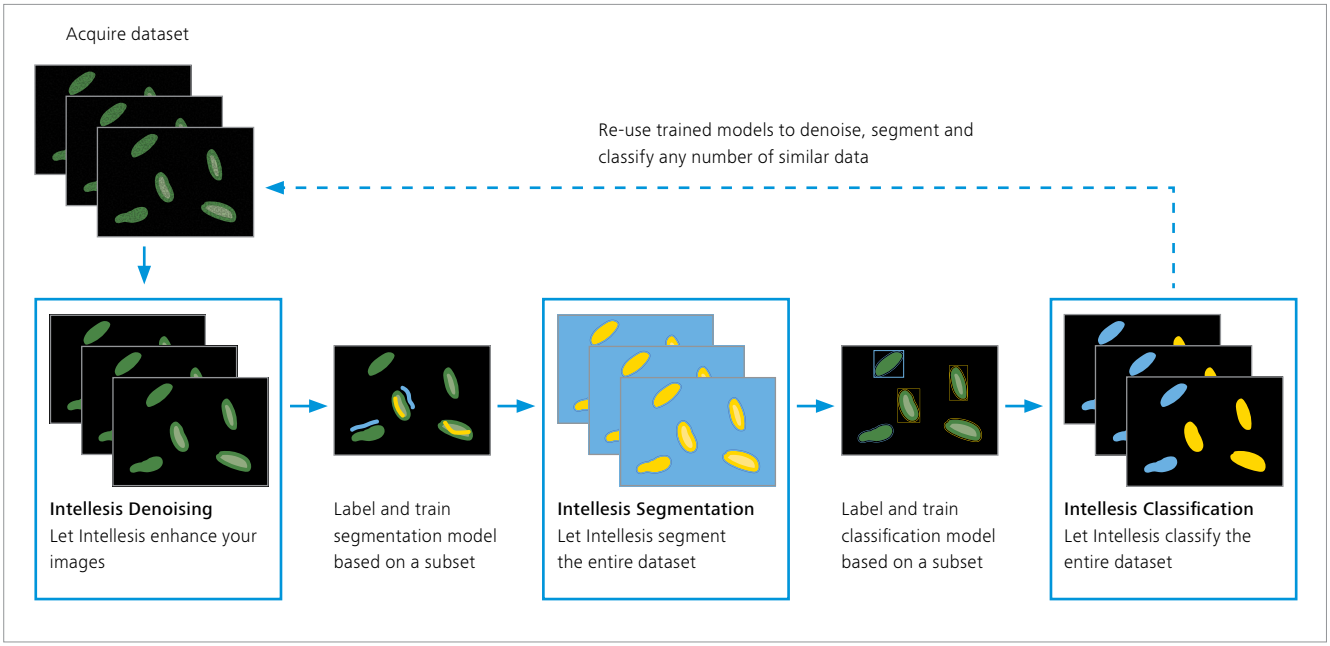
Seeing beyond

# A Companion on Your Analysis Journey

## Smart Tools for Every Step along the Workflow

### Machine Learning in Image Analysis

Today's imaging systems can reveal the most intricate processes of life; however, transforming this image data into meaningful scientific insight can be intensive and lengthy. Image processing also has grown more complex. With the AI Toolkit, a collection of ZEN Intellesis tools, ZEISS has integrated modern Machine Learning capabilities that allow you to maintain your own intuitive language on your journey from image to data. All you need for success is your life science expertise.




**Step 1 – Denoising**

Even with modern imaging systems, raw images still contain image imperfections – suboptimal signal-to-noise ratio or artifacts like shot or camera noise – which can be easily corrected with Intellesis Denoising. The Deep Learning algorithm requires no additional training data and is very intuitive to use without the need for extensive parameter settings. Intellesis Denoising produces smoothed, contrast-enhanced images. It can be used as a stand-alone tool or applied after other image processing methods such as Deconvolution, Apotome or Airyscan processing.

**Step 2 – Segmentation**

With optimally preprocessed images, the next step is to segment objects of interest in the image. This can be a notoriously tedious task, requiring expert knowledge of the many algorithms available and their underlying data structures. Intellesis Segmentation employs a completely different paradigm. Instead of setting up a series of complex methods, you simply annotate some of your favorite objects of interest with a brush tool to teach a Machine Learning model. Previously impossible segmentation challenges become feasible.

**Step 3 – Classification**

The work is not complete simply because objects have been identified. It may be necessary to further classify them based on their appearance, texture, shape, or other features. This process is radically simplified by Machine Learning. With Intellesis Object Classification, you assign some characteristic objects of your dataset to the desired classes. These assignments are then learned by a Machine Learning model and applied to the entire dataset. Compared to conventional methods, you benefit from a simpler procedure with high-quality results.

