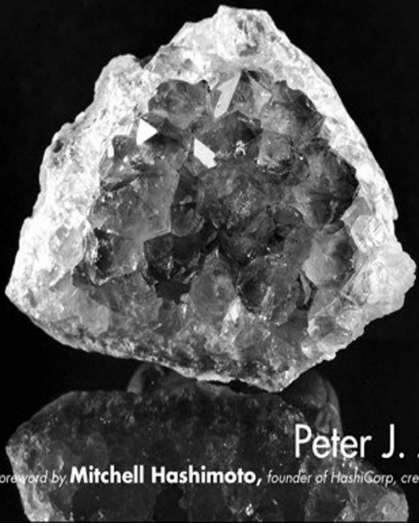
*Effective* SOFTWARE DEVELOPMENT SERIES
Scott Meyers, Consulting Editor

# *Effective* RUBY

*48 Specific Ways to Write Better Ruby*



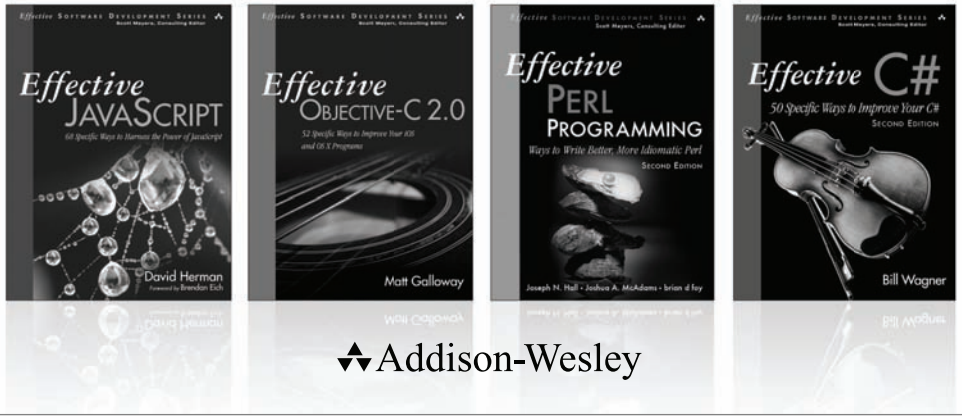
Peter J. Jones

Foreword by **Mitchell Hashimoto,** *founder of HashiCorp, creator of Vagrant*

# Effective Ruby

# The Effective Software Development Series

Scott Meyers, Consulting Editor




Visit **informit.com/esds** for a complete list of available publications.

---

**The Effective Software Development Series** provides expert advice on all aspects of modern software development. Titles in the series are well written, technically sound, and of lasting value. Each describes the critical things experts always do — or always avoid — to produce outstanding software.

Scott Meyers, author of the best-selling books *Effective C++* (now in its third edition), *More Effective C++*, and *Effective STL* (all available in both print and electronic versions), conceived of the series and acts as its consulting editor. Authors in the series work with Meyers to create essential reading in a format that is familiar and accessible for software developers of every stripe.

# Effective Ruby

## 48 Specific Ways to Write Better Ruby

**Peter J. Jones**

Addison-Wesley

Upper Saddle River, NJ • Boston • Indianapolis • San Francisco
New York • Toronto • Montreal • London • Munich • Paris • Madrid
Capetown • Sydney • Tokyo • Singapore • Mexico City

*Library of Congress Cataloging-in-Publication Data*
Jones, Peter J., author.
Effective Ruby : 48 specific ways to write better Ruby / Peter J. Jones.
Pages cm
Includes index.
ISBN 978-0-13-384697-3 (pbk. : alk. paper)
1. Ruby (Computer program language) 2. Object-oriented programming (Computer science) I. Title.
QA76.73.R83J66 2015
005.13'3—dc23

2014026572



ISBN-13: 978-0-13-384697-3
ISBN-10: 0-13-384697-0
Text printed in the United States on recycled paper at RR Donnelley, Crawfordsville, Indiana.
First printing, September 2014

**Editor-in-Chief**
Mark L. Taub

**Senior Acquisitions Editor**
Trina MacDonald

**Development Editor**
Songlin Qiu

**Managing Editor**
John Fuller

**Full-Service Production Manager**
Julie B. Nahil

**Copy Editor**
Christina Edwards

**Indexer**
Jack Lewis

**Proofreader**
Andrea Fox

**Technical Reviewers**
Bruce Williams
Bobby Wilson

**Editorial Assistant**
Olivia Basegio

**Cover Designer**
Chuti Prasertsith

**Compositor**
LaurelTech

*For Shanna, the reason my life has balance and purpose.*

*This page intentionally left blank*

# Contents

*This page intentionally left blank*

# Foreword

When I was asked to do a technical review and write the foreword for a book on Ruby, I was skeptical. Several Ruby books already exist that run the gamut from beginner to advanced Ruby VM internals. I thought, "What could *another* Ruby book offer?" But I agreed to look over the text, and to my surprise a great and novel book about Ruby was laid out before my eyes. This book is quite unlike any other Ruby book, and in a couple hundred pages, I imagine anyone who reads this—novice or expert—will emerge a better Ruby programmer.

