APPENDIX A

Writing Mathematical Expressions with LaTeX

LaTeX is extensively used in Python. In this appendix there are many examples that can be useful to represent LaTeX expressions inside Python implementations. This same information can be found at the link http://matplotlib.org/users/mathtext.html.

With matplotlib

You can enter the LaTeX expression directly as an argument of various functions that can accept it. For example, the title() function that draws a chart title.

```
import matplotlib.pyplot as plt
%matplotlib inline
plt.title(r'$\alpha > \beta$')
```

With IPython Notebook in a Markdown Cell

You can enter the LaTeX expression between two '$$'.

```
$$c = \sqrt{a^2 + b^2}$$
```

$$c = \sqrt{a^2 + b^2}$$

F. Nelli, *Python Data Analytics*, https://doi.org/10.1007/978-1-4842-3913-1

With IPython Notebook in a Python 2 Cell

You can enter the LaTeX expression within the Math() function.

```
from IPython.display import display, Math, Latex
display(Math(r'F(k) = \int_{-\infty}^{\infty} f(x) e^{2\pi i k} dx'))
```

Subscripts and Superscripts

To make subscripts and superscripts, use the '_' and '^' symbols:

```
r'$\alpha_i > \beta_i$'
```

$$\alpha_i > \beta_i$$

This could be very useful when you have to write summations:

```
r'$\sum_{i=0}^\infty x_i$'
```

$$\sum_{i=0}^{\infty} x_i$$

Fractions, Binomials, and Stacked Numbers

Fractions, binomials, and stacked numbers can be created with the \frac{}{}, \binom{}{}, and \stackrel{}{} commands, respectively:

```
r'$\frac{3}{4} \binom{3}{4} \stackrel{3}{4}$'
```

$$\frac{3}{4}\binom{3}{4}^{3}$$

Fractions can be arbitrarily nested:

$$\cfrac{5 - \cfrac{1}{x}}{4}$$

Note that special care needs to be taken to place parentheses and brackets around fractions. You have to insert \left and \right preceding the bracket in order to inform the parser that those brackets encompass the entire object:

$$\left(\frac{5-\frac{1}{x}}{4}\right)$$

Radicals

Radicals can be produced with the \sqrt[]{} command.

r'$\sqrt{2}$'

$\sqrt{2}$

Fonts

The default font is italics for mathematical symbols. To change fonts, for example with trigonometric functions as sin:

$s(t) = Asin(2\omega t)$

The choices available with all fonts are

```
from IPython.display import display, Math, Latex
display(Math(r'\mathrm{Roman}'))
display(Math(r'\mathit{Italic}'))
display(Math(r'\mathtt{Typewriter}'))
display(Math(r'\mathcal{CALLIGRAPHY}'))
```

Roman

Italic

Typewriter

CALLIGRAPHY

Accents

An accent command may precede any symbol to add an accent above it. There are long and short forms for some of them.

\acute a or \'a	$\acute{a}$
\bar a	$\bar{a}$
\breve a	$\breve{a}$
\ddot a or \"a	$\ddot{a}$
\dot a or \.a	$\dot{a}$
\grave a or \`a	$\grave{a}$
\hat a or \^a	$\hat{a}$
\tilde a or \~a	$\tilde{a}$
\vec a	$\vec{a}$
\overline{abc}	$\overline{abc}$

Symbols

You can also use a large number of the TeX symbols.

Lowercase Greek

α\alpha	β \beta	χ \chi	δ \delta	F \digamma
ϵ\epsilon	η \eta	γ \gamma	ι \iota	κ\kappa
λ\lambda	μ \mu	ν \nu	ω \omega	ϕ \phi
π \pi	ψ \psi	ρ \rho	σ \sigma	τ \tau
θ \theta	υ\upsilon	ε\varepsilon	$\varkappa$\varkappa	φ\varphi
ϖ\varpi	ϱ\varrho	ς \varsigma	ϑ\vartheta	ξ \xi
ζ \zeta				

