1

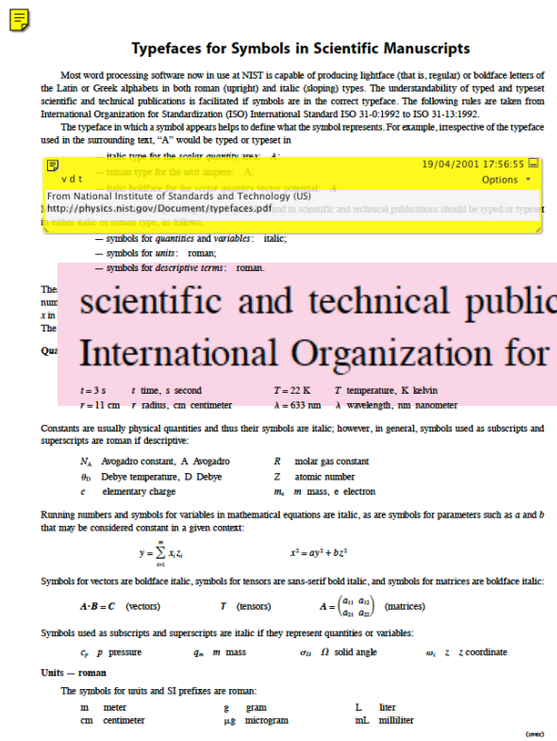
Grandezas físicas, equações, gráficos, tabelas, etc.: normas

Escrita de símbolos matemáticos
Software para escrita de símbolos matemáticos
“Technical drawing”
“Chemical drawing”
Tabelas, gráficos & imagens
Computação simbólica, numérica e muito mais... online

2

Escrita de símbolos matemáticos

http://physics.nist.gov/Document/typefaces.pdf



Typefaces for Symbols in Scientific Manuscripts

Most word processing software now in use at NIST is capable of producing lightface (that is, regular) or boldface letters of the Latin or Greek alphabets in both roman (upright) and italic (sloping) types. The understandability of typed and typeset scientific and technical publications is facilitated if symbols are in the correct typeface. The following rules are taken from International Organization for Standardization (ISO) International Standard ISO 31-0:1992 to ISO 31-13:1992.

The typeface in which a symbol appears helps to define what the symbol represents. For example, irrespective of the typeface used in the surrounding text, "A" would be typed or typeset in

— roman type for the unit ampere: A;

— symbols for *quantities* and *variables*: italic;

— symbols for *units*: roman;

— symbols for *descriptive terms*: roman.

$t = 3$ s t time, s second $T = 22$ K T temperature, K kelvin

$r = 11$ cm r radius, cm centimeter $\lambda = 633$ nm λ wavelength, nm nanometer

Constants are usually physical quantities and thus their symbols are italic; however, in general, symbols used as subscripts and superscripts are roman if descriptive:

N_A Avogadro constant, A Avogadro R molar gas constant

θ_D Debye temperature, D Debye Z atomic number

e elementary charge m_e m mass, e electron

Running numbers and symbols for variables in mathematical equations are italic, as are symbols for parameters such as a and b that may be considered constant in a given context:

$$y = \sum_{i=1}^{n} x_i z_i \qquad x^2 = ay^2 + bz^2$$

Symbols for vectors are boldface italic, symbols for tensors are sans-serif bold italic, and symbols for matrices are boldface italic:

$\boldsymbol{A} \cdot \boldsymbol{B} = \boldsymbol{C}$ (vectors) T (tensors) $\boldsymbol{A} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$ (matrices)

Symbols used as subscripts and superscripts are italic if they represent quantities or variables:

c_p p pressure q_m m mass σ_{12} Ω solid angle ω_z z z coordinate

Units — roman

The symbols for units and SI prefixes are roman:

m meter g gram L liter

cm centimeter µg microgram mL milliliter

(over)

19/04/2001 17:56:55
v d t
Options
From National Institute of Standards and Technology (US)
http://physics.nist.gov/Document/typefaces.pdf

scientific and technical publications is facilitated if symbols are in the correct typeface. The following rules are taken from International Organization for Standardization (ISO) International Standard ISO 31-0:1992 to ISO 31-13:1992.

http://www.ipq.pt/backhtmlfiles/ipq_mei.htm

Instituto Português da Qualidade

http://www.nist.gov/index.html

The typeface in which a symbol appears helps to define what the symbol represents. For example, irrespective of the typeface used in the surrounding text, "A" would be typed or typeset in

— italic type for the *scalar quantity* area: A;

— roman type for the *unit* ampere: A;

— italic boldface for the *vector quantity* vector potential: $\boldsymbol{A}$.

More specifically, the three major categories of symbols found in scientific and technical publications should be typed or typeset in either italic or roman type, as follows:

— symbols for *quantities* and *variables*: italic;

— symbols for *units*: roman;

— symbols for *descriptive terms*: roman.

"*italic*" = *itálico*

"roman" = redondo

O volt é a unidade de potencial eléctrico. O símbolo da grandeza potencial eléctrico é V e o símbolo da unidade SI é V.

V = 4,5 V

Constants are usually physical quantities and thus their symbols are italic; however, in general, symbols used as subscripts and superscripts are roman if descriptive:

N_A	Avogadro constant, A Avogadro	R	molar gas constant
θ_D	Debye temperature, D Debye	Z	atomic number
e	elementary charge	m_e	m mass, e electron

Running numbers and symbols for variables in mathematical equations are italic, as are symbols for parameters such as *a* and *b* that may be considered constant in a given context:

$$y = \sum_{i=1}^{m} x_i z_i \qquad x^2 = ay^2 + bz^2$$

Symbols for vectors are boldface italic, symbols for tensors are sans-serif bold italic, and symbols for matrices are boldface italic:

$\boldsymbol{A}\cdot\boldsymbol{B}=\boldsymbol{C}$ (vectors) $\quad\mathsf{T}$ (tensors) $\quad\boldsymbol{A}=\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$ (matrices)

Symbols used as subscripts and superscripts are italic if they represent quantities or variables:

c_p p pressure q_m m mass σ_Ω Ω solid angle ω_z z z coordinate

Units — roman

The symbols for units and SI prefixes are roman:

m	meter	g	gram	L	liter
cm	centimeter	µg	microgram	mL	milliliter

SI prefixes

1000^m	10^n	Prefix	Symbol	Since[1]	Short scale	Long scale	Decimal
1000^8	10^{24}	yotta	Y	1991	Septillion	Quadrillion	1 000 000 000 000 000 000 000 000
1000^7	10^{21}	zetta	Z	1991	Sextillion	Trilliard	1 000 000 000 000 000 000 000
1000^6	10^{18}	exa	E	1975	Quintillion	Trillion	1 000 000 000 000 000 000
1000^5	10^{15}	peta	P	1975	Quadrillion	Billiard	1 000 000 000 000 000
1000^4	10^{12}	tera	T	1960	Trillion	Billion	1 000 000 000 000
1000^3	10^9	giga	G	1960	Billion	Milliard	1 000 000 000
1000^2	10^6	mega	M	1960	Million		1 000 000
1000^1	10^3	kilo	k	1795	Thousand		1 000
$1000^{2/3}$	10^2	hecto	h	1795	Hundred		100
$1000^{1/3}$	10^1	deca	da	1795	Ten		10
1000^0	10^0	*(none)*	*(none)*	NA	One		1
$1000^{-1/3}$	10^{-1}	deci	d	1795	Tenth		0.1
$1000^{-2/3}$	10^{-2}	centi	c	1795	Hundredth		0.01
1000^{-1}	10^{-3}	milli	m	1795	Thousandth		0.001
1000^{-2}	10^{-6}	micro	µ	1960[2]	Millionth		0.000 001
1000^{-3}	10^{-9}	nano	n	1960	Billionth	Milliardth	0.000 000 001
1000^{-4}	10^{-12}	pico	p	1960	Trillionth	Billionth	0.000 000 000 001
1000^{-5}	10^{-15}	femto	f	1964	Quadrillionth	Billiardth	0.000 000 000 000 001
1000^{-6}	10^{-18}	atto	a	1964	Quintillionth	Trillionth	0.000 000 000 000 000 001
1000^{-7}	10^{-21}	zepto	z	1991	Sextillionth	Trilliardth	0.000 000 000 000 000 000 001
1000^{-8}	10^{-24}	yocto	y	1991	Septillionth	Quadrillionth	0.000 000 000 000 000 000 000 001

1. The metric system was introduced in 1795 with six prefixes. The other dates relate to recognition by a resolution of the CGPM.
2. The 1948 recognition of the micron by the CGPM was abrogated in 1967.

Portugal, 1 bilião usualmente 10^{12}, fora de contexto técnico-científico

Descriptive terms — roman

Symbols representing purely descriptive terms (for example, the chemical elements) are roman, as are symbols representing mathematical constants that never change (for example, π) and symbols representing explicitly defined functions or well defined operators (for example, $\Gamma(x)$ or div):

Chemical elements:

Ar argon B boron C carbon

Mathematical constants, functions, and operators:

e	base of natural logarithms	$\sum x_i$	$\sum$	sum of	$\ln x$	$\log_e$	natural logarithm of
$\exp x$	exp	exponential of	$\sin x$	sin	sine of	$\lg x$	$\log_{10}$	common (decimal) logarithm of
$\mathrm{d}x/\mathrm{d}t$	d	1st derivative of	$\log_a x$	$\log_a$	logarithm to the base a of	$\mathrm{lb}\, x$	$\log_2$	binary logarithm of

Symbols used as subscripts and superscripts are roman if descriptive:

$\varepsilon_0^{(\mathrm{ir})}$	ir	irrational	E_k	k	kinetic
V_m^l	m	molar, l liquid phase	μ_B	B	Bohr

Sample equations showing correct type

$$F = \frac{q_1\, q_2}{4\pi\varepsilon_0\, r^2}$$

$$F = ma$$

$$pV = nRT$$

$$\varphi_{\mathrm{B}} = x_{\mathrm{B}} V^{*}_{\mathrm{m,B}} / \Sigma x_{\mathrm{A}} V^{*}_{\mathrm{m,A}}$$

$$E_{\mathrm{a}} = RT^2\, \mathrm{d}(\ln k)/\mathrm{d}T$$

$$c_1 = \lambda^{-5}/[\exp(c_2/\lambda T) - 1]$$

$$E = mc^2$$

$$\tilde{p}_{\mathrm{B}} = \lambda_{\mathrm{B}} \lim_{p \to 0} (x_{\mathrm{B}}\, p / \lambda_{\mathrm{B}})$$

$$\frac{\boldsymbol{F}}{Q} = -\,\mathbf{grad}\ V$$

Greek alphabet in roman and italic type

The following table shows the proper form, in both roman and italic type, of the upper-case and lower-case letters of the Greek alphabet.

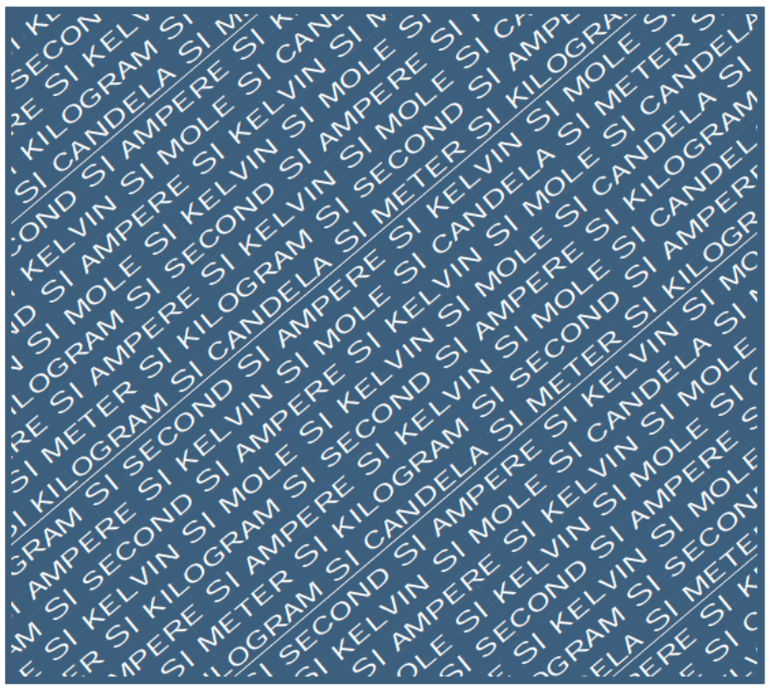
Greek alphabet in roman and italic type

alpha	A	α	A	α
beta	B	β	B	β
gamma	Γ	γ	Γ	γ
delta	Δ	δ	Δ	δ
epsilon	E	ε, ϵ	E	ε, ϵ
zeta	Z	ζ	Z	ζ
eta	H	η	H	η
theta	Θ, Θ[a]	θ, ϑ[b]	Θ, Θ[a]	θ, ϑ[b]
iota	I	ι	I	ι
kappa	K	κ, $\varkappa$[b]	K	κ, $\varkappa$[b]
lambda	Λ	λ	Λ	λ
mu	M	μ	M	μ
nu	N	ν	N	ν
xi	Ξ	ξ	Ξ	ξ
omicron	O	o	O	o
pi	Π	π, ϖ	Π	π, ϖ
rho	P	ρ, [b]	P	ρ, [b]
sigma	Σ	σ	Σ	σ
tau	T	τ	T	τ
upsilon	Υ	υ	Υ	υ
phi	Φ	φ, ϕ	Φ	φ, ϕ
chi	X	χ	X	χ
psi	Ψ	ψ	Ψ	ψ
omega	Ω	ω	Ω	ω

[a] The International Organization for Standardization (ISO) gives only the first of these two letters (see ISO International Standard ISO 31-0:1992).

