

typst-theorems

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<https://github.com/sahasatvik/typst-theorems>

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1. Introduction

The typst-theorems package provides Typst functions that help create numbered theorem environments. This is heavily inspired by the `\newtheorem` functionality of LaTeX.

A *theorem environment* lets you wrap content together with automatically updating *numbering* information. Such environments use internal state counters for this purpose. Environments can

- share the same counter (*Theorems* and *Lemmas* often do so)
- keep a global count, or be attached to
 - other environments (*Corollaries* are often numbered based upon the parent *Theorem*)
 - headings
- have a numbering level depth fixed (for instance, use only top level heading numbers)
- be referenced elsewhere in the document, via `labels`

2. Using typst-theorems

Import all functions provided by typst-theorems using

```
#import "theorems.typ": *
```

The core of this module consists of `thmenv` and `thmref`. The functions `thmbox` and `thmplain` provide some simple defaults for the appearance of `thmenvs`.

3. Feature demonstration

Create box-like *theorem environments* using `thmbox`, a wrapper around `thmenv` which provides some simple defaults.

```
#let theorem = thmbox(
  "theorem",           // identifier
  "Theorem",          // head
  fill: rgb("#e8e8f8")
)
```

Such definitions are convenient to place in the preamble or a template; use the environment in your document via

```
#theorem(name: "Euclid")[
  There are infinitely many primes. <euclid>
]
```

This produces the following.

Theorem 3.1 (Euclid): There are infinitely many primes.

Note that name is optional. This theorem environment will be numbered based on its parent heading counter, with successive theorems automatically updating the final index.

The <euclid> label can be used to refer to this Theorem via `thmref`; this will be further explained in Section 3.4.

You can create another environment which uses the same counter, say for *Lemmas*, as follows.

```
#let lemma = thmbox(
  "theorem",           // identifier - same as that of theorem
  "Lemma",            // head
  fill: rgb("#efe6ff")
)

#lemma[
  If  $n$  divides both  $x$  and  $y$ , it also divides  $x - y$ .
]
```

Lemma 3.2: If n divides both x and y , it also divides $x - y$.

You can *attach* other environments to ones defined earlier. For instance, *Corollaries* can be created as follows.

```
#let corollary = thmbox(
  "corollary",         // identifier
  "Corollary",         // head
  base: "theorem",     // base - use the theorem counter
  fill: rgb("#f8e8e8")
)

#corollary(numbering: "1.1")[
  If  $n$  divides two consecutive natural numbers, then  $n = 1$ .
]
```

Corollary 3.2.1: If n divides two consecutive natural numbers, then $n = 1$.

Note that we have provided a numbering string; this can be any valid numbering pattern as described in the [numbering](#) documentation.

3.1. Suppressing numbering

Supplying `numbering: none` to an environment suppresses numbering for that block, and prevents it from updating its counter.

```
#let example = thmplain(  
  "example",  
  "Example"  
) .with(numbering: none)  
  
#example[  
  The numbers $2$, $3$, and $17$ are prime.  
]
```

Example: The numbers 2, 3, and 17 are prime.

Here, we have used the `thmplain` function, which is identical to `thmbox` but sets some plainer defaults. You can also write

```
#lemma(numbering: none)[  
  The square of any even number is divisible by $4$.  
]  
#lemma[  
  The square of any odd number is one more than a multiple of $4$.  
]
```

Lemma: The square of any even number is divisible by 4.

Lemma 3.1.1: The square of any odd number is one more than a multiple of 4.

Note that the last *Lemma* is *not* numbered 3.1.2!

3.2. Limiting depth

You can limit the number of levels of the base numbering used as follows.

```
#let definition = thmbox(  
  "definition",  
  "Definition",  
  base_level: 1,           // take only the first level from the base  
  stroke: rgb("#68ff68") + 1pt  
)  
  
#definition(name: "Prime numbers")[  
  A natural number is called a _prime number_ if it is greater than $1$ and  
  cannot be written as the product of two smaller natural numbers. <prime>  
]
```

Definition 3.1 (Prime numbers): A natural number is called a *prime number* if it is greater than 1 and cannot be written as the product of two smaller natural numbers.

Note that this environment is *not* numbered 3.2.1!

```
#definition(name: "Composite numbers")[
  A natural number is called a _composite number_ if it is greater than $1$
  and not prime.
]
```

Definition 3.2 (Composite numbers): A natural number is called a *composite number* if it is greater than 1 and not prime.

Setting a `base_level` higher than what `base` provides will introduce padded zeroes.

```
#example(base_level: 4, numbering: "1.1")[
  The numbers $4$, $6$, and $42$ are composite.
]
```

Example 3.2.0.0.1: The numbers 4, 6, and 42 are composite.

3.3. Custom formatting

The `thmbox` function lets you specify rules for formatting the title, the name, and the body individually. Here, the title refers to the head and number together.

```
#let proof = thmplain(
  "proof",
  "Proof",
  base: "theorem",
  titlefmt: smallcaps,
  bodyfmt: body => [
    #body #h(1fr) $square$ // float a QED symbol to the right
  ]
).with(numbering: none)

#lemma[
  All even natural numbers greater than 2 are composite.
]
#proof[
  Every even natural number  $n$  can be written as the product of the natural
  numbers  $2$  and  $n/2$ . When  $n > 2$ , both of these are smaller than  $2$ 
  itself.
]
```

Lemma 3.3.1: All even natural numbers greater than 2 are composite.

