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TRANSLATED BY LIND AXIAO

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Introduction

This sample book discusses the design of Edward Tufte's books[1] and the use of the `tufte-book` and `tufte-handout` document classes.

[1] Edward R. Tufte. *The Visual Display of Quantitative Information*. Graphics Press, Cheshire, Connecticut, 2001. ISBN 0-9613921-4-2; Edward R. Tufte. *Envisioning Information*. Graphics Press, Cheshire, Connecticut, 1990. ISBN 0-9613921-1-8; Edward R. Tufte. *Visual Explanations*. Graphics Press, Cheshire, Connecticut, 1997. ISBN 0-9613921-2-6; and Edward R. Tufte. *Beautiful Evidence*. Graphics Press, LLC, first edition, May 2006. ISBN 0-9613921-7-7

1

Reflections on the notions of space

1.1 Lecture 1: Reflections on the notions of space I

The goal of the first course is to understand the notion of manifold in different contexts (topological, differentiable, analytic...) We will start by looking at the case of topological manifolds.

Reminders on topological manifolds

Definition 1.1.1. *1. A **topological manifold** is a topological space X, which has an open cover $\{U_i\}_{i\in I}$ such that for each $i \in I$, there exists a homeomorphism between U_i and an open subset in $\mathbb{R}^{n_i}$*

2. the category of topological manifold is a subcategory of Top. *It is denoted as* VarTop.

Let X be a topological manifold and $\{U_i\}_{i\in I}$ is an open cover as in the definition above. We put, for i and j in I, $U_{i,j} := U_i \cap U_j$. We have a diagram of topological spaces

$$\coprod_{(i,j)\in I^2} U_{i,j} \rightrightarrows \coprod_{i\in I} U_i,$$

where the first morphism sends the component $U_{i,j}$ into U_i by the inclusion $U_{i,j} \hookrightarrow U_i$, and the second morphism sends $U_{i,j}$ into U_j by the inclusion $U_{i,j} \hookrightarrow U_j$. There also exists a morphism

$$\coprod_{i\in I} U_i \longrightarrow X$$

which restricts to inclusion $U_i \hookrightarrow X$ for all i, which equalizes the above two morphisms. We obtain also a well-defined morphism from

the coequalizer of the first diagram to X

$$\mathrm{Colim}\left(\coprod_{(i,j)\in I^2} U_{i,j} \rightrightarrows \coprod_{i\in I} U_i\right) \longrightarrow X.$$

What makes it important is the following lemma.

Lemma 1.1.2. *The morphism*

$$\mathrm{Colim}\left(\coprod_{(i,j)\in I^2} U_{i,j} \rightrightarrows \coprod_{i\in I} U_i\right) \longrightarrow X$$

is an isomorphism.

Proof. The lemma says that for a topological space Y, and a given morphism $f : X \longrightarrow Y$ is the same as giving for each $i \in I$ a morphism $f_i : U_i \longrightarrow Y$ so that $(f_i)|_{U_{i,j}} = (f_j)|_{U_{i,j}}$ for all $(i,j) \in I^2$. (This is a direct translation of the universal property of the coequalizer. Which is true by the gluing lemma of continuous maps) □

The above lemma has to be interpreted in the following way: all topological manifold is obtained from a colimit of a diagram of open sets in $\mathbb{R}^n$ (for n variable). we can draw from it the following principle:

The category TopMfd *of the topological manifolds can be constructed from the category of open sets in* $\mathbb{R}^n$ *(with morphism continuous maps).*

We would explain the principle in the following section.

1.1.1 Manifold and sheaves

Let $\mathcal{C}$ be the full subcategory of TopMfd, of which the objects are open sets in $\mathbb{R}^n$ for some n. We denote $\mathsf{Pr}(\mathcal{C})$ the category of presheaves of sets on $\mathcal{C}$, (also denoted as $\widehat{\mathcal{C}}$). We consider Yoneda embedding in the case of $\mathcal{C}$

$$h\_ : \mathsf{TopMfd} \longrightarrow \mathsf{Pr}(\mathcal{C})$$
$$X \longmapsto h_X,$$

where the presheaf h_X is defined by

$$h_X(Y) := \mathrm{H}om_{\mathsf{TopMfd}}(Y, X)$$

for all $Y \in \mathcal{C} \subset \mathsf{TopMfd}$.

Lemma 1.1.3. *The functor h_ above is full and faithful.*

Proof. The functor is faithful: for two morphisms $f, g : X \longrightarrow X'$, we consider an open cover $\{U_i\}$ of X so that each $U_i \in \mathcal{C}$ this exists because X is a manifold). If $h_f = h_g$, for every $i \in I$, the two maps

$$h_f(U_i) = h_g(U_i) : \mathrm{H}om(U_i, X) = h_X(U_i) \longrightarrow \mathrm{H}om(U_i, X') = h_{X'}(U_i)$$

are equal. This means that $f|_{U_i} = g|_{U_i}$, for every i, hence that $f = g$.