[b] ISO gives these two letters in the reverse order (see ISO International Standard ISO 31-0:1992).

Mais informação:



Software para escrita de símbolos matemáticos

http://www.dessci.com/en/products/mathtype/

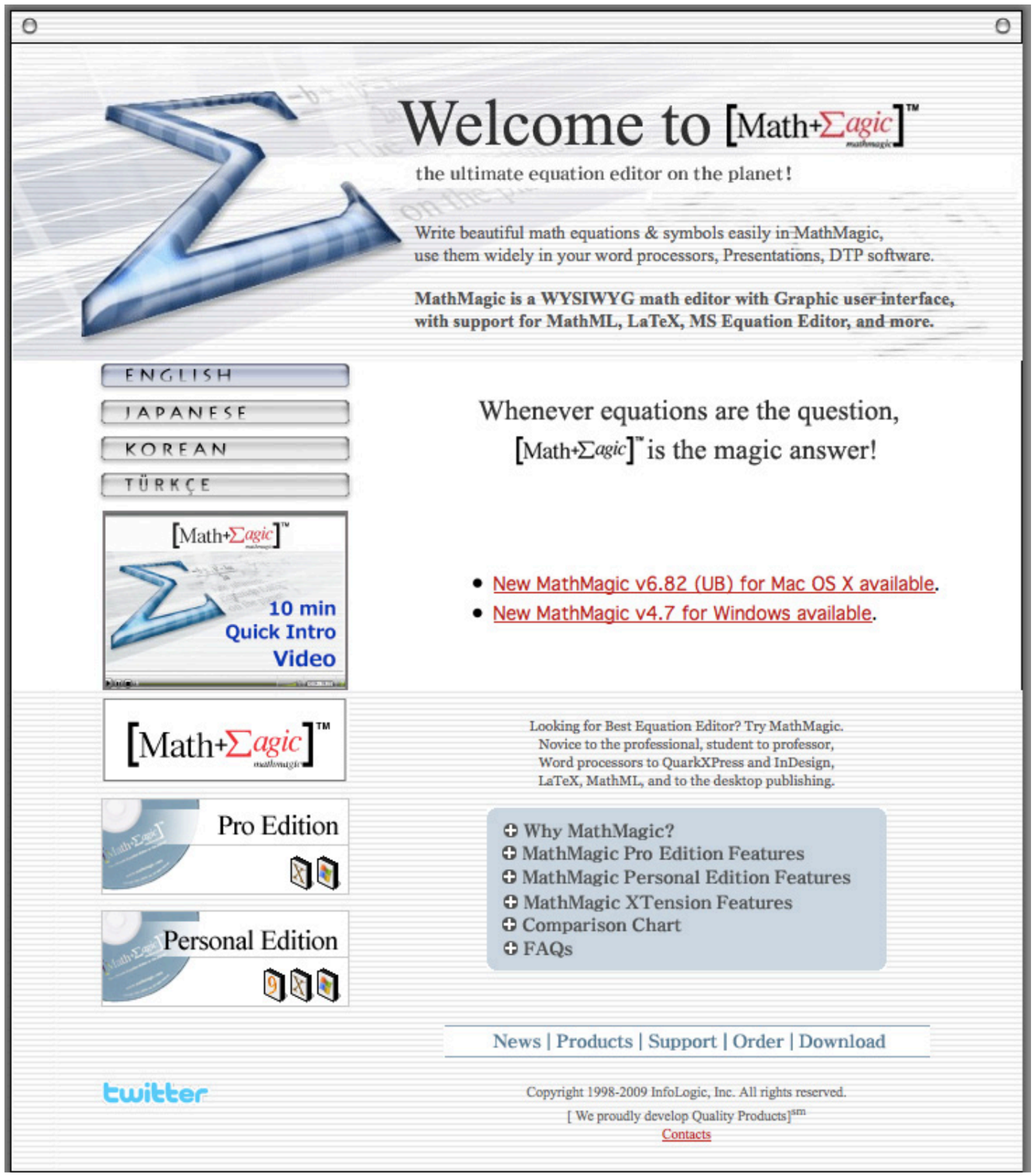
What to expect after installing MathType

You will have 30 days in which to enjoy all of the features of MathType. If you do not purchase MathType within 30 days, it will become MathType Lite. This is exactly like Equation Editor, with the bonus of MathType's fonts and symbols, which you may use with our compliments.

Once you've tried out MathType and like it (we think you will), just come back here to our online store and purchase a product key. Whether you register your copy during or after your trial, you will not need to reinstall. Choose "Unlock MathType" from MathType's Help menu and enter your new product key.

... mais Copy & Paste para outros programas...

http://www.mathmagic.com/



http://en.wikipedia.org/wiki/TeX

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TeX

From Wikipedia, the free encyclopedia

For help displaying mathematical formulae in Wikipedia, see Help:Displaying a formula.

TeX (pronounced /ˈtɛx/ as in Greek, often /tɛk/ in English; written with a lowercase 'e' in imitation of the logo) is a typesetting system designed and mostly written by Donald Knuth.[1] Together with the METAFONT language for font description and the Computer Modern family of typefaces, it was designed with two main goals in mind: to allow anybody to produce high-quality books using a reasonable amount of effort, and to provide a system that would give the exact same results on all computers, now and in the future. Within the typesetting system, its name is formatted as TEX.

TeX is a way to typeset complex mathematical formulae. It has been noted as one of the most sophisticated digital typographical systems in the world.[2] TeX is popular in academia, especially in the mathematics, computer science, and physics communities. It has largely displaced Unix troff, the other favored formatter, in many Unix installations, which use both for different purposes. It is now also being used for many other typesetting tasks, especially in the form of LaTeX and other template packages.

The widely-used MIME type for TeX is `application/x-tex`. TeX is free software.

TeX

Developer(s)	Donald Knuth
Stable release	3.1415926 / March 2008
Written in	Originally WEB
Operating system	Cross-platform
Type	Typesetting
License	Permissive
Website	http://www.tug.org/

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  4.2 Editors

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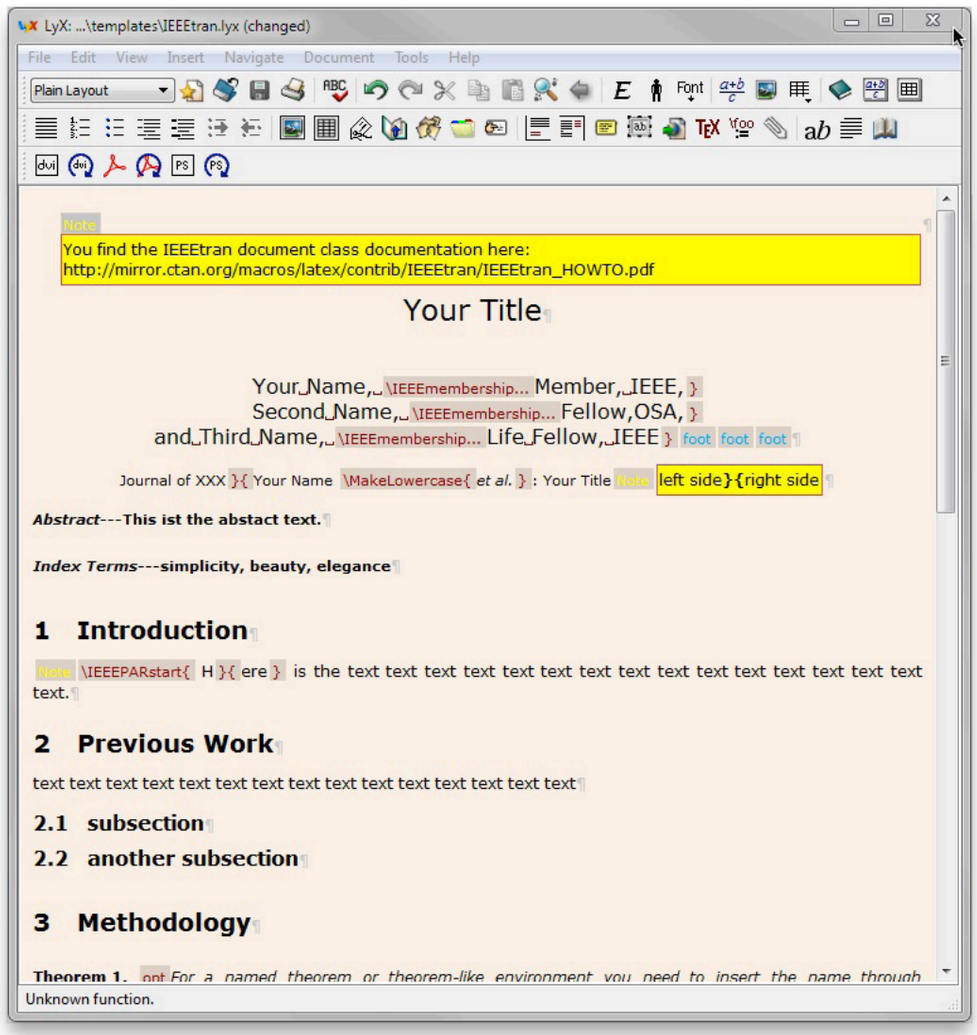
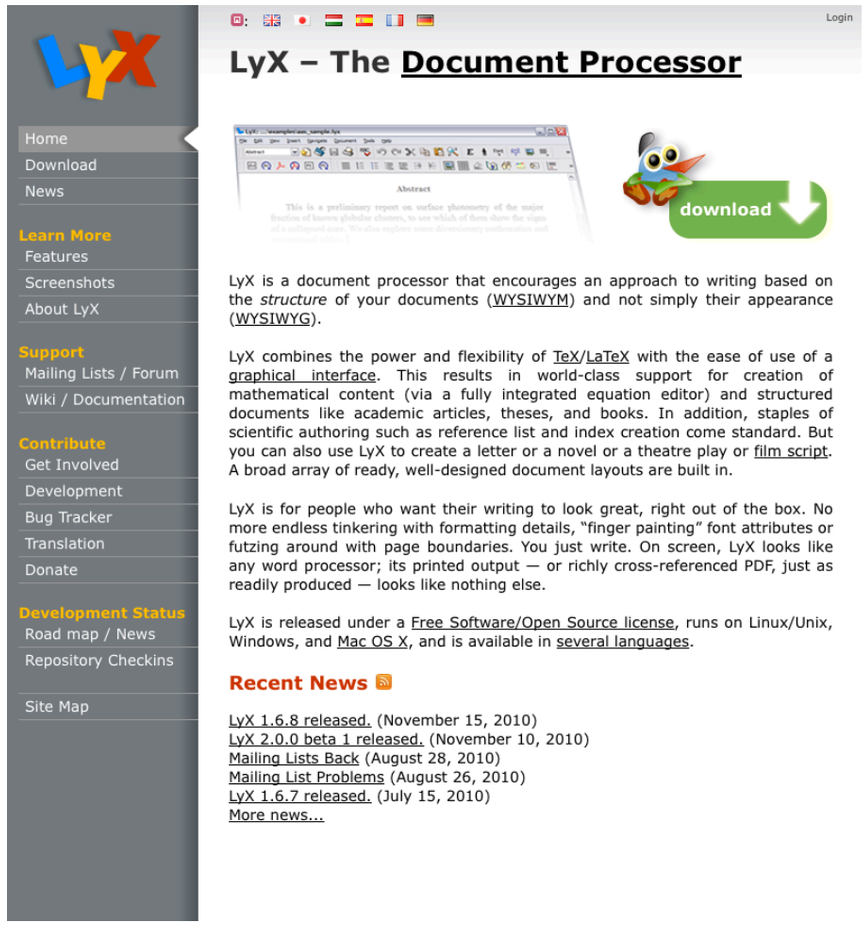
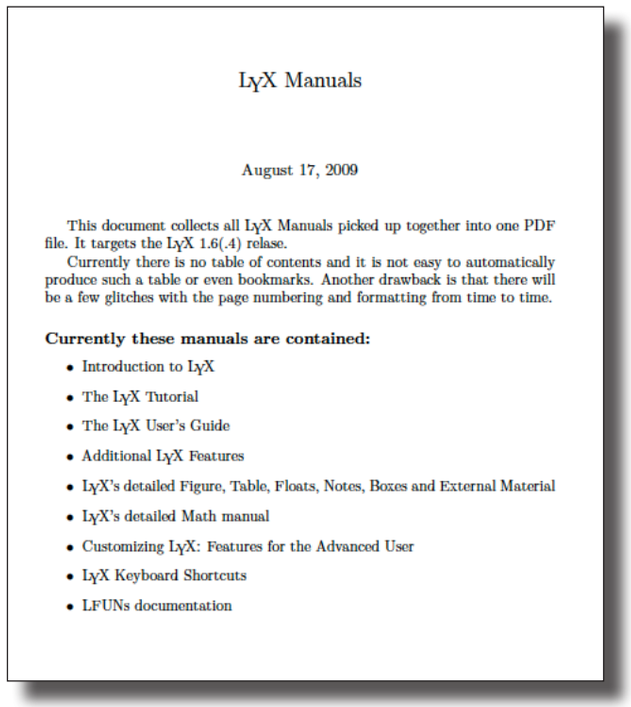
http://www.lyx.org/