Ruby as a language has matured a lot in the past decade, when I got started with it. Early on, there was the hype phase, when Ruby was touted as the end-all and be-all of languages. Then emerged the proliferation of libraries, when it felt like libraries were being abandoned and re-created daily, and none could be trusted to remain up to date. Then other "new hotness" languages started emerging, and Ruby went through a phase of being seen as the language of yesteryear. But now, finally, Ruby is seen as a practical, effective language for solving many problems, although it understandably won't solve all of them. (You're not going to be writing the next big operating system in Ruby.)

Instead of being a book that covers basic syntax or advanced practices, this book masterfully walks the line of introducing real-world best practices for writing Ruby applications that won't crash, will be maintainable, and will be fast. It is a book that every Ruby programmer should read. Beginners should learn best practices to better understand the language, and experienced developers should double-check their own practices and maybe learn a couple of new ones as well.

The book is written in my favorite way: lots of examples, and the examples don't just explain "What?" and "How?", but also "Why?" Although these are best practices curated from the Ruby community

over years of maturation, it is important to always remain skeptical, ask questions, and perhaps find new best practices that improve on the old.

With that, I wish you a fun journey through this book, and fully expect you to grow as a Ruby programmer in just a couple hundred pages.

*—Mitchell Hashimoto, founder and CEO of HashiCorp, creator of Vagrant*

# Preface

Learning a new programming language usually happens in two phases. During the first phase you spend time learning the syntax and structure of the language. This phase is often short when you have previous experience learning new programming languages. In the case of Ruby, the syntax is very familiar to those who have experience with other object-oriented languages. The structure of the language—how you build programs out of the syntax—should also be very familiar to experienced programmers.

The second phase, on the other hand, can take a bit more work. This is when you dig deeper into the language and learn its idioms. Most languages have a unique way of solving common problems, and Ruby is no different. For example, Ruby uses blocks along with the iterator pattern instead of explicit looping. Learning how to solve problems "the Ruby way" while avoiding any sharp edges is what this phase is all about.

And that's what this book is all about, too. But it's not an introductory book. I assume you've already completed the first phase of learning Ruby—that is, learning its syntax and structure. My goal with this book is to take you deeper into Ruby. I want to show you how to get the most out of the language and how to write effective code that is more reliable and easier to maintain. Along the way we'll also explore how parts of the Ruby interpreter work internally, knowledge that will allow you to write more efficient programs.

## Ruby Implementations and Versions

As you know, Ruby has a very active community of contributors. They work on all sorts of projects, including different implementations of the Ruby interpreter. Besides the official Ruby implementation (colloquially known as MRI), there are several others to choose from. Need to deploy your Ruby application to production servers that

are already configured for running Java applications? No problem, that's what JRuby is for. How about the opposite end of the spectrum, Ruby applications targeting smartphones and tablets? There's a Ruby implementation for that, too.

Having several Ruby implementations to choose from is a good sign that Ruby is alive and well. Obviously, each of them has a unique, internal implementation. But from the perspective of a programmer writing Ruby code, the various interpreters behave closely enough to MRI that you won't have to worry much.

The vast majority of this book applies equally to all of the various Ruby implementations. The only exceptions are the items that describe Ruby internal details such as how the garbage collector works. In those cases, I will narrow my focus to the official Ruby implementation, MRI. You'll know when we're talking about MRI specifically when I mention specific Ruby versions in the text.

Speaking of specific versions, all of the code in this book has been tested with Ruby 1.9.3 and later. At the time of writing, Ruby 2.1 was the most recent version, with 2.2 just around the corner. When I don't mention a specific version of Ruby in the text, the example code will work on all supported versions.

## A Note about Style

Ruby programmers have, for the most part, converged on a single way of formatting their Ruby code. There are even a handful of RubyGems that can inspect your code and scold you when it isn't formatted according to a set of predetermined styling rules. I bring this up because the style I've chosen for the example code in this book deviates slightly from what might be considered normal.

When I call a method and supply arguments to it, I use parentheses around the arguments, without any space between the opening parenthesis and the name of the method. Out in the wild, it's common to see method calls *without* parentheses, probably because Ruby doesn't require them. But as we'll see in Chapter 1, omitting parentheses in some situations can cause ambiguities in your code, which in turn forces Ruby to guess what you mean. Because of these ambiguities, I think it's a bad habit to omit parentheses and one the community needs to wean itself from.

The other reason I use parentheses is to clearly show when an identifier is a method call versus a keyword. You might be surprised to learn that things you thought were keywords are actually method calls (e.g., `require`). Using parentheses helps illustrate this.

