T-Area-Marker for Scientific Images

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Abstract

Labeled images are one of the most important means of scientific communication and education. However, traditional markers (arrows, lines) are point markers; do not include information about how large the feature is. We designed an efficient marker system for labeling scientific images (electron or light microscopy, CT, MRI, ultrasonography, camera pictures, etc), called the "T Area Marker, (TAM)". The basic TAM marker looks like a "T", composed of a line segment and a small tick on one end; it defines an imagined circle that stands on the tickless end and the diameter of the circle is equal to the length of the line segment. Thus the TAM can define an exact area rather than a single point; and the imagined circle does not break the continuity of the image (unlike traditional visible circles, rectangles, etc). A TAM with N ticks (N>1) means the diameter equals to N times the length of TAM. A TAM may also have a tail and/or several tail branches to define translation of the imagined circle, thus define complicated areas. tAreaMarker.py is free software that combines the drawing and reading of TAMs, although in most cases TAMs are easily interpreted without computer assistance.

Full Text

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Abstract

Labeled images are essential for scientific communication and education. However, conventional markers such as arrows and lines are point-based and provide no information about the size of the labeled feature. To address this limitation,

we developed the T Area Marker (TAM), an efficient system for annotating scientific images including electron and light microscopy, CT, MRI, ultrasonography, and conventional photographs. The basic TAM resembles the letter "T" and consists of a shaft with a small tick at one end. It defines an implicit circle located at the tickless end, where the circle' s diameter equals the shaft length. This design allows TAMs to specify precise regions rather than single points, while the implied circle preserves image continuity—unlike traditional visible shapes such as circles or rectangles. A TAM with N ticks (N>1) indicates that the target diameter is N times the shaft length. TAMs may also include a tail and/or multiple tail branches to indicate translation of the implied circle, enabling annotation of complex regions. The tAreaMarker.py software provides tools for drawing and interpreting TAMs, though in most cases TAMs can be understood without computational assistance.

Main Text

Labeled images are fundamental to scientific communication and education. However, traditional markers are often inadequate. For example, Tomer et al. [1] used arrows and lines as point markers, which convey no information about feature size. Conversely, the rectangle in Fig. 1 [Figure 1: see original paper] surrounds the target area, breaking image continuity.

Fig. 1 [Figure 1: see original paper]. Example of traditional markers used to label a scientific image. Interpretation of these labels is sometimes challenging.

To facilitate more accurate image labeling, we designed the T Area Marker (TAM) and developed the companion software tAreaMarker.py.

Fig. 2 [Figure 2: see original paper]. Explanations of T Area Markers (TAM). (A) The basic TAM resembles the letter "T" or a nail, comprising a shaft and a tick at one end. (B) The marker defines an implicit circular region at the tickless end, with the circle's diameter equal to the shaft length. (C) For very small features, the marker becomes short and may be difficult to see. (D) A tail may be added for visibility; this "tail stem" extends the shaft. (E) The tail can be bent to create a "tail branch," which must be separated from the tick by a tail stem. (F) For large objects, multiple ticks indicate the diameter is a multiple of shaft length. (G) Multi-tick markers may also have tails. (H) TAMs can annotate complex, non-circular regions using tail branches to indicate extension beyond the implied circle and consequent markers (unlabeled) to continue the annotation. (I) Some consequent markers may lack tails. (J) TAMs for a J-shaped area.

The basic TAM resembles a "T" or a nail, comprising a shaft and a tick at one end. As illustrated in Fig. 2B, this marker defines an implicit circular region at the tickless end, with the circle' s diameter equal to the shaft length.

When labeling very small features, the marker itself becomes short and poten-

tially difficult to see (Fig. 2C). To improve visibility, a tail may be added (Fig. 2D). This extension of the shaft, called a "tail stem," is easily distinguished from the shaft because the label letter always appears on the side opposite the target area.

The tail can be bent to create a "tail branch" (Fig. 2E), which must be separated from the tick by a tail stem. Tail branches help prevent labels from obscuring critical image regions.

For larger objects, a TAM may feature two or more ticks (Fig. 2F), indicating that the target diameter is multiple times the shaft length. Such markers may also include a tail (Fig. 2G).

A marker without any tick (Fig. 3C [Figure 3: see original paper]) has two possible meanings: either the target area represents a boundary without depth, or the area extends infinitely in the indicated direction (downward in Fig. 3C).

TAMs can also annotate non-circular regions (Fig. 2H). The marker near label "H" has a single tail branch pointing upward (away from its label), indicating the target area exceeds the TAM-defined circular region and extends in the direction of the tail branch. The adjacent marker above it features two tail branches pointing up and down but no label, marking it as a "consequent marker" that continues the complex region annotation. The topmost marker has one downward-pointing tail branch and no label, serving as the terminating consequent marker.

While some consequent markers may lack tails (Fig. 2I), both starting and ending markers must have tail branches. Fig. 2J demonstrates TAMs annotating a J-shaped area. In some cases, a single consequent marker may appear without explicit start or end markers (Figs. 3A, 3B), in which case it must include a label.

The tAreaMarker software (available at https://sourceforge.net/projects/tareamarker/files/ as tAreaMarker15.zip) facilitates drawing and reading TAMs. Fig. 3 shows application examples in skin histology images. Fig. 3C depicts a shaft-only marker (no tick or tail), indicating an area extending infinitely in the downward direction. Figs. 3E and 3F demonstrate that basic TAMs without tails suffice for clearly bounded areas, making most practical TAM annotations quite concise.

For software-assisted reading of a three-tick TAM (Fig. 3G), users scroll the mouse wheel to set "N times" to 3, then right-click-drag from the tickless end to the ticked end to display a temporary circle showing the target area. Precise cursor alignment is facilitated by pixel-by-pixel movement using keyboard arrow keys. Pressing Ctrl toggles the temporary circle' s visibility, and right-clicking anywhere deletes it. The same procedure creates new TAMs (see supplementary materials for details).

Fig. 3. Example of TAMs labeling a skin histology image. A: stratum corneum, B: epidermis, C: dermis, D: hair follicle, E: hair follicle, F: sebaceous gland and

hair follicle, G: sebaceous gland, H: sweat gland, I: sweat duct, J: infiltrating inflammatory cells.

References

1. Tomer, R., Khairy, K., Amat, F. & Keller, P.J. Quantitative high-speed imaging of entire developing embryos with simultaneous multiview light-sheet microscopy. *Nat. Methods* 9, 755-763 (2012).

Note: Figure translations are in progress. See original paper for figures.