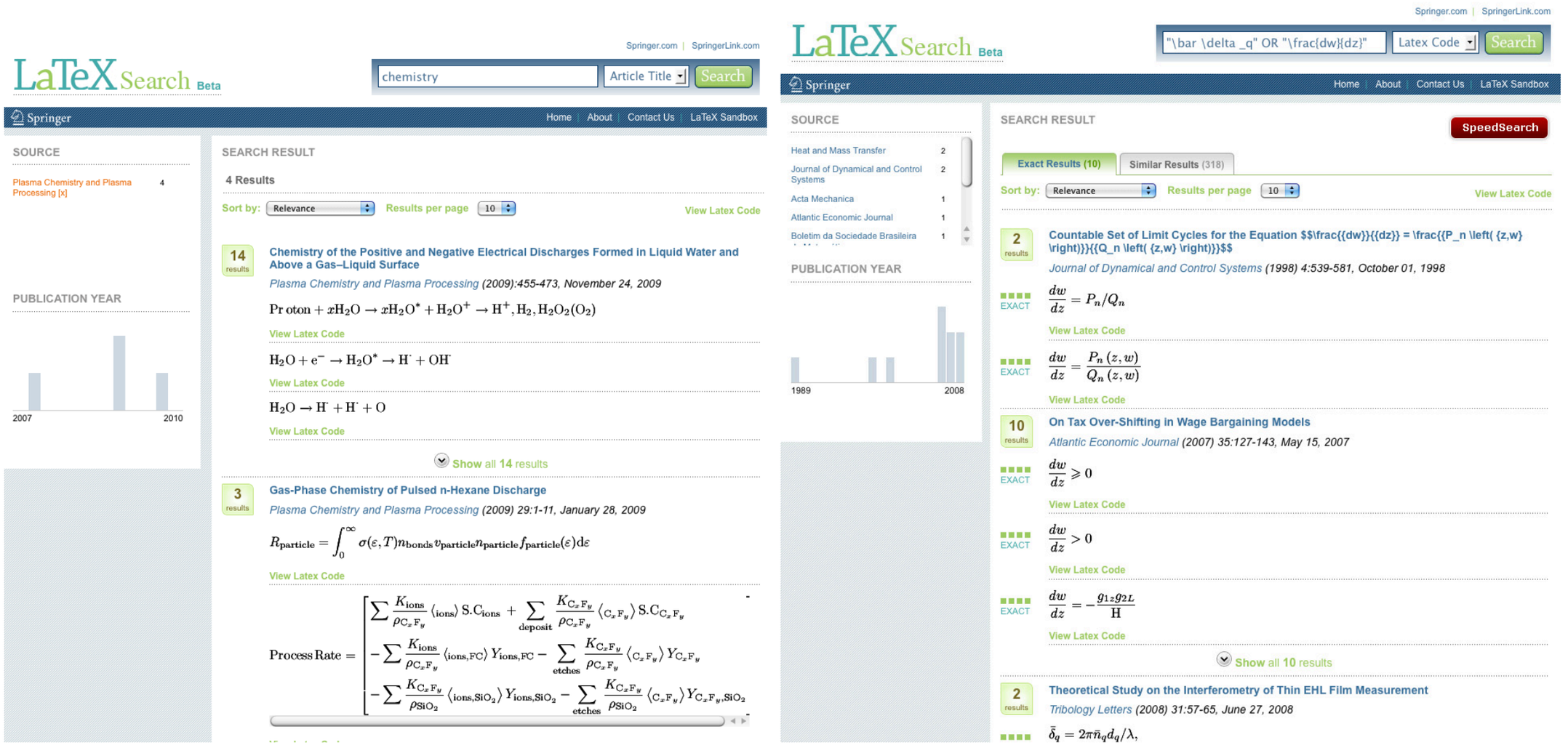






http://www.latexsearch.com

Uma base de dados de expressões matemáticas escritas em LaTex



http://www.tug.org/

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The TeX Users Group (TUG) was founded in 1980 to provide an organization for people who are interested in typography and font design, and/or are users of the TeX typesetting system invented by Donald Knuth.

TUG is a not-for-profit organization by, for, and of its members, also representing the interests of TeX users worldwide. It is nearly entirely member-supported, so if you use any TeX-related programs (TeX, LaTeX, ConTeXt, Metafont, MetaPost, Texinfo, et al.), please consider joining TUG (or another TeX user group). The membership benefits include our journal *TUGboat* (available both in print and online), as well as the TeX software collection TeX Live, proTeXt, MacTeX, and more.

The Comprehensive TeX Archive Network (CTAN) is the primary repository for TeX-related software on the Internet. CTAN has many thousands of items: the TeX Catalogue and CTAN search page can help you find what you need.

If you are new to TeX and are looking for a system to install, or have questions to ask, click here to get started.

Latest CTAN updates XML - PerlTeX - polyglossia - sparklines - datetime - expl3 - memoir - datatool - pstricks-add - prerex

News

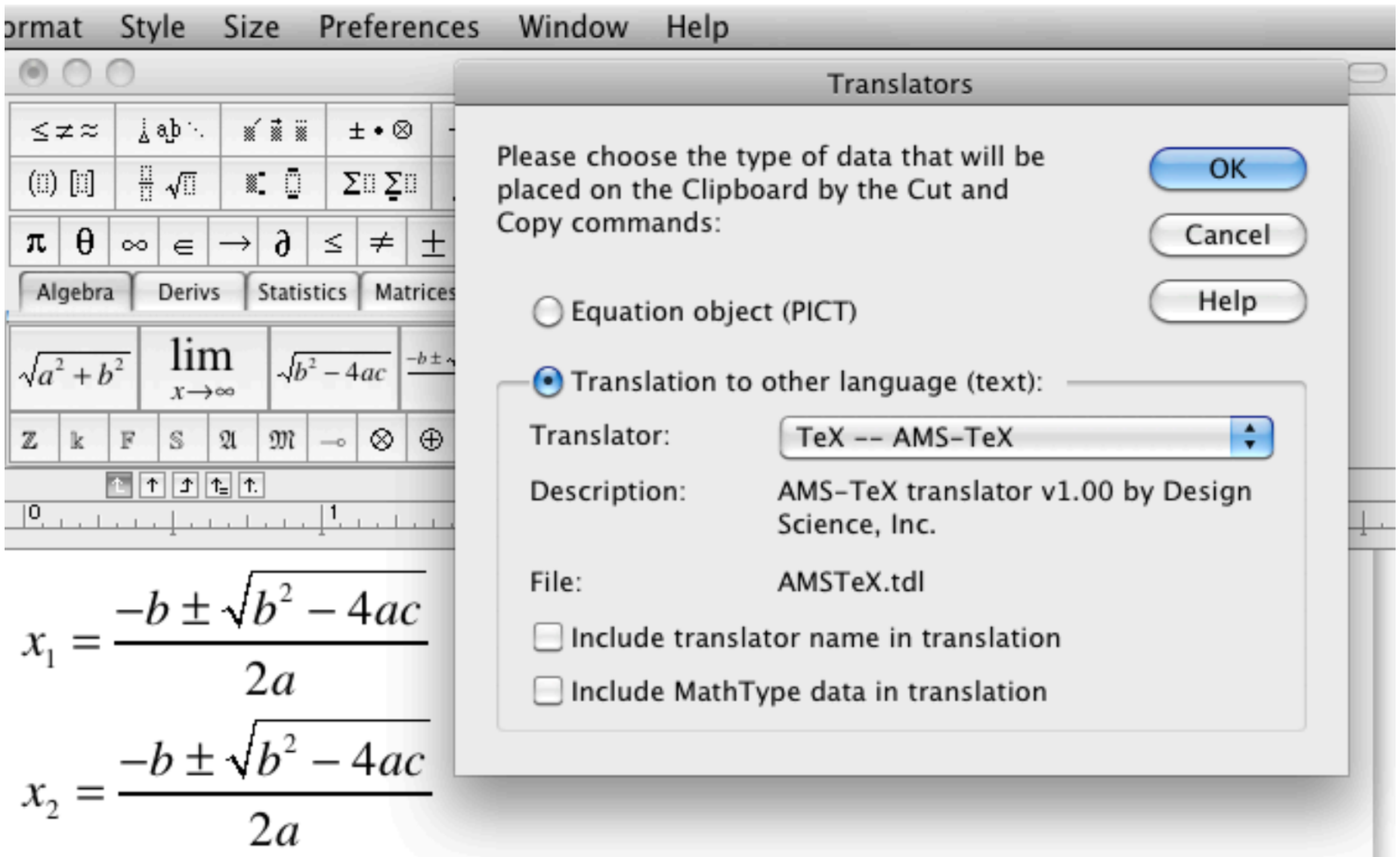
- **TUG 2011 proposals solicited:** TUG is asking for proposals to host the 2011 conference. Deadline: February 1, 2010.
- **TeX Live 2009** and **MacTeX 2009** have been released. They are primarily distributed online through CTAN (TL, MacTeX).
- **TUGboat 29:3**, the TUG 2008 conference proceedings, is now publicly available online. Printed copies are available through the TUG store.
- **Idris Hamid**, who has been instrumental in developing better TeX support for Arabic-script languages, is the latest subject in the Interview Corner. A book of interviews from the first few years of the Interview Corner has been published and can be ordered through TUG or from most online bookstores.
- **TUGboat 30:2** (the TUG'09 proceedings) has been mailed to current TUG members. It is also available online to members and from the TUG store.

Upcoming Events (full calendar)

- **TUG 2010** will be held in San Francisco, California, USA, June 28-30, 2010. This being TeX's 32nd anniversary, Don Knuth and other members of the original Stanford TeX project expect to be present. Registration form, Call for papers.

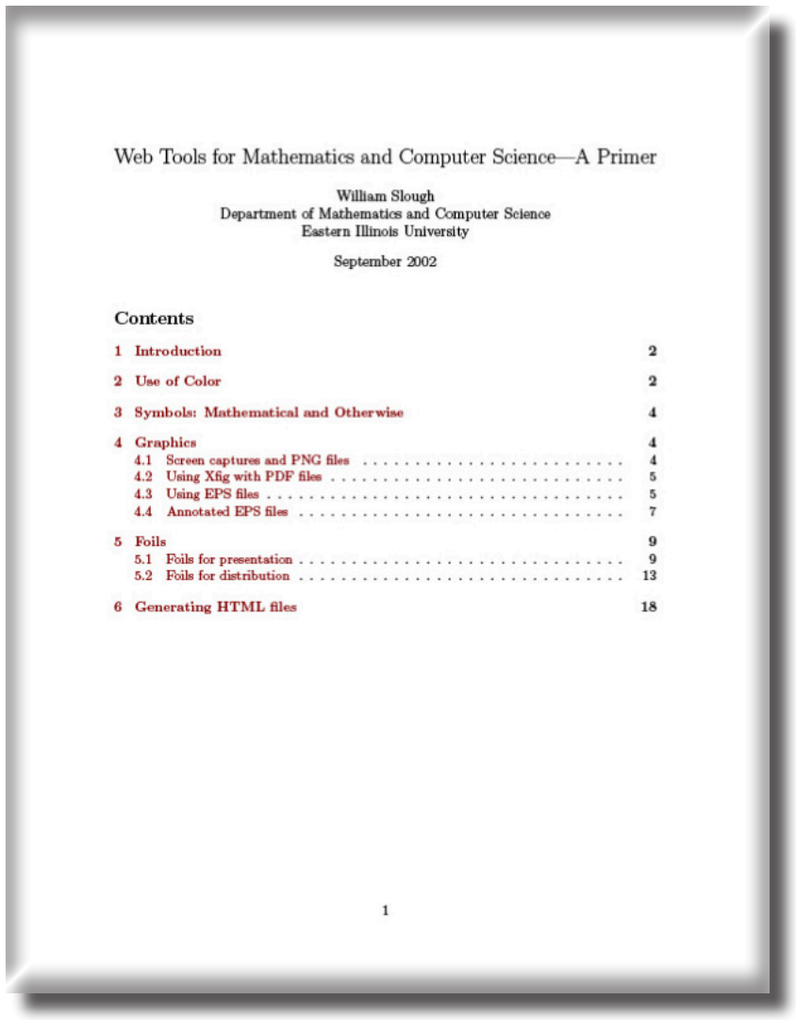
Recent Events (comprehensive meeting list)

