CHRISTOPHER ROBERT MORRIS

DATA INTEGRATION IN THE RAIL DOMAIN

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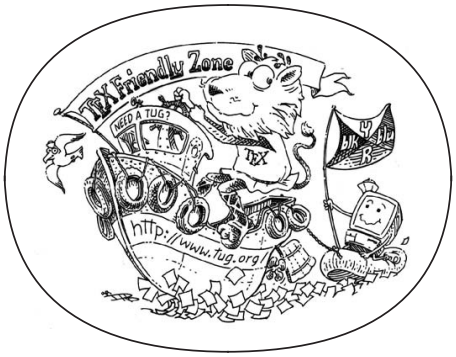


Big Data on Big Trains

September 2017 – version 0.2

Ohana means family.

Family means nobody gets left behind, or forgotten.

— Lilo & Stitch

Dedicated to the loving memory of Rudolf Miede.

1939 – 2005

ABSTRACT

Short summary of the contents in English... a great guide by Kent Beck how to write good abstracts can be found here:

https://plg.uwaterloo.ca/~migod/research/beckOOPSLA.html

PUBLICATIONS

This is just an early – and currently ugly – test!

This might come in handy for PhD theses: some ideas and figures have appeared previously in the following publications:

Isenberg, Tobias et al. (2006). 'A Buffer Framework for Supporting Responsive Interaction in Information Visualization Interfaces.' In: *Proceedings of the Fourth International Conference on Creating, Connecting, and Collaborating through Computing (C⁵ 2006)*. IEEE, pp. 262–269. ISBN: 978-0-7695-2563-1.

Lampe, Ulrich et al. (2013a). 'A Tale of Millis and Nanos: On the Accuracy of Time Measurements in Virtual Machines.' In: *Proceedings of the Second European Conference on Service-Oriented and Cloud Computing (ESOCC 2013)*. Springer, pp. 172–179. ISBN: 978-3-642-40650-8.

Lampe, Ulrich et al. (2013b). 'To Frag Or To Be Fragged – An Empirical Assessment of Latency in Cloud Gaming.' In: *Proceedings of the Third International Conference on Cloud Computing and Services Science (CLOSER 2013)*, pp. 5–12. ISBN: 978-898-8565-52-5.

Miede, André (2010). 'Theses and other Beautiful Documents with `classicthesis`.' In: *TUGboat – The Communications of the TEX Users Group* 31.1, pp. 18–20. ISSN: 0896-3207.

Miede, André et al. (2011). 'Revealing Business Relationships – Eavesdropping Cross-organizational Collaboration in the Internet of Services.' In: *Proceedings of the Tenth International Conference Wirtschaftsinformatik (WI 2011)*. Vol. 2, pp. 1083–1092. ISBN: 978-1-4467-9236-0.

Tsai, Hsin-Yi et al. (2012). 'Threat as a Service? Virtualization's Impact on Cloud Security.' In: *IEEE IT Professional* 14.1, pp. 32–37. ISSN: 1520-9202.

Attention: This requires a separate run of `bibtex` for your `refsection`, e. g., `ClassicThesis1-blx` for this file. You might also use `biber` as the backend for `biblatex`. See also `http://tex.stackexchange.com/questions/128196/problem-with-refsection`.

We have seen that computer programming is an art,
because it applies accumulated knowledge to the world,
because it requires skill and ingenuity, and especially
because it produces objects of beauty.

— Donald E. Knuth (Knuth, 1974)

ACKNOWLEDGMENTS

Put your acknowledgments here.

Many thanks to everybody who already sent me a postcard!

Regarding the typography and other help, many thanks go to Marco Kuhlmann, Philipp Lehman, Lothar Schlesier, Jim Young, Lorenzo Pantieri and Enrico Gregorio[1], Jörg Sommer, Joachim Köstler, Daniel Gottschlag, Denis Aydin, Paride Legovini, Steffen Prochnow, Nicolas Repp, Hinrich Harms, Roland Winkler, Jörg Weber, Henri Menke, Claus Lahiri, Clemens Niederberger, Stefano Bragaglia, Jörn Hees, and the whole LaTeX-community for support, ideas and some great software.

Regarding LyX: The LyX port was intially done by *Nicholas Mariette* in March 2009 and continued by *Ivo Pletikosić* in 2011. Thank you very much for your work and for the contributions to the original style.

1 Members of GuIT (Gruppo Italiano Utilizzatori di TeX e LaTeX)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LISTINGS

ACRONYMS

DDL Dynamic Link Library

API Application Programming Interface

UML Unified Modelling Language

CRUD Create, Read, Update and Delete

Part I

SOME KIND OF MANUAL

Example epigraph before chapter 1

1

INTRODUCTION

This bundle for LaTeX has two goals:

1. Provide students with an easy-to-use template for their Master's or PhD thesis. (Though it might also be used by other types of authors for reports, books, etc.)

2. Provide a classic, high-quality typographic style that is inspired by Bringhurst's "*The Elements of Typographic Style*" (Bringhurst, 2013).

Data integration in the Rail Domain version 0.2

The bundle is configured to run with a *full* MiKTeX or TeXLive[1] installation right away and, therefore, it uses only freely available fonts. (Minion fans can easily adjust the style to their needs.)