While we're on the topic of style, I should mention that throughout this book, when I mention methods, I use RI notation. If you're not familiar with RI notation it's easy to learn and can be very helpful. Its primary purpose is to differentiate between class and instance methods. When referring to class methods I'll write the name of the class and the method separated by two colons ("::"). For example, `File::open` is the `open` class method from the `File` class. Likewise, instance methods are written with a number sign ("#") between the class name and the name of the instance method (e.g., `Array#each`). The same is true of module methods (e.g., `GC::stat`) and module instance methods (e.g., `Enumerable#grep`). Item 40 goes into more detail about RI notation and how to use it to look up method documentation. But this little primer is enough to get you started.

## Where to Get the Source Code

Throughout the book we'll examine many listings of example source code. To make it easier to digest, code will often be broken up into small chunks that we'll work though one at a time. There are even times when unimportant details are omitted. Sometimes it's nice to see all the code at once, to get the bigger picture, so to speak. All of the code shown can be found at the website for the book at http://effectiveruby.com.

*This page intentionally left blank*

# Acknowledgments

Writing something that people are willing to spend their time reading, and something worthy of spending their money on, isn't a solo endeavor. As a matter of fact, beyond the close group of people who were directly involved in this book, many others unknowingly contributed in one way or another. For example, my friend Michael Garriss had no idea what the consequences of his actions would be when he sweet-talked me into learning Ruby. He certainly didn't expect for me to drag him from company to company, introducing Ruby at each step of the way. Nevertheless, that's what happened.

It might be a bit unorthodox (and vague) but I want to thank everyone who's ever contributed their time and creativity to the open-source community. Every single tool I used while writing this book, even those I created specifically for it, are open-source projects. There's no way I could have written this book without being able to review the source code to the Ruby interpreter and the handful of gems that are discussed. I spent many hours curled up with code, dissecting, experimenting, and sometimes crying. The fact that I was able to do that is wonderful all by itself.

Of course, without the generosity of those who volunteered to work with me, this book wouldn't be worthy of your attention. Several people gave up their free time to review early drafts of the chapters and provided me with immensely useful feedback. Isaac Foraker, Timothy Clayton, and my wife, Shanna Jones, spent many hours reading text and experimenting with code. Thank you so much for your time.

Probably not realizing what they were getting themselves into, Bruce Williams and Bobby Wilson agreed to be technical reviewers. They both helped me improve the examples in the book and the explanations that go along with them. They also encouraged me when the anxiety of having someone else poking around my work was a bit overwhelming.

Everyone at Pearson made things as easy for me as they could. Trina MacDonald, Olivia Basegio, and Songlin Qiu were extremely patient with me and shaped this book into what it is now. I've grown so much during this project and a large part of that is due to them.

Scott Meyers is a hero of mine and being able to work with him is like having a dream come true. In the late 1990s I came across Scott's book, *Effective C++*, and it changed the way I approached programming. It also inspired me to teach others the things I have learned. Sending my work to Scott for review was terrifying, but Scott was nothing less than encouraging and extremely helpful. Thank you, Scott.

My wife, Shanna Jones, was a huge source of encouragement and understanding. Knowing that it would take me away from her, she pushed me to write this book anyway. Shanna, you've taught me more than you understand. Thank you for always supporting me.

# About the Author

**Peter J. Jones** has been working professionally with Ruby since 2005. He began programming before he learned how to use a keyboard properly after stumbling upon a Commodore 64, a few code listings, and some cassette tapes. Peter is a freelance software engineer and a senior instructor for programming related workshops taught by Devalot.com.

*This page intentionally left blank*

# 1 Accustoming Yourself to Ruby

With each programming language you learn, it's important to dig in and discover its idiosyncrasies. Ruby is no different. While it borrows heavily from the languages that preceded it, Ruby certainly has its own way of doing things. And sometimes those ways will surprise you.

We begin our journey through Ruby's many features by examining its unique take on common programming ideas. That is, those that impact every part of your program. With these items mastered, you'll be prepared to tackle the chapters that follow.

## Item 1: Understand What Ruby Considers to Be True

Every programming language seems to have its own way of dealing with Boolean values. Some languages only have a single representation of true or false. Others have a confusing blend of types that are sometimes true and sometimes false. Failure to understand which values are true and which are false can lead to bugs in conditional expressions. For example, how many languages do you know where the number zero is false? What about those where zero is true?

Ruby has its own way of doing things, Boolean values included. Thankfully, the rule for figuring out if a value is true or false is pretty simple. It's different than other languages, which is the whole reason this item exists, so make sure you understand what follows. In Ruby, every value is true *except* `false` and `nil`.

It's worth taking a moment and thinking about what this means. While it's a simple rule, it has some strange consequences when compared with other mainstream languages. In a lot of programming languages the number zero is false, with all other numbers being true. Using the rule just given for Ruby, zero is *true*. That's probably one of the biggest gotchas for programmers coming to Ruby from other languages.