- **GuIT 2009**: will be held in Pisa, Italy, October 17, 2009.
- **EuroTeX 2009**: Educational Uses of TeX, was held at the Netherlands Defence College, The Hague, The Netherlands, August 31-September 4, 2009, and also served as the 2009 ConTeXt meeting.
- **TUG 2009** was held at the University of Notre Dame in Indiana, USA, July 28-31, 2009. Lists of presentations and participants are available, as well as videos.




```
$$
\eqalign{
  & x_1  = \frac{{ - b \pm \sqrt {b^2  - 4ac}
}}
{{2a}}  \cr
  & x_2  = \frac{{ - b \pm \sqrt {b^2  - 4ac}
}}
{{2a}} \cr}
$$
```

Mais informação



Web Tools for Mathematics and Computer Science—A Primer

William Slough
Department of Mathematics and Computer Science
Eastern Illinois University

September 2002

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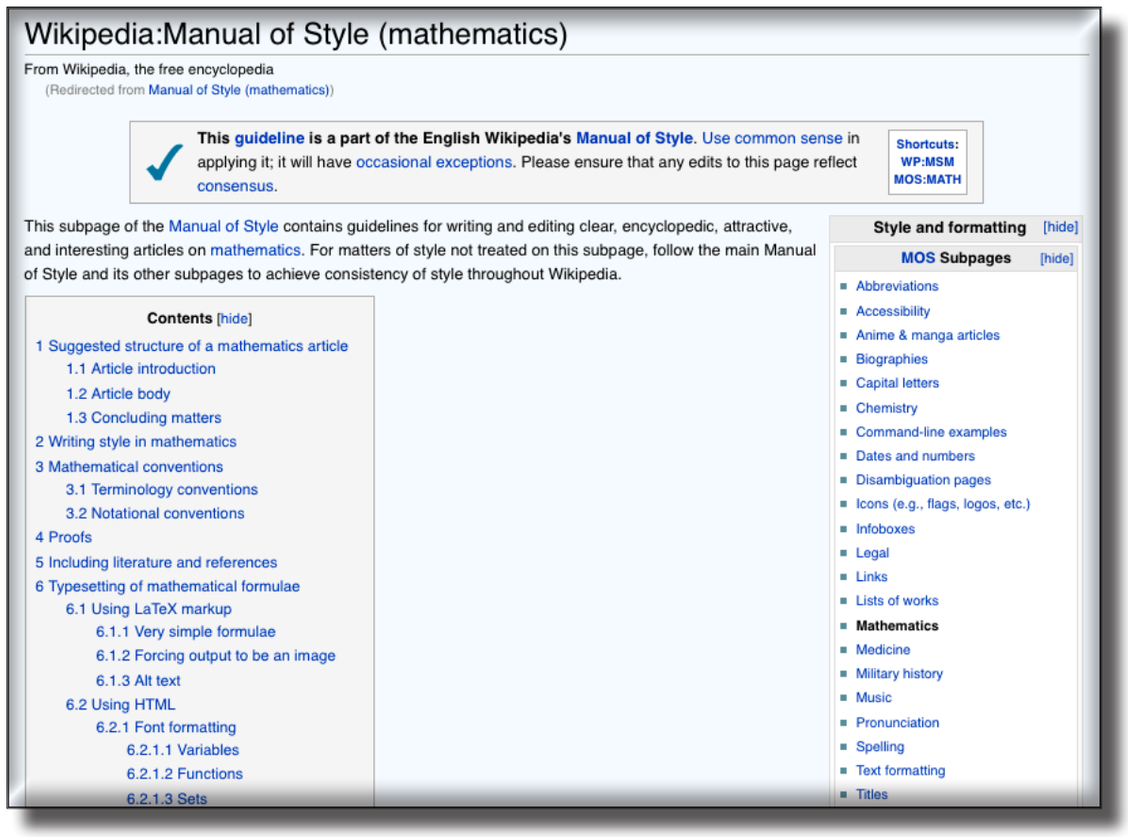

Wikipedia:Manual of Style (mathematics)

From Wikipedia, the free encyclopedia
(Redirected from Manual of Style (mathematics))

This guideline is a part of the English Wikipedia's Manual of Style. Use common sense in applying it; it will have occasional exceptions. Please ensure that any edits to this page reflect consensus.

Shortcuts: WP:MSM MOS:MATH

This subpage of the Manual of Style contains guidelines for writing and editing clear, encyclopedic, attractive, and interesting articles on mathematics. For matters of style not treated on this subpage, follow the main Manual of Style and its other subpages to achieve consistency of style throughout Wikipedia.

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“Technical drawing”

Bitmap

Bitmap

From Wikipedia, the free encyclopedia

For other uses, see Bitmap (disambiguation).

In computer graphics, a **bitmap** or **pixmap** is a type of memory organization or image file format used to store digital images. The term *bitmap* comes from the computer programming terminology, meaning just a *map of bits*, a spatially mapped array of bits. Now, along with *pixmap*, it commonly refers to the similar concept of a spatially mapped array of pixels. Raster images in general may be referred to as bitmaps or pixmaps, whether synthetic or photographic, in files or memory.

In some contexts, the term bitmap implies one bit per pixel, while pixmap is used for images with multiple bits per pixel.[1][2]

Many graphical user interfaces use bitmaps in their built-in graphics subsystems;[3] for example, the Microsoft Windows and OS/2 platforms' GDI subsystem, where the specific format used is the *Windows and OS/2 bitmap file format*, usually named with the file extension of `.BMP` (or `.DIB` for *device-independent bitmap*). Besides BMP, other file formats that store literal bitmaps include InterLeaved Bitmap (ILBM), Portable Bitmap (PBM), X Bitmap (XBM), and Wireless Application Protocol Bitmap (WBMP). Similarly, most other image file formats, such as JPEG, TIFF, PNG, and GIF, also store bitmap images (as opposed to vector graphics), but they are not usually referred to as *bitmaps*, since they use compressed formats internally.

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3 See also
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Pixel storage [edit]

In typical uncompressed bitmaps, image pixels are generally stored with a color depth of 1, 4, 8, 16, 24, 32, 48, or 64 bits per pixel. Pixels of 8 bits and fewer can represent either grayscale or indexed color. An alpha channel (for transparency) may be stored in a separate bitmap, where it is similar to a greyscale bitmap, or in a fourth channel that, for example, converts 24-bit images to 32 bits per pixel.

The bits representing the bitmap pixels may be packed or unpacked (spaced out to byte or word boundaries), depending on the format or device requirements. Depending on the color depth, a pixel in the picture will occupy at least **n/8** bytes, where n is the bit depth.

For an uncompressed, packed within rows, bitmap, such as is stored in Microsoft DIB or BMP file format, or in uncompressed TIFF format, a lower bound on storage size for a n-bit-per-pixel (2^n colors) bitmap, in bytes, can be calculated as:

size = width · height · n/8, where height and width are given in pixels.

In the formula above, header size and color palette size, if any, are not included. Due to effects of row padding to align each row start to a storage unit boundary such as a word, additional bytes may be needed.

Vector object

Vector graphics

From Wikipedia, the free encyclopedia

(Redirected from Vector image)

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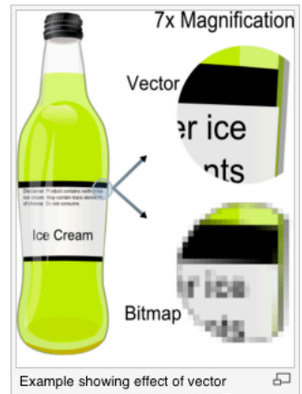
Vector graphics is the use of geometrical primitives such as points, lines, curves, and shapes or polygon(s), which are all based on mathematical equations, to represent images in computer graphics.

Vector graphics formats are complementary to raster graphics, which is the representation of images as an array of pixels, as it is typically used for the representation of photographic images.[1] There are instances when working with vector tools and formats is the best practice, and instances when working with raster tools and formats is the best practice. There are times when both formats come together. An understanding of the advantages and limitations of each technology and the relationship between them is most likely to result in efficient and effective use of tools.



Example showing effect of vector graphics versus raster graphics. The original vector-based illustration is at the left. The upper-right image illustrates magnification of 7x as a vector image. The lower-right image illustrates the same magnification as a bitmap image. Raster images are based on pixels and thus scale with loss of clarity, while vector-based images can be scaled indefinitely without degrading.

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2 Motivation
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5 Printing
6 Vector Illustration
7 3D modelling
8 Formats
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10 References

Overview [edit]

Computer displays are made up from grids of small rectangular cells called pixels. The picture is built up from these cells. The smaller and closer the cells are together, the better the quality of the image, but the bigger the file needed to store the data. If the number of pixels is kept constant, the size of each pixel will grow and the image becomes grainy (pixellated) when magnified, as the resolution of the eye enables it to pick out individual pixels.

Vector graphics files store the lines, shapes and colours that make up an image as mathematical formulae. A vector graphics program uses these mathematical formulae to construct the screen image, building the best quality image possible, given the screen resolution. The

http://en.wikipedia.org/wiki/Technical_drawing

Technical drawing

From Wikipedia, the free encyclopedia

Technical drawing, also known as **drafting**, is the academic discipline of creating standardized technical drawings by architects, interior designers, drafters, design engineers, and related professionals. Standards and conventions for layout, line thickness, text size, symbols, view projections, descriptive geometry, dimensioning, and notation are used to create drawings that are ideally interpreted in only one way.

A person who does drafting is known as a drafter. In some areas this person may be referred to as a drafting technician, draftsperson, or draughtsperson. This person creates technical drawings which are a form of specialized graphic communication. A technical drawing differs from a common drawing by how it is interpreted. A common drawing can hold many purposes and meanings, while a technical drawing is intended to concisely and clearly communicate all needed specifications to transform an idea into physical form.[1]

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1 Methods
- 1.1 Sketching
- 1.2 Manual or by instrument
- 1.3 Computer Aided Design

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- 2.1 Architecture
- 2.2 Engineering
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Drafter at work.

Copying technical drawings in 1973

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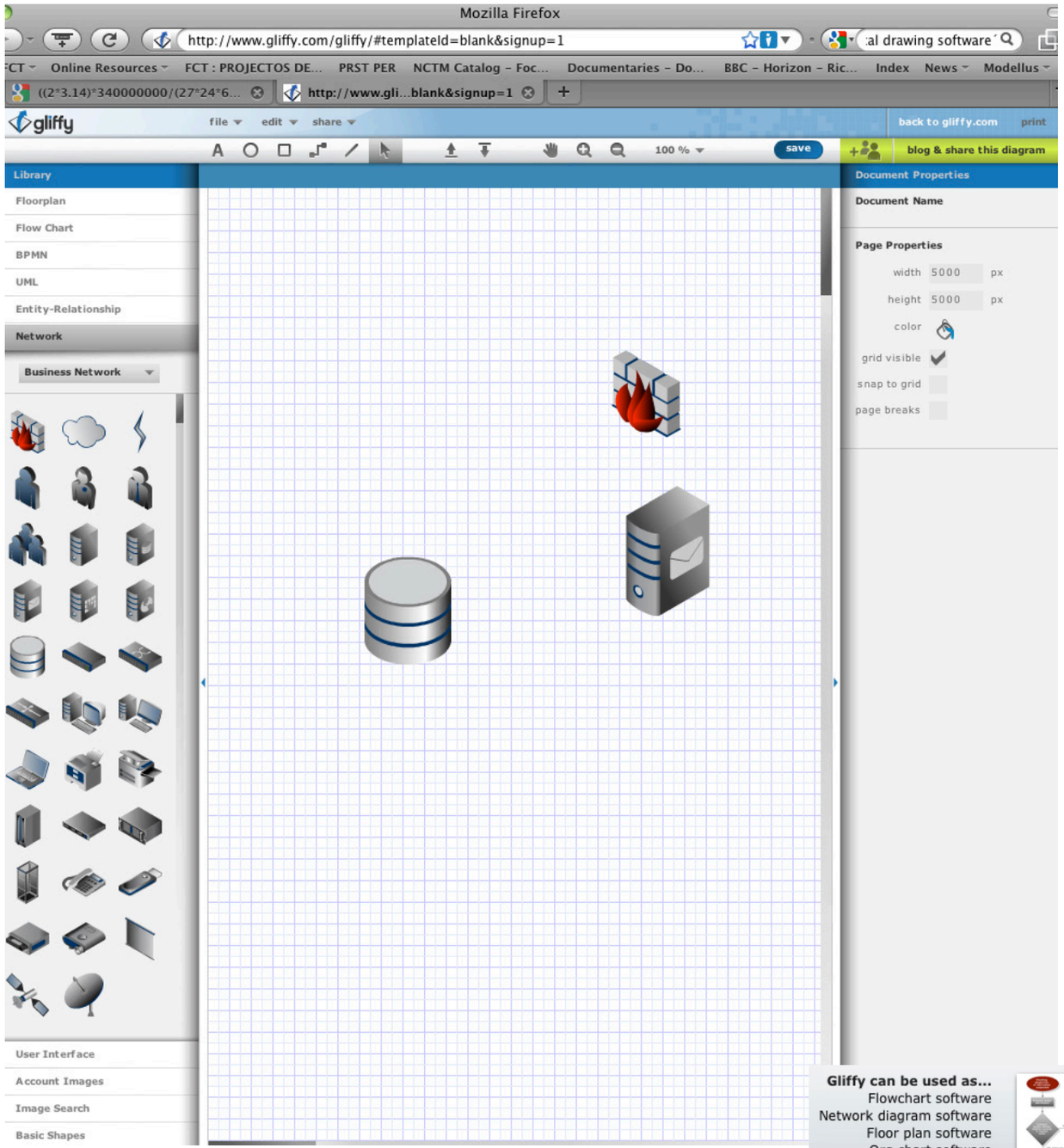

