Advanced R Programming for Bioinformatics.

Exercises for session 8: Interfacing to C.

1. The files `nnfind.c, bin_heap.c, bin_heap.h, item.h` implement an algorithm based on k-d trees for finding nearest neighbours. Write an R interface to the functions in `nnfind.c`:

```
void within_neighbours(const double *X, int *pNx, const int *pp,
                int *neighbours, double *dists)
```

and

```
void between_neighbours(const double *X, int *pNx,
                        const double *Y, const int *pNy, const int *pp,
                        int *neighbours, double *dists)
```

In these functions `X` and `Y` are matrices of points in p-dimensional space, `*pNx` is the number of rows in `X, *pNy` is the number of rows in `Y, *pp` is the dimension of the space (number of columns in `X` and `Y`), neighbours is used to return the row number of the nearest neighbour (from 0 to (n-1)) and dists returns the distance to the nearest neighbour.

The difference between the two functions is that `within_neighbours` finds the nearest neighbour in X of each point in X and `between_neighbours` finds the nearest neighbour in X of each point in Y. This means that `neighbours` and `dists` have length `*pNx` in `within_neighbours` and `*pNy` in `between_neighbours`.

The row numbers returned are C row numbers from 0 to (n-1); you need to add 1 to get R row numbers.

Test the code by drawing a scatterplot and connecting each point to its nearest neighbour (with `segments()`). A nice data example is `data(faithful)`

2. A `box-car' filter is a simple smoother; on a scatterplot of (X_1, Y_1), (X_2, Y_2), … (Y_n, X_n), it provides a smooth line illustrating how Y changes with X. Formally, for given radius *r*, at point *x* it is evaluated as;

$$Y_{smooth}(x) = \frac{\sum_{i:|X_i - x|<r} Y_i}{\sum_{i:|X_i - x|<r} 1},$$

in other words, it is the average of the Y's that have X's within *r* of *x*. Typically, we evaluate the box-car filter at x=X_1, X_2, … X_n.

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In R, one simple way to implement the box-car filter is the following;

```
boxcar <- function(Y, X, radius, n=length(Y)){
     y.smooth <- rep(0,n)
     x <- 0
     for (i in 1:n){
          count <- 0
          x <- X[i]
          for (j in 1:n){
               if(abs(X[j]-x)<radius){
                    count <- count+1
                    y.smooth[i] <- y.smooth[i] + Y[j]
                    }
               }
          y.smooth[i] <- y.smooth[i]/count
     }
     y.smooth
}
```

Try this code, for n=1000 data points, and then n=10,000. What takes the time? Code this approach in C, and see how much faster it becomes.

For keen people; a preliminary sort of the data enables you to implement this filter without the double loop; think of 'sliding' a window of radius r along the sorted X values. Implement the filter using this observation, and see what speed improvement you can achieve.