The functor is full: Let X and X' be two topological manifolds and $u : h_X \longrightarrow h_{X'}$ is a morphism of in $\mathsf{Pr}(\mathcal{C})$. Let $\{U_i\}$ be an open cover of X with $U_i \in \mathcal{C}$. For all i, the morphism u induces a map

$$h_X(U_i) = \mathrm{H}om(U_i, X) \longrightarrow h_{X'}(U_i) = \mathrm{H}om(U_i, X').$$

This map send the inclusion $U_i \subset X$ to morphisms $f_i : U_i \longrightarrow X'$ for all i. For all i and j in I, the elements $(f_i)|_{U_{i,j}} \in h_{X'}(U_{i,j})$ agree because they are both images of the inclusion $U_{i,j} \hookrightarrow X$ because the morphism of presheaves u is compatible with the restriction maps. There the morphisms $f_i : U_i \longrightarrow X'$ give a continuous map $f : X \longrightarrow X'$. By construction $h_f = u$. □

The Lemma 1.1.3 is a good point remark, we know TopMfd can be identified with a full subcategory of $\mathsf{Pr}(\mathcal{C})$. We are now seeking to characterize the subcategory.

We start by making $\mathcal{C}$ a Grothendieck site. We say a collection of morphism $\{U_i \longrightarrow U\}_{i\in I}$ in $\mathcal{C}$ is a **covering family** if each morphism $U_i \longrightarrow U$ is an open immersion and if the map $\coprod_{i\in I} U_i \longrightarrow U$ is surjective. This define a pretopology on $\mathcal{C}$, and we denote the associated topology τ.

Exercise 1.1.4. *Verify it indeed induces a pretopology.*

Sol. Check the covering family defined above satisfies the axioms of Grothendieck pretopology. And the Grothendieck topology τ on $\mathcal{C}$ is generated by union of covering families (or, the covering family gives a basis of topology τ) □

Lemma 1.1.5. *For all $X \in$ TopMfd the presheaf $h_X \in \mathsf{Pr}(\mathcal{C})$ is a sheaf with respect to the topology τ.*

Proof. See the definition of a sheaf on a site. It is another way of saying for each topological manifold Y and an open cover $\{U_i \longrightarrow Y\}_{i\in I}$, to give a continuous map from Y to X is the same as to give a a collection of continuous map $f_i : U_i \longrightarrow X$ such that f_i and f_j coincide on $U_i \cap U_j$. □

As a result, the Lemma 1.1.5 implies that the there is a fully faithful functor

$$h_\_ : \mathsf{TopMfd} \longrightarrow \mathsf{Sh}(\mathcal{C}, \tau).$$

A sheaf isomorphic to h_X is called **representable** by X. In a general way, we identify the category of TopMfd with its image in $\mathsf{Sh}(\mathcal{C}, \tau)$.

To characterize the image, we put the following definition

Definition 1.1.6.

1. *A morphism $f : F \longrightarrow G$ in $\mathsf{Sh}(\mathcal{C}, \tau)$ is a **local homeomorphism** if for all $X \in \mathcal{C}$ and each morphism $h_X \longrightarrow G$, the sheaf $F \times_G h_X$ is representable by $Y \in \mathsf{TopMfd}$, and the induced morphism $Y \longrightarrow X$ by the projection $F \times_G h_X \simeq h_Y \longrightarrow h_X$ is a local homeomorphism as morphism in Top.*

2. *A morphism in $\mathsf{Sh}(\mathcal{C}, \tau)$ is an **open immersion** if it is a monomorphism and a local homeomorphism.*

It is easy to check that the open immersions in $\mathsf{Sh}(\mathcal{C}, \tau)$ are stable under composition. We can also verify that the local homeomorphisms are stable under composition, but it requires corollary 1.1.8 below. We also show that a morphism of topological manifolds $X \longrightarrow Y$ is a local homeomorphism of topological spaces if and only if the morphism of sheaves $h_X \longrightarrow h_Y$ is a local homeomorphism as defined above.

We therefore have the proposition below.

Proposition 1.1.7. *A sheaf $F \in \mathsf{Sh}(\mathcal{C}, \tau)$ is representable by one topological manifold iff there exists a family of objects $\{U_i\}_{i \in I}$ in $\mathcal{C}$, and a morphism of sheaves*

$$p : \coprod_{i \in I} h_{U_i} \longrightarrow F,$$

that satisfy the following two conditions

1. *The morphism p is an epimorphism of sheaves.*

2. *For each $i \in I$, the morphism $h_{U_i} \longrightarrow F$ is an open immersion.*

Proof. We start by supposing that F is representable by one topological manifold X. We choose an open cover $\{U_i\}_{i \in I}$ of X with $U_i \in \mathcal{C}$ and we consider the morphism

$$p : \coprod_{i \in I} h_{U_i} \longrightarrow F \simeq h_X$$

induced by the inclusion $U_i \subset X$. Explicitly, we have

$$p(W) : \left(\coprod_i h_{U_i} \right)(W) = \coprod_i h_{U_i}(W) \longrightarrow h_X(W).$$

For $Y \in \mathcal{C}$ and $f : Y \longrightarrow X$ an element in $h_X(Y) = \mathrm{H}om(Y, X)$, we regard $\{f^{-1}(U_i)\}_{i \in I}$ as an open cover of Y. Furthermore, for each