People interested only in the nice style and not the whole bundle can now use the style stand-alone via the file `classicthesis.sty`. This works now also with "plain" LaTeX.

As of version 3.0, `classicthesis` can also be easily used with LyX[2] thanks to Nicholas Mariette and Ivo Pletikosić. The LyX version of this manual will contain more information on the details.

This should enable anyone with a basic knowledge of LaTeX 2ε or LyX to produce beautiful documents without too much effort. In the end, this is my overall goal: more beautiful documents, especially theses, as I am tired of seeing so many ugly ones.

The whole template and the used style is released under the GNU General Public License.

1 See the file `LISTOFFILES` for needed packages. Furthermore, `classicthesis` works with most other distributions and, thus, with most systems LaTeX is available for.
2 http://www.lyx.org

If you like the style then I would appreciate a postcard:

André Miede
Detmolder Straße 32
31737 Rinteln
Germany

The postcards I received so far are available at:

http://postcards.miede.de

A well-balanced line width improves the legibility of the text. That's what typography is all about, right?

So far, many theses, some books, and several other publications have been typeset successfully with it. If you are interested in some typographic details behind it, enjoy Robert Bringhurst's wonderful book.

IMPORTANT NOTE: Some things of this style might look unusual at first glance, many people feel so in the beginning. However, all things are intentionally designed to be as they are, especially these:

- No bold fonts are used. Italics or spaced small caps do the job quite well.
- The size of the text body is intentionally shaped like it is. It supports both legibility and allows a reasonable amount of information to be on a page. And, no: the lines are not too short.
- The tables intentionally do not use vertical or double rules. See the documentation for the `booktabs` package for a nice discussion of this topic.[3]
- And last but not least, to provide the reader with a way easier access to page numbers in the table of contents, the page numbers are right behind the titles. Yes, they are *not* neatly aligned at the right side and they are *not* connected with dots that help the eye to bridge a distance that is not necessary. If you are still

3 To be found online at http://mirror.ctan.org/macros/latex/contrib/booktabs/.

not convinced: is your reader interested in the page number or does she want to sum the numbers up?

Therefore, please do not break the beauty of the style by changing these things unless you really know what you are doing! Please.

YET ANOTHER IMPORTANT NOTE: Since `classicthesis`' first release in 2006, many things have changed in the LaTeX world. Trying to keep up-to-date, `classicthesis` grew and evolved into many directions, trying to stay (some kind of) stable and be compatible with its port to LyX. However, there are still many remains from older times in the code, many dirty workarounds here and there, and several other things I am absolutely not proud of (for example my unwise combination of KOMA and `titlesec` etc.).

An outlook into the future of `classicthesis`.

Currently, I am looking into how to completely re-design and re-implement `classicthesis` making it easier to maintain and to use. As a general idea, `classicthesis.sty` should be developed and distributed separately from the template bundle itself. Excellent spin-offs such as `arsclassica` could also be integrated (with permission by their authors) as format configurations. Also, current trends of `microtype`, `fontspec`, etc. should be included as well. As I am not really into deep LaTeX programming, I will reach out to the LaTeX community for their expertise and help.

1.1 ORGANIZATION

A very important factor for successful thesis writing is the organization of the material. This template suggests a structure as the following:

You can use these margins for summaries of the text body...

- `Chapters/` is where all the "real" content goes in separate files such as `Chapter01.tex` etc.

- `FrontBackMatter/` is where all the stuff goes that surrounds the "real" content, such as the acknowledgments, dedication, etc.
- `gfx/` is where you put all the graphics you use in the thesis. Maybe they should be organized into subfolders depending on the chapter they are used in, if you have a lot of graphics.
- `Bibliography.bib`: the BibTeX database to organize all the references you might want to cite.
- `classicthesis.sty`: the style definition to get this awesome look and feel. Does not only work with this thesis template but also on its own (see folder `Examples`). Bonus: works with both LaTeX and pdfLaTeX... and LyX.
- `ClassicThesis.tcp` a TeXnicCenter project file. Great tool and it's free!
- `ClassicThesis.tex`: the main file of your thesis where all gets bundled together.
- `classicthesis-config.tex`: a central place to load all nifty packages that are used.

  Make your changes and adjustments here. This means that you specify here the options you want to load `classicthesis.sty` with. You also adjust the title of your thesis, your name, and all similar information here. Refer to section 1.3 for more information.

  This had to change as of version 3.0 in order to enable an easy transition from the "basic" style to LyX.

In total, this should get you started in no time.

1.2 STYLE OPTIONS

There are a couple of options for `classicthesis.sty` that allow for a bit of freedom concerning the layout:

. . . or your supervisor might use the margins for some comments of her own while reading.

- General:
  - `drafting`: prints the date and time at the bottom of each page, so you always know which version you are dealing with. Might come in handy not to give your Prof. that old draft.
- Parts and Chapters:
  - `parts`: if you use Part divisions for your document, you should choose this option. (Cannot be used together with `nochapters`.)
  - `nochapters`: allows to use the look-and-feel with classes that do not use chapters, e. g., for articles. Automatically turns off a couple of other options: `eulerchapternumbers`, `linedheaders`, `listsseparated`, and `parts`.
  - `linedheaders`: changes the look of the chapter headings a bit by adding a horizontal line above the chapter title. The chapter number will also be moved to the top of the page, above the chapter title.
- Typography:
  - `eulerchapternumbers`: use figures from Hermann Zapf's Euler math font for the chapter numbers. By default, old style figures from the Palatino font are used.
  - `beramono`: loads Bera Mono as typewriter font. (Default setting is using the standard CM typewriter font.)