Another trick that Ruby plays on you if you're coming from another language is the assumption that `true` and `false` are keywords. They're not. In fact, they're best described as global variables that don't follow the naming and assignment rules. What I mean by this is that they don't begin with a "$" character, like most global variables, and they can't be used as the left-hand side of an assignment. But in all other regards they're global variables. See for yourself:

```
irb> true.class
---> TrueClass

irb> false.class
---> FalseClass
```

As you can see, `true` and `false` act like global objects, and like any object, you can call methods on them. (Ruby also defines `TRUE` and `FALSE` constants that reference these `true` and `false` objects.) They also come from two different classes: `TrueClass` and `FalseClass`. Neither of these classes allows you to create new objects from them; `true` and `false` are all we get. Knowing the rule Ruby uses for conditional expressions, you can see that the `true` object only exists for convenience. Since `false` and `nil` are the only false values, the `true` object is superfluous for representing a true value. Any non-`false`, non-`nil` object can do that for you.

Having two values to represent false and all others to represent true can sometimes get in your way. One common example is when you need to differentiate between `false` and `nil`. This comes up all the time in objects that represent configuration information. In those objects, a `false` value means that something should be disabled, while a `nil` value means an option wasn't explicitly specified and the default value should be used instead. The easiest way to tell them apart is by using the `nil?` method, which is described further in Item 2. Another way is by using the "==" operator with `false` used as the left operand:

```
if false == x
  ...
end
```

With some languages there's a stylistic rule that says you should always use immutable constants as the left-hand side of an equality operator. That's not why I'm recommending `false` as the left operand to the "==" operator. In this case, it's important for a functional reason. Placing `false` on the left-hand side means that Ruby parses the expression as a call to the `FalseClass#==` method (which comes from the `Object` class). We can rest safely knowing this method only returns `true` if the right operand is also the `false` object. On the other

hand, using false as the *right* operand may not work as expected since other classes can override the Object#== method and loosen the comparison:

```
irb> class Bad
       def == (other)
         true
       end
     end

irb> false == Bad.new
---> false
irb> Bad.new == false
---> true
```

Of course, something like this would be pretty silly. But in my experience, that means it's more likely to happen. (By the way, we'll cover the "==" operator more in Item 12.)

### Things to Remember

- Every value is true *except* false and nil.
- Unlike in a lot of languages, the number zero is true in Ruby.
- If you need to differentiate between false and nil, either use the nil? method or use the "==" operator with false as the left operand.

## Item 2: Treat All Objects as If They Could Be nil

Every object in a running Ruby program comes from a class that, in one way or another, inherits from the BasicObject class. Imagining how all these objects relate to one another should conjure up the familiar tree diagram with BasicObject at the root. What this means in practice is that an object of one class can be substituted for an object of another (thanks to polymorphism). That's why we can pass an object that *behaves* like an array—but is not actually an array—to a method that expects an Array object. Ruby programmers like to call this "duck typing." Instead of requiring that an object be an instance of a specific class, duck typing shifts the focus to what the object can do; in other words, interface over type. In Ruby terms, duck typing means you should prefer using the respond_to? method over the is_a? method.

But in reality, it's rare to see a method inspect its arguments using respond_to? to make sure it supports the correct interface. Instead, we tend to just invoke methods on an object and if the object doesn't respond to a particular method, we leave it up to Ruby to raise a

NoMethodError exception at run time. On the surface, it seems like this could be a real problem for Ruby programmers. Well, just between you and me, it is. It's one of the core reasons testing is so very important. There's nothing stopping you from accidentally passing a Time object to a method expecting a Date object. These are the kinds of mistakes we have to tease out with good tests. And thanks to testing, these types of problems can be avoided. But one of these polymorphic substitutions plagues even well-tested applications:

```
undefined method 'fubar' for nil:NilClass (NoMethodError)
```

This is what happens when you call a method on an object and it turns out to be that pesky nil object…the one and only object from the NilClass class. Errors like this tend to slip through testing only to show up in production when a user does something out of the ordinary. Another situation where this can occur is when a method returns nil and then that return value gets passed directly into another method as an argument. There's a surprisingly large number of ways nil can unexpectedly get introduced into your running program. The best defense is to assume that any object might actually be the nil object. This includes arguments passed to methods and return values from them.