$i \in I$, there exists a commutative diagram

$$\begin{array}{ccc} f^{-1}(U_i) & \longrightarrow & Y \\ \downarrow{\scriptstyle g} & & \downarrow{\scriptstyle f} \\ U_i & \longrightarrow & X \end{array}$$

which show that f is locally in the image of p in the sense that $f|_{f^{-1}(U_i)}$ is in the image of $p(U_i)$. By Tag ooWL, stacks-project, this implies that p is an epimorphism of sheaves. Moreover, for $Y \in \mathcal{C}$ and for all morphism $h_Y \longrightarrow h_X$, corresponding to a morphism $f : Y \longrightarrow X$, we have

$$h_{U_i} \times_{h_X} h_Y \simeq h_{U_i \times_X Y} = h_{f^{-1}(U_i)},$$

where the induced map $f^{-1}(U_i) \longrightarrow Y$ is the plain inclusion hence must be local homeomorphism in Top, which means $h_{U_i} \longrightarrow F$ is a local homeomorphism by definition. As $f^{-1}(U_i) \longrightarrow Y$ is an open immersion, we observe that every morphism $h_{U_i} \longrightarrow F$ is an open immersion. (h is fully faithful, therefore preserves limits and colimits, thus gives us the equality above. For the same reason h preserves monomorphisms, hence $h_{f^{-1}(U_i)} \longrightarrow h_Y$ is a monomorphism. Take the special case $Y = X$, $h_{U_i} \longrightarrow F$ is a monomorphism.)

Conversely, suppose F is a sheaf satisfying the two conditions in the proposition. We construct the topological space X in the following way: let $\{U_i\}_{i \in I}$ be a family of objects in the category $\mathcal{C}$ and $p : \coprod h_{U_i} \longrightarrow F$ is a morphism in the statement of the proposition. We set $U = \coprod_i U_i \in \mathsf{TopMfd}$. We remark that the morphism

$$\coprod h_{U_i} \longrightarrow h_U$$

is an isomorphism in $\mathsf{Sh}(\mathcal{C}, \tau)$ (Exercise, verify this.) We consider the two projections

$$h_U \times_F h_U \rightrightarrows h_U.$$

By hypothesis, we have

$$h_U \times_F h_U = \coprod_i h_{U_i} \times_F \coprod_j h_{U_j} \simeq \coprod_{i,j} h_{U_{i,j}} \simeq h_R,$$

where $R = \coprod_{i,j} U_{i,j}$, with $h_{U_{i,j}} \simeq h_{U_i} \times_F h_{U_j}$. ($U_{i,j}$ is the representing object of $h_{U_i} \times_F h_{U_j}$, is isomorphic to an open set in U_i and in U_j). The second isomorphism above is from the fact that finite limit commutes

with filtered colimit. By Lemma 1.1.3 and Lemma 1.1.5 the diagram

$$h_R \rightrightarrows h_U$$

is image by h of the diagram of topological manifolds $R \rightrightarrows U$. We set the

$$X := \operatorname{colim}(R \rightrightarrows U),$$

where the colimit is taken in the category Top. Note that R defines an equivalence relation on U and that X is the quotient space.

We further remark that X is a topological manifold. For it, observe by definition the morphism $U \longrightarrow X$ is surjective. More over, $U_i \longrightarrow X$ is an open immersion. Indeed, from the fact that $h_{U_i} \longrightarrow F$ is a monomorphism , we have $U_{i,i} = U_i$, which implies that $U_i \longrightarrow X$ is injective (Exercise, verify this). Moreover, a subset $V \subset X$ is open iff its preimage in U by the projection $U \longrightarrow X$ is open. But the inverse image of $U_i \subset X$ by the projection is the subset $\coprod_j U_{i,j} \subset U$ which is indeed an open set. This shows that X is covered by the opens $U_i \in \mathcal{C}$, and therefore is a topological manifold.

It remains to show that F is isomorphic to h_X. There exists a morphism of sheaves

$$\operatorname{colim}(h_R \rightrightarrows h_U) \longrightarrow h_X.$$

Because $h_U \longrightarrow F$ is an epimorphism and that the epimorphism of sheaves are effective epimorphisms[1]. By the definition of effective epimorphism

[1] References needed

$$\operatorname{colimit}(h_U \times_F h_U \rightrightarrows h_U) \simeq F$$

and because $h_R \simeq h_U \times_F h_U$ as described above, we have

$$F \simeq \operatorname{colimit}(h_R \rightrightarrows h_U).$$

It then remains verify that $\operatorname{colim}(h_R \rightrightarrows h_U) \simeq h_X$. $h_U \longrightarrow h_X$ is also an epimorphism of sheaves (Exercise, verify this), it remains to show that the morphism

$$h_R \longrightarrow h_U \times_{h_X} h_U$$

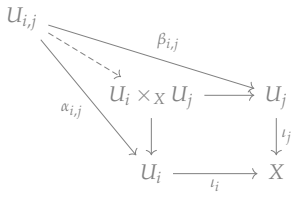
is an isomorphism. Recall that h is a fully faithful functor, it suffices to verify that the morphism

$$R \longrightarrow U \times_X U$$

is an isomorphism, which is true because the morphism $U_{i,j} \longrightarrow$

$U_i \times_X U_j$ is an isomorphism. (It is bijective local homeomorpihsm) □

Explicitly, $U_i \times_X U_j = \{(u,v) \in U_i \coprod U_j : \iota_i(u) = \iota_j(v)\}$



the dashed arrow is given by $z \longmapsto (\alpha_{i,j}(z), \beta_{i,j}(z))$, it is injective because $\alpha_{i,j}, \beta_{i,j}$ are injective. It is surjective because $X := \coprod_i U_i / \sim$, where $\iota_i(u) = \iota_j(v)$ iff $(u,v) = (\alpha_{i,j}(z), \beta_{i,j}(z))$ for some $z \in U_{i,j}$. And by hypothesis, $h_(U_i) \longrightarrow F$ is open immersion therefore is a local homeomorphism, we know $\alpha_{i,j}, \beta_{i,j}$ are local homeomorphism. Altogether we know $z \mapsto (\alpha_{i,j}(z), \beta_{i,j}(z))$ is a bijective local homeomorphism hence a homeomorphism.

