

Image data and naming conventions

The objective of this document is to describe the format and naming conventions of individual frames of each video and their corresponding reference annotations and standardized instance segmentations. For the sake of brevity, we refer to the gold-standard corpus containing human-origin reference annotations as gold truth (GT) and the silver-standard corpus containing computer-origin reference annotations as silver truth (ST).

Each dataset has the following structure:

Dataset_name ----- ON (original image data of the N-th sequence)

----- ON_ERR_SEG (imperfect/perfect segmentation masks for the N-th sequence of the real/computer-generated dataset, obtained by systematically relabeling its silver/ground segmentation truth with the aim of breaking temporal coherence of their labels)

----- ON_GT (gold truth for the N-th sequence)

----- SEG (gold segmentation truth for the SEG measure)

----- TRA (gold tracking truth for the DET and TRA measures)

----- ON_RES (results produced by a competing algorithm)

----- ON_ST (silver truth for the N-th sequence)

----- SEG (silver segmentation truth for fine-tuning of algorithms)

Indexing

T - A zero-based temporal index composed of either three or four digits depending on the dataset

Z - A zero-based, three-digit slice index

Original image data

tT.tif - Multi-page tiff file that contains the original image data (i.e., either 8-bit or 16-bit image data depending on the dataset) of a given frame.

Reference tracking annotations (real datasets)

man_trackT.tif - 16-bit multi-page tiff file (markers have unique positive labels propagated over time, background has zero label). It contains markers for the corresponding original image tT.tif. The man_trackT.tif file does not have to be provided for every training tT.tif file. However, it is provided for every test tT.tif file with non-empty reference tracking annotation.

man_track.txt - A text file representing an acyclic graph for the whole video. Every line corresponds to a single track that is encoded by four numbers separated by a space:

L B E P where

L - a unique label of the track (label of markers, 16-bit positive value)

B - a zero-based temporal index of the frame in which the track begins

E - a zero-based temporal index of the frame in which the track ends

P - label of the parent track (0 is used when no parent is defined)