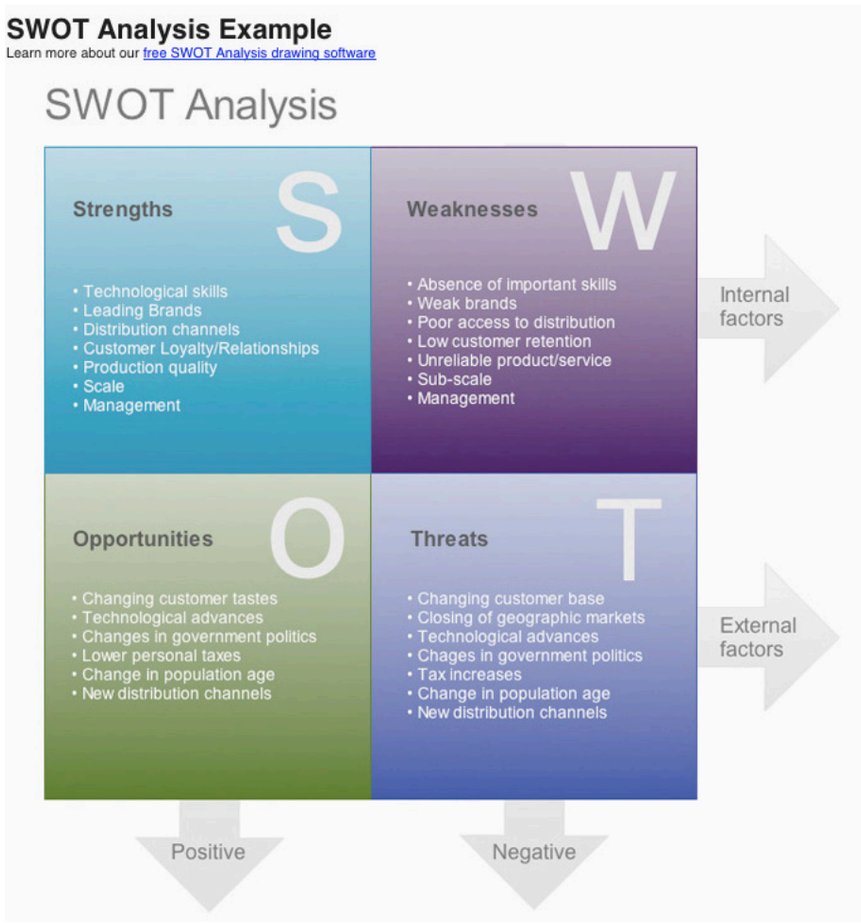

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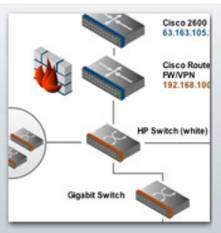

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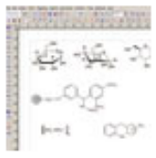

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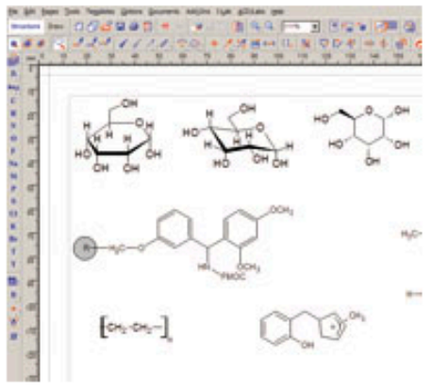

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ACD/Labs, www.acdlabs.com

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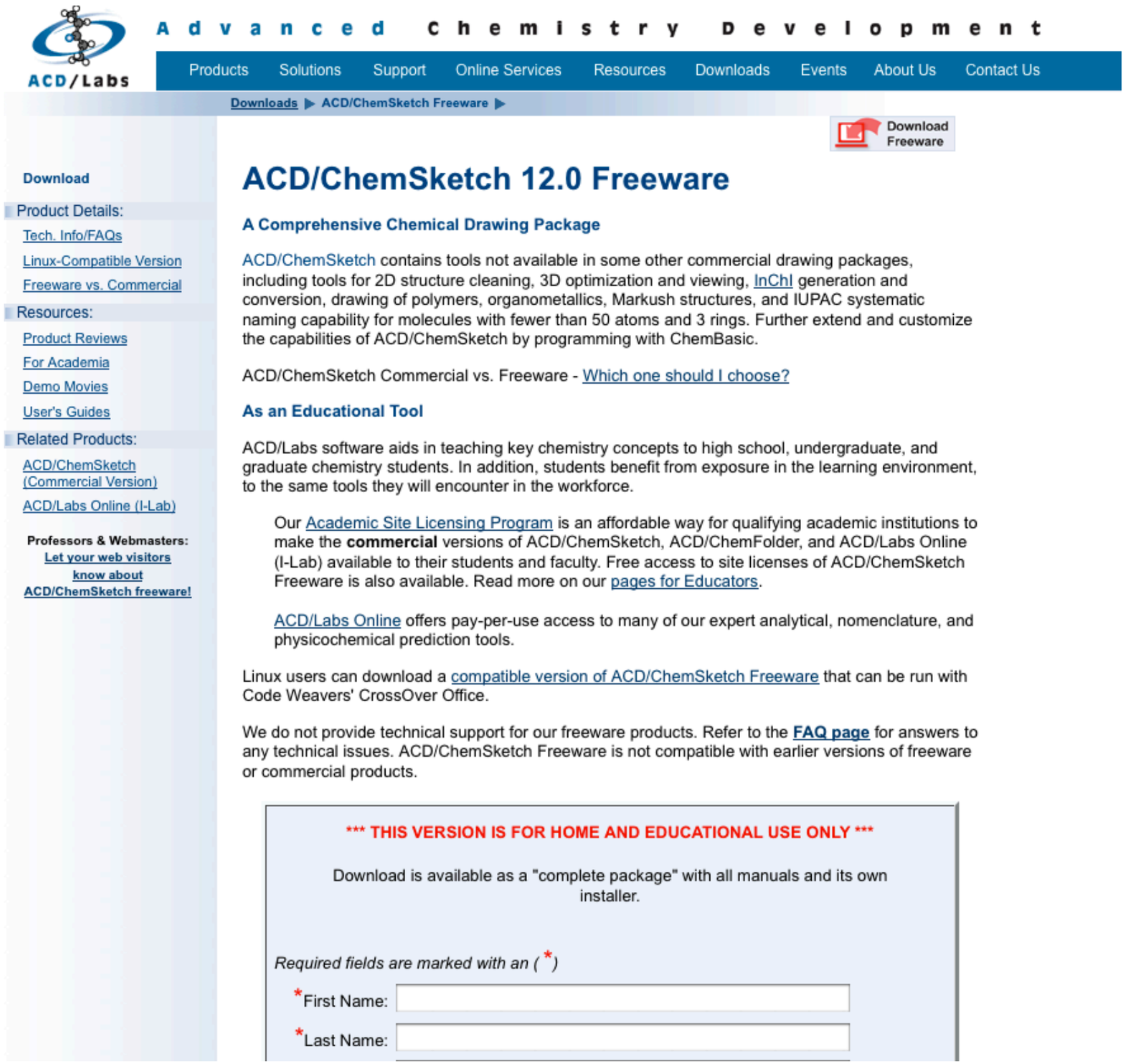

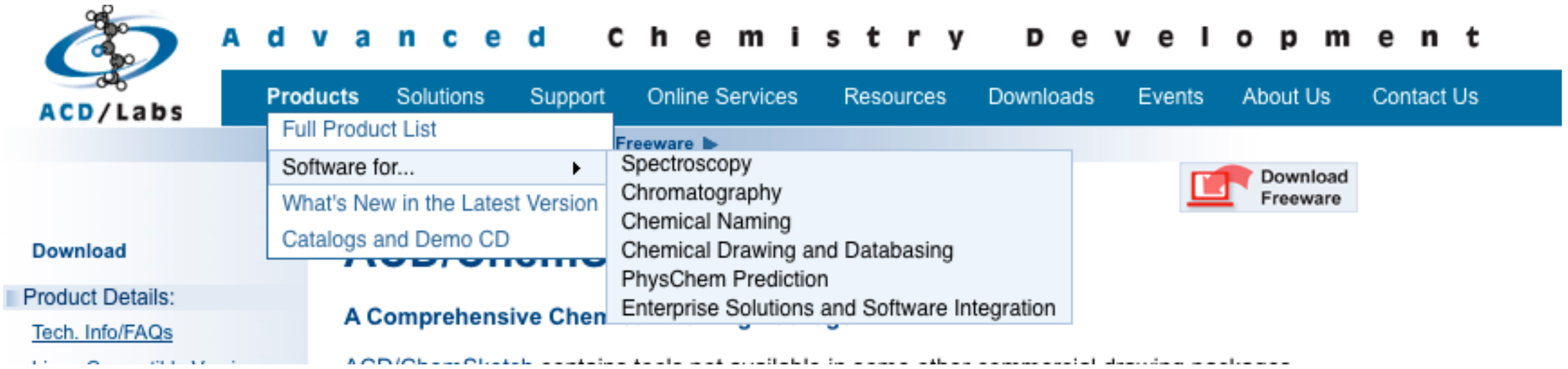
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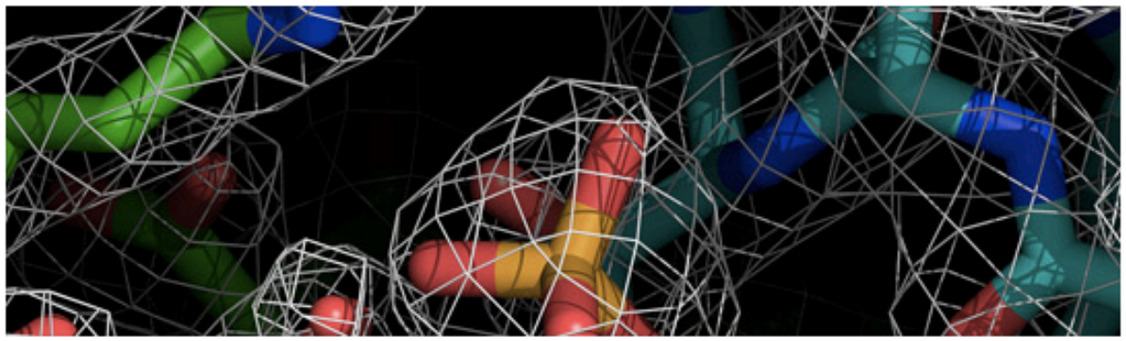

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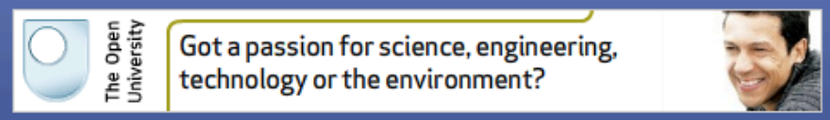

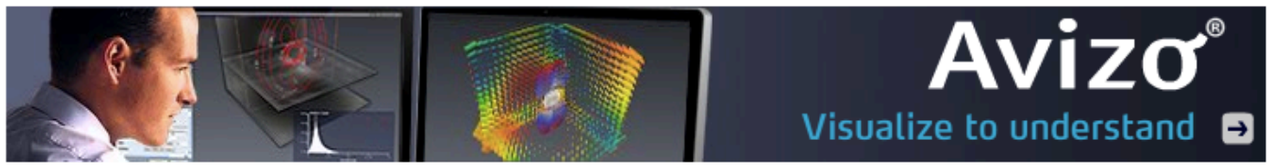

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26 November 2008

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'As Symyx Draw is increasingly adopted and deployed in the commercial research environment, hands-on experience with the application at universities prepares students for success in today's highly competitive job market and in their future scientific careers,' said Dr Trevor Heritage, president of Symyx Software.