Uppercase Greek

Δ \Delta	Γ \Gamma	Λ \Lambda	Ω \Omega	Φ \Phi	Π \Pi
Ψ \Psi	Σ \Sigma	Θ \Theta	Υ \Upsilon	Ξ \Xi	$\mho$ \mho
∇ \nabla					

Hebrew

$\aleph$ \aleph	$\beth$ \beth	$\daleth$ \daleth	$\gimel$ \gimel

Delimiters

/ /	[[	$\Downarrow$ \Downarrow	$\Uparrow$ \Uparrow	$\Vert$ \Vert	$\backslash$ \backslash
$\downarrow$ \downarrow	$\langle$ \langle	$\lceil$ \lceil	$\lfloor$ \lfloor	$\llcorner$ \llcorner	$\lrcorner$ \lrcorner
$\rangle$ \rangle	$\rceil$ \rceil	$\rfloor$ \rfloor	$\ulcorner$ \ulcorner	$\uparrow$ \uparrow	$\urcorner$ \urcorner
$\vert$ \vert	$\{$ \{	$\vert$ |	$\}$ \}	]]	| |

Big Symbols

$\bigcap$ \bigcap	$\bigcup$ \bigcup	$\bigodot$ \bigodot	$\bigoplus$ \bigoplus	$\bigotimes$ \bigotimes
$\biguplus$ \biguplus	$\bigvee$ \bigvee	$\bigwedge$ \bigwedge	$\coprod$ \coprod	$\int$ \int
$\oint$ \oint	$\prod$ \prod	$\sum$ \sum		

Standard Function Names

$\Pr$ \Pr	$\arccos$ \arccos	$\arcsin$ \arcsin	$\arctan$ \arctan
$\arg$ \arg	$\cos$ \cos	$\cosh$ \cosh	$\cot$ \cot
$\coth$ \coth	$\csc$ \csc	$\deg$ \deg	$\det$ \det
$\dim$ \dim	$\exp$ \exp	$\gcd$ \gcd	$\hom$ \hom
$\inf$ \inf	$\ker$ \ker	$\lg$ \lg	$\lim$ \lim
$\liminf$ \liminf	$\limsup$ \limsup	$\ln$ \ln	$\log$ \log
$\max$ \max	$\min$ \min	$\sec$ \sec	$\sin$ \sin
$\sinh$ \sinh	$\sup$ \sup	$\tan$ \tan	$\tanh$ \tanh

Binary Operation and Relation Symbols

$\Bumpeq$ \Bumpeq	$\Cap$ \Cap	$\Cup$ \Cup
$\Doteq$ \Doteq	$\Join$ \Join	$\Subset$ \Subset
$\Supset$ \Supset	$\Vdash$ \Vdash	$\Vvdash$ \Vvdash
$\approx$ \approx	$\approxeq$ \approxeq	$\ast$ \ast
$\asymp$ \asymp	$\backepsilon$ \backepsilon	$\backsim$ \backsim
$\backsimeq$ \backsimeq	$\barwedge$ \barwedge	$\because$ \because
$\between$ \between	$\bigcirc$ \bigcirc	$\bigtriangledown$ \bigtriangledown
$\bigtriangleup$ \bigtriangleup	$\blacktriangleleft$ \blacktriangleleft	$\blacktriangleright$ \blacktriangleright
$\bot$ \bot	$\bowtie$ \bowtie	$\boxdot$ \boxdot
$\boxminus$ \boxminus	$\boxplus$ \boxplus	$\boxtimes$ \boxtimes
$\bullet$ \bullet	$\bumpeq$ \bumpeq	$\cap$ \cap
$\cdot$ \cdot	$\circ$ \circ	$\circeq$ \circeq
$\coloneq$ \coloneq	$\cong$ \cong	$\cup$ \cup
$\curlyeqprec$ \curlyeqprec	$\curlyeqsucc$ \curlyeqsucc	$\curlyvee$ \curlyvee
$\curlywedge$ \curlywedge	$\dagger$ \dag	$\dashv$ \dashv

(*continued*)

