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 * HOMEWORK #8
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/***** [ INSTRUCTIONS TO RUN CODE ] *****/

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OPTION #1: RUN WITH RSTUDIO

This option assumes R and RStudio are installed in device: Double click hw7code.Rproj. After opening, click "Source" Button on top to run

OPTION #2: WITHOUT RSTUDIO

The hw7code is the source code to run the program in any R compiler or environment. Copy & paste or open in a different environment and run code.

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/***** [ HIGH LEVEL PROGRAM DESCRIPTION && HOMEWORK ANSWERS] *****/

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This program will simulate a quantum walk algorithm for SEARCHing. We will use the algorithm found in class as described here:

$$(2uu_{\text{dagger}} - I) * (I - 2(e_{\text{hat}}_w)(e_{\text{hat}}_w_{\text{dagger}}))^t * u$$

where  $u$  is a vector with values  $(1, \dots, 1) / \text{rad}(N)$  and  $e_{\text{hat}}_w$  is the unit basis vector for initial vector  $u$ .

First we create the  $u$  vector and fill it with the above values. We then create the identity matrix  $I$ . From there, we find the unit basis vector for  $u$  at  $w$  in  $N$ . After finding these things, we do the above equation to come up with an appropriate  $\psi$  value and plot:

$$|e_{\text{hat}}_w_{\text{dagger}} * \psi_t| ^2$$

For  $t$  in  $\{0, 1, \dots, 50\}$ . We run a loop for this and put the results in a vector  $p1$  and then plot the results of that vector.

The second half of this program involves having multiple  $w$  values in  $W$  where  $W$  is a subset of  $N$  with  $k$  elements. We adjust the equation for  $\psi$  but adding a summation so that the second value shown previously becomes the following:

$$I - 2 * \text{SUM}(\text{for } w \text{ in } W)[e_{\text{hat}}_w * e_{\text{hat}}_w_{\text{dagger}}]$$

We do this for  $W$  of size  $k=4$  and  $k=16$ .

We create a loop for going through a list  $K = c(4, 16)$ . Then, following a very similar procedure as above, we find  $\psi$  and put the results in a vector to sum up the results for all  $w$  for a specific  $k$ .

[ PROBLEM 1 ]

First value of  $t$  where prob is a local max is  $t = 25$  for  $N = 1024$

[ PROBLEM 2 ]

NOTE: THIS WILL REQUIRE Unix Terminal TO RUN WITH FASTER TIME. R CALCULATES THIS VERY SLOWLY!

CODE TO RUN IN UNIX (BE IN CORRECT DIRECTORY):

```

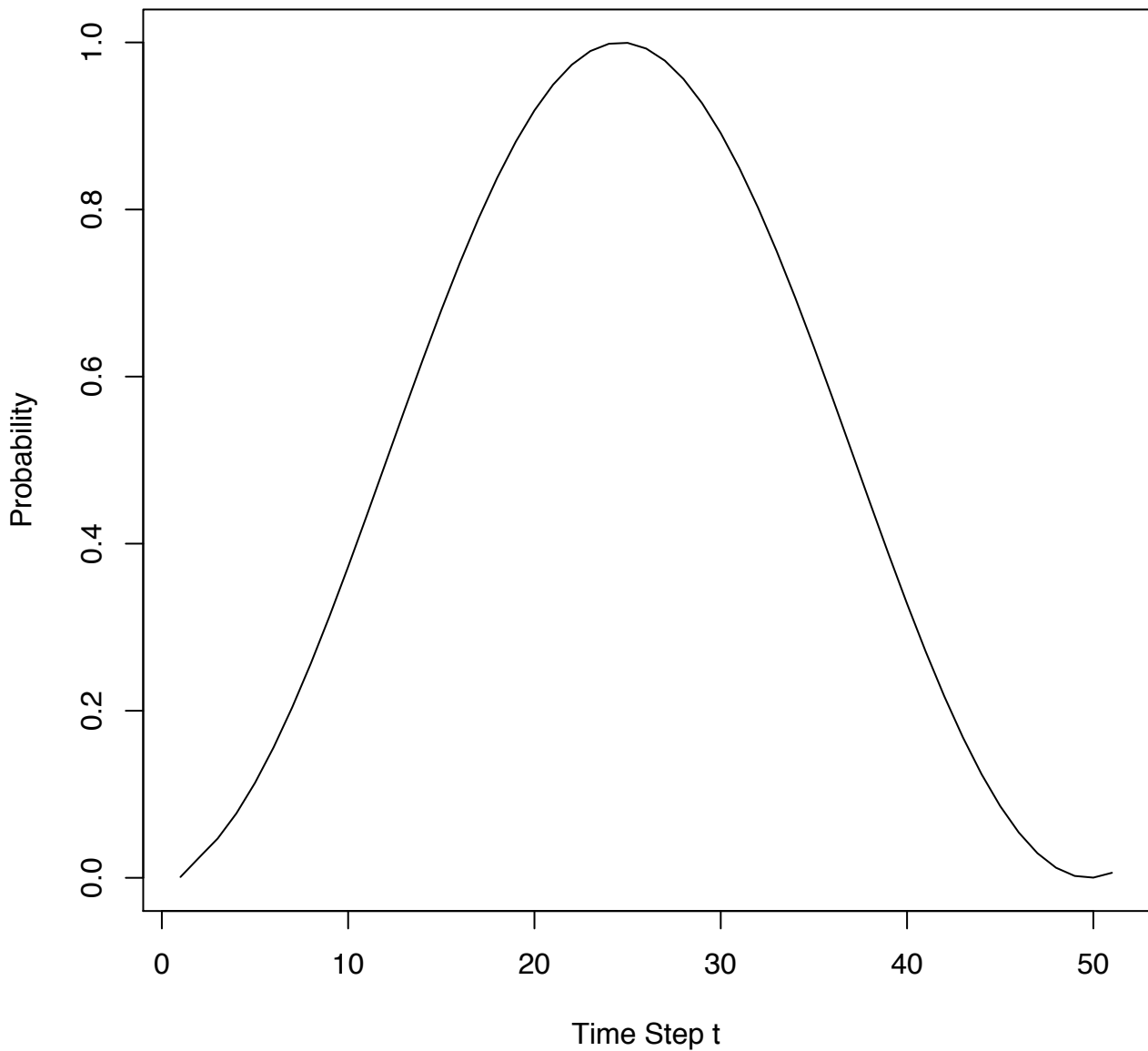
r -f hw8.R