Example: Imagine a sequence of five frames. An object with label 1 exists in the first three frames. Then, a division event occurs in the fourth frame and daughter objects (with labels 2 and 3) exist until the end of the sequence. The corresponding track file contains the following three lines:

```
1 0 2 0
```

```
2 3 4 1
```

```
3 3 4 1
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Reference segmentation annotations (2D real datasets)

man_segT.tif - 16-bit multi-page tiff file (segmented objects have unique positive labels that are not necessarily propagated over time, background has zero label). It contains reference segmentation for the corresponding original image tT.tif. In the case of gold segmentation truth, only selected frames are annotated (i.e., the man_segT.tif file does not have to be provided for every tT.tif file), but not all objects have to be segmented in them because of their counts. In the case of silver segmentation truth, all frames with the existing reference tracking annotation tend to be completely annotated. Nevertheless, some objects may be missing there due to their difficulty in being segmented automatically. If that involves all objects in a particular frame, the reference segmentation annotation is not released at all.

Reference segmentation annotations (3D real datasets)

man_seg_T_Z.tif (gold segmentation truth only) - 16-bit multi-page tiff file (segmented objects have unique positive labels that are not necessarily propagated over time, background has zero label). It contains reference segmentation for the Z-th slice from the corresponding original image tT.tif. Not all objects have to be segmented. The man_seg_T_Z.tif file does not have to be provided for every slice of each tT.tif file. Only the slices with non-empty reference segmentation are released.

man_segT.tif - 16-bit multi-page tiff file (segmented objects have unique positive labels that are not necessarily propagated over time, background has zero label). It contains reference segmentation for the corresponding original image tT.tif. In the case of gold segmentation truth, only selected frames are annotated (i.e., the man_segT.tif file does not have to be provided for every tT.tif file). However, in those frames, all objects are segmented. In the case of silver segmentation truth, all frames tend to be completely annotated. Nevertheless, some objects may be missing there due to their difficulty in being segmented automatically. If that involves all objects in a particular frame, the reference segmentation annotation is not released at all.

Reference tracking annotations (computer-generated datasets)

man_trackT.tif - 16-bit multi-page tiff file (markers have unique positive labels propagated over time, background has zero label). It contains ground truth markers for the corresponding original image tT.tif. The man_trackT.tif file is provided for every tT.tif file.

man_track.txt - A text file representing an acyclic graph for the whole video. Every line corresponds to a single track that is encoded by four numbers separated by a space (see **Reference tracking annotations (real datasets)** for further details).

Reference segmentation annotations (computer-generated datasets)

man_segT.tif - 16-bit multi-page tiff file (segmented objects have unique positive labels that are not necessarily propagated over time, background has zero label). It contains ground truth segmentation for the corresponding original image tT.tif. All objects are segmented. The man_segT.tif file is provided for every tT.tif file.

Segmentation-and-tracking results (Cell Tracking Benchmark)

maskT.tif - 16-bit multi-page tiff file (segmented and tracked objects have unique positive labels propagated over time, background has zero label). It contains segmented and tracked objects for the corresponding original image tT.tif. The maskT.tif file is provided for every tT.tif file.

res_track.txt - A text file representing an acyclic graph for the whole video. Every line corresponds to a single track that is encoded by four numbers separated by a space (see **Manual tracking (real datasets)** for further details).

It is the responsibility of each participant to provide results only for those objects that lie at least partly within the field of interest (FOI) for a particular dataset. The FOI specification is described in detail in [Annotation procedure.pdf](#).

In the case of Fluo-N3DL-DRO, Fluo-N3DL-TRIC, and Fluo-N3DL-TRIF, it is the responsibility of each participant to provide results only for those lineages of objects that are uniquely determined by the tracking markers available in man_track000.tif under Fluo-N3DL-DRO/ON_GT/TRA, Fluo-N3DL-TRIC/ON_GT/TRA, and Fluo-N3DL-TRIF/ON_GT/TRA, respectively.

Segmentation-only results (Cell Segmentation Benchmark)

maskT.tif - 16-bit multi-page tiff file (segmented objects have unique positive labels within individual frames, but the labels do not have to be propagated over time, background has zero label). It contains segmented objects for the corresponding original image tT.tif. The maskT.tif file is provided for every tT.tif file.

It is the responsibility of each participant to provide results only for those objects that lie at least partly within the field of interest (FOI) for a particular dataset. The FOI specification is described in detail in [Annotation procedure.pdf](#).

In the case of Fluo-N3DL-DRO, Fluo-N3DL-TRIC, and Fluo-N3DL-TRIF, all extra objects detected and segmented will automatically be filtered out based on the lineages of objects that are uniquely determined by the tracking markers available in man_track000.tif under Fluo-N3DL-DRO/ON_GT/TRA, Fluo-N3DL-TRIC/ON_GT/TRA, and Fluo-N3DL-TRIF/ON_GT/TRA, respectively. Therefore, all extra detected and segmented objects will not be penalized at all.

Segmentation-and-tracking results (Cell Linking Benchmark)

maskT.tif - 16-bit multi-page tiff file (segmented and tracked objects have unique positive labels propagated over time, background has zero label). It contains segmented and tracked objects for the corresponding original image tT.tif. The maskT.tif file is provided for every tT.tif file.

res_track.txt - A text file representing an acyclic graph for the whole video. Every line corresponds to a single track that is encoded by four numbers separated by a space (see **Manual tracking (real datasets)** for further details).

it is strictly forbidden to completely resegment the original image data to identify missing object instances in the given input set of imperfect/perfect segmentation masks. Instead, such instances can only be identified by automated analysis of intermediate tracking results and segmented by local processing of the original image data in their vicinity. Furthermore, it is the responsibility of each participant to provide results only for those objects that lie at least partly within the field of interest (FOI) for a particular dataset. The FOI specification is described in detail in [Annotation procedure.pdf](#).