‡ \ddag	◇ \diamond	÷ \div
⋇ \divideontimes	$\dot{e}q$ \doteq	$\dot{e}qdot$ \doteqdot
$\dot{p}lus$ \dotplus	⩚ \doublebarwedge	⧦ \eqcirc
≒ \eqcolon	≃ \eqsim	⪖ \eqslantgtr
⪕ \eqslantless	≡ \equiv	≒ \fallingdotseq
⌢ \frown	≥ \geq	≧ \geqq
⩾ \geqslant	≫ \gg	⋙ \ggg
⪊ \gnapprox	≩ \gneqq	⋧ \gnsim
⪆ \gtrapprox	⋗ \gtrdot	⋛ \gtreqless
⪌ \gtreqqless	≷ \gtrless	≳ \gtrsim
∈ \in	⊺ \intercal	⋋ \leftthreetimes
≤ \leq	≦ \leqq	⩽ \leqslant
⪅ \lessapprox	⋖ \lessdot	⋚ \lesseqgtr
⪋ \lesseqqgtr	≶ \lessgtr	≲ \lesssim
≪ \ll	⋘ \lll	⪉ \lnapprox
⪈ \lneqq	⋦ \lnsim	⋉ \ltimes
∣ \mid	⊨ \models	∓ \mp
⊯ \nVDash	⊮ \nVdash	≉ \napprox
≇ \ncong	≠ \ne	≠ \neq
≠ \neq	≢ \nequiv	≱ \ngeq
≯ \ngtr	∋ \ni	≰ \nleq
≮ \nless	∤ \nmid	∉ \notin
∦ \nparallel	⊀ \nprec	≁ \nsim

(*continued*)

$\not\subset$ \nsubset	$\not\subseteq$ \nsubseteq	$\not\succ$ \nsucc
$\not\supset$ \nsupset	$\not\supseteq$ \nsupseteq	$\not\triangleleft$ \ntriangleleft
$\not\trianglelefteq$ \ntrianglelefteq	$\not\triangleright$ \ntriangleright	$\not\trianglerighteq$ \ntrianglerighteq
$\nvDash$ \nvDash	$\nvdash$ \nvdash	$\odot$ \odot
$\ominus$ \ominus	$\oplus$ \oplus	$\oslash$ \oslash
$\otimes$ \otimes	$\parallel$ \parallel	$\perp$ \perp
$\pitchfork$ \pitchfork	$\pm$ \pm	$\prec$ \prec
$\precapprox$ \precapprox	$\preccurlyeq$ \preccurlyeq	$\preceq$ \preceq
$\precnapprox$ \precnapprox	$\precnsim$ \precnsim	$\precsim$ \precsim
$\propto$ \propto	$\rightthreetimes$ \rightthreetimes	$\risingdotseq$ \risingdotseq
$\rtimes$ \rtimes	$\sim$ \sim	$\simeq$ \simeq
$/$ \slash	$\smile$ \smile	$\sqcap$ \sqcap
$\sqcup$ \sqcup	$\sqsubset$ \sqsubset	$\sqsubset$ \sqsubset
$\sqsubseteq$ \sqsubseteq	$\sqsupset$ \sqsupset	$\sqsupset$ \sqsupset
$\sqsupseteq$ \sqsupseteq	$\star$ \star	$\subset$ \subset
$\subseteq$ \subseteq	$\subseteqq$ \subseteqq	$\subsetneq$ \subsetneq
$\subsetneqq$ \subsetneqq	$\succ$ \succ	$\succapprox$ \succapprox
$\succcurlyeq$ \succcurlyeq	$\succeq$ \succeq	$\succnapprox$ \succnapprox
$\succnsim$ \succnsim	$\succsim$ \succsim	$\supset$ \supset
$\supseteq$ \supseteq	$\supseteqq$ \supseteqq	$\supsetneq$ \supsetneq
$\supsetneqq$ \supsetneqq	$\therefore$ \therefore	$\times$ \times
$\top$ \top	$\triangleleft$ \triangleleft	$\trianglelefteq$ \trianglelefteq
$\triangleq$ \triangleq	$\triangleright$ \triangleright	$\trianglerighteq$ \trianglerighteq
$\uplus$ \uplus	$\vDash$ \vDash	$\varpropto$ \varpropto
$\vartriangleleft$ \vartriangleleft	$\vartriangleright$ \vartriangleright	$\vdash$ \vdash
$\vee$ \vee	$\veebar$ \veebar	$\wedge$ \wedge
$\wr$ \wr		