One of the easiest ways to avoid invoking methods on the nil object is by using the nil? method. It returns true if the receiver is nil and false otherwise. Of course, nil objects are always false in a Boolean context, so the if and unless expressions work as expected. All of the following lines are equivalent to one another:

```
person.save if person
person.save if !person.nil?
person.save unless person.nil?
```

It's often easier to explicitly convert a variable into the expected type rather than worry about nil all the time. This is especially true when a method should produce a result even if some of its inputs are nil. The Object class defines several conversion methods that can come in handy in this case. For example, the to_s method converts the receiver into a string:

```
irb> 13.to_s
---> "13"

irb> nil.to_s
---> ""
```

As you can see, NilClass#to_s returns an empty string. What makes to_s really nice is that String#to_s simply returns self without performing any conversion or copying. If a variable is already a string then using to_s will have minimal overhead. But

if nil somehow winds up where a string is expected, to_s can save the day. As an example, suppose a method expects one of its arguments to be a string. Using to_s, you can hedge against that argument being nil:

```
def fix_title (title)
  title.to_s.capitalize
end
```

The fun doesn't stop there. As you'd expect, there's a matching conversion method for almost all of the built-in classes. Here are some of the more useful ones as they apply to nil:

```
irb> nil.to_a
---> []

irb> nil.to_i
---> 0

irb> nil.to_f
---> 0.0
```

When multiple values are being considered at the same time, you can make use of a neat trick from the Array class. The Array#compact method returns a copy of the receiver with all nil elements removed. It's common to use it for constructing a string out of a set of variables that might be nil. For example, if a person's name is made up of first, middle, and last components—any of which might be nil—you can construct a complete full name with the following code:

```
name = [first, middle, last].compact.join(" ")
```

The nil object has a tendency to sneak into your running programs when you least expect it. Whether it's from user input, an unconstrained database, or methods that return nil to signal failure, always assume that every variable could be nil.

### Things to Remember

- Due to the way Ruby's type system works, any object can be nil.
- The nil? method returns true if its receiver is nil and false otherwise.
- When appropriate, use conversion methods such as to_s and to_i to coerce nil objects into the expected type.
- The Array#compact method returns a copy of the receiver with all nil elements removed.

## Item 3: Avoid Ruby's Cryptic Perlisms

If you've ever used the Perl programming language then you undoubtedly recognize its influence on Ruby. The majority of Ruby's perlisms have been adopted in such a way that they blend perfectly with the rest of the ecosystem. But others either stick out like an unnecessary semicolon or are so obscure that they leave you scratching your head trying to figure out how a particular piece of code works.

Over the years, as Ruby matured, alternatives to some of the more cryptic perlisms were added. As more time went on, some of these holdovers from Perl were deprecated or even completely removed from Ruby. Yet, a few still remain, and you're likely to come across them in the wild. This item can be used as a guide to deciphering those perlisms while acting as a warning to avoid introducing them into your own code.

The corner of Ruby where you're most likely to encounter features borrowed from Perl is a set of cryptic global variables. In fact, Ruby has some pretty liberal naming rules when it comes to global variables. Unlike with local variables, instance variables, or even constants, you're allowed to use all sorts of characters as variable names. Recalling that global variables begin with a "$" character, consider this:

```
def extract_error (message)
  if message =~ /^ERROR:\s+(.+)$/
    $1
  else
    "no error"
  end
end
```

There are two perlisms packed into this code example. The first is the use of the "=~" operator from the `String` class. It returns the position within the string where the right operand (usually a regular expression) matches, or `nil` if no match can be found. When the regular expression matches, several global variables will be set so you can extract information from the string. In this example, I'm extracting the contents of the first capture group using the `$1` global variable. And this is where things get a bit weird. That variable might look and smell like a global variable, but it surely doesn't act like one.

The variables created by the "=~" operator are called *special* global variables. That's because they're scoped *locally* to the current thread and method. Essentially, they're local values with global names. Outside of the `extract_error` method from the previous example, the `$1` "global" variable is `nil`, even after using the "=~" operator. In the example,

returning the value of the $1 variable is just like returning the value of a local variable. The whole situation can be confusing. The good news is that it's completely unnecessary. Consider this alternative:

```
def extract_error (message)
  if m = message.match(/^ERROR:\s+(.+)$/)
    m[1]
  else
    "no error"
  end
end
```

Using String#match is much more idiomatic and doesn't use any of the special global variables set by the "=~" operator. That's because the match method returns a MatchData object (when the regular expression matches) and it contains all of the same information that was previously available in those special global variables. In this version of the extract_error method, you can see that using the index operator with a value of 1 gives you the same string that $1 would have given you in the previous example. The bonus feature is that the MatchData object is a plain old local variable and you get to choose the name of it. (It's fairly common to make an assignment inside the conditional part of an if expression like this. That said, it's all too easy to use "=" when you really meant "==". Watch out for these kinds of mistakes.)

Besides those set by the "=~" operator, there are other global variables borrowed from Perl. The one you're most likely to see is $:, which is an array of strings representing the directories where Ruby will search for libraries that are loaded with the require method. Instead of using the $: global variable, you should use its more descriptive alias: $LOAD_PATH. As a matter of fact, there are more descriptive versions for all of the other cryptic global variables such as $; and $/. But there's a catch. Unlike with $LOAD_PATH, you have to load a library to access the other global variables' aliases:

```
require('English')
```

Once the English library is loaded, you can replace all those strange global variables by their longer, more descriptive aliases. For a full list of these aliases, take a look at the documentation for the English module.