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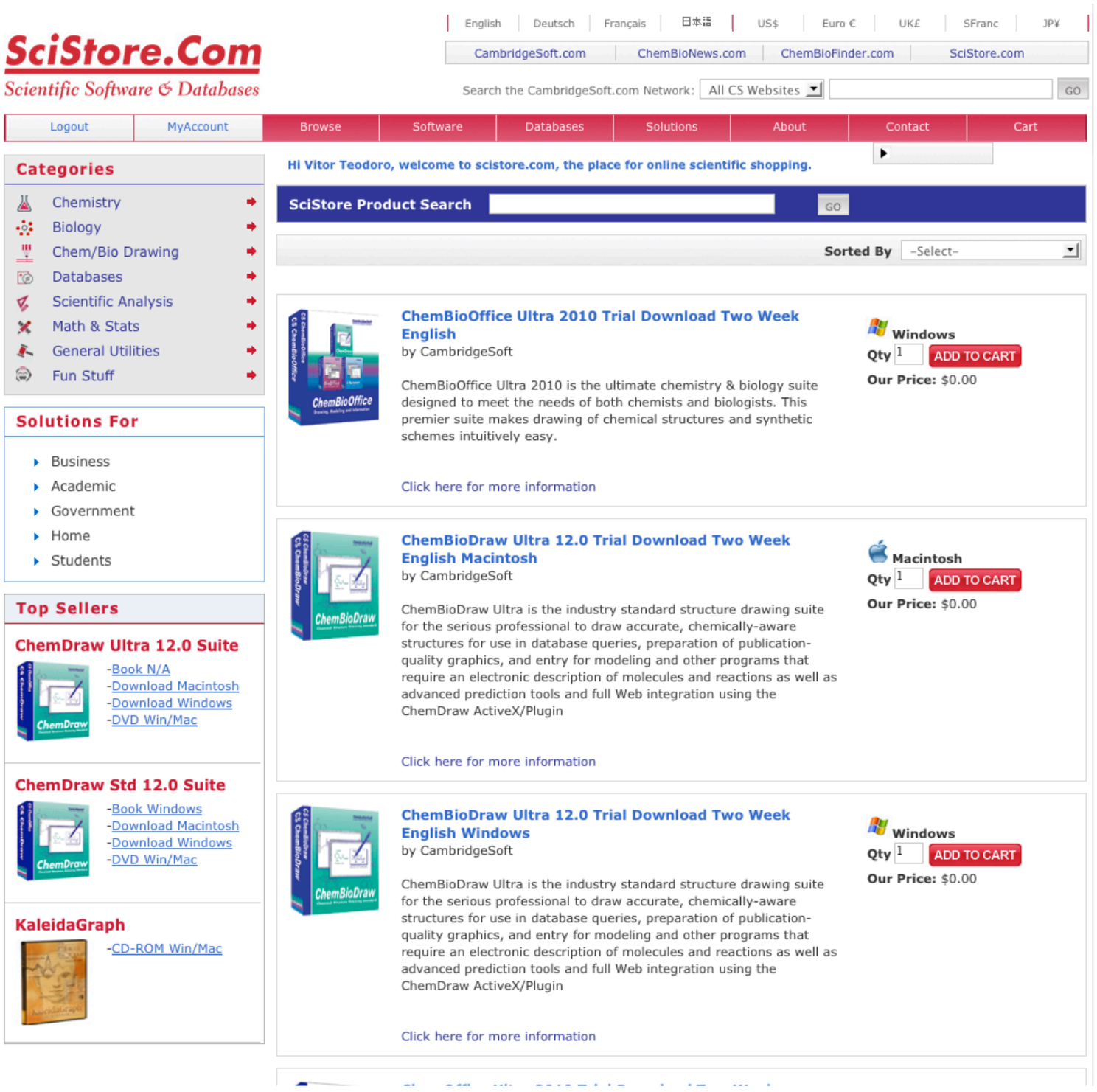
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Tabelas, gráficos & imagens

Palavra-chave: *simplicidade...*

KISS principle

From Wikipedia, the free encyclopedia

"K-I-S-S" redirects here. For other uses, see Kiss (disambiguation).

The **KISS principle**: KISS is a bacronym for the empirical principle "Keep it simple, stupid".[1] KISS states that design simplicity should be a key goal and that unnecessary complexity should be avoided. Some propose that it follow its own principle by dropping the redundant letter to be: KIS "Keep it simple". Another possible interpretation is "Keep it short and simple"[2].

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1 Related concepts
2 In film animation
3 See also
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http://www.ploscompbiol.org/article/info%3Adoi%2F10.1371%2Fjournal.pcbi.1000554

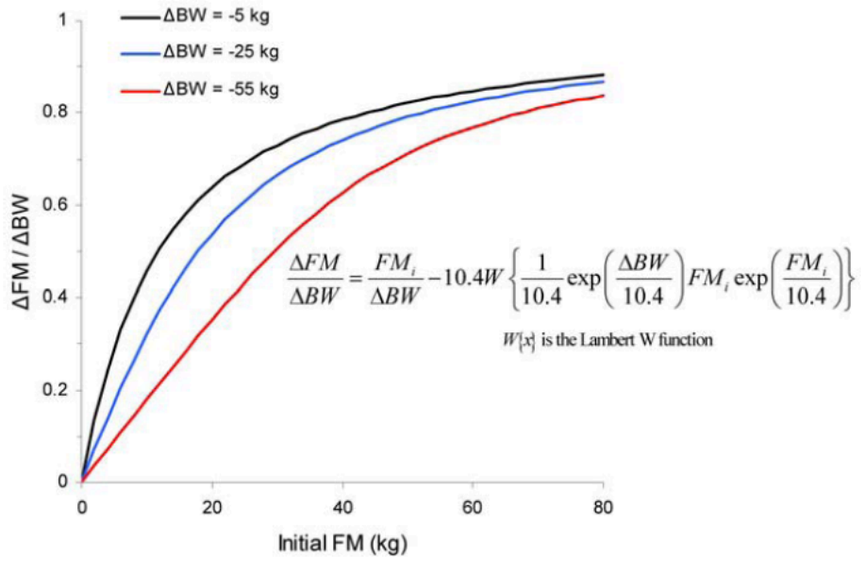

Figure 2. The proportion of body weight loss (ΔBW) from loss of body fat mass (ΔFM) as a function of initial fat mass (FM) for different degrees of weight loss ΔBW as calculated using a novel mathematical model [62] that revisits Forbes classical theory [61].
doi:10.1371/journal.pcbi.1000554.g002

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PLoS COMPUTATIONAL BIOLOGY

Review

Nutritional Systems Biology Modeling: From Molecular Mechanisms to Physiology

Albert A. de Graaf[1]*, Andreas P. Freidig[1,2], Baukje De Roos[3], Neema Jamshidi[4], Matthias Heinemann[5], Johan A.C. Rullmann[6], Kevin D. Hall[7], Martin Adiels[8], Ben van Ommen[1]

1 Biosciences, TNO Quality of Life, Zeist, The Netherlands, **2** Amsterdam Molecular Therapeutics, Amsterdam, The Netherlands, **3** Rowett Research Institute, Aberdeen, United Kingdom, **4** Department of Bioengineering, University of California, San Diego, La Jolla, California, United States of America, **5** Institute of Molecular Systems Biology, ETH Zurich, Zurich, Switzerland, **6** Department of Molecular Design & Informatics, NV Organon, a part of Schering-Plough Corporation, Oss, The Netherlands, **7** Laboratory of Biological Modeling, NIDDK/NIH, Bethesda, Maryland, United States of America, **8** Sahlgrenska Academy at University Göteborg, Göteborg, Sweden

Abstract: The use of computational modeling and simulation has increased in many biological fields, but despite their potential these techniques are only marginally applied in nutritional sciences. Nevertheless, recent applications of modeling have been instrumental in answering important nutritional questions from the cellular up to the physiological levels. Capturing the complexity of today's important nutritional research questions poses a challenge for modeling to become truly integrative in the consideration and interpretation of experimental data at widely differing scales of space and time. In this review, we discuss a selection of available modeling approaches and applications relevant for nutrition. We then put these models into perspective by categorizing them according to their space and time domain. Through this categorization process, we identified a dearth of models that consider processes occurring between the microscopic and macroscopic scale. We propose a "middle-out" strategy to develop the required full-scale, multilevel computational models. Exhaustive and accurate phenotyping, the use of the virtual patient concept, and the development of biomarkers from "-omics" signatures are identified as key elements of a successful systems biology modeling approach in nutrition research—one that integrates physiological mechanisms and data at multiple space and time scales.

Introduction

Nutritional science is presently undergoing a data explosion as an increasing number of studies are incorporating methods from genomics, transcriptomics, proteomics, and metabolomics. However, it is presently unclear how these high-dimensional datasets can be related to the physiological characterization of phenotype using traditional nutritional research methods such as indirect calorimetry, nutrient balance, body composition assessment, and isotopic tracer methods. Thus, a fundamental challenge for nutrition research is to connect these data that are collected at vastly different spatial, temporal, and dimensionality scales. Although statistical analysis is still the method of choice to deal with the high dimensionality of "-omics" datasets, systems biology and computational modeling approaches begin to reveal quantitative mechanistic relationships between these various measurements.

A large variety of computational modeling approaches have been applied to wide-ranging levels of organization—from molecules to humans. The processes that are modeled include molecular interactions, signaling pathways, metabolic pathways, cellular growth, anatomical structures, and physiological processes. Accordingly, computational approaches differ widely with application.

In this review, we discuss the relevance of current and future applications of computational modeling in nutrition research. To this end, we first introduce important concepts in nutrition and the typical issues for modeling that arise in this field. Then, we give a broader review of some representative modeling approaches that have successfully addressed key nutritional questions. We then proceed to identify knowledge and technology gaps and suggest how the computational approaches may be integrated and extended to address these gaps and bring nutritional systems biology modeling an important step forward in the near future.

Nutrition and Modeling

Nutrition research investigates the processes by which the living organism receives and utilizes the materials necessary for the maintenance of life and health (as defined by James S. McLester in his classic 1927 textbook) [1]. Traditionally, nutritional research investigates these processes at the level of the whole organism. From a thermodynamic viewpoint, all living organisms exist in a state that is far from equilibrium. To maintain this state, it is of central importance to harvest sufficient energy from the surroundings. This energy comes from the controlled combustion of the macronutrients carbohydrate, fat, and protein. The overarching organizing principle expressed in the Dynamic Energy Budget theory [2], which considers that energy from food is extracted (by the gut), stored in reserves (body fat, protein, and carbohydrate pools), and distributed throughout the body to fuel the processes essential for life. These processes include the generation of heat, maintenance of gradients across cell membranes, the production of gametes, the synthesis of structural mass, the establishment of maturity, somatic maintenance, and maturity maintenance. This organization effectively decouples the organism's internal energy from the external world, facilitating

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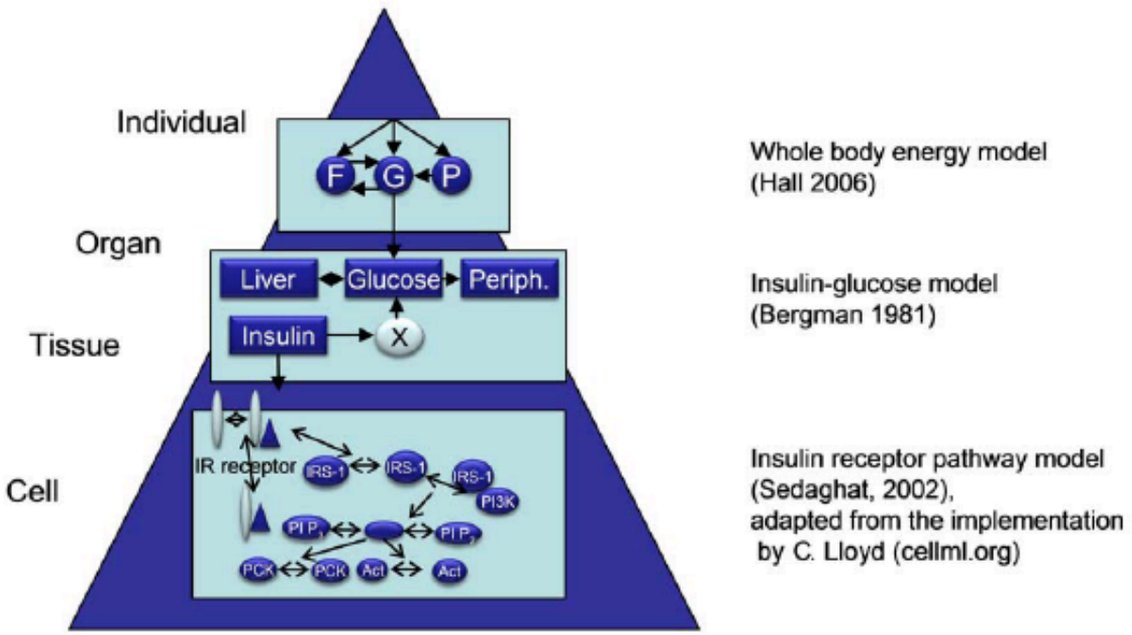

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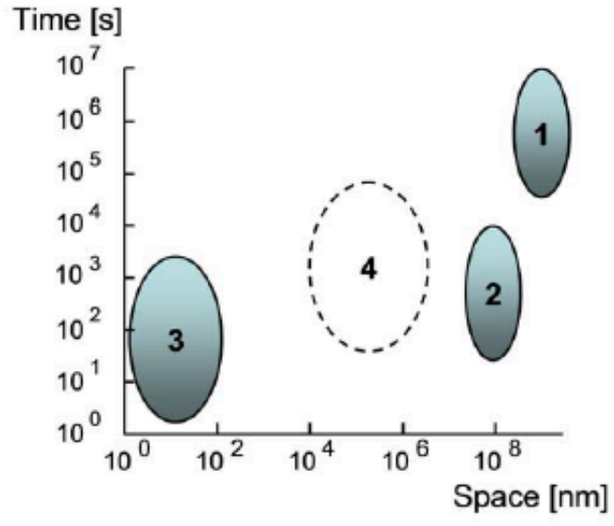