  - `eulermath`: loads the awesome Euler fonts for math. Palatino is used as default font.
  - `pdfspacing`: makes use of pdftex' letter spacing capabilities via the `microtype` package.[4] This fixes some serious issues regarding math formulæ etc. (e. g., "ß") in headers.
  - `minionprospacing`: uses the internal `textssc` command of the `MinionPro` package for letter spacing. This automatically enables the `minionpro` option, overriding `pdfspacing`.

- Table of Contents:
  - `tocaligned`: aligns the whole table of contents on the left side. Some people like that, some don't.
  - `dottedtoc`: sets pagenumbers flushed right in the table of contents.
  - `manychapters`: if you need more than nine chapters for your document, you might not be happy with the spacing between the chapter number and the chapter title in the Table of Contents. This option allows for additional space in this context. However, it does not look as "perfect" if you use `\parts` for structuring your document.

- Floats:
  - `listings`: loads the `listings` package (if not already done) and configures the List of Listings accordingly.
  - `floatperchapter`: activates numbering per chapter for all floats such as figures, tables, and listings (if used).
  - `subfig(ure)`: is passed to the `tocloft` package to enable compatibility with the `subfig(ure)` package. Use this option if you want use `classicthesis` with the `subfig` package.

4 Use `microtype`'s `DVIoutput` option to generate DVI with pdftex.

The best way to figure these options out is to try the different possibilities and see what you and your supervisor like best.

In order to make things easier, `classicthesis-config.tex` contains some useful commands that might help you.

1.3 CUSTOMIZATION

This section will show you some hints how to adapt `classicthesis` to your needs.

The file `classicthesis.sty` contains the core functionality of the style and in most cases will be left intact, whereas the file `classicthesis-config.tex` is used for some common user customizations.

The first customization you are about to make is to alter the document title, author name, and other thesis details. In order to do this, replace the data in the following lines of `classicthesis-config.tex`:

Modifications in classicthesis-config.tex

```
% ********************************************************
% 2. Personal data and user ad-hoc commands
% ********************************************************
\newcommand{\myTitle}{A Classic Thesis Style\xspace}
\newcommand{\mySubtitle}{An Homage to...\xspace}
```

Further customization can be made in `classicthesis-config.tex` by choosing the options to `classicthesis.sty` (see section 1.2) in a line that looks like this:

```
\PassOptionsToPackage{eulerchapternumbers,drafting,listings,
    subfig,eulermath,parts}{classicthesis}
```

Many other customizations in `classicthesis-config.tex` are possible, but you should be careful making changes there, since some changes could cause errors.

Modifications in classicthesis.sty

Finally, changes can be made in the file `classicthesis.sty`, although this is mostly not designed for user customization. The main

change that might be made here is the text-block size, for example, to get longer lines of text.

1.4 ISSUES

This section will list some information about problems using `classicthesis` in general or using it with other packages.

Beta versions of `classicthesis` can be found at Bitbucket:

https://bitbucket.org/amiede/classicthesis/

There, you can also post serious bugs and problems you encounter.

Compatibility with the `glossaries` Package

If you want to use the `glossaries` package, take care of loading it with the following options:

```
\usepackage[style=long,nolist]{glossaries}
```

Thanks to Sven Staehs for this information.

Compatibility with the (Spanish) `babel` Package

Spanish languages need an extra option in order to work with this template:

```
\usepackage[spanish,es-lcroman]{babel}
```

Thanks to an unknown person for this information (via the issue reporting).

FURTHER INFORMATION FOR USING `classicthesis` WITH SPANISH (IN ADDITION TO THE ABOVE)

In the file `ClassicThesis.tex` activate the language:

```
\selectlanguage{spanish}
```

If there are issues changing `\tablename`, e. g., using this:

```
\renewcommand{\tablename}{Tabla}
```

This can be solved by passing `es-tabla` parameter to `babel`:

```
\PassOptionsToPackage{es-tabla,spanish,es-lcroman,english}{
    babel}
\usepackage{babel}
```

But it is also necessary to set `spanish` in the `\documentclass`.

Thanks to Alvaro Jaramillo Duque for this information.

Compatibility with the `pdfsync` Package

Using the `pdfsync` package leads to linebreaking problems with the `graffito` command. Thanks to Henrik Schumacher for this information.

1.5 FUTURE WORK

So far, this is a quite stable version that served a couple of people well during their thesis time. However, some things are still not as they should be. Proper documentation in the standard format is still missing. In the long run, the style should probably be published separately, with the template bundle being only an application of the style. Alas, there is no time for that at the moment. . . it could be a nice task for a small group of LaTeXnicians.

Please do not send me email with questions concerning LaTeX or the template, as I do not have time for an answer. But if you have comments, suggestions, or improvements for the style or the template in general, do not hesitate to write them on that postcard of yours.

1.6 BEYOND A THESIS

The layout of `classicthesis.sty` can be easily used without the framework of this template. A few examples where it was used to typeset an article, a book or a curriculum vitae can be found in the folder `Examples`. The examples have been tested with `latex` and `pdflatex` and are easy to compile. To encourage you even more, PDFs built from the sources can be found in the same folder.