There's one last perlism you should be aware of. Not surprisingly, it also has something to do with a global variable. Consider this:

```
while readline
  print if ~ /^ERROR:/
end
```

If you think this code is a bit obfuscated, then congratulations, you're in good company. You might be wondering what the `print` method is actually printing and what that regular expression is matching against. It just so happens that all of the methods in this example are working with a global variable—the `$_` variable to be more precise.

So, what's going on here? It all starts with the `readline` method. More specifically, it's the `Kernel#readline` method. (In Item 6, we'll dig more into how Ruby determines that, in this context, `readline` comes from the `Kernel` module.) This version of `readline` is a little different from its counterpart in the `IO` class. You can probably gather that it reads a line from standard input and returns it. The subtle part is that it also stores that line of input in the `$_` variable. (`Kernel#gets` does the same thing but doesn't raise an exception when the end-of-file marker is reached.) In a similar fashion, if `Kernel#print` is called without any arguments, it will print the contents of the `$_` variable to standard output.

You can probably guess what that unary "~" operator and the regular expression are doing. The `Regexp#~` operator tries to match the contents of the `$_` variable against the regular expression to its right. If there's a match, it returns the position of the match; otherwise, it returns `nil`. While all these methods might look like they are somehow magically working together, you now know that it's all thanks to the `$_` global variable. But why does Ruby even support this?

The only legitimate use for these methods (and the `$_` variable) is for writing short, simple scripts on the command line, so-called "one liners." This allows Ruby to compete with tools such as Perl, awk, and sed. When you're writing real code you should avoid methods that implicitly read from, or write to, the `$_` global variable. These include other similar `Kernel` methods I haven't listed here such as `chomp`, `sub`, and `gsub`. The difference with those is that they can no longer be used in recent versions of Ruby without using either the "`-n`" or the "`-p`" command-line option to the Ruby interpreter. That is, it's like these methods don't even exist without one of those command-line options. That's a good thing.

Now you can see how some of the more cryptic perlisms can affect the readability, and thus maintainability, of your code. Especially those obscure global variables and the ones that are global in name only. It is best to use the more Ruby-like methods (`String#match` vs. `String#=~`) and the longer, more descriptive names for global variables (`$LOAD_PATH` vs. `$:`).

### Things to Remember

- Prefer `String#match` to `String#=~`. The former returns all the match information in a `MatchData` object instead of several special global variables.
- Use the longer, more descriptive global variable aliases as opposed to their short cryptic names (e.g., `$LOAD_PATH` instead of `$:`). Most of the longer names are only available after loading the `English` library.
- Avoid methods that implicitly read from, or write to, the `$_` global variable (e.g., `Kernel#print`, `Regexp#~`, etc.).

## Item 4: Be Aware That Constants Are Mutable

If you're coming to Ruby from another programming language, there's a good chance that constants don't behave the way you expect them to. But before we dig into that let's review what Ruby considers to be a constant.

When you first learned Ruby you were probably taught that constants are identifiers that are made up of uppercase alphanumeric characters and underscores. Some examples include `STDIN`, `ARGV`, and `RUBY_VERSION`. But that's not the entire story. In reality, a constant is any identifier that begins with an uppercase letter. This means that identifiers like `String` and `Array` are also constants. That's right…the names of classes and modules are actually constants in Ruby. With that in mind, let's take a closer look at how constants differ from other variable-like things in Ruby.

As their name suggests, constants are meant to remain unchanged during the lifetime of a program. You might assume, therefore, that Ruby would prevent you from altering the value stored in a constant. Well, that assumption would be wrong. Consider this:

```
module Defaults
  NETWORKS = ["192.168.1", "192.168.2"]
end

def purge_unreachable (networks=Defaults::NETWORKS)
  networks.delete_if do |net|
    !ping(net + ".1")
  end
end
```

If you invoke the `purge_unreachable` method without an argument, it will accidentally mutate a constant. It will do this without so much

as a warning from Ruby. Essentially, constants are more like global variables than unchanging values. If you think about it, since class and module names are constants, and you can change a class at anytime (e.g., add methods), then the objects referenced by constants need to be mutable in Ruby. That's fine for classes and modules, but not so great for the values we actually want to be constant and immutable. Thankfully, there's a solution to this problem—the `freeze` method:

```
module Defaults
  NETWORKS = ["192.168.1", "192.168.2"].freeze
end
```

With this change in place, the `purge_unreachable` method will raise a `RuntimeError` exception if it tries to alter the array referenced by the `NETWORKS` constant. As a general rule of thumb, always freeze constants to prevent them from being mutated. Unfortunately, freezing the `NETWORKS` array isn't quite enough. Consider this:

```
def host_addresses (host, networks=Defaults::NETWORKS)
  networks.map {|net| net << ".#{host}"}
end
```