Model	space range	time range
1-Whole body energy balance	m	days to year
2-Minimal model	dm	min-h
3-Insulin signalling pathway	1-100 nm	s-h
4-New tissue-specific pathway model	10 μm-1cm	min-day

B

Figure 4. Example of a future multiscale model in the area of insulin resistance, built from three existing models [78–80]. (A) schematic overview of the different model layers. (B) Individual model layers plotted along their time–space dimensions. Model 4 denotes a new model that enables the incorporation of tissue-specific gene expression data, which form an important data source from the nutritional wet lab.
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TABLE 8

Units in use with the International System

Name	Symbol	Value in SI units
minute	min	1 min = 60 s
hour[(a)]	h	1 h = 60 min = 3600 s
day	d	1 d = 24 h = 86 400 s
degree	°	1° = (π/180) rad
minute	'	1' = (1/60)° = (π/10 800) rad
second	"	1" = (1/60)' = (π/648 000) rad
liter[(b)†]	l, L	1 L = 1 dm^3 = 10^{-3} m^3
tonne[(c)(d)‡]	t	1 t = 10^3 kg

[(a)] The symbol of this unit is included in Resolution 7 of the 9th CGPM (1948).
[(b)] This unit and the symbol l were adopted by CIPM in 1879 (*BIPM Proc.-Verb. Com. Int. Poids et Mesures,* 1879, p. 41). The alternative symbol, L, was adopted by the 16th CGPM (1979, Resolution 6) in order to avoid the risk of confusion between the letter l and the number 1.[†] The present definition of the liter is in Resolution 6 of the 12th CGPM (1964).
[(c)] This unit and its symbol were adopted by the International Committee in 1879 (*BIPM Proc.-Verb. Com. Int. Poids et Mesures,* 1879, p. 41).
[(d)] In some English-speaking countries this unit is called ''metric ton.''[‡]

TABLE 3'

SI derived units with special names admitted for reasons of safeguarding human health

Quantity	SI Unit			
	Name	Symbol	Expression in terms of other units	Expression in terms of SI base units
activity (of a radionuclide)	becquerel	Bq		s^{-1}
absorbed dose, specific energy imparted, kerma, absorbed dose index	gray	Gy	J/kg	$m^2 \cdot s^{-2}$
dose equivalent, dose equivalent index	sievert	Sv	J/kg	$m^2 \cdot s^{-2}$

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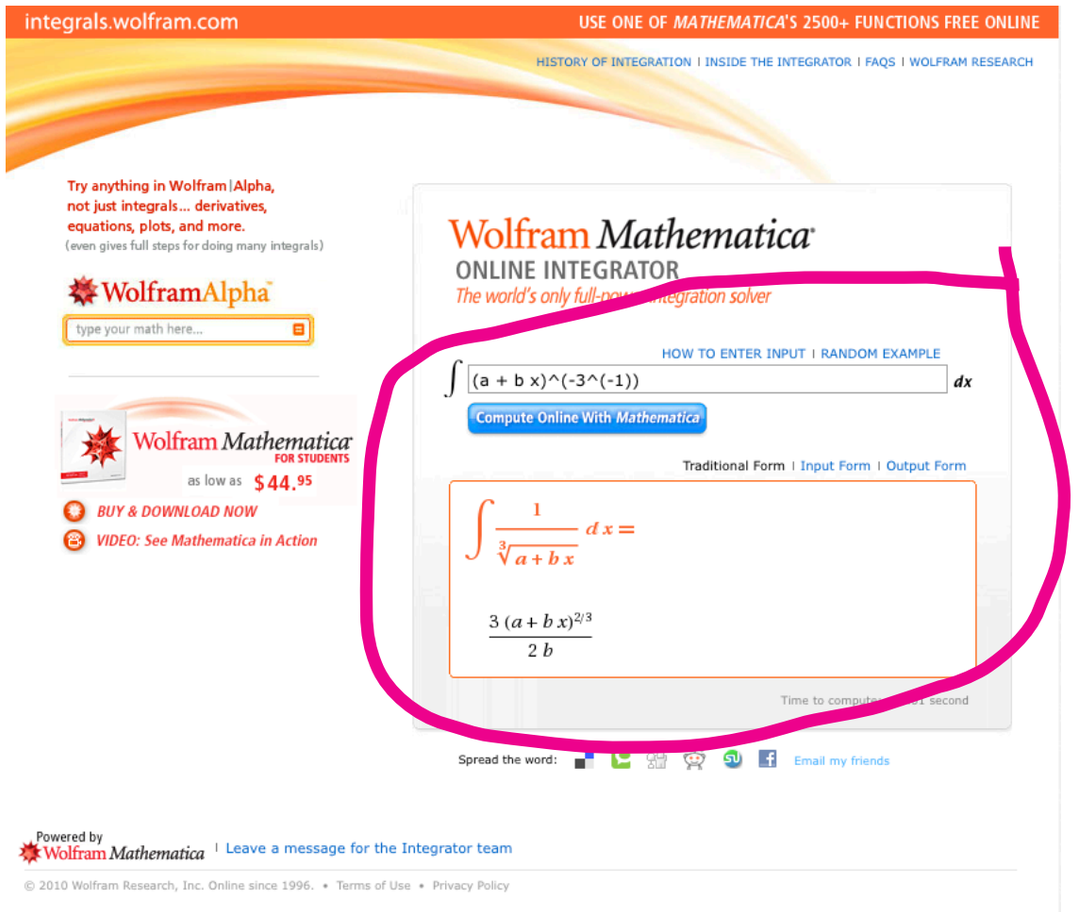

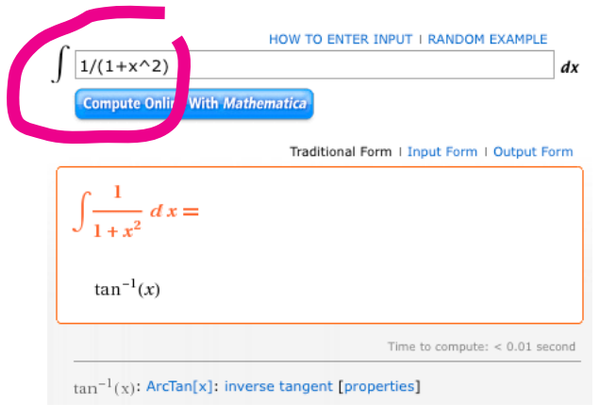

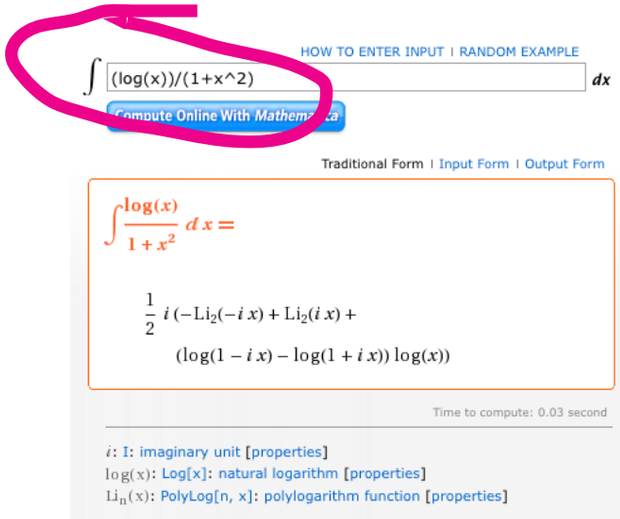

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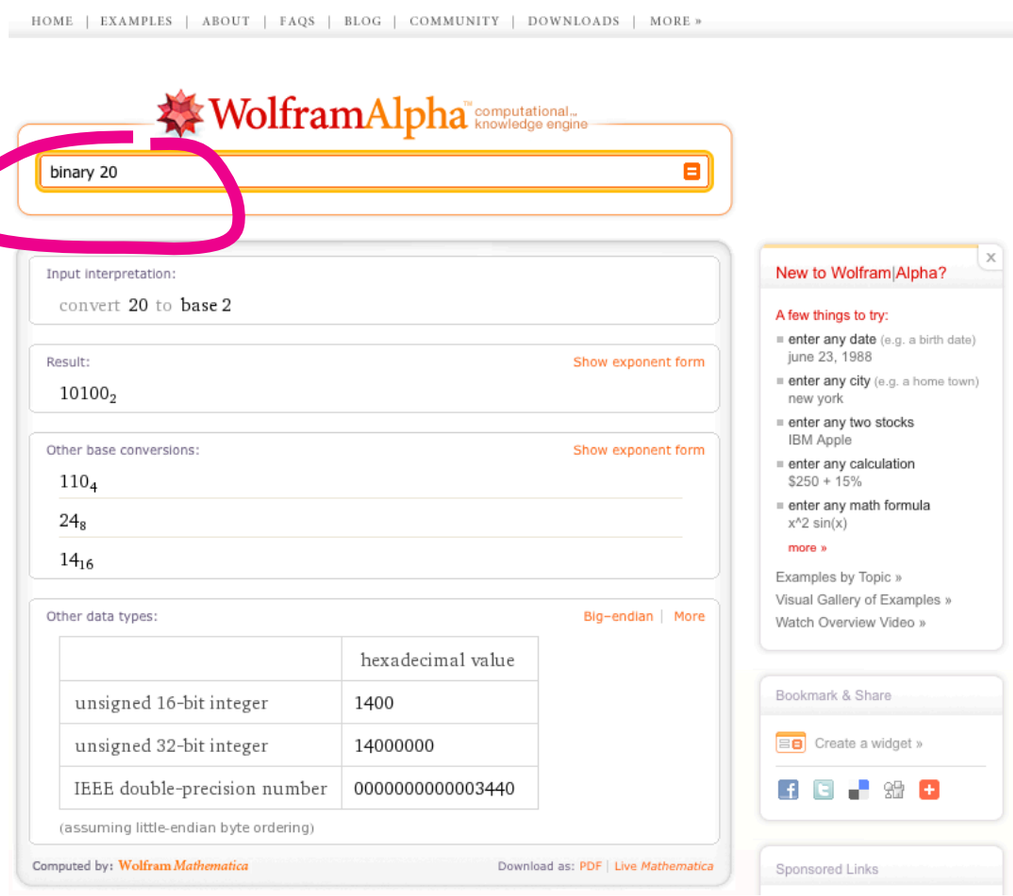