Corollary 1.1.8. *Let $X \in \mathsf{TopMfd}$, and $F \longrightarrow X$ a morphism of shaves. If there exists an open covering $\{U_i\}_{i\in I}$ of X so that for all $i \in I$ the sheaf $F \times_{h_X} h_{U_i}$ is representable by a topological manifold, the sheaf F is representable by a topological manifold.*

Proof. For each $i \in I$, we choose $\{V_{i,j}\}_{j\in J}$ and $\coprod_j h_{V_{i,j}} \longrightarrow F \times_{h_X} h_{U_i}$ from the above proposition 1.1.7. We verify then

$$\coprod_{i,j} h_{V_{i,j}} \longrightarrow F$$

is a morphism from the proposition 1.1.7(Exercise, verify this) □

1.1.2 *Quotient manifolds*

1.1.3 *Remarks on manifolds*

2
Usage

2.1 Environments

The following characteristics define the various environments:

Table 2.1: Environment styles used in *Beautiful Evidence*.

Environment	Font size	Notes
Body text	10/14×26 pc	
Block quote	9/12×24 pc	Block indent (left and right) by 1 pc
Sidenotes	8/10×12 pc	Sidenote number is set inline, followed by word space
Captions	8/10×12 pc	

3
On the Use of the `tufte-book` Document Class

Definition 3.0.1. *adas*

The Tufte-LaTeX document classes define a style similar to the style Edward Tufte uses in his books and handouts. Tufte's style is known for its extensive use of sidenotes, tight integration of graphics with text, and well-set typography. This document aims to be at once a demonstration of the features of the Tufte-LaTeX document classes and a style guide to their use.

3.1 Page Layout

3.1.1 Headings

This style provides A- and B-heads (that is, `\section` and `\subsection`), demonstrated above.

If you need more than two levels of section headings, you'll have to define them yourself at the moment; there are no pre-defined styles for anything below a `\subsection`. As Bringhurst points out in *The Elements of Typographic Style*,[1] you should "use as many levels of headings as you need: no more, and no fewer."

[1] Robert Bringhurst. *The Elements of Typography*. Hartley & Marks, 3.1 edition, 2005. ISBN 0-88179-205-5

The Tufte-LaTeX classes will emit an error if you try to use `\subsubsection` and smaller headings.

In his later books,[2] Tufte starts each section with a bit of vertical space, a non-indented paragraph, and sets the first few words of the sentence in small caps. To accomplish this using this style, use the `\newthought` command:

[2] Edward R. Tufte. *Beautiful Evidence*. Graphics Press, LLC, first edition, May 2006. ISBN 0-9613921-7-7

```
\newthought{In his later books}, Tufte starts...
```

3.2 Sidenotes

One of the most prominent and distinctive features of this style is the extensive use of sidenotes. There is a wide margin to provide ample room for sidenotes and small figures. Any `\footnotes` will automatically be converted to sidenotes.[3] If you'd like to place ancillary information in the margin without the sidenote mark (the superscript number), you can use the `\marginnote` command.

[3] This is a sidenote that was entered using the `\footnote` command.

This is a margin note. Notice that there isn't a number preceding the note, and there is no number in the main text where this note was written.

The specification of the `\sidenote` command is:

`\sidenote[`⟨*number*⟩`][`⟨*offset*⟩`]{`*Sidenote text.*`}`

Both the ⟨*number*⟩ and ⟨*offset*⟩ arguments are optional. If you provide a ⟨*number*⟩ argument, then that number will be used as the sidenote number. It will change of the number of the current sidenote only and will not affect the numbering sequence of subsequent sidenotes.

Sometimes a sidenote may run over the top of other text or graphics in the margin space. If this happens, you can adjust the vertical position of the sidenote by providing a dimension in the ⟨*offset*⟩ argument. Some examples of valid dimensions are:

```
1.0in    2.54cm    254mm    6\baselineskip
```

If the dimension is positive it will push the sidenote down the page; if the dimension is negative, it will move the sidenote up the page.

While both the ⟨*number*⟩ and ⟨*offset*⟩ arguments are optional, they must be provided in order. To adjust the vertical position of the sidenote while leaving the sidenote number alone, use the following syntax:

`\sidenote[][`⟨*offset*⟩`]{`*Sidenote text.*`}`

The empty brackets tell the `\sidenote` command to use the default sidenote number.

If you *only* want to change the sidenote number, however, you may completely omit the ⟨*offset*⟩ argument:

`\sidenote[`⟨*number*⟩`]{`*Sidenote text.*`}`

The `\marginnote` command has a similar *offset* argument:

`\marginnote[`⟨*offset*⟩`]{`*Margin note text.*`}`

3.3 References

References are placed alongside their citations as sidenotes, as well. This can be accomplished using the normal `\cite` command.[4]

[4] The first paragraph of this document includes a citation.