PROOF: Every even natural number n can be written as the product of the natural numbers 2 and $n/2$. When $n > 2$, both of these are smaller than 2 itself. \square

You can go even further and use the `thmenv` function directly. It accepts an identifier, a base, a `base_level`, and a `fmt` function.

```
#let notation = thmenv(
  "notation",           // identifier
  none,                 // base - do not attach, count globally
  none,                 // base_level - use the base as-is
  (name, number, body) => [ // fmt - format content using the environment
    // name, number, and body
    #h(1.2em) *Notation (#number) #name*:
    #h(0.2em)
    #body
    #v(0.5em)
  ]
).with(numbering: "I") // use Roman numerals

#notation[
  The variable  $p$  is reserved for prime numbers.
]
```

Notation (I): The variable p is reserved for prime numbers.

3.4. Labels and references

You can place a `<label>` *inside* a theorem environment to reference it later via `thmref`.

Recall that there are infinitely many prime numbers via
`#thmref(<euclid>)[Theorem]`.

Recall that there are infinitely many prime numbers via Theorem 3.1.

The optional `fmt` argument can be used to convert the counter value (an array of integers) and the optional body text into content.

```
#let numfmt = (nums, body) => {
  if body.pos().len() > 0 {
    body = body.pos().join(" ")
    return smallcaps([#body (#strong(numbering("1.1", ..nums)))]])
  }
  return smallcaps(strong(numbering("1.1", ..nums)))
}
```

You can reference future environments too, like
`#thmref(<oddprime>, fmt: numfmt)[Corollary]`.

You can reference future environments too, like COROLLARY (3.3.1.1).

Note that all such references are links to the the label location. The `makelink` argument lets you disable this behaviour.

This reference to `#thmref(<prime>, makelink: false)[Definition]` is not linked!

This reference to Definition 3.1 is not linked!

3.5. Overriding base

```
#let remark = thmplain("remark", "Remark", base: "heading")
#remark[
  There are infinitely many composite numbers.
]
```

```
#corollary[
  All primes greater than $2$ are odd. <oddprime>
]
#remark(base: "corollary")[
  Two is a _lone prime_.
]
```

Remark 3.5.1: There are infinitely many composite numbers.

Corollary 3.3.1.1: All primes greater than 2 are odd.

Remark 3.3.1.1.1: Two is a *lone prime*.

This remark environment, which would normally be attached to the current *heading*, now uses the corollary as a base.

4. Function reference

4.1. thmenv

The thmenv function produces a *theorem environment*.

```
#let thmenv(
  identifier,          // environment counter name
  base,                // base counter name, can be "heading" or none
  base_level,          // number of base number levels to use
  fmt                  // formatting function of the form
                      // (name, number, body) -> content
) = { ... }
```

A *theorem environment* is itself a map of the following form.

```
(
  body,                // body content
  name: "",            // name, often used in the title
  numbering: "1.1",    // numbering style, can be a function
  base: base,          // base counter name override
  base_level: base_level // base_level override
) -> content
```

4.2. thmref

A <label> placed within an environment can be referenced using thmref.

```
#let thmref(
  label,              // label
  fmt: auto,          // formatting function, of the form
                      // (number array, body arguments) -> content
  makelink: true,     // create link to label
  ..body              // body - typically prepended to number
) = { ... }
```

Note that the `<label>` *must* be attached to something *inside* the environment.

Caution: Links created by `thmref` will be styled according to `#show link:` rules, not `#show ref:` rules.

4.3. `thmbox` and `thmplain`

The `thmbox` wraps `thmenv`, supplying a box-like `fmt` function.

```
#let thmbox(  
  identifier,           // identifier  
  head,                // head - common name, used in the title  
  fill: none,          // box fill  
  stroke: none,        // box stroke  
  inset: 1.2em,        // box inset  
  radius: 0.3em,       // box corner radius  
  breakable: false,    // box breakability  
  padding: (top: 0.5em, bottom: 0.5em),  
                                // box padding, passed to #pad  
  namefmt: x => [(#x)],    // formatting for name  
  titlefmt: strong,     // formatting for title (head + number)  
  bodyfmt: x => x,       // formatting for body  
  separator: [#h(0.1em):#h(0.2em)],  
                                // separator inserted between name and body  
  base: "heading",      // base - defaults to using headings  
  base_level: none,     // base_level - defaults to using base as-is  
) = { ... }
```

The `thmplain` function is identical to `thmbox`, except with plainer defaults.

```
#let thmplain = thmbox.with(  
  padding: (top: 0em, bottom: 0em),  
  breakable: true,  
  inset: (top: 0em, left: 1.2em, right: 1.2em),  
  namefmt: name => emph([(#name)]),  
  titlefmt: emph,  
)
```

5. Acknowledgements

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