vsolve instructions

Visualizing Vectors on the Computer

The `vsolve` program (included in the `ISM.Rdata` workspace) lets you visualize fitting in variable space. The program displays model vectors and lets you combine them into walks in order to reach toward a target point.

Because the computer display (and our retinas!) are limited to two dimensions, it's feasible only to display 2-dimensional vectors or, with the help of perspective drawing tricks and rotation, 3-dimensional vectors. But this is sufficient to illustrate the principles that are at work: linear combinations, approximation and least squares fitting, redundancy, the direction of the residual, etc.

To use `vsolve`, you need first to set up a target vector and a set of one or more explanatory model vectors. An example shows how to do this:

```
> target = vec(3,5)
> modelvecs = mat( vec(1,-2), vec(0,1) )
```

In this example, the target vector (corresponding to the response variable) is $\begin{bmatrix} 3 \\ 5 \end{bmatrix}$ and the explanatory model vectors is the pair $\begin{bmatrix} 1 \\ -2 \end{bmatrix}$ and $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$. Note that the coordinates of each vector are brought together as arguments to the `vec` operator. To create a *set* of vectors, that is, a **matrix**, you use the `mat` vector.

Ordinarily, you would use the `lm` operator to find the linear combination of `modelvecs` to get as close as possible to `target`. You could do that with a statement like this:

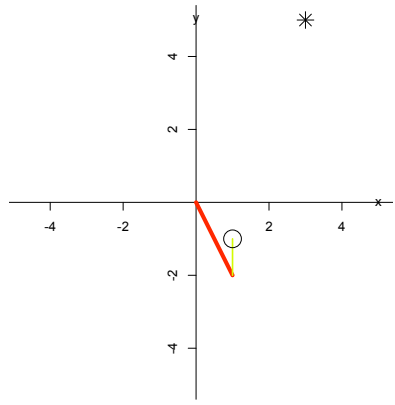
```
> lm( target ~ modelvecs -1)
Coefficients:
modelvecs1  modelvecs2
         3          11
```

The coefficients tell us that the closest point to the target is reached by a linear combination of $3 \times \begin{bmatrix} 1 \\ -2 \end{bmatrix} + 11 \times \begin{bmatrix} 0 \\ 1 \end{bmatrix}$. (Note that the model design include `-1` so that `lm` does not add an intercept term to the model vectors.)

You are going to use `vsolve` in place of `lm` so that you can visualize the process of fitting and what different linear combinations of the model vectors look like. The command to give is

```
> vsolve( modelvecs, target )
```

In response, R will display a plot, like this:



The vectors are displayed as lines. They are placed head to tail, to indicate the path you would follow if you walked first along one of the vectors and then along the other: a linear combination of the vectors. The target point is shown by a $\star$. As you can see from the graph, this particularly linear combination (which has the coefficients 1 and 1, not the coefficients from the fitted model, 3 and 11) doesn't bring the walker to the target point. (If no graph is displayed on your computer, it might be that you already have a graphics window and it is too small. Dismiss the graphics window with the usual mouse-click command, and try again. A new window should open up that's the right size.)

At this point, you use the keyboard to change the coefficients and, if needed, modify the display. You can increase the length of the walk along any of the vectors (that is, increase the coefficient in the linear combination), walk backwards along the vector, zoom in and out on the display, etc.

Exactly how you use the keyboard depends a bit on what type of computer you are using.

Windows/PC Place the command console next to the graphics window. Click on the graphics window itself and make sure that the mouse cursor stays over the graphics window. Then press individual keys as indicated by the table below.

Macintosh, Linux, and others Place the command console next to the graphics window but click on console window. You will see a prompt:

```
> vsolve command:
```

You type each command (typically a single character) followed by ENTER.

Any command that you give applies to what might be called the **active vector** in the display, which is the vector drawn with a heavy line.

PC	**Walking Commands**	Mac
→	Walk farther along the active vector	.
←	Don't walk as far along the active vector	,
↑	A gentler version walking farther.	>
↓	A gentler version of less far.	<
f	Flip the vector (i.e., walk in the negative direction).	f
n	Make the next vector the active vector.	n
	Change the Display	
z	Zoom IN on the display	z
s	Zoom OUT on the display	s
r	Show the residual vector.	r
PC	**Print Information**	Mac
x	Show in the command console the coefficients that correspond to the current walk.	x
L	Show the length of the residual vector. Press L repeatedly to toggle this on and off.	L
	Automatic Fitting	
b	Give a hint about what the best-fitting walk looks like by changing the current coefficients to be half-way to the best coefficients.	b
B	Show the walk corresponding to the coefficients that give the best fit.	b

	3-D display	
	`vsolve` will work for 3-dimensional vectors, that is, those with 3 components. All the vectors given to `vsolve` must have the same number of components, either 2 or 3.	
`t` or `T`	Rotate the display around a vertical axis.	`t` or `T`
`p` or `P`	Rotate the display around a horizontal axis.	`p` or `P`
`c`	Rotate the display so you are looking down the current active vector.	`c`
`C`	Rotate the display so you are looking down the residual vector.	`C`
F1	Toggle on/off a display of a grid along the x-y plane. Projections of the vectors onto that plane are also shown.	`a1`
F2	Toggle on/off a display of a grid along the y-z plane.	`a2`
F3	Toggle on/off a display of a grid along the x-z plane.	`a3`
	Finished?	
`q`	Quit.	`q`