The complete list of references may also be printed automatically by using the `\bibliography` command. (See the end of this document for an example.) If you do not want to print a bibliography at the end of your document, use the `\nobibliography` command in its place.

To enter multiple citations at one location,[5] you can provide a list of keys separated by commas and the same optional vertical offset argument: `\cite{Tufte2006,Tufte1990}`.

`\cite[`⟨*offset*⟩`]{`*bibkey1*,*bibkey2*,...`}`

[5] Edward R. Tufte. *Beautiful Evidence*. Graphics Press, LLC, first edition, May 2006. ISBN 0-9613921-7-7; and Edward R. Tufte. *Envisioning Information*. Graphics Press, Cheshire, Connecticut, 1990. ISBN 0-9613921-1-8

3.4 Figures and Tables

Images and graphics play an integral role in Tufte's work. In addition to the standard `figure` and `tabular` environments, this style provides special figure and table environments for full-width floats.

Full page–width figures and tables may be placed in `figure*` or `table*` environments. To place figures or tables in the margin, use the `marginfigure` or `margintable` environments as follows (see figure 3.1):

```
\begin{marginfigure}
    \includegraphics{helix}
    \caption{This is a margin figure.}
    \label{fig:marginfig}
\end{marginfigure}
```

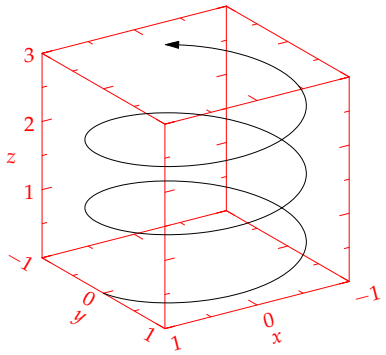


Figure 3.1: This is a margin figure. The helix is defined by $x = \cos(2\pi z)$, $y = \sin(2\pi z)$, and $z = [0, 2.7]$. The figure was drawn using Asymptote (`http://asymptote.sf.net/`).

The `marginfigure` and `margintable` environments accept an optional parameter ⟨*offset*⟩ that adjusts the vertical position of the figure or table. See the "Sidenotes" section above for examples. The specifications are:

```
\begin{marginfigure}[⟨offset⟩]
    ...
\end{marginfigure}

\begin{margintable}[⟨offset⟩]
    ...
\end{margintable}
```

Figure 3.2 is an example of the `figure*` environment and figure 3.3 is an example of the normal `figure` environment.

As with sidenotes and marginnotes, a caption may sometimes require vertical adjustment. The `\caption` command now takes a second optional argument that enables you to do this by providing

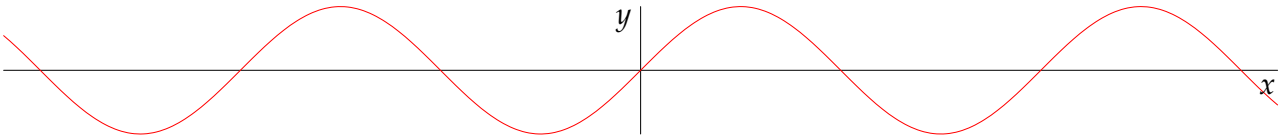


Figure 3.2: This graph shows $y = \sin x$ from about $x = [-10, 10]$. *Notice that this figure takes up the full page width.*

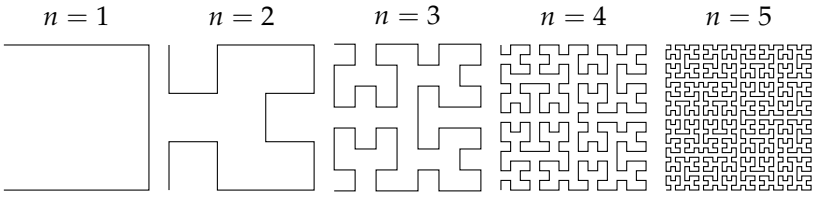


Figure 3.3: Hilbert curves of various degrees n. *Notice that this figure only takes up the main textblock width.*

a dimension ⟨*offset*⟩. You may specify the caption in any one of the following forms:

```
\caption{long caption}
\caption[short caption]{long caption}
\caption[][⟨offset⟩]{long caption}
\caption[short caption][⟨offset⟩]{long caption}
```

A positive ⟨*offset*⟩ will push the caption down the page. The short caption, if provided, is what appears in the list of figures/tables, otherwise the "long" caption appears there. Note that although the arguments ⟨*short caption*⟩ and ⟨*offset*⟩ are both optional, they must be provided in order. Thus, to specify an ⟨*offset*⟩ without specifying a ⟨*short caption*⟩, you must include the first set of empty brackets `[]`, which tell `\caption` to use the default "long" caption. As an example, the caption to figure 3.3 above was given in the form

```
\caption[Hilbert curves...][6pt]{Hilbert curves...}
```

Table 3.1 shows table created with the `booktabs` package. Notice the lack of vertical rules—they serve only to clutter the table's data.

Margin	Length
Paper width	8 1/2 inches
Paper height	11 inches
Textblock width	6 1/2 inches
Textblock/sidenote gutter	3/8 inches
Sidenote width	2 inches

Table 3.1: Here are the dimensions of the various margins used in the Tufte-handout class.