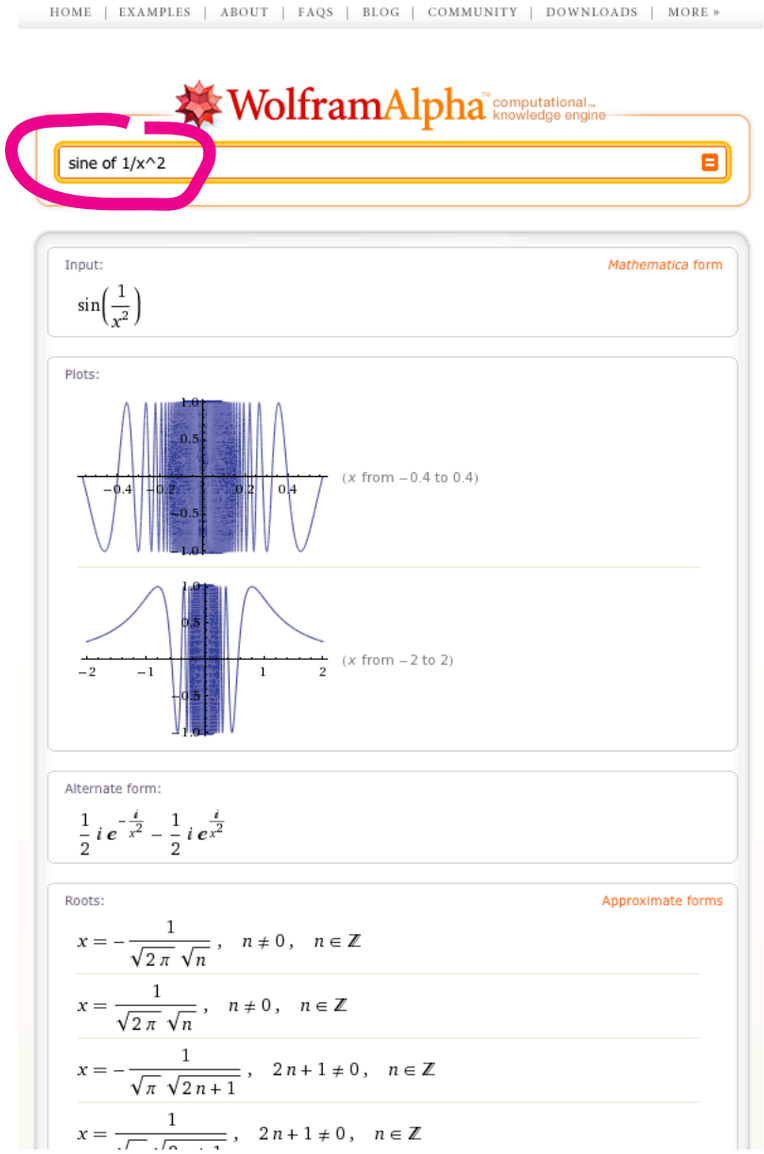

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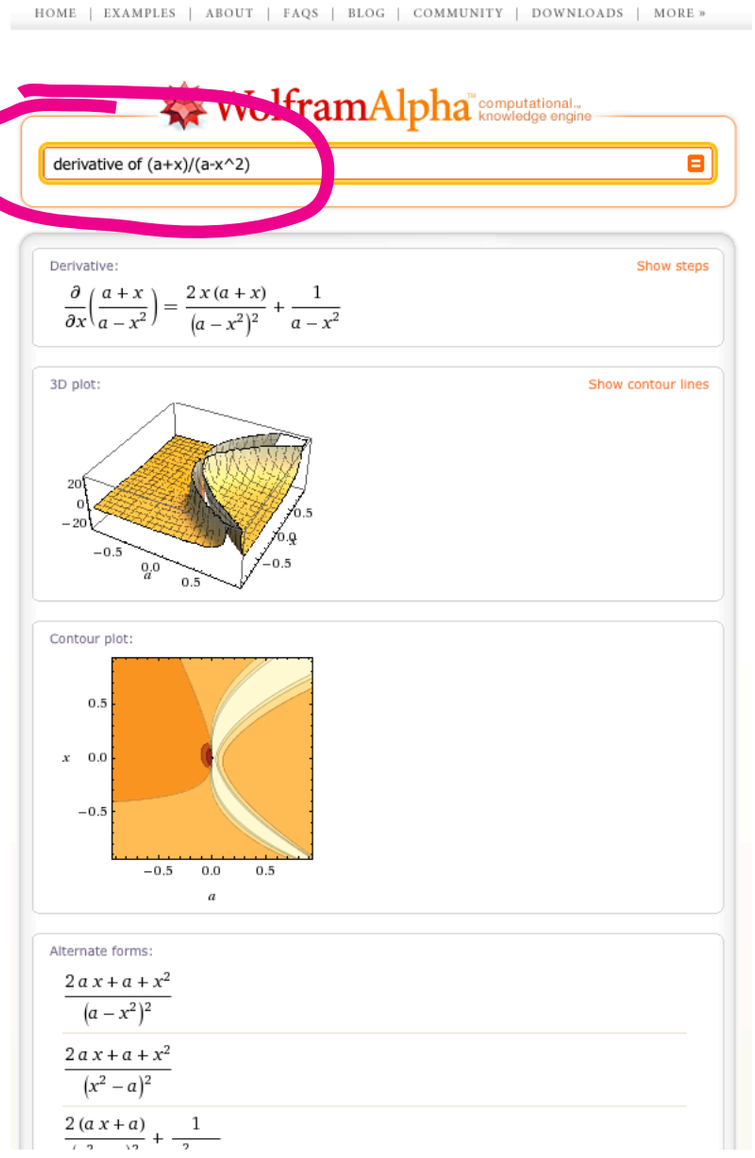

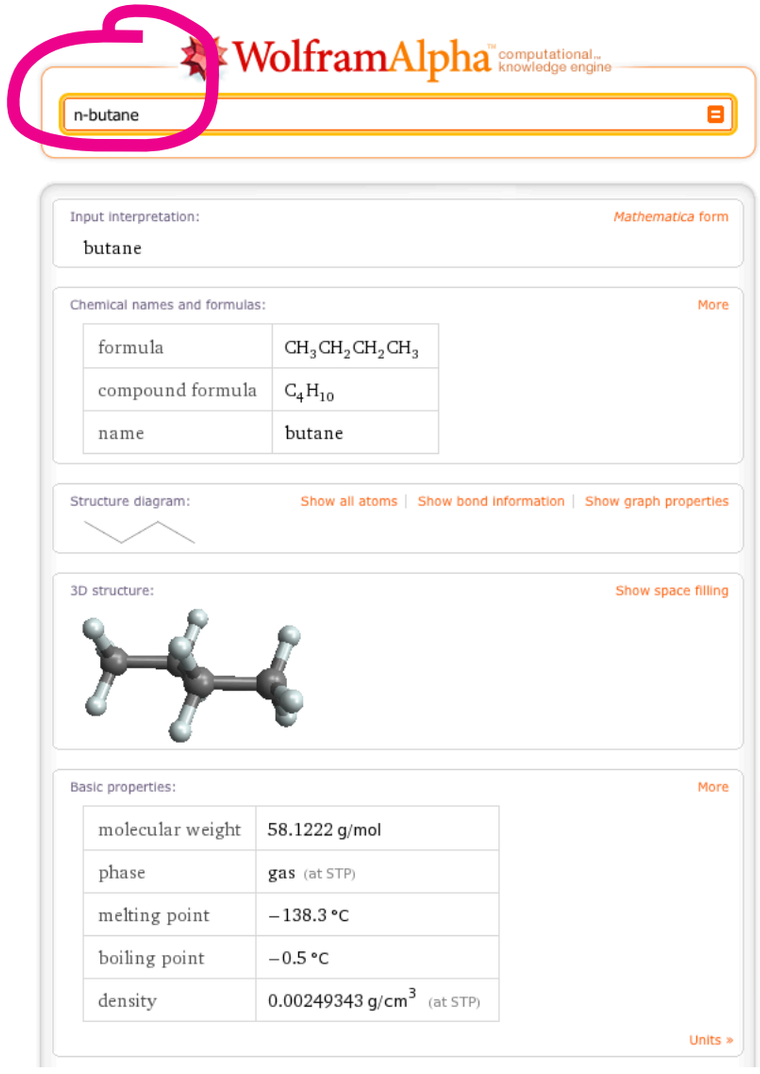
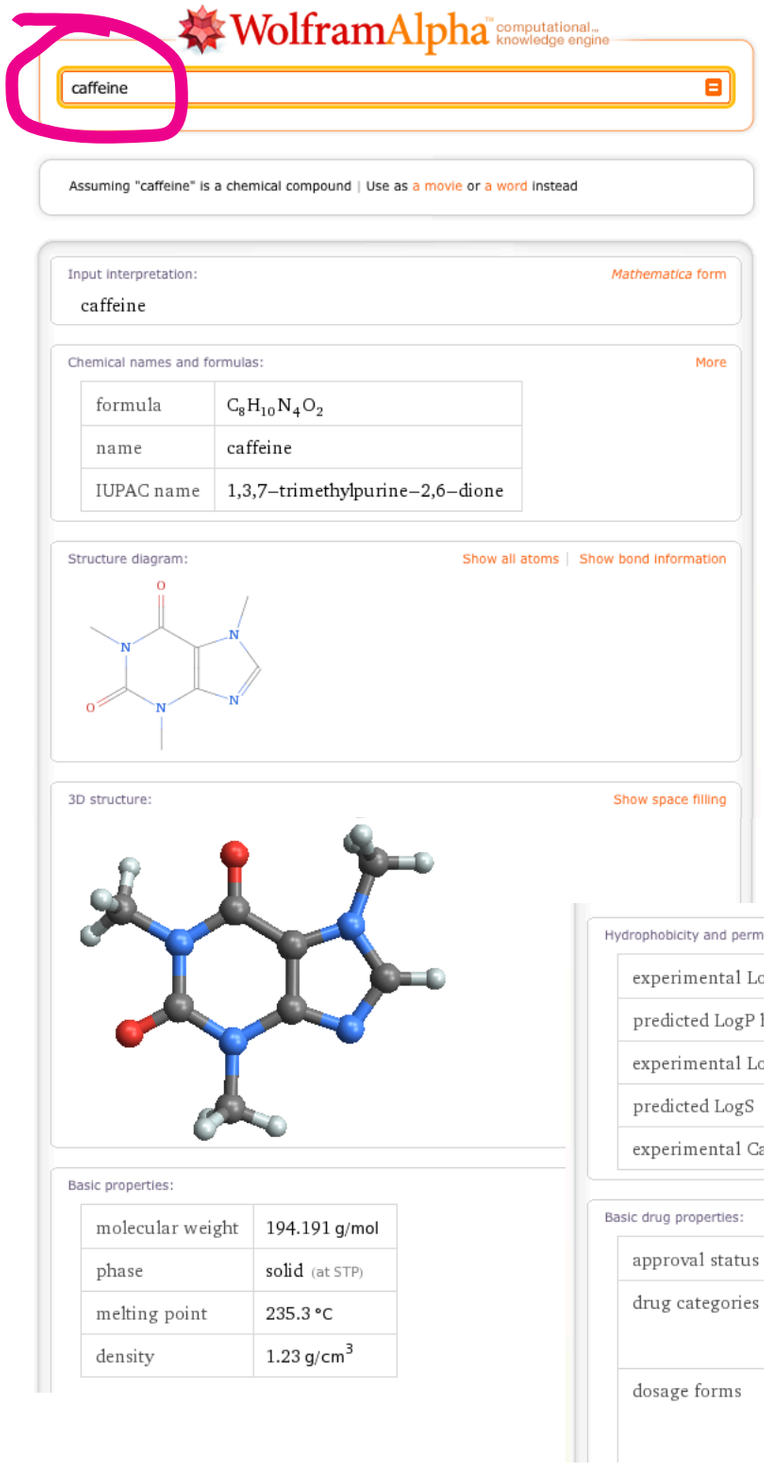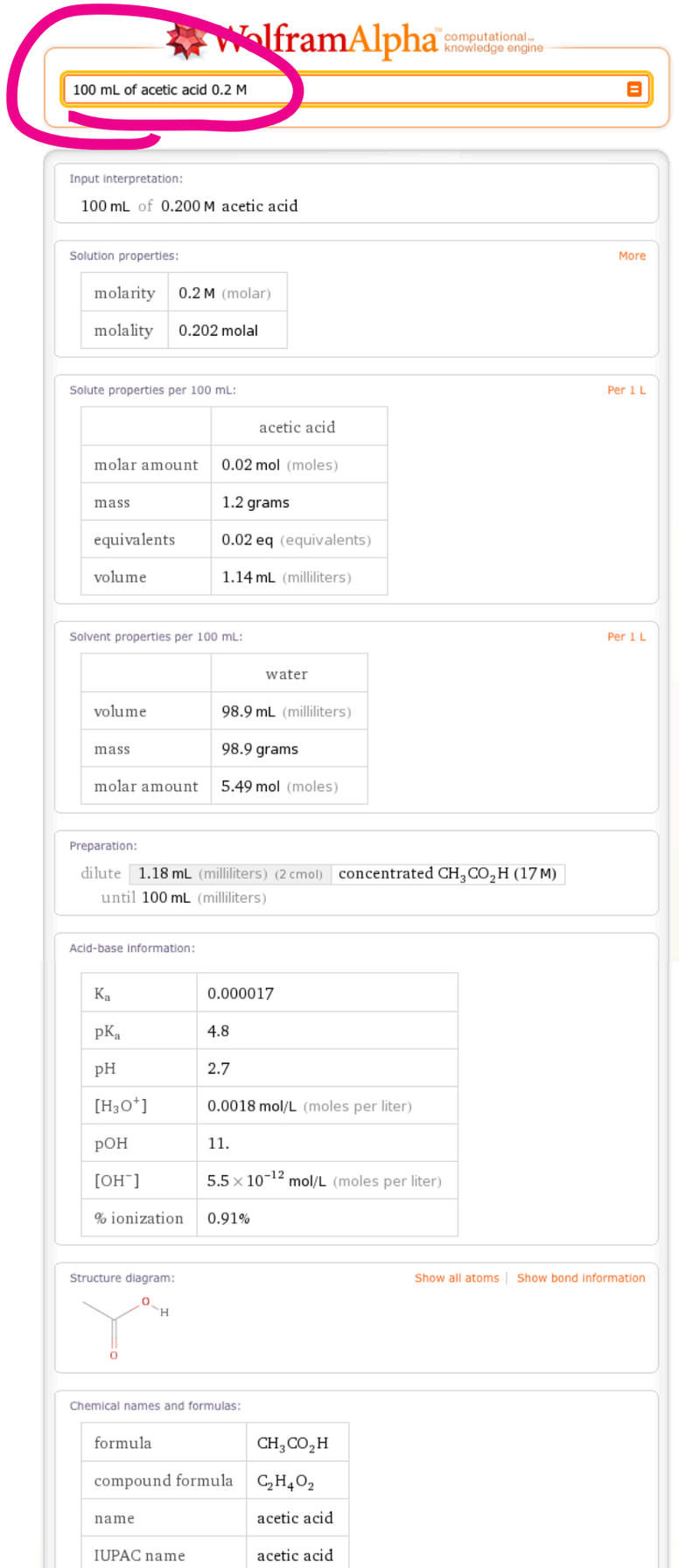
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