Nomograms

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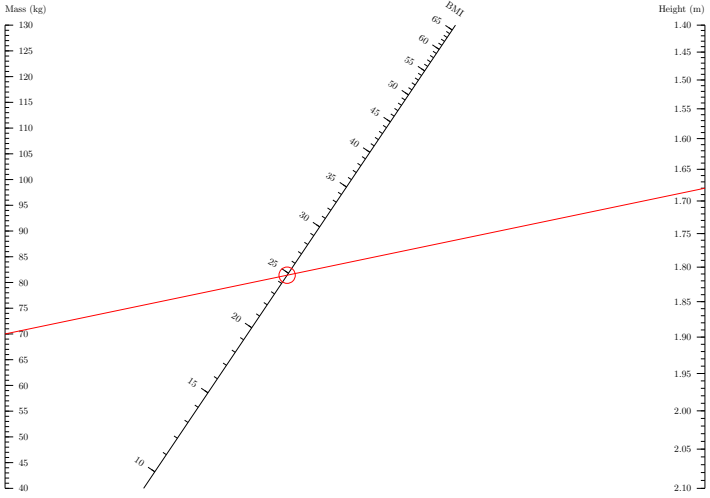
What is a nomogram?



A minute of maths

If you have three points (x_1, y_1), (x_2, y_2), (x_3, y_3) and the determinant

$$\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = 0$$

then the points lie on the same line.

Nomogram strategy:

Express equation as zero determinant.

Example

BMI is $B = M/H^2$ and this is equivalent to the determinant:

$$\begin{vmatrix} 0 & M & 1 \\ 1 & -H^2 & 1 \\ B/(B+1) & 0 & 1 \end{vmatrix} = 0$$

Points $(0, M)$, $(1, -H^2)$, and $(B/(B+1), 0)$ lie on the same line.

Transforming

Initial formulation is often unsightly. Use projective transformation to take four corners of an ugly quadrilateral to any four nicer points (e.g. to a square filling the page).
For BMI this was used (following some matrix algebra):

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \frac{1}{\frac{-1488.35}{1530}x + 1} \begin{bmatrix} \frac{-1906.295}{1530}x + 2 \\ \frac{9857.79}{1530}x + \frac{17}{90}y - \frac{50}{9} \end{bmatrix}$$

How to actually draw it?

GWBasic?

e.g. `LINE (0,100)-(639,100)`. Appealing but obsolete.

PyNomo?

Awesome but couldn't work out how to do what I wanted.

PostScript/MetaPost/TikZ

General-purpose programming is hard!

PyX?

YES!

Minimal boilerplate

```
from pyx import *
c = canvas.canvas()
[...actual drawing commands...]
pg = document.page(c)
doc = document.document([pg])
doc.writePDFfile("doc")
```

Simple drawing commands

Red line from (x1,y1) to (x2,y2) (default units are cm):

```
c.stroke(path.line(x1,y1,x2,y2),[color.rgb.red])
```

Circle, radius 1 cm, centre at (x,y):

```
c.stroke(path.circle(x,y,1))
```

Write "Hello world!" at (x,y), rotated 45°:

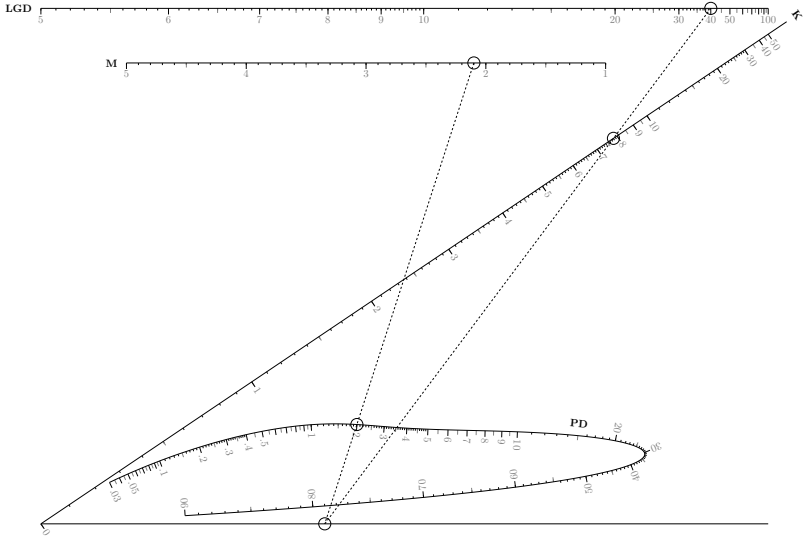
```
c.text(x,y,"Hello world!",[trafo.rotate(45)])
```

The equation I wanted to plot

Actually used by bankers(!!).

$$K = LGD \times \left[\Phi \left(\frac{\Phi^{-1}(PD) + \Phi^{-1}(0.999)\sqrt{\frac{.12\left(e^{-50PD}+1\right)-.24e^{-50}}{1-e^{-50}}}}{\sqrt{1-\frac{.12\left(e^{-50PD}+1\right)-.24e^{-50}}{1-e^{-50}}}} \right) - PD \right] \times \frac{1+(M-2.5)(0.11852-0.05478\ln PD)^2}{1-1.5(0.11852-0.05478\ln PD)^2}$$

The result



Finding out more

- https://pyx-project.org/
- Allcock, Jones, and Michel (1963), The nomogram: the theory and practical construction of computation charts. Available at https://babel.hathitrust.org/cgi/pt?id=mdp.39015000960115.