Arrow Symbols

⇓ \Downarrow	⇐ \Leftarrow
⇔ \Leftrightarrow	⇚ \Lleftarrow
⟸ \Longleftarrow	⟺ \Longleftrightarrow
⟹ \Longrightarrow	↰ \Lsh
⇗ \Nearrow	⇖ \Nwarrow
⇒ \Rightarrow	⇛ \Rrightarrow
↱ \Rsh	⇘ \Searrow
⇙ \Swarrow	⇑ \Uparrow
⇕ \Updownarrow	↺ \circlearrowleft
↻ \circlearrowright	↶ \curvearrowleft
↷ \curvearrowright	⇠ \dashleftarrow
⇢ \dashrightarrow	↓ \downarrow
⇊ \downdownarrows	⇃ \downharpoonleft
⇂ \downharpoonright	↩ \hookleftarrow
↪ \hookrightarrow	⇝ \leadsto
← \leftarrow	↢ \leftarrowtail
↽ \leftharpoondown	↼ \leftharpoonup
⇇ \leftleftarrows	↔ \leftrightarrow
⇆ \leftrightarrows	⇋ \leftrightharpoons
↭ \leftrightsquigarrow	↜ \leftsquigarrow
⟵ \longleftarrow	⟷ \longleftrightarrow
⟼ \longmapsto	⟶ \longrightarrow
↫ \looparrowleft	↬ \looparrowright
↦ \mapsto	⊸ \multimap
⇍ \nLeftarrow	⇎ \nLeftrightarrow
⇏ \nRightarrow	↗ \nearrow
↚ \nleftarrow	↮ \nleftrightarrow

(*continued*)

↛ \nrightarrow	↖ \nwarrow
→ \rightarrow	↦ \rightarrowtail
⇁ \rightharpoondown	⇀ \rightharpoonup
⇄ \rightleftarrows	⇄ \rightleftarrows
⇌ \rightleftharpoons	⇌ \rightleftharpoons
⇉ \rightrightarrows	⇉ \rightrightarrows
⇝ \rightsquigarrow	↘ \searrow
↙ \swarrow	→ \to
↞ \twoheadleftarrow	↠ \twoheadrightarrow
↑ \uparrow	↕ \updownarrow
↕ \updownarrow	↿ \upharpoonleft
↾ \upharpoonright	⇈ \upuparrows

Miscellaneous Symbols

$ \$	Å \AA	∃ \Finv
⅁ \Game	ℑ \Im	¶ \P
ℜ \Re	§ \S	∠ \angle
‵ \backprime	★ \bigstar	■ \blacksquare
▲ \blacktriangle	▼ \blacktriangledown	… \cdots
✓ \checkmark	® \circledR	Ⓢ \circledS
♣ \clubsuit	∁ \complement	© \copyright
s⃜ \ddots	♢ \diamondsuit	ℓ \ell
∅ \emptyset	ð \eth	∃ \exists
♭ \flat	∀ \forall	ℏ \hbar
♡ \heartsuit	ℏ \hslash	⨌ \iiint

(*continued*)

$\iint$ \iint	$\iint$ \iint	$\imath$ \imath
∞ \infty	$\jmath$ \jmath	$\ldots$ \ldots
$\measuredangle$ \measuredangle	$\natural$ \natural	$\neg$ \neg
$\nexists$ \nexists	$\oiiint$ \oiiint	∂ \partial
$\prime$ \prime	$\sharp$ \sharp	$\spadesuit$ \spadesuit
$\sphericalangle$ \sphericalangle	β \ss	$\triangledown$ \triangledown
$\varnothing$ \varnothing	$\vartriangle$ \vartriangle	$\vdots$ \vdots
$\wp$ \wp	¥ \yen	

APPENDIX B

Open Data Sources

Political and Government Data

Data.gov

http://data.gov

This is the resource for most government-related data.