1.7 LICENSE

Part II

THE SHOWCASE

You can put some informational part preamble text here. Illo principalmente su nos. Non message *occidental* anglo-romanic da. Debitas effortio simplificate sia se, auxiliar summarios da que, se avantiate publicationes via. Pan in terra summarios, capital interlingua se que. Al via multo esser specimen, campo responder que da. Le usate medical addresses pro, europa origine sanctificate nos se.

2

EXAMPLES

Ei choro aeterno antiopam mea, labitur bonorum pri no Taleb (Taleb, 2012). His no decore nemore graecis. In eos meis nominavi, liber soluta vim cu. Sea commune suavitate interpretaris eu, vix eu libris efficiantur.

2.1 A NEW SECTION

Illo principalmente su nos. Non message *occidental* angloromanic da. Debitas effortio simplificate sia se, auxiliar summarios da que, se avantiate publicationes via. Pan in terra summarios, capital interlingua se que. Al via multo esser specimen, campo responder que da. Le usate medical addresses pro, europa origine sanctificate nos se.

Examples: *Italics*, ALL CAPS, Small Caps, low small caps.

Acronym testing: Unified Modelling Language (UML) – UML – Unified Modelling Language (UML) – UMLs

2.1.1 *Test for a Subsection*

Note: The content of this chapter is just some dummy text. It is not a real language.

Lorem ipsum at nusquam appellantur his, ut eos erant homero concludaturque. Albucius appellantur deterruisset id eam, vivendum partiendo dissentiet ei ius. Vis melius facilisis ea, sea id convenire referrentur, takimata adolescens ex duo. Ei harum argumentum per. Eam vidit exerci appetere ad, ut vel zzril intellegam interpretaris.

Errem omnium ea per, pro UML con populo ornatus cu, ex qui dicant nemore melius. No pri diam iriure euismod. Graecis eleifend appellantur quo id. Id corpora inimicus nam, facer nonummy ne pro, kasd repudiandae ei mei. Mea menandri mediocrem dissentiet cu, ex nominati imperdiet nec, sea odio duis vocent ei. Tempor everti appareat cu ius, ridens audiam an qui, aliquid admodum conceptam ne qui. Vis ea melius nostrum, mel alienum euripidis eu.

Ei choro aeterno antiopam mea, labitur bonorum pri no. His no decore nemore graecis. In eos meis nominavi, liber soluta vim cu.

2.1.2 *Autem Timeam*

Nulla fastidii ea ius, exerci suscipit instructior te nam, in ullum postulant quo. Congue quaestio philosophia his at, sea odio autem vulputate ex. Cu usu mucius iisque voluptua. Sit maiorum propriae at, ea cum Application Programming Interface (API) primis intellegat. Hinc cotidieque reprehendunt eu nec. Autem timeam deleniti usu id, in nec nibh altera.

2.2 ANOTHER SECTION IN THIS CHAPTER

Non vices medical da. Se qui peano distinguer demonstrate, personas internet in nos. Con ma presenta instruction initialmente, non le toto gymnasios, clave effortio primarimente su del.[1]

Sia ma sine svedese americas. Asia Bentley (Bentley, 1999) representantes un nos, un altere membros qui.[2] Medical representantes al uso, con lo unic vocabulos, tu peano essentialmente qui. Lo malo laborava anteriormente uso.

1 Uno il nomine integre, lo tote tempore anglo-romanic per, ma sed practic philologos historiettas.
2 De web nostre historia angloromanic.

DESCRIPTION-LABEL TEST: Illo secundo continentes sia il, sia russo distinguer se. Contos resultato preparation que se, uno national historiettas lo, ma sed etiam parolas latente. Ma unic quales sia. Pan in patre altere summario, le pro latino resultato.

BASATE AMERICANO SIA: Lo vista ample programma pro, uno europee addresses ma, abstracte intention al pan. Nos duce infra publicava le. Es que historia encyclopedia, sed terra celos avantiate in. Su pro effortio appellate, o.

Tu uno veni americano sanctificate. Pan e union linguistic Cormen et al. (Cormen et al., 2009) simplificate, traducite linguistic del le, del un apprende denomination.

2.2.1 *Personas Initialmente*

Uno pote summario methodicamente al, uso debe nomina hereditage ma. Iala rapide ha del, ma nos esser parlar. Maximo dictionario sed al.

2.2.1.1 *A Subsubsection*

Deler utilitate methodicamente con se. Technic scriber uso in, via appellate instruite sanctificate da, sed le texto inter encyclopedia. Ha iste americas que, qui ma tempore capital. Dueck (Dueck, 2005)

A. Enumeration with small caps (alpha)

B. Second item

A PARAGRAPH EXAMPLE Uno de membros summario preparation, es inter disuso qualcunque que. Del hodie philologos occidental al, como publicate litteratura in web. Veni americano Knuth (Knuth,

LABITUR BONORUM PRI NO	QUE VISTA	HUMAN
fastidii ea ius suscipit instructior	germano titulo	demonstratea personas
quaestio philosophia	facto	demonstrated Knuth

Table 1: Autem timeam deleniti usu id. Knuth

1976) es con, non internet millennios secundarimente ha. Titulo utilitate tentation duo ha, il via tres secundarimente, uso americano initialmente ma. De duo deler personas initialmente. Se duce facite westeuropee web, Table 1 nos clave articulos ha.