***Title image:*** *Drosophila embryo images recorded with ZEISS Celldiscoverer 7 and Airyscan 2. Images Courtesy of University of Gothenburg*

# Harnessing the Power of Deep Learning

## The Fastest Bridge from Image to Information

The AI Toolkit provides easy access to rapid and robust image denoising, segmentation and classification. Stay focused on your biology and let the software take care of the technical details.

**Intuitive for Life Scientists**
The beauty of Machine Learning applications is their ease of use. You don't need expert knowledge of image analysis and are almost completely relieved from method selection and parameter fine-tuning. Instead, you instruct the algorithm by providing examples of segmentation or classification. The denoising algorithm does not require any adjustments at all.

**More Than a Sum of Pixel Values**
Conventional image analysis methods almost exclusively employ basic features like pixel intensities. But images aren't just pixels; they have texture and shape and object relationships. Machine Learning algorithms take all these attributes into account, which is what makes the AI Toolkit uniquely capable of tackling more complex tasks.

**Train. Eat. Sleep. Repeat.**
Today's science demands reproducibility and throughput. Machine Learning is made for that. Once trained for a specific task, a model can be re-used for similar data.

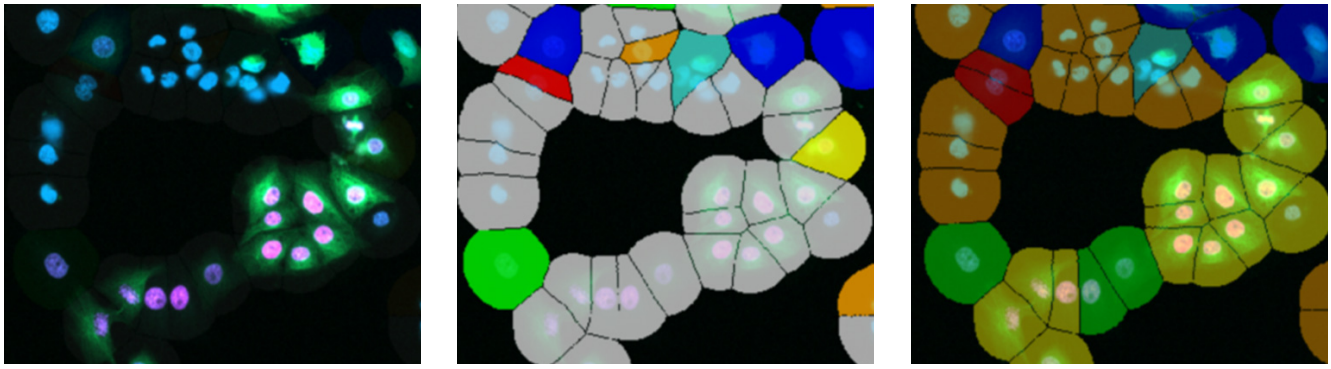
**Employ Your Hardware Efficiently**
A Machine Learning tool requires a lot of processing power. Fortunately, resources for that are standard for modern multi-core CPU computers. The AI Toolkit is designed to run with high degrees of parallelization and employs GPU processing to get you accurate results quickly.

**Integration in Imaging Workflows**
Intellesis is well-embedded into ZEN's image analysis tools to unleash the full power of Machine Learning segmentation and classification. Use these tools in automated workflows with the Image Analysis Wizard or Python scripting to extract data and generate publishable visualizations. Or, employ the AI Toolkit in correlative experiments along with other ZEN workflow packages:

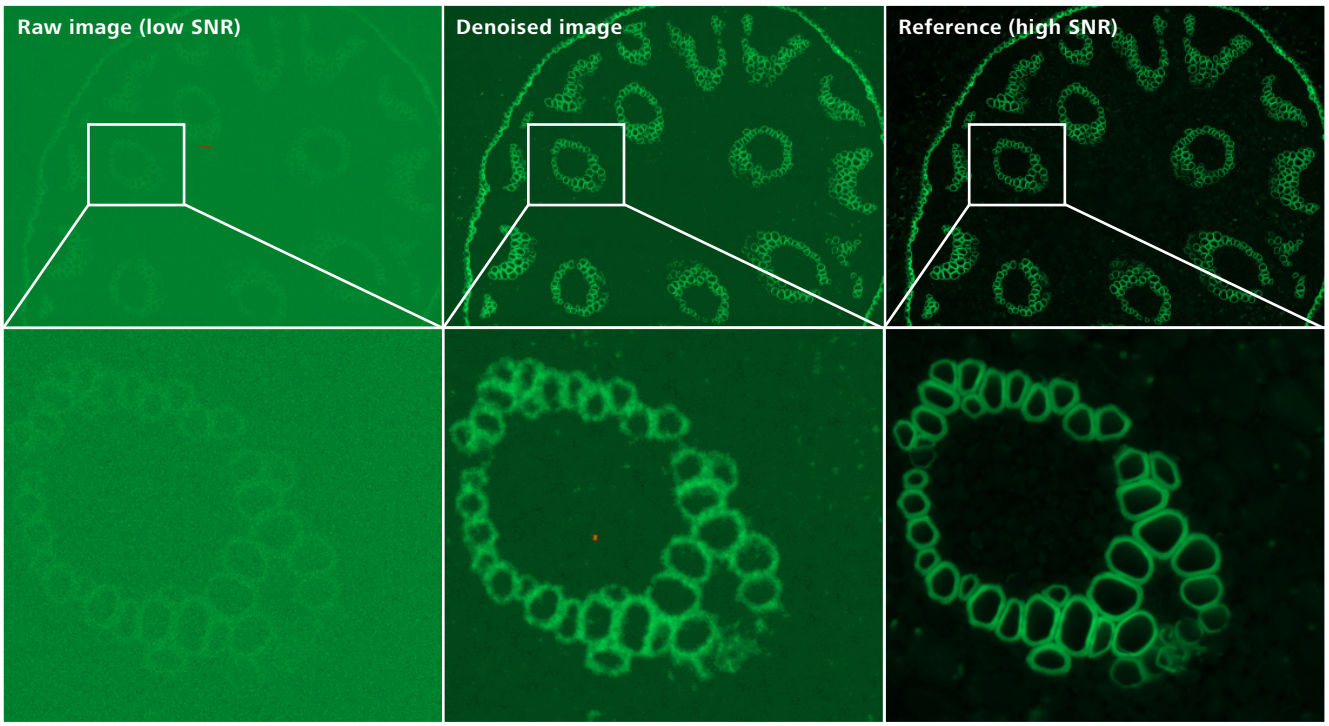
- 2D Toolkit
- 3D Toolkit
- Smart Acquisition Toolkit
- Bio Apps Toolkit

**AI-Ready Beyond ZEN**
Machine Learning is a highly dynamic, developing field involving an active academic community. To facilitate the use of the latest tools, ZEISS made Intellesis an open, adaptable machine learning platform. Pre-trained models from other software platforms can be imported and employed easily. ZEISS's public image analysis platform, APEER, has a dedicated machine learning section to address the continuously growing number of applications.

**Try it on Your Dataset**
The AI Toolkit is extremely flexible and allows segmenting any multi-dimensional image from light, electron or x-ray microscopes. No matter whether your focus is cell biology, neuroscience or developmental biology, or if you regularly use cell culture, organoids, tissues or whole organisms, Intellesis will make your image analysis easier and more reliable. Now, it's your turn to test it on your dataset.



*U2OS + LLC2 cell culture – classification of cellular phenotypes based on nuclear mCherry and cytosolic GFP fluorescence (left image). Cells were segmented with conventional threshold segmentation. Then, a few cells were manually assigned with Intellesis Classification (center image). Intellesis finally predicted the complete dataset (right image).*




*Convolaria, acquired with ZEISS Axio Imager and processed with AI Denoising*
*A short acquisition time (0.2 ms) results in a noisy raw image (left panel), but the signal-to-noise ratio (SNR) can be improved significantly by AI Denoising post-processing (center panel). A high-SNR image (acquisition time 150 ms) is shown as reference (right panel).*

## ZEISS ZEN AI Toolkit features

- Denoising, segmentation, and classification of every image type readable by ZEN
- Compatible with multi-dimensional datasets including stacks and tiled images
- Intuitive training interfaces for segmentation and classification
- Import of deep-learning models from APEER and external tools (AI-ready)
- Seamless integration within ZEN framework and Image Analysis Wizard
- Export of segmented images to third-party software tools
- Exchange and sharing of models via an open model format
- Parallel and GPU computing
- Large data handling
- Well-established open-source Machine Learning algorithms, powered by Python, TensorFlow, ONNX, Scikit-Learn and Dask

## Availability

The AI Toolkit is available for the following systems and software:

- ZEN 3.6 (blue edition)
- Windows 10, 64 Bit Systems
- 64 GB RAM + 8 GB GPU (recommended)

**Note:** The module ZEN Intellesis Object Classification requires an analyzed image created with ZEN Image Analysis.

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APEER ML provides an easy way to train your own Deep Learning models to be used in ZEN.
No expertise or coding required.
www.apeer.com

**Carl Zeiss Microscopy GmbH**
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/zen