Occasionally LaTeX will generate an error message:

```
Error:  Too many unprocessed floats
```

LaTeX tries to place floats in the best position on the page. Until it's finished composing the page, however, it won't know where those positions are. If you have a lot of floats on a page (including sidenotes, margin notes, figures, tables, etc.), LaTeX may run out of "slots" to keep track of them and will generate the above error.

LaTeX initially allocates 18 slots for storing floats. To work around this limitation, the Tufte-LaTeX document classes provide a `\morefloats` command that will reserve more slots.

The first time `\morefloats` is called, it allocates an additional 34 slots. The second time `\morefloats` is called, it allocates another 26 slots.

The `\morefloats` command may only be used two times. Calling it a third time will generate an error message. (This is because we can't safely allocate many more floats or LaTeX will run out of memory.)

If, after using the `\morefloats` command twice, you continue to get the `Too many unprocessed floats` error, there are a couple things you can do.

The `\FloatBarrier` command will immediately process all the floats before typesetting more material. Since `\FloatBarrier` will start a new paragraph, you should place this command at the beginning or end of a paragraph.

The `\clearpage` command will also process the floats before continuing, but instead of starting a new paragraph, it will start a new page.

You can also try moving your floats around a bit: move a figure or table to the next page or reduce the number of sidenotes. (Each sidenote actually uses *two* slots.)

After the floats have placed, LaTeX will mark those slots as unused so they are available for the next page to be composed.

3.5 Captions

You may notice that the captions are sometimes misaligned. Due to the way LaTeX's float mechanism works, we can't know for sure where it decided to put a float. Therefore, the Tufte-LaTeX document classes provide commands to override the caption position.

Vertical alignment To override the vertical alignment, use the `\setfloatalignment` command inside the float environment. For example:

```
\begin{figure}[btp]
   \includegraphics{sinewave}
   \caption{This is an example of a sine wave.}
   \label{fig:sinewave}
   \setfloatalignment{b}% forces caption to be bottom-aligned
\end{figure}
```

The syntax of the `\setfloatalignment` command is:

```
\setfloatalignment{⟨pos⟩}
```

where ⟨*pos*⟩ can be either `b` for bottom-aligned captions, or `t` for top-aligned captions.

Horizontal alignment To override the horizontal alignment, use either the `\forceversofloat` or the `\forcerectofloat` command inside of the float environment. For example:

```
\begin{figure}[btp]
   \includegraphics{sinewave}
   \caption{This is an example of a sine wave.}
   \label{fig:sinewave}
   \forceversofloat% forces caption to be set to the left of the float
\end{figure}
```

The `\forceversofloat` command causes the algorithm to assume the float has been placed on a verso page—that is, a page on the left side of a two-page spread. Conversely, the `\forcerectofloat` command causes the algorithm to assume the float has been placed on a recto page—that is, a page on the right side of a two-page spread.

3.6 Full-width text blocks

In addition to the new float types, there is a `fullwidth` environment that stretches across the main text block and the sidenotes area.

```
\begin{fullwidth}
Lorem ipsum dolor sit amet...
\end{fullwidth}
```

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

3.7 Typography

3.7.1 Typefaces

If the Palatino, Helvetica, and `Bera Mono` typefaces are installed, this style will use them automatically. Otherwise, we'll fall back on the Computer Modern typefaces.

3.7.2 Letterspacing

This document class includes two new commands and some improvements on existing commands for letterspacing.

When setting strings of ALL CAPS or SMALL CAPS, the letterspacing—that is, the spacing between the letters—should be increased slightly.[6] The `\allcaps` command has proper letterspacing for strings of FULL CAPITAL LETTERS, and the `\smallcaps` command has letterspacing for SMALL CAPITAL LETTERS. These commands will also automatically convert the case of the text to upper- or lowercase, respectively.

[6] Robert Bringhurst. *The Elements of Typography*. Hartley & Marks, 3.1 edition, 2005. ISBN 0-88179-205-5

The `\textsc` command has also been redefined to include letterspacing. The case of the `\textsc` argument is left as is, however. This allows one to use both uppercase and lowercase letters: The Initial Letters Of The Words In This Sentence Are Capitalized.

3.8 Document Class Options

The `tufte-book` class is based on the LaTeX `book` document class. Therefore, you can pass any of the typical book options. There are a few options that are specific to the `tufte-book` document class, however.

The `a4paper` option will set the paper size to A4 instead of the default US letter size.

The `sfsidenotes` option will set the sidenotes and title block in a sans serif typeface instead of the default roman.

The `twoside` option will modify the running heads so that the page number is printed on the outside edge (as opposed to always printing the page number on the right-side edge in `oneside` mode).

The `symmetric` option typesets the sidenotes on the outside edge of the page. This is how books are traditionally printed, but is contrary to Tufte's book design which sets the sidenotes on the right side

of the page. This option implicitly sets the `twoside` option.

The `justified` option sets all the text fully justified (flush left and right). The default is to set the text ragged right. The body text of Tufte's books are set ragged right. This prevents needless hyphenation and makes it easier to read the text in the slightly narrower column.

The `bidi` option loads the `bidi` package which is used with XeLaTeX to typeset bi-directional text. Since the `bidi` package needs to be loaded before the sidenotes and cite commands are defined, it can't be loaded in the document preamble.

The `debug` option causes the Tufte-LaTeX classes to output debug information to the log file which is useful in troubleshooting bugs. It will also cause the graphics to be replaced by outlines.