The `host_addresses` method will modify the elements of the `NETWORKS` array if it isn't given a second argument. While the `NETWORKS` array itself is frozen, its *elements* are still mutable. You might not be able to add or remove elements from the array, but you can surely make changes to the existing elements. So, if a constant references a collection object such as an array or hash, freeze the collection *and* its elements:

```
module Defaults
  NETWORKS = [
    "192.168.1",
    "192.168.2",
  ].map!(&:freeze).freeze
end
```

(If you happen to be using Ruby 2.1 or later you can make use of a trick from Item 47 and freeze the string literals directly. This can save you a bit of memory while keeping the elements from accidentally being mutated.)

Freezing a constant will change an obscure, hard-to-track-down bug into an exception. That's an obvious win. Unfortunately, it's still not enough. Even if you freeze the object a constant refers to, you can still

cause problems by assigning a *new* value to an existing constant. See for yourself:

```
irb> TIMEOUT = 5
---> 5

irb> TIMEOUT += 5
(irb):2: warning: already initialized constant TIMEOUT
(irb):1: warning: previous definition of TIMEOUT was here
---> 10
```

As you can see, assigning a new value to an existing constant is perfectly legal in Ruby. You can also see that Ruby produces a warning telling us that we're redefining a constant. But that's it, just a warning. Thankfully, if we take things into our own hands, we can make Ruby raise an exception if we accidentally redefine a constant. The solution is a bit clumsy, and may be too heavy-handed for some situations, but it's simple. To prevent Ruby from assigning new values to existing constants, freeze the class or module they're defined in. You may even want to structure your code so that all constants are defined in their own module, isolating the effects of the `freeze` method:

```
module Defaults
  TIMEOUT = 5
end

Defaults.freeze
```

There are three levels of freezing you should consider when defining constants. The first two are easy: freeze the object that the constant references and the module the constant is defined in. Those two steps prevent the constant from being mutated or assigned to. The third is a bit more complicated. We saw that if a constant references an array of strings, we need to freeze the array *and* the elements. In other words, you need to deeply freeze the object the constant refers to. Each constant will be different, just make sure it's completely frozen.

### Things to Remember

- ✦ Always freeze constants to prevent them from being mutated.
- ✦ If a constant references a collection object such as an array or hash, freeze the collection *and* its elements.
- ✦ To prevent assignment of new values to existing constants, freeze the module they're defined in.

## Item 5: Pay Attention to Run-Time Warnings

Ruby programmers enjoy a shortened feedback loop while writing, executing, and testing code. Being interpreted, the compilation phase isn't present in Ruby. Or is it? If you think about it, Ruby must do some of the same things a compiler does, such as parsing our source code. When you give your Ruby code to the interpreter, it has to perform some compiler-like tasks before it starts to execute the code. It's useful to think about Ruby working with our code in two phases: compile time and run time.

Parsing and making sense of our code happens at compile time. Executing that code happens at run time. This distinction is especially important when you consider the various types of warnings that Ruby can produce. Warnings emitted during the compilation phase usually have something to do with syntax problems that Ruby was able to work around. Run-time warnings, on the other hand, can indicate sloppy programming that might be the source of potential bugs. Paying attention to these warnings can help you fix mistakes before they become real problems. Before we talk about how to enable the various warnings in Ruby, let's explore a few of the common warning messages and what causes them.

Warnings emitted during the compilation phase are especially important to pay attention to. The majority of them are generated when Ruby encounters ambiguous syntax and proceeds by choosing one of many possible interpretations. You obviously don't want Ruby guessing what you really meant. Imagine what would happen if a future version of Ruby changed its interpretation of ambiguous code and your program started behaving differently! By paying attention to these types of warnings you can make the necessary changes to your code and completely avoid the ambiguity in the first place. Here's an example of where the code isn't completely clear and Ruby produces a warning:

```
irb> "808".split /0/
warning: ambiguous first argument; put parentheses or even spaces
```

When Ruby's parser reaches the first forward slash, it has to decide if it's the beginning of a regular expression literal, or if it's the division operator. In this case, it makes the reasonable assumption that the slash starts a regular expression and should be the first argument to the `split` method. But it's not hard to see how it could also be interpreted as the division operator with the output of the `split` command being its left operand. The warning itself is generic, and only half of it is helpful. But the fix is simple enough—use parentheses:

```
irb> "808".split(/0/)
---> ["8", "8"]
```

