

An introduction to the **reshape2** package

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reshape2 is an R package written by Hadley Wickham that makes it easy to transform data between wide and long formats.

What makes data wide or long?

Wide data has a column for each variable. For example, this is wide-format data:

```
> head(d)
```

	ozone	wind	temp
1	23.61538	11.622581	65.54839
2	29.44444	10.266667	79.10000
3	59.11538	8.941935	83.90323
4	59.96154	8.793548	83.96774

And this is long-format data:

```
> melt(d)
```

	variable	value
1	ozone	23.615385
2	ozone	29.444444
3	ozone	59.115385
4	ozone	59.961538
5	wind	11.622581
6	wind	10.266667
7	wind	8.941935
8	wind	8.793548
9	temp	65.548387
10	temp	79.100000
11	temp	83.903226
12	temp	83.967742

Long-format data has a column for possible variable types and a column for the values of those variables. Long-format data isn't necessarily only two columns. For example, we might have ozone measurements for each day of the year. In that case, we could have another column for day. In other words, there are different levels of "longness". The ultimate shape you want to get your data into will depend on what you are doing with it.

It turns out that you need wide-format data for some types of data analysis and long-format data for others. In reality, you need long-format data much more commonly than wide-format data. For example, `ggplot2` requires long-format data, `plyr` requires long-format data, and most modelling functions (such as `lm()`, `glm()`, and `gam()`) require long-format data. But people often find it easier to record their data in wide format.

The reshape2 package

`reshape2` is based around two key functions: `melt` and `cast`:

`melt` takes wide-format data and melts it into long-format data.

`cast` takes long-format data and casts it into wide-format data.

Think of working with metal: if you melt metal, it drips and becomes long. If you cast it into a mould, it becomes wide.

Wide- to long-format data: the melt function

For this example we'll work with the `airquality` dataset that is built into R. First we'll change the column names to lower case to make them easier to work with. Then we'll look at the data:

```
> names(airquality) <- tolower(names(airquality))
> head(airquality)
```

	ozone	solar.r	wind	temp	month	day
1	41	190	7.4	67	5	1
2	36	118	8.0	72	5	2
3	12	149	12.6	74	5	3
4	18	313	11.5	62	5	4
5	NA	NA	14.3	56	5	5
6	28	NA	14.9	66	5	6

What happens if we run the function `melt` with all the default argument values?

```
> aql <- melt(airquality) # [a]ir [q]uality [l]ong format
> head(aql)
```

	variable	value
1	ozone	41
2	ozone	36
3	ozone	12
4	ozone	18
5	ozone	NA
6	ozone	28

```
> tail(aql)
```

	variable	value
913	day	25
914	day	26
915	day	27

```

916      day    28
917      day    29
918      day    30

```

By default, `melt` has assumed that all columns with numeric values are variables with values. Often this is what you want. Maybe here we want to know the values of `ozone`, `solar.r`, `wind`, and `temp` for each `month` and `day`. We can do that with `melt` by telling it that we want `month` and `day` to be “ID variables”. ID variables are the variables that identify individual rows of data.

```

> aql <- melt(airquality, id.vars = c("month", "day"))
> head(aql)

```

	month	day	variable	value
1	5	1	ozone	41
2	5	2	ozone	36
3	5	3	ozone	12
4	5	4	ozone	18
5	5	5	ozone	NA
6	5	6	ozone	28

What if we wanted to control the column names in our long-format data? `melt` lets us set those too all in one step:

```

> aql <- melt(airquality, id.vars = c("month", "day"),
+   variable.name = "climate_variable", value.name = "climate_value")
> head(aql)

```

	month	day	climate_variable	climate_value
1	5	1	ozone	41
2	5	2	ozone	36
3	5	3	ozone	12
4	5	4	ozone	18
5	5	5	ozone	NA
6	5	6	ozone	28

Long- to wide-format data: the cast functions

Whereas going from wide- to long-format data is pretty straightforward, going from long- to wide-format data can take a bit more thought. It usually involves some head scratching and some trial and error for all but the simplest cases. Let's go through some examples.

In `reshape2` there are multiple `cast` functions. Since you will most commonly work with `data.frame` objects, we'll explore the `dcast` function. (There is also `acast` to return a vector, matrix, or array.)

Let's take the long-format `airquality` data and `cast` it into some different wide formats. To start with, we'll recover the same format we started with and compare the two.

`dcast` uses a formula to describe the shape of the data. The arguments on the left refer to the ID variables and the arguments on the right refer to the measured variables. Coming up with the right formula can take some trial and error at first. So, if you're stuck don't feel bad about just experimenting with formulas. There are usually only so many ways you can write the formula.