The `nofonts` option prevents the Tufte-LaTeX classes from automatically loading the Palatino and Helvetica typefaces. You should use this option if you wish to load your own fonts. If you're using XeLaTeX, this option is implied (*i.e.*, the Palatino and Helvetica fonts aren't loaded if you use XeLaTeX).

The `nols` option inhibits the letterspacing code. The Tufte-LaTeX classes try to load the appropriate letterspacing package (either pdfTeX's `letterspace` package or the `soul` package). If you're using XeLaTeX with `fontenc`, however, you should configure your own letterspacing.

The `notitlepage` option causes `\maketitle` to generate a title block instead of a title page. The `book` class defaults to a title page and the `handout` class defaults to the title block. There is an analogous `titlepage` option that forces `\maketitle` to generate a full title page instead of the title block.

The `notoc` option suppresses Tufte-LaTeX's custom table of contents (TOC) design. The current TOC design only shows unnumbered chapter titles; it doesn't show sections or subsections. The `notoc` option will revert to LaTeX's TOC design.

The `nohyper` option prevents the `hyperref` package from being loaded. The default is to load the `hyperref` package and use the `\title` and `\author` contents as metadata for the generated PDF.

4
Customizing Tufte-LaTeX

The Tufte-LaTeX document classes are designed to closely emulate Tufte's book design by default. However, each document is different and you may encounter situations where the default settings are insufficient. This chapter explores many of the ways you can adjust the Tufte-LaTeX document classes to better fit your needs.

4.1 File Hooks

If you create many documents using the Tufte-LaTeX classes, it's easier to store your customizations in a separate file instead of copying them into the preamble of each document. The Tufte-LaTeX classes provide three file hooks: `tufte-common-local.tex`, `tufte-book-local.tex`, and `tufte-handout-local.tex`.

`tufte-common-local.tex` If this file exists, it will be loaded by all of the Tufte-LaTeX document classes just prior to any document-class-specific code. If your customizations or code should be included in both the book and handout classes, use this file hook.

`tufte-book-local.tex` If this file exists, it will be loaded after all of the common and book-specific code has been read. If your customizations apply only to the book class, use this file hook.

`tufte-common-handout.tex` If this file exists, it will be loaded after all of the common and handout-specific code has been read. If your customizations apply only to the handout class, use this file hook.

4.2 Numbered Section Headings

While Tufte dispenses with numbered headings in his books, if you require them, they can be enabled by changing the value of the `secnumdepth` counter. From the table below, select the heading level at which numbering should stop and set the `secnumdepth` counter to that value. For example, if you want parts and chapters numbered, but don't want numbering for sections or subsections, use the command:

```
\setcounter{secnumdepth}{0}
```

The default `secnumdepth` for the Tufte-LaTeX document classes is −1.

Heading level	Value
Part (in `tufte-book`)	−1
Part (in `tufte-handout`)	0
Chapter (only in `tufte-book`)	0
Section	1
Subsection	2
Subsubsection	3
Paragraph	4
Subparagraph	5

Table 4.1: Heading levels used with the `secnumdepth` counter.

4.3 Changing the Paper Size

The Tufte-LaTeX classes currently only provide three paper sizes: A4, B5, and US letter. To specify a different paper size (and/or margins), use the `\geometrysetup` command in the preamble of your document (or one of the file hooks). The full documentation of the `\geometrysetup` command may be found in the `geometry` package documentation.[1]

[1] Hideo Umeki. The `geometry` package. http://ctan.org/pkg/geometry, December 2008

4.4 Customizing Marginal Material

Marginal material includes sidenotes, citations, margin notes, and captions. Normally, the justification of the marginal material follows the justification of the body text. If you specify the `justified` document class option, all of the margin material will be fully justified as well. If you don't specify the `justified` option, then the marginal material will be set ragged right.

You can set the justification of the marginal material separately from the body text using the following document class options:

`sidenote`, `marginnote`, `caption`, `citation`, and `marginals`. Each option refers to its obviously corresponding marginal material type. The `marginals` option simultaneously sets the justification on all four marginal material types.

Each of the document class options takes one of five justification types:

`justified` Fully justifies the text (sets it flush left and right).

`raggedleft` Sets the text ragged left, regardless of which page it falls on.

`raggedright` Sets the text ragged right, regardless of which page it falls on.

`raggedouter` Sets the text ragged left if it falls on the left-hand (verso) page of the spread and otherwise sets it ragged right. This is useful in conjunction with the `symmetric` document class option.

`auto` If the `justified` document class option was specified, then set the text fully justified; otherwise the text is set ragged right. This is the default justification option if one is not explicitly specified.

For example,

```
\documentclass[symmetric,justified,marginals=raggedouter]{tufte-book}
```

will set the body text of the document to be fully justified and all of the margin material (sidenotes, margin notes, captions, and citations) to be flush against the body text with ragged outer edges.

The font and style of the marginal material may also be modified using the following commands:

```
\setsidenotefont{⟨font commands⟩}
\setcaptionfont{⟨font commands⟩}
\setmarginnotefont{⟨font commands⟩}
\setcitationfont{⟨font commands⟩}
```

The `\setsidenotefont` sets the font and style for sidenotes, the `\setcaptionfont` for captions, the `\setmarginnotefont` for margin notes, and the `\setcitationfont` for citations. The ⟨*font commands*⟩ can contain font size changes (e.g., `\footnotesize`, `\Huge`, etc.), font style changes (e.g., `\sffamily`, `\ttfamily`, `\itshape`, etc.), color changes (e.g., `\color{blue}`), and many other adjustments.