If you send your code through Ruby with warnings enabled you're likely to see other warnings related to operators and parentheses. The reason is nearly always the same. Ruby isn't 100% sure what you mean and picks the most reasonable interpretation. But again, do you really want Ruby guessing what you mean or would you rather be completely clear from the start? Here are two more examples of ambiguous method calls that are fixed by adding parentheses around the arguments:

```
irb> dirs = ['usr', 'local', 'bin']

irb> File.join *dirs
warning: '*' interpreted as argument prefix

irb> File.join(*dirs)
---> "usr/local/bin"

irb> dirs.map &:length
warning: '&' interpreted as argument prefix

irb> dirs.map(&:length)
---> [3, 5, 3]
```

Other useful warnings during the compilation phase have to do with variables. For example, Ruby will warn you if you assign a value to a variable, but then never end up using it. This might mean you're wasting a bit of memory but could also mean you've forgotten to include a value in your calculation. You'll also receive a warning if you create two variables with the same name in the same scope, so-called *variable shadowing*. This can happen if you accidentally specify a block argument with the same name as a variable that's already in scope. Both types of variable warnings can be seen in this example:

```
irb> def add (x, y)
       z = 1
       x + y
     end
warning: assigned but unused variable - z

irb> def repeat (n, &block)
       n.times {|n| block.call(n)}
     end
warning: shadowing outer local variable - n
```

As you can see, these compile-time warnings don't necessarily mean that you've done anything wrong, but they certainly *could* mean that.

So the best course of action is to review the warnings and make changes to your source code accordingly. The same can also be said of warnings generated while your code is executing, or what I call run-time warnings. These are warnings that can only be detected after your code has done something suspicious such as accessing an uninitialized instance variable or redefining an existing method. Both of which could have been done on purpose or by accident. Like the other warnings we've seen, these are easy to remedy.

I think you get the point, so I won't enumerate a bunch of descriptive, easy-to-fix run-time warnings for you. Instead, I'd rather show you how to enable warnings in the first place. Here again, it becomes important to distinguish between compile time and run time. If you want Ruby to produce warnings about your code as it's being parsed, you need to make sure the interpreter's warning flag is enabled. That might be as easy as passing the "`-w`" command-line option to Ruby:

```
ruby -w script.rb
```

For some types of applications, it's not that simple. Perhaps your Ruby program is being started automatically by a web server or a background job processing server. More commonly, you're using something like Rake to run your tests and you want warnings enabled. When you can't enable warnings by giving the interpreter the "`-w`" command-line option, you can do it indirectly by setting the `RUBYOPT` environment variable. How you set this variable will depend on the operating system and how your application is being started. What's most important is that the `RUBYOPT` environment variable be set to "`-w`" within the environment where your application is going to run *before* Ruby starts.

(I should also mention that if you're using Rake to run your tests you have another option available for enabling warnings. Item 36 includes an example `Rakefile` that does just that.)

Now, there's one last way to enable warnings. It's poorly documented and as a result often causes a lot of confusion. Within your program you can inspect and manipulate the `$VERBOSE` global variable (and its alias, `$-w`). If you want all possible warning messages you should set this variable to `true`. Setting it to `false` lowers the verbosity (producing fewer warnings) and setting it to `nil` disables warnings altogether. You might be thinking to yourself, "Hey, if I can set `$VERBOSE` to `true`, then I don't need to mess around with this '`-w`' business." This is where the distinction between compile time and run time really helps.

If you don't use the "`-w`" command-line option with the Ruby interpreter, but instead rely upon the `$VERBOSE` variable, you won't be able

to see compile-time warnings. That's because setting the `$VERBOSE` global variable doesn't happen until your program is *running*. By that time, the parsing phase is over and you've missed all the compile-time warnings. So, there are two guidelines to follow. First, enable compile-time warnings by using the "`-w`" command-line option to the Ruby interpreter or by setting the `RUBYOPT` environment variable to "`-w`". Second, control run-time warnings using the `$VERBOSE` global variable.

My advice is to always enable compile-time *and* run-time warnings during application development and while tests are running. If you absolutely must disable run-time warnings, do so by temporarily setting the `$VERBOSE` global variable to `nil`.

Unfortunately, enabling warning messages comes with a warning of its own. I'm disappointed to report that it's not common practice to enable warnings. So, if you're using any RubyGems and enable warnings, you're likely to get *a lot* of warnings originating from within them. This may strongly tempt you to subsequently disable warnings. Thankfully, when Ruby prints warnings to the terminal it includes the file name and line number corresponding to the warning. It shouldn't be too hard for you to write a script to filter out unwanted warnings. Even better, become a good open-source citizen and contribute fixes for any gems that are being a little sloppy and producing warnings.

### Things to Remember

- Use the "`-w`" command-line option to the Ruby interpreter to enable compile-time and run-time warnings. You can also set the `RUBYOPT` environment variable to "`-w`".
- If you must disable run-time warnings, do so by temporarily setting the `$VERBOSE` global variable to `nil`.

*This page intentionally left blank*

*This page intentionally left blank*

# Index

## C



## D



## E

## F



## G

## H



## I



## J



## K

## N



## O



## P

## R

## S



## T



## U