```

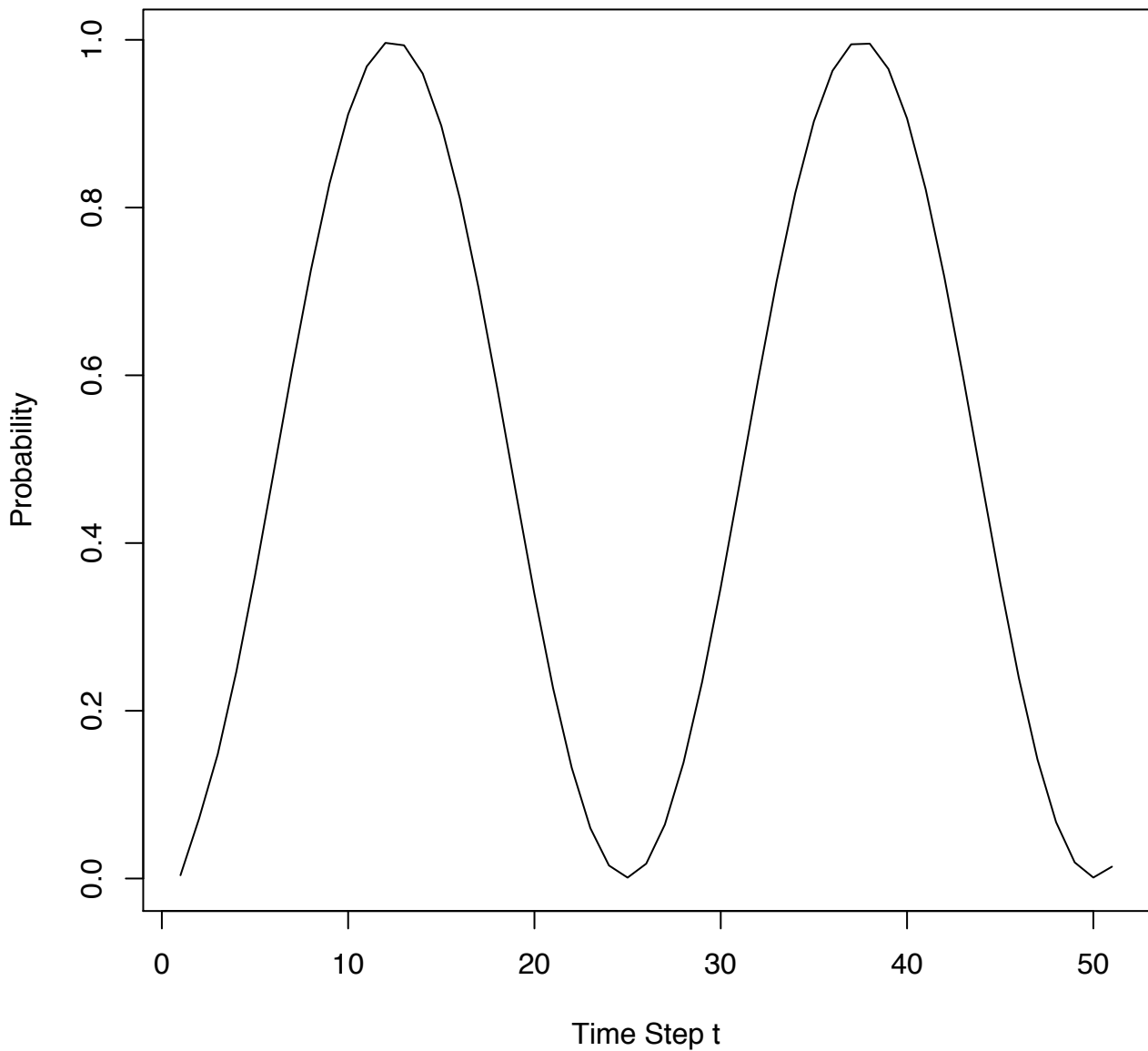
First value of  $t$  where prob is local max is  $t = 14$  for  $k = 4$

$t = 8$  for  $k = 16$

# QR walk SEARCH



# QR walk SEARCH for k=4



# QR walk SEARCH for k=16

