How big is an int in Go?

Go has several built-in numeric types, "sets of integer or floating-point values." Some *architecture-independent* types are `uint8` (8-bit, unsigned integer), `int16` (16-bit, signed integer), and `complex128` (128-bit complex number). Curiously, the Go spec also includes *architecture-dependent* types:

- `uint`
- `int`
- `uintptr`

How many bits do these types require? Unhelpfully, the spec says `int` and `uint` are the same size, "either 32 or 64 bits." A `uintptr` is "an unsigned integer large enough to store the uninterpreted bits of a pointer value."

By far the most common of these three types I've seen is `int`. If you know your program will only use non-negative numbers, you could use `uint` instead. The most common time to use `uintptr` is when you're importing `unsafe`, which is as safe to use as it sounds.

Practicalities

If these types are architecture-dependent, how can we tell how big an `int` is for an architecture we care about? One way is to go through the compiler source code, mapping your target architecture to its corresponding bit size. But, there are at least two solutions better than this:

- **Use architecture-independent types.** If you need to know exactly how many bits an `int` is using in your program, don't rely on the whims of the compiler — use one of the predefined types (for example, `int64`)! This communicates your intent as the author for a variable to have a particular size (the size is in the type's name!), improving readability and saving mental resources when your code is read later.
- **Write a program to tell you.** The standard library's `strconv` package contains a helper to let you know how large an `int` is. `strconv.IntSize` "is the size in bits of an int or uint value." You can use it in your program like this:

```go
// This program prints the number of bits in an int.
package main

import (
        "fmt"
        "strconv"
)

func main() {
        fmt.Println(strconv.IntSize)
}
```

main.go hosted with ❤ by GitHub view raw

Sample main package using `strconv.IntSize`.

On 32-bit architectures, this will print `32`. On 64-bit architectures, it will print `64`. Check it out on the Playground, your computer, or in a 32-bit Docker image (e.g. `i686/ubuntu`).

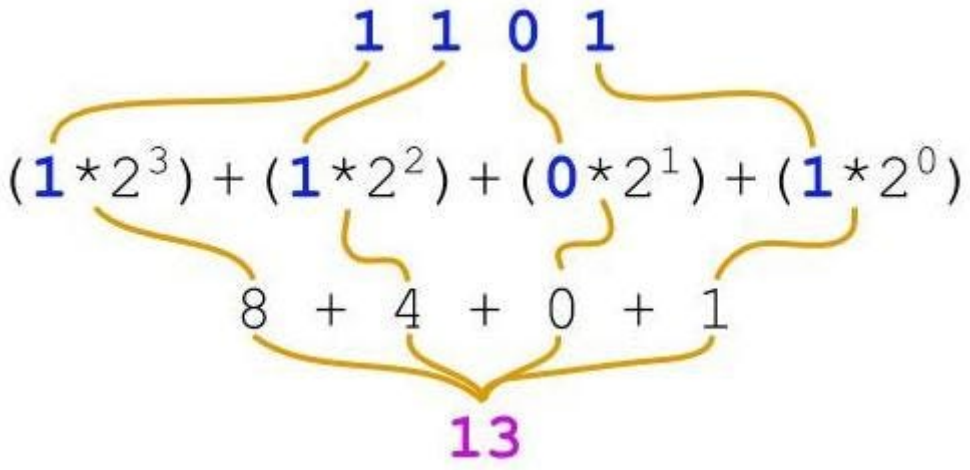
Bitwise Magic

You can see the definition of `strconv.IntSize` in https://golang.org/src/strconv/atoi.go:

```
const intSize = 32 << (^uint(0) >> 63)
// IntSize is the size in bits of an int or uint value.
const IntSize = intSize
```

Let's break this down into individual bitwise operations to see how it works.

- Unsigned integers are represented with base 2, each bit corresponding to an increasing power of two. For example, `1101` equals $1*2^3 + 1*2^2 + 0*2^1 + 1*2^0 = 8 + 4 + 0 + 1$, or `13`.



Graphical representation of `1101` equals `1*2³ + 1*2² + 0*2¹ + 1*2⁰ = 8 + 4 + 0 + 1`, or `13`.

- The `^` operator does a bitwise complement. `^` flips bits from `1` to `0` and `0` to `1`. For example, with 3 unsigned bits, `^(101) = 010`.
- `uint(0)` uses a type conversion to get a `0` value of type `uint`.
- `>>` is the right shift operator. A right shift moves all of the bits to the right, dropping bits off the right and inserting zeros on the left. For example, with 3 unsigned bits, `101 >> 2 = 001`.
- `<<` is the left shift operator, which is just like `>>` except the bits shift the opposite direction. For example, `101 << 2 = 100`.

Here is how all of these operators are used in the `strconv.IntSize` expression above:

Expression	32-bit representation	64-bit representation
uint(0)	00...00 (32 zeros)	0000...0000 (64 zeros)
^uint(0)	11...11 (32 ones)	1111...1111 (64 ones)
(^uint(0) >> 63)	00...00 = 0	0000...0001 = 1
32	00...100000	0000...100000
32 << (^uint(0) >> 63)	32 << (0) =100000 << 0 =**32**	32 << (1) =100000 << 1 =1000000 =**64**

Table representation of “In other words” below.

In other words:

1. Start with `0`.
2. `^` to flip all bits to `1`.
3. Right shift (`>>`) by `63` to only keep a single `1` from 64-bit numbers and zero out 32-bit numbers.
4. Left shift (`<<`) `32` by whatever the result is.
5. This leaves `32` on architectures that use 32-bit integer representations and `64` for 64-bit architectures.

The future of `int` in Go

Arbitrary precision integers can cause problems. For example:

- What if your application is running on a 32-bit machine, but you assume an `int` has 64 bits? Your variable may silently overflow.
- It's difficult to convert large values into an `int` — you have to be careful not to exceed the bounds.

For Go 2, Rob Pike proposed changing `int` (and `uint`) to be arbitrary precision, growing to fit whatever values as needed.

> *`strconv.IntSize` relies on the fact `int` and `uint` are either 32 bits or 64 bits. How could you modify it to work if an `int` was either 32 or 128 bits?*
>
> *Do you know any other tricks for learning how large an `int` is in Go? Let me know in the comments or on Twitter!*

This post was inspired by Franziska Hinkelmann, who recently wrote "V8 Internals: How Small is a 'Small Integer?'" I'd highly recommend reading it to learn more about how integers work in general and in JavaScript.

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