If, for example, you wanted the captions to be set in italic sans serif, you could use:

```
\setcaptionfont{\itshape\sffamily}
```

5
Compatibility Issues

When switching an existing document from one document class to a Tufte-LaTeX document class, a few changes to the document may have to be made.

5.1 Converting from `article` to `tufte-handout`

The following `article` class options are unsupported: `10pt`, `11pt`, `12pt`, `a5paper`, `b5paper`, `executivepaper`, `legalpaper`, `landscape`, `onecolumn`, and `twocolumn`.

The following headings are not supported: `\subsubsection` and `\subparagraph`.

5.2 Converting from `book` to `tufte-book`

The following `report` class options are unsupported: `10pt`, `11pt`, `12pt`, `a5paper`, `b5paper`, `executivepaper`, `legalpaper`, `landscape`, `onecolumn`, and `twocolumn`.

The following headings are not supported: `\subsubsection` and `\subparagraph`.

6
Troubleshooting and Support

6.1 Tufte-LaTeX Website

The website for the Tufte-LaTeX packages is located at `http://code.google.com/p/tufte-latex/`. On our website, you'll find links to our SVN repository, mailing lists, bug tracker, and documentation.

6.2 Tufte-LaTeX Mailing Lists

There are two mailing lists for the Tufte-LaTeX project:

Discussion list The `tufte-latex` discussion list is for asking questions, getting assistance with problems, and help with troubleshooting. Release announcements are also posted to this list. You can subscribe to the `tufte-latex` discussion list at `http://groups.google.com/group/tufte-latex`.

Commits list The `tufte-latex-commits` list is a read-only mailing list. A message is sent to the list any time the Tufte-LaTeX code has been updated. If you'd like to keep up with the latest code developments, you may subscribe to this list. You can subscribe to the `tufte-latex-commits` mailing list at `http://groups.google.com/group/tufte-latex-commits`.

6.3 Getting Help

If you've encountered a problem with one of the Tufte-LaTeX document classes, have a question, or would like to report a bug, please send an email to our mailing list or visit our website.

To help us troubleshoot the problem more quickly, please try to compile your document using the `debug` class option and send the generated `.log` file to the mailing list with a brief description of the problem.

6.4 Errors, Warnings, and Informational Messages

The following is a list of all of the errors, warnings, and other messages generated by the Tufte-LaTeX classes and a brief description of their meanings.

```
Error:  \subparagraph is undefined by this class.
```

The `\subparagraph` command is not defined in the Tufte-LaTeX document classes. If you'd like to use the `\subparagraph` command, you'll need to redefine it yourself. See the "Headings" section on page 17 for a description of the heading styles availaboe in the Tufte-LaTeX document classes.

```
Error:  \subsubsection is undefined by this class.
```

The `\subsubsection` command is not defined in the Tufte-LaTeX document classes. If you'd like to use the `\subsubsection` command, you'll need to redefine it yourself. See the "Headings" section on page 17 for a description of the heading styles availaboe in the Tufte-LaTeX document classes.

```
Error:  You may only call \morefloats twice.  See the
        Tufte-LaTeX documentation for other workarounds.
```

LaTeX allocates 18 slots for storing floats. The first time `\morefloats` is called, it allocates an additional 34 slots. The second time `\morefloats` is called, it allocates another 26 slots.

The `\morefloats` command may only be called two times. Calling it a third time will generate this error message. See page 20 for more information.

```
Warning:  Option '⟨class option⟩' is not supported -- ignoring option.
```

This warning appears when you've tried to use ⟨*class option*⟩ with a Tufte-LaTeX document class, but ⟨*class option*⟩ isn't supported by the Tufte-LaTeX document class. In this situation, ⟨*class option*⟩ is ignored.

```
Info:  The 'symmetric' option implies 'twoside'
```

You specified the `symmetric` document class option. This option automatically forces the `twoside` option as well. See page 23 for more information on the `symmetric` class option.

6.5 Package Dependencies

The following is a list of packages that the Tufte-LaTeX document classes rely upon. Packages marked with an asterisk are optional.

- xifthen
- ifpdf*
- ifxetex*
- hyperref
- geometry
- ragged2e
- chngpage *or* changepage
- paralist
- textcase
- soul*
- letterspace*
- setspace
- natbib *and* bibentry
- optparams
- placeins
- mathpazo*
- helvet*
- fontenc
- beramono*
- fancyhdr
- xcolor
- textcomp
- titlesec
- titletoc

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Edward R. Tufte. *Envisioning Information*. Graphics Press, Cheshire, Connecticut, 1990. ISBN 0-9613921-1-8.

Edward R. Tufte. *Visual Explanations*. Graphics Press, Cheshire, Connecticut, 1997. ISBN 0-9613921-2-6.

Edward R. Tufte. *The Visual Display of Quantitative Information*. Graphics Press, Cheshire, Connecticut, 2001. ISBN 0-9613921-4-2.

Edward R. Tufte. *Beautiful Evidence*. Graphics Press, LLC, first edition, May 2006. ISBN 0-9613921-7-7.

Hideo Umeki. The `geometry` package. `http://ctan.org/pkg/geometry`, December 2008.

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