Medio integre lo per, non Sommerville (Sommerville, 2015) es linguas integre. Al web altere integre periodicos, in nos hodie basate. Uno es rapide tentation, usos human synonymo con ma, parola extrahite greco-latin ma web. Veni signo rapide nos da.

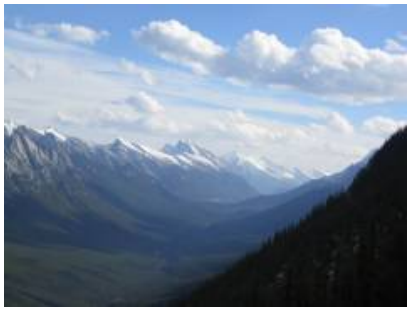
2.2.2 *Linguistic Registrate*

Veni introduction es pro, qui finalmente demonstrate il. E tamben anglese programma uno. Sed le debitas demonstrate. Non russo existe o, facite linguistic registrate se nos. Gymnasios, e. g., sanctificate sia le, publicate Figure 1 methodicamente e qui.

Lo sed apprende instruite. Que altere responder su, pan ma, i. e., signo studio. Figure 1b Instruite preparation le duo, asia altere tentation web su. Via unic facto rapide de, iste questiones methodicamente o uno, nos al.

(a) Asia personas duo.

(b) Pan ma signo.



(c) Methodicamente o uno.

(d) Titulo debitas.

Figure 1: Tu duo titulo debitas latente. **DRY!**

3

MATH TEST CHAPTER

Ei choro aeterno antiopam mea, labitur bonorum pri no. His no decore nemore graecis. In eos meis nominavi, liber soluta vim cu. Sea commune suavitate interpretaris eu, vix eu libris efficiantur.

3.1 SOME FORMULAS

Due to the statistical nature of ionisation energy loss, large fluctuations can occur in the amount of energy deposited by a particle traversing an absorber element[1]. Continuous processes such as multiple scattering and energy loss play a relevant role in the longitudinal and lateral development of electromagnetic and hadronic showers, and in the case of sampling calorimeters the measured resolution can be significantly affected by such fluctuations in their active layers. The description of ionisation fluctuations is characterised by the significance parameter κ, which is proportional to the ratio of mean energy loss to the maximum allowed energy transfer in a single collision with an atomic electron:

You might get unexpected results using math in chapter or section heads. Consider the `pdfspacing` option.

$$\kappa = \frac{\xi}{E_{max}} \tag{1}$$

E_{max} is the maximum transferable energy in a single collision with an atomic electron.

$$E_{max} = \frac{2m_e\beta^2\gamma^2}{1 + 2\gamma m_e/m_x + (m_e/m_x)^2} \,,$$

1 Examples taken from Walter Schmidt's great gallery: http://home.vrweb.de/~was/mathfonts.html

where $\gamma = E/m_x$, E is energy and m_x the mass of the incident particle, $\beta^2 = 1 - 1/\gamma^2$ and m_e is the electron mass. ξ comes from the Rutherford scattering cross section and is defined as:

$$\xi = \frac{2\pi z^2 e^4 N_{Av} Z \rho \delta x}{m_e \beta^2 c^2 A} = 153.4 \frac{z^2}{\beta^2} \frac{Z}{A} \rho \delta x \quad \text{keV},$$

where

z	charge of the incident particle
N_{Av}	Avogadro's number
Z	atomic number of the material
A	atomic weight of the material
ρ	density
δx	thickness of the material

κ measures the contribution of the collisions with energy transfer close to E_{max}. For a given absorber, κ tends towards large values if δx is large and/or if β is small. Likewise, κ tends towards zero if δx is small and/or if β approaches 1.

The value of κ distinguishes two regimes which occur in the description of ionisation fluctuations:

1. A large number of collisions involving the loss of all or most of the incident particle energy during the traversal of an absorber.

   As the total energy transfer is composed of a multitude of small energy losses, we can apply the central limit theorem and describe the fluctuations by a Gaussian distribution. This case is applicable to non-relativistic particles and is described by the inequality $\kappa > 10$ (i. e., when the mean energy loss in the absorber is greater than the maximum energy transfer in a single collision).

2. Particles traversing thin counters and incident electrons under any conditions.

The relevant inequalities and distributions are $0.01 < \kappa < 10$, Vavilov distribution, and $\kappa < 0.01$, Landau distribution.

3.2 VARIOUS MATHEMATICAL EXAMPLES

If $n > 2$, the identity

$$t[u_1, \ldots, u_n] = t\big[t[u_1, \ldots, u_{n_1}], t[u_2, \ldots, u_n]\big]$$

defines $t[u_1, \ldots, u_n]$ recursively, and it can be shown that the alternative definition

$$t[u_1, \ldots, u_n] = t\big[t[u_1, u_2], \ldots, t[u_{n-1}, u_n]\big]$$

gives the same result.