Socrata

http://www.socrata.com/resources/

Socrata is a good place to explore government-related data. Furthermore, it provides some visualization tools for exploring data.

US Census Bureau

http://www.census.gov/data.html

This site provides information about US citizens covering population data, geographic data, and education.

UN3ta

https://data.un.org/

UNdata is an Internet-based data service which brings UN statistical databases.

European Union Open Data Portal

http://open-data.europa.eu/en/data/

This site provides a lot of data from European Union institutions.

F. Nelli, *Python Data Analytics*, https://doi.org/10.1007/978-1-4842-3913-1

Data.gov.uk

http://data.gov.uk/

This site of the UK Government includes the British National Bibliography: metadata on all UK books and publications since 1950.

The CIA World Factbook

https://www.cia.gov/library/publications/the-world-factbook/

This site of the Central Intelligence Agency provides a lot of information on history, population, economy, government, infrastructure, and military of 267 countries.

Health Data

Healthdata.gov

https://www.healthdata.gov/

This site provides medical data about epidemiology and population statistics.

NHS Health and Social Care Information Centre

http://www.hscic.gov.uk/home

Health data sets from the UK National Health Service.

Social Data

Facebook Graph

https://developers.facebook.com/docs/graph-api

Facebook provides this API which allows you to query the huge amount of information that users are sharing with the world.

Topsy

http://topsy.com/

Topsy provides a searchable database of public tweets going back to 2006 as well as several tools to analyze the conversations.

Google Trends

http://www.google.com/trends/explore

Statistics on search volume (as a proportion of total search) for any given term, since 2004.

Likebutton

http://likebutton.com/

Mines Facebook's public data—globally and from your own network—to give an overview of what people "Like" at the moment.

Miscellaneous and Public Data Sets

Amazon Web Services public datasets

http://aws.amazon.com/datasets

The public data sets on Amazon Web Services provide a centralized repository of public data sets. An interesting dataset is the 1000 Genome Project, an attempt to build the most comprehensive database of human genetic information. Also a NASA database of satellite imagery of Earth is available.

DBPedia

http://wiki.dbpedia.org

Wikipedia contains millions of pieces of data, structured and unstructured, on every subject. DBPedia is an ambitious project to catalogue and create a public, freely distributable database allowing anyone to analyze this data.

Freebase

http://www.freebase.com/

This community database provides information about several topics, with over 45 million entries.

Gapminder

http://www.gapminder.org/data/

This site provides data coming from the World Health Organization and World Bank covering economic, medical, and social statistics from around the world.

Financial Data

Google Finance

https://www.google.com/finance

Forty years' worth of stock market data, updated in real time.

Climatic Data

National Climatic Data Center

http://www.ncdc.noaa.gov/data-access/quick-links#loc-clim

Huge collection of environmental, meteorological, and climate data sets from the US National Climatic Data Center. The world's largest archive of weather data.

WeatherBase

http://www.weatherbase.com/

This site provides climate averages, forecasts, and current conditions for over 40,000 cities worldwide.

Wunderground

http://www.wunderground.com/

This site provides climatic data from satellites and weather stations, allowing you to get all information about the temperature, wind, and other climatic measurements.

Sports Data

Pro-Football-Reference

http://www.pro-football-reference.com/

This site provides data about football and several other sports.

Publications, Newspapers, and Books

New York Times

http://developer.nytimes.com/docs

Searchable, indexed archive of news articles going back to 1851.

Google Books Ngrams

http://storage.googleapis.com/books/ngrams/books/datasetsv2.html

This source searches and analyzes the full text of any of the millions of books digitized as part of the Google Books project.

Musical Data

Million Song Data Set

http://aws.amazon.com/datasets/6468931156960467

Metadata on over a million songs and pieces of music. Part of Amazon Web Services.

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