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IF THIS DOCUMENT IS PRINTED TO SCALE
THE LENGTH OF THIS LINE WILL BE 1.0 INCH

Limits of Human Visual Acuity and Consequences on Sequence Visualization

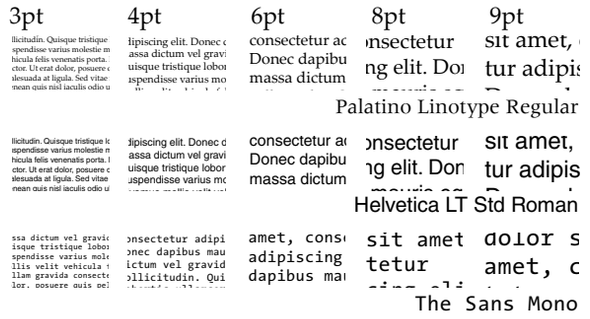
Limitations in print resolution, visual acuity and display technology impose a minimum resolution at which data can be legibly displayed. The resolving power of the eye is approximately 50 cycles per degree [1] (0.1 mm or 0.3 pt at a distance of 30 cm). This is typically lower than the resolution of printers and displays — the limitation of our visual system must be respected.

POINT – A UNIT OF LENGTH

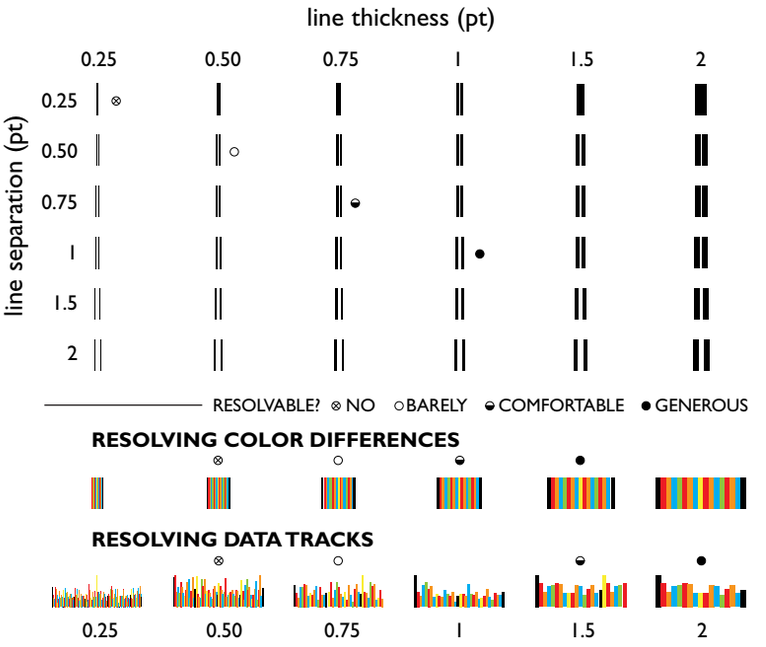
Common unit of size in print is the *point* (*pt*). This unit is used to describe line width and type size, and to define artwork requirements.

1 point	=	1/72 inch	0.0353 cm
12 points	= 1 pica	1/6 inch	0.423 cm

For example, *Genome Research* requires type to be between 8 and 10 pt, and line weight at least 0.25 pt [2]. Note that this requirement exceeds visual acuity limits.

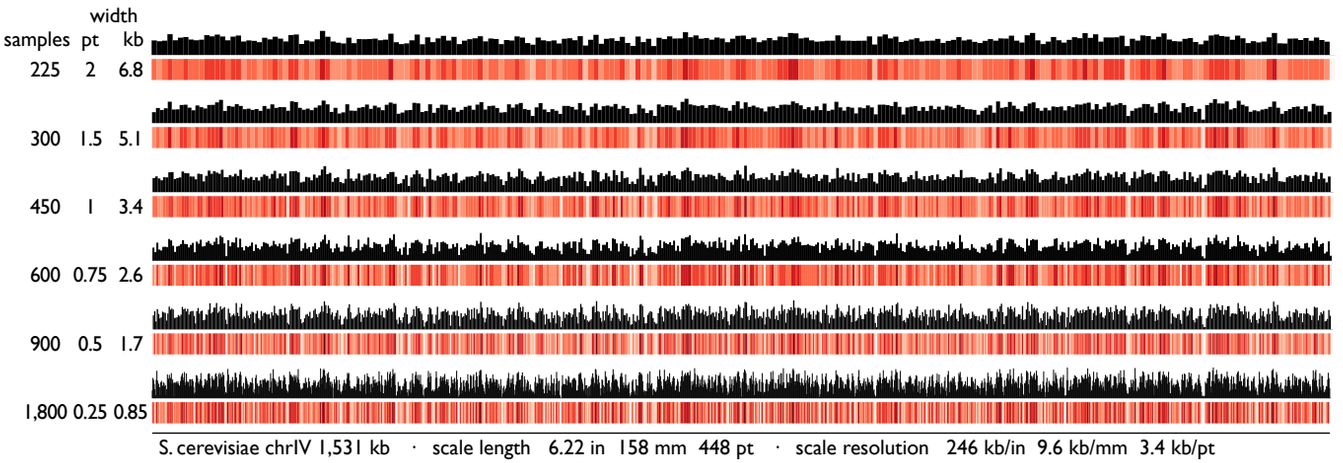


RESOLVING DETAIL



Consider needing to display the longest *S. cerevisiae* chromosome (chrIV 1,531kb) in a journal which has a maximum figure size of 158 mm (6.22 in, 448 pt). With an artwork limit of 0.25 pt, the smallest sequence fragment you can print is 0.85 kb. However, given that the smallest element size you can see and comfortably resolve is ~0.75 pt, you are limited to fragments of 2.6 kb.

When displaying larger genomes (e.g. human 3.10 Gb, mouse 2.65 Gb, rat 2.72 Gb) with chromosomes up to 249,250 kb (human chr1), you are limited to 125, 250 and 500 kb divisions when using 0.25, 0.50 and 1 pt elements, respectively.



AS A RULE OF THUMB, YOU SHOULD DIVIDE YOUR SCALE INTO NO MORE THAN 500 INTERVALS. THIS CORRESPONDS TO 1 PT ON A NATURE JOURNAL FIGURE, 4 PIXELS ON A 1920 HORIZONTAL RESOLUTION DISPLAY, OR 2 PIXELS ON A TYPICAL LCD PROJECTOR.

[1] en.wikipedia.org/wiki/Eye#Visual_acuity [2] genome.cshlp.org/site/misc/ifora_digartsubm.xhtml [3] www.nature.com/nature/authors/gta/