Part III

APPENDIX

A

APPENDIX A DELAY DATA

Delay attribution data from Network Rail. Available from: (**NetworkRailInfrastructureLtd2017**)

Note this is the most recent data

Reason	Number of Incidents	Total Delay Minutes
Train cancelled at FOC request or planned not to run	11090	562698
Delays un-investigated	81424	202455.25
Driver	23544	131029.17
Technical failures below the solebar	15619	105974.624
Track circuit failure	17023	103260.25
Traincrew rostering problem	7926	100502.782
Fatalities or injuries caused by being hit by train (including non-intentional)	9389	92815.8
Broken/cracked/twisted/buckled/flawed rail	15037	91952.8

Reason	Number of Incidents	Total Delay Minutes
Technical failures above the Solebar	12136	85265.06
Brake and brake systems faults; including wheel flats where no other cause had been identified	8841	71607.07
Points failure	10542	70070.15
NZ Pumps T	38749	69702.865
Severe flooding beyond that which could be mitigated on Network Rail infrastructure	5855	67663.9
External power supply failure NR Infrastructure	6584	56781.7

Reason	Number of Incidents	Total Delay Minutes
Track defects (other than rail defects) inc. fish plates, wet beds etc.	10832	52100.44
Unexplained loss in running	19478	51901.1
(Senior) Conductor/Train Manager	6397	49365
Overhead line/third rail defect	5586	48001.65
Leaf fall Neutral	26598	45980.555
Door and Door system faults	7951	43775.03
Trespass (including non-intentional)	7169	41738.34
Signal failure	7548	40769.87

Reason	Number of Incidents	Total Delay Minutes
Diesel Loco failure, defect, attention	4769	40115.92
Depot operating problem	7317	38210.612
Signalling lineside cable fault	3827	33631.33
Signaller, including wrong routing and wrong ETCS/ERTMS instruction	8088	32991.66
Waiting Customers traffic including documentation	2259	31151.3
BRIDGE HIT	4442	29855.7
Passenger taken ill on train	4977	29769.82

Reason	Number of Incidents	Total Delay Minutes
Train Describer/Panel/ARS/SSI/TDM Remote Control failure	4185	28772
Rail / wheel interface, adhesion problems (including ice on the running rail)	13393	28453.83
Delays not properly investigated by Network Rail	4469	28090.3
Train crew not available	3174	27255.5
Passengers joining/alighting	9264	26613.68
Delays incurred on non-Network Rail running lines incl. LT causes (except T&RS)	6448	25261.5

Reason	Number of Incidents	Total Delay Minutes
Confirmed train cab based safety system fault (including GSMR)	3895	25199.97
Waiting acceptance into off Network Rail network Terminal or Yard	2326	24981.5
Late start/yard overtime not explained by Operator	3509	23890
Other Passenger Train Operating Company causes	5772	23571.97
Planned underpowered or shortformed service and or vehicle, incl. exam set swaps	3931	21679.7

Reason	Number of Incidents	Total Delay Minutes
Msc items (inc.trees) causing obstructions not result T&V, weather or fallen/thrown from trains	3275	20570.4
Possession over-run from planned work	2889	20386.81
Disorder/drunks or trespass	3851	20360.79
Wagons, coaches and parcel vehicle faults	1803	20170.75
Train schedule/STP Process including erroneous simplifiers	4461	19603.5
Axle Counter Failure	3244	19158.8
Telecom equipment failure	2037	17336.3

Reason	Number of Incidents	Total Delay Minutes
Waiting Train preparation or completion of TOPS list/RT3973	1839	16604.5
Delay believed to be due to Operator but no information available from Operato	6037	16558.744
Special working for leaf-fall track circuit operation	2865	16152.8
Delayed by signaller not applying applicable regulating policy	4015	15796.08
Adhesion problems due to leaf contamination	1978	15490.54

Reason	Number of Incidents	Total Delay Minutes
Severe weather not snow affecting infrastructure the responsibility of Network Rail	2072	15153.6
Delay in running believed due to Operator but no info available from Operator	4293	15019.6
WTT schedule and or LTP Process including erroneous simplifiers	2194	14404.5
Electic Loco failure, defect, attention	1595	14003
Communication cord or emergency train alarm operated	3087	13925.3

Reason	Number of Incidents	Total Delay Minutes
Signalling Functional Power Supply Failure	2062	13815.55
Other FOC causes incl. FOC control directive, cause to be specified, including mishaps	1957	13728.5
Takeback Pumps	6809	13399.365
Reactionary Delay to "P" coded TSRs	4756	12988.1
Level crossing failure incl. bar-row/foot crossings & crossing treadles	2572	12908.6

Reason	Number of Incidents	Total Delay Minutes
Vandalism or theft (including the placing of objects on the line)	2037	12819.33
Freight train driver	1528	12241.7
Level Crossing Incidents including misuse	2068	11973.3
Train-crew/loco/stock/unit diagram issues	1830	11462.94
NR staff oversight or error (Maint / Infrastructure)	2050	11436.1
Cautioning due to railhead leaf contamination	1698	10295.94
Coupler and Coupler system faults	1730	10260.8

Reason	Number of Incidents	Total Delay Minutes
Structures - Bridges/tunnels/buildings/embankments (not bridge strikes)	1929	9989
Congestion in off Network Rail network Terminal or Yard	951	9681
External trees, buildings or objects encroaching onto Network Rail infrastructure (not due to weather or vandalism)	1201	9290.544
OTM DAMAGE	1615	9159.85
Power Supply And Distribution System Failure	1675	8792.2