Here, we need to tell `dcast` that `month` and `day` are the ID variables (we want a column for each) and that `variable` describes the measured variables. Since there is only one remaining column, `dcast` will figure out that it contains the values themselves. We could explicitly declare this with `value.var`. (And in some cases it will be necessary to do so.)

```
> aql <- melt(airquality, id.vars = c("month", "day"))
> head(aql)
```

	month	day	variable	value
1	5	1	ozone	41
2	5	2	ozone	36
3	5	3	ozone	12
4	5	4	ozone	18
5	5	5	ozone	NA
6	5	6	ozone	28

```
> aqw <- dcast(aql, month + day ~ variable) # [a]ir [q]uality [w]ide
```

```
> aqw <- dcast(aql, month + day ~ variable, value.var = "value") # same thing
> head(aqw)
```

	month	day	ozone	solar.r	wind	temp
1	5	1	41	190	7.4	67
2	5	2	36	118	8.0	72
3	5	3	12	149	12.6	74
4	5	4	18	313	11.5	62
5	5	5	NA	NA	14.3	56
6	5	6	28	NA	14.9	66

```
> head(airquality) # original data
```

	ozone	solar.r	wind	temp	month	day
1	41	190	7.4	67	5	1
2	36	118	8.0	72	5	2
3	12	149	12.6	74	5	3
4	18	313	11.5	62	5	4
5	NA	NA	14.3	56	5	5
6	28	NA	14.9	66	5	6

So, besides re-arranging the columns, we've recovered our original data.

If it isn't clear to you what just happened there, then have a look at Figure 1.

dcast formula `dcast(aql, month + day ~ variable, value.var = "value")`

ID variables (left side of formula)		Variable to swing into column names (right side of formula)		Values (value.var)		
Long-format data	month	day	variable	value		
	5	1	ozone	41		
	5	2	ozone	36		
	5	3	ozone	12		
	5	4	ozone	18		
	5	5	ozone	NA		
	5	6	ozone	28		
Wide-format data	month	day	ozone	solar.r	wind	temp
	5	1	41	190	7.4	67
	5	2	36	118	8.0	72
	5	3	12	149	12.6	74
	5	4	18	313	11.5	62
	5	5	NA	NA	14.3	56
	5	6	28	NA	14.9	66

Figure 1: An illustration of the `dcast` function. The blue shading indicates ID variables that we want to represent individual rows. The red shading represents variable names that we want to swing into column names. The grey shading represents the data values that we want to fill in the cells with.

One confusing “mistake” you might make is casting a dataset in which there is more than one value per data cell. For example, this time we won’t include `day` as an ID variable:

```
> dcast(aql, month ~ variable)
```

	month	ozone	solar.r	wind	temp
1	5	31	31	31	31
2	6	30	30	30	30
3	7	31	31	31	31
4	8	31	31	31	31
5	9	30	30	30	30

When you run this in R, you’ll notice the warning message:

Aggregation function missing: defaulting to length

And if you look at the output, the cells are filled with the number of data rows for each month-climate combination. The numbers we’re seeing are the number of days recorded in each month. When you `cast` your data and there are multiple values per cell, you also need to tell `dcast` how to aggregate the data. For example, maybe you want to take the `mean`, or the `median`, or the `sum`. Let’s try the last example, but this time we’ll take the mean of the climate values. We’ll also pass the option `na.rm = TRUE` through the `...` argument to remove NA values. (The `...` let’s you pass on additional arguments to your `fun.aggregate` function, here `mean`.)

```
> dcast(aql, month ~ variable, fun.aggregate = mean, na.rm = TRUE)
```

	month	ozone	solar.r	wind	temp
1	5	23.61538	181.2963	11.622581	65.54839
2	6	29.44444	190.1667	10.266667	79.10000
3	7	59.11538	216.4839	8.941935	83.90323
4	8	59.96154	171.8571	8.793548	83.96774
5	9	31.44828	167.4333	10.180000	76.90000

Unlike `melt`, there are some other fancy things you can do with `dcast` that I’m not covering here. It’s worth reading the help file `?dcast`. For example, you can compute summaries for rows and columns, subset the columns, and fill in missing cells in one call to `dcast`.

Additional help

Read the package help:

```
help(package = "reshape2")
```

See the `reshape2` website:

<http://had.co.nz/reshape/>

And read the paper on `reshape`:

Wickham, H. (2007). Reshaping data with the `reshape` package. 21(12):1–20.

<http://www.jstatsoft.org/v21/i12>

(But note that the paper is written for the `reshape` package not the `reshape2` package.)