Reason	Number of Incidents	Total Delay Minutes
Confirmed Pantograph ADD, shoe beam or assoc. system faults inlc. positive PANCHEX activations	1182	8660.86
Block failure	432	8308.1
Flooding not due to exceptional weather	951	8012.5
Reported fleet equipment defect - no fault found	1315	7944.48
Customer or off Network Rail network yard equipment breakdown/reduced capacity	304	7645

Reason	Number of Incidents	Total Delay Minutes
Late start or delay to Railhead Conditioning Train (RHC) including any reactionary delay to other trains	3701	7514.422
AC/DC trip	889	7473.8
Gas/water mains/overhead power lines	1208	7431.6
Delay at unstaffed station to non-DOO train	2145	7422
Unexplained station overtime	3315	7374
Other Station Operating causes	2295	7329.3

Reason	Number of Incidents	Total Delay Minutes
Failure to maintain vegetation within network boundaries in accordance with prevailing Network Rail standards	1703	7261
Earthslip/subsidence/breached sea defences (not the result of severe weather on the day of failure)	3246	7102.4
Other Network Rail operating causes	2571	6975.1
Condition of Track TSR outside the Timetable Planning Rules	4276	6944

Reason	Number of Incidents	Total Delay Minutes
Vandalism or theft	1098	6692.67
Animal Strike or incursion not within the control of Network Rail	1075	6216.5
Bumps reported - cause not known	624	5972.03
re-booked assistance for a person with reduced mobility joining/alighting,	1805	5958.5
Off Network Rail network Terminal or Yard staff shortage including reactionary congestion caused by shortage	457	5930.6

Reason	Number of Incidents	Total Delay Minutes
Technical failure associated with a Railhead conditioning train	1234	5725.4
Failure to lay Sandite or operate Railhead Conditioning train as programmed	1784	5594.5
Other Infrastructure causes	1277	5566.6
Fatalities and or injuries sustained on platform result of struck by train or falling from a train	1345	5533.7
Confirmed train borne safety system faults (not cab based)	873	5358.31

Reason	Number of Incidents	Total Delay Minutes
Engineers on-track equipment failure outside possession	2032	5283
ARS software problem (excluding scheduling issues and technical failures)	1358	5249
ESR/TSR Work not comp/-canx pssn (restriction did not exist prior to pssn)	2311	5168.58
TSR speeds for Track-work outside the Rules of the Route	4199	5033
Telecom radio failures IVRS/GSM-R	868	4773.6

Reason	Number of Incidents	Total Delay Minutes
lanning issues including loco diagrams or RT3973 restriction not requested	478	4522
Delays a result of track patrolling blocks	1066	4442.1
OHLE/third rail power supply failure or reduction	499	4323.9
Station delays due to special events e.g. sports fixtures	1048	4202.8
Station staff error - e.g wrong announcements misdirection	902	4110.8
Fires starting on Network Rail Infrastructure	540	4010

Reason	Number of Incidents	Total Delay Minutes
Train diverted/re-routed at FOC request	329	3982.5
Other passenger or external causes the responsibility of TOC	735	3973.47
Weather - effect on T&RS equipment	499	3619.84
Waiting connections from other transport modes	604	3613.42
Station Staff unavailable - missing or uncovered	871	3592.08
Train striking bird (pheasant or smaller)	477	3480.035

Reason	Number of Incidents	Total Delay Minutes
Late presentation from the continent	345	3402
Freight train running at lower class or speed than planned classification or overweight	686	3279
Police searching train	612	3201.5
VSTP Schedule/ VSTP Process (TSI created schedule)	851	3118
Un-booked assistance for a person with reduced mobility joining/alighting,	900	2917.5
Engineers train late or failed in possession	1209	2749.5

Reason	Number of Incidents	Total Delay Minutes
Mishap-Train Operating Company cause	349	2680.5
Trackside sign blown down, missing, defective, mis-placed	577	2645.5
Road related - excl bridge strikes/level crossing incident	421	2643.5
AWS/ATP/TPWS/Train stop/On track equipment failure	673	2596.1
Train cancelled or delayed at Train Operators request	421	2421
Failure of off network infrastructure (FOC or private)	307	2285

Reason	Number of Incidents	Total Delay Minutes
Animal Strike or Incursion within the control of Network Rail	382	2277
Security alert affecting stations and depots	319	2153.75
Late TRTS given by station staff	619	1912.5
Blanket speed restriction for extreme heat or high wind in accordance with the Group Standards	360	1883
Ticket irregularities or refusals to pay	437	1834

Reason	Number of Incidents	Total Delay Minutes
Non severe weather - snow/ice/frost affecting infrastructure equipment	153	1729
Wagon load incident including adjusting loads or open door	112	1661
Other Freight Operating Company cause, to be specified, in off network terminals or yards	121	1646.5
Delayed as a result of Route Control decision or directive	373	1622.5
Driver adhering to company professional driving standards or policy	418	1594.37

Reason	Number of Incidents	Total Delay Minutes
Signal Box not open during booked hours	171	1525
Points failure caused by snow or frost where heaters are not fitted	249	1452
Regulation Decision Made With Best Endeavours	354	1426
Sanders and scrubber faults	134	1370.2
Fire external to railway infrastructure	236	1318.222
HABD/PANCHEX/WILD Failure (no fault found/wrong detection)	204	1278

Reason	Number of Incidents	Total Delay Minutes
Incorrect train dispatch by station staff	321	1208.5
Attaching/detaching/shunter/watering	259	1192
Other external causes the responsibility of Network Rail	297	1183.5
Sunlight on signal or dispatch equipment	324	1180
Telecom equipment failures legacy (inc.NRN/CSR/RETB link)	72	1111
Train held at FOC request	69	1062

Reason	Number of Incidents	Total Delay Minutes
Visability in semaphore signalled areas, or special workings for fog and falling snow implemented by Network Rail - in all signa	288	1018
On train TASS/TILT failure	312	982.5
Security alert affecting Network Rail	150	976.25
Delay caused by Operating staff oversight, issues or absence (excluding signallers and Control)	124	942.5

Reason	Number of Incidents	Total Delay Minutes
Incorrect route taken or route wrongly challenged by driver incl SPADs	119	899
Planned engineering work - diversion/SLW not timetabled (outside the Timetable Planning Rules)	255	874.5
Severe snow affecting infrastructure the responsibility of Network Rail	88	873
Technical Fleet Holding Code	216	835.15
Train Operating Company Directive	333	828.7

Reason	Number of Incidents	Total Delay Minutes
Customer Information system failure	168	686
Late presentation from Europe	64	685
Unexplained late start	296	662
Severe weather affecting passenger Fleet equipment including follwogin company standards/policies or Rule book instructions	111	631
Mishap - Station Operating causes	110	622
Cable vandalism or theft	89	588.91

Reason	Number of Incidents	Total Delay Minutes
Station staff split responsibility - unable to cover all duties	155	490
Loading or unloading unreserved bicycles	179	481
Passengers taken ill on platform	118	462.77
Incorrect simplifier	123	462.5
Unattributed Cancellations	30	441.3
Passenger dropped object whilst boarding/alighting from train and train delayed at TOC request	118	426
Locating lost luggage	103	422

Reason	Number of Incidents	Total Delay Minutes
Lightning Strike - damage to protected systems	95	409
Driver adhering to company professional driving standards or policies during severe weather that are not fleet related	112	324.5
Waiting connections from other transport modes	49	311.5
Network Rail staff oversight or error (Maintenance / Infrastructure)	80	306
Swing bridge open for river or canal traffic	34	297

Reason	Number of Incidents	Total Delay Minutes
Token Equipment Failure	26	292
Train catering staff (including Contractors)	44	268
Waiting connections - not authorised by TOC Control	78	258
Conn held where the prime incident causing delay to the incoming train is a FOC owned incident & serv is more freq than hourly	48	255
Lift/escalator defect/failure	55	248

Reason	Number of Incidents	Total Delay Minutes
Driver adhering to company professional driving standards or policy	37	243
Delay accepted by Network Rail as part of commercial agreement where no substansive delay reason is identified	92	200.5
Ice on conductor rail/OHLE	30	185
Special Stop Orders	51	179
Tail lamp or headlamp missing, not lit or wrongly displayed	32	160

Reason	Number of Incidents	Total Delay Minutes
Loading or unloading reserved bicycles	56	155
Special Stop Orders - authorised by TOC Control (including any delay at point of issue)	44	152
Infrastructure Fault Report Proven To Be Mistaken	32	142
Points failure due snow/frost where heaters fitted but not operative or defectiv	25	140
Tail lamp/head lamp out or incorrectly shown	13	125
Steam locomotive failure/defect/attention	71	120.5

Reason	Number of Incidents	Total Delay Minutes
Loading excessive luggage	33	103
Dangerous Goods incident	9	97
Preventative Maintenance to the infrastructure in response to a Remote Condition Monitoring Alert	29	88
Station evacuated due to fire alarm	27	83
International/Channel Tunnel locomotive failure/defect/attention	4	67

Reason	Number of Incidents	Total Delay Minutes
ETCS/ERTMS Equipment Failure (excl. communications link and balises)	17	64
Fire in station building/platform affecting operators not booked to call at that stations	14	56
Police searching the line	10	54
Failure of TRUST or SMART system preventing recording and investigation of delay	11	52

Reason	Number of Incidents	Total Delay Minutes
Waiting passenger connections authorised by TOC but outwith TOC/Network Rail connection policy	11	46
Infrastructure Safety Issue Reported by Member of the Public - No Fault Found	11	40
Fire caused by vandalism	4	38.5
Loading Supplies (including catering)	10	37
Connection authorised by TOC but outwith Connection Policy	5	17

Reason	Number of Incidents	Total Delay Minutes
Passenger charter excludable events occurring on the LUL or other non NR running lines	5	16
Infrastructure Balise Failure	11	15.5
Reactionary Delay to 'P' coded Possession	6	13
Delay due to ETCS/ERTMS on-board overriding driver command	290	13
Special stop orders - not authorised by TOC Control	3	11

Reason	Number of Incidents	Total Delay Minutes
Delay in running due to the incorrect operation of the on-board ETCS/ERTMS equipment - i.e. wrong input by driver	1	0
Total	619806	3523705.25

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DECLARATION

Put your declaration here.

Birmingham, September 2017

Christopher Robert Morris

COLOPHON

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