Plotting U vs. C_D using R and RStudio for DLC and VISF

Prepared for CPE 619 Petroleum Engineering Lab I by Stephen Johnson

For the DLC and VISF labs, you will need to plot U against C_D with C_D on a probability scale. You can use an R script called **Dispersion.R** to plot your data. You will be supplied with a zip file containing the script, example data files, and these instructions. To run the script you will need access to a PC running R and RStudio. These should already be installed on the computers in LEA 3108. R (https://www.r-project.org/) is a free, open-source statistical programming language; RStudio (https://www.rstudio.com/) is an integrated development environment that makes it easy to use R without prior experience.

Instructions

1. DO NOT EDIT **Dispersion.R**
2. Prepare your input data
   - Data to be plotted should be in a comma-separated file called **data.csv**
   - The file should contain two columns headed *U* and *C_D*
     - *U* = your calculated values for U
     - *C_D* = Concentration as % of maximum concentration
   - Save the **data.csv** file in the same directory as **Dispersion.R**. You can edit the file provided in the zip file.
3. Prepare your input parameters in a comma separated file called **parameters.csv**
   - See the example below for the format
   - The only columns that are required by the script are *Parameter* and *Value* but the other columns are a useful reminder for when you look at the data later.
   - Replace *V_p, tStar* and L with your measured/calculated values
   - Leave *lo_x, hi_x, lo_y* and *hi_y* at their default values for now. We will edit them to adjust the plot later.
   - Save the **parameters.csv** file in the same directory as **Dispersion.R**. You can edit the file provided in the zip file.

Parameter	Description	Value	Units
V_p	Pore volume	10.9	mL
tStar	Time for one V_p	3300	s
L	Core Length	30.48	cm
lo_x	Lowest value of linear C_D	0.1	
hi_x	Highest value of linear C_D	0.95	
lo_y	Lowest U to plot	-4	cm^{3/2}
hi_y	Highest U to plot	4	cm ^{3/2}

4. Make sure the two input files are in the same folder as the R script
5. Double click on the **Dispersion.R** script. It should open in **RStudio**
6. Once the file is open in RStudio, execute **Dispersion.R** by clicking on the *Source* button at the top right of the script window (Figure 1) and examine the two output plots that will be saved in

the same folder as the script (Figure 2 & Figure 3). There might be a short delay the first time the script is executed as it installs some R packages.

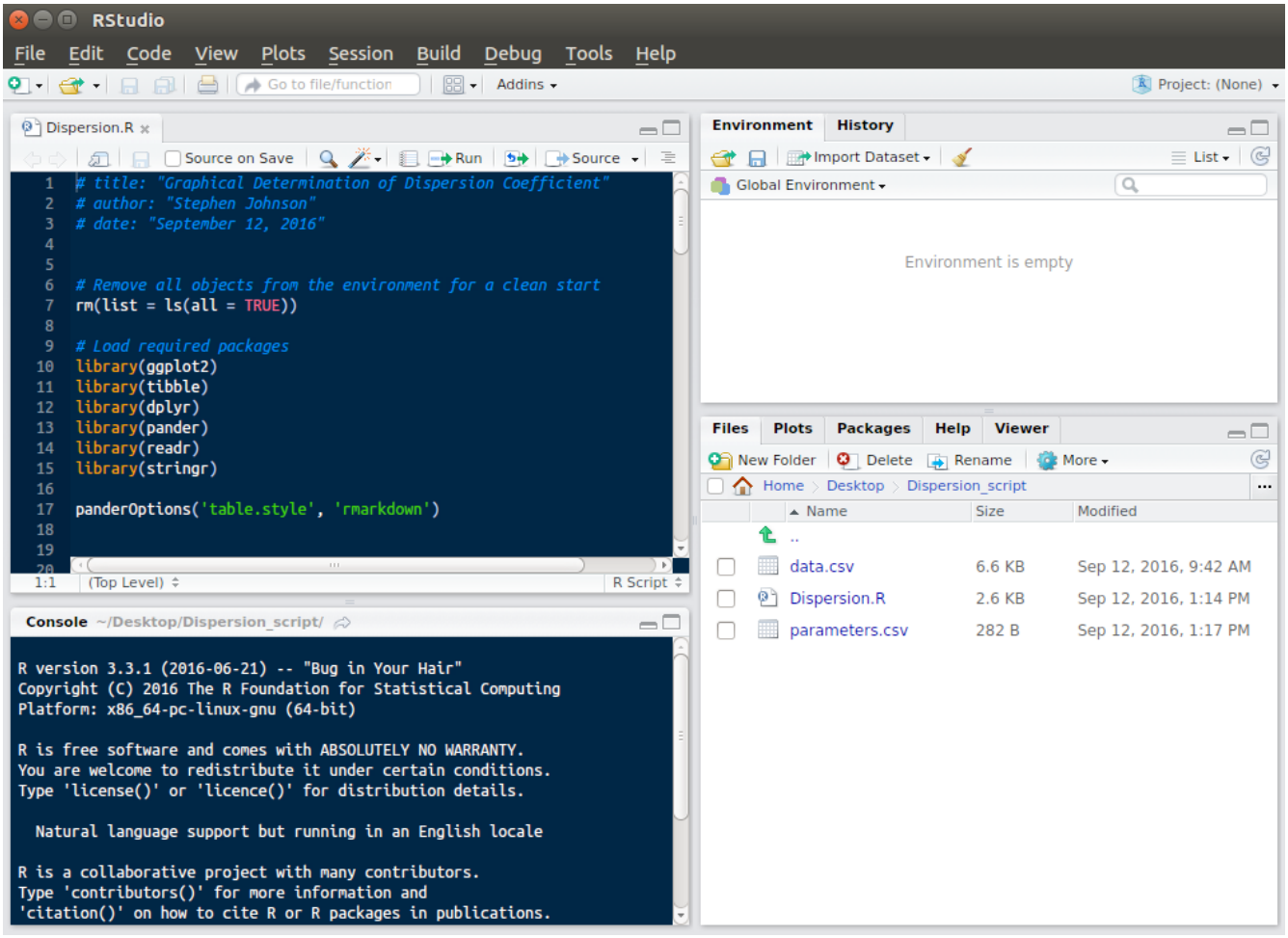

Figure 1: RStudio window with script in upper left pane. Click on Source *to run the script. Note the* **data.csv** *and* **parameters.csv** *files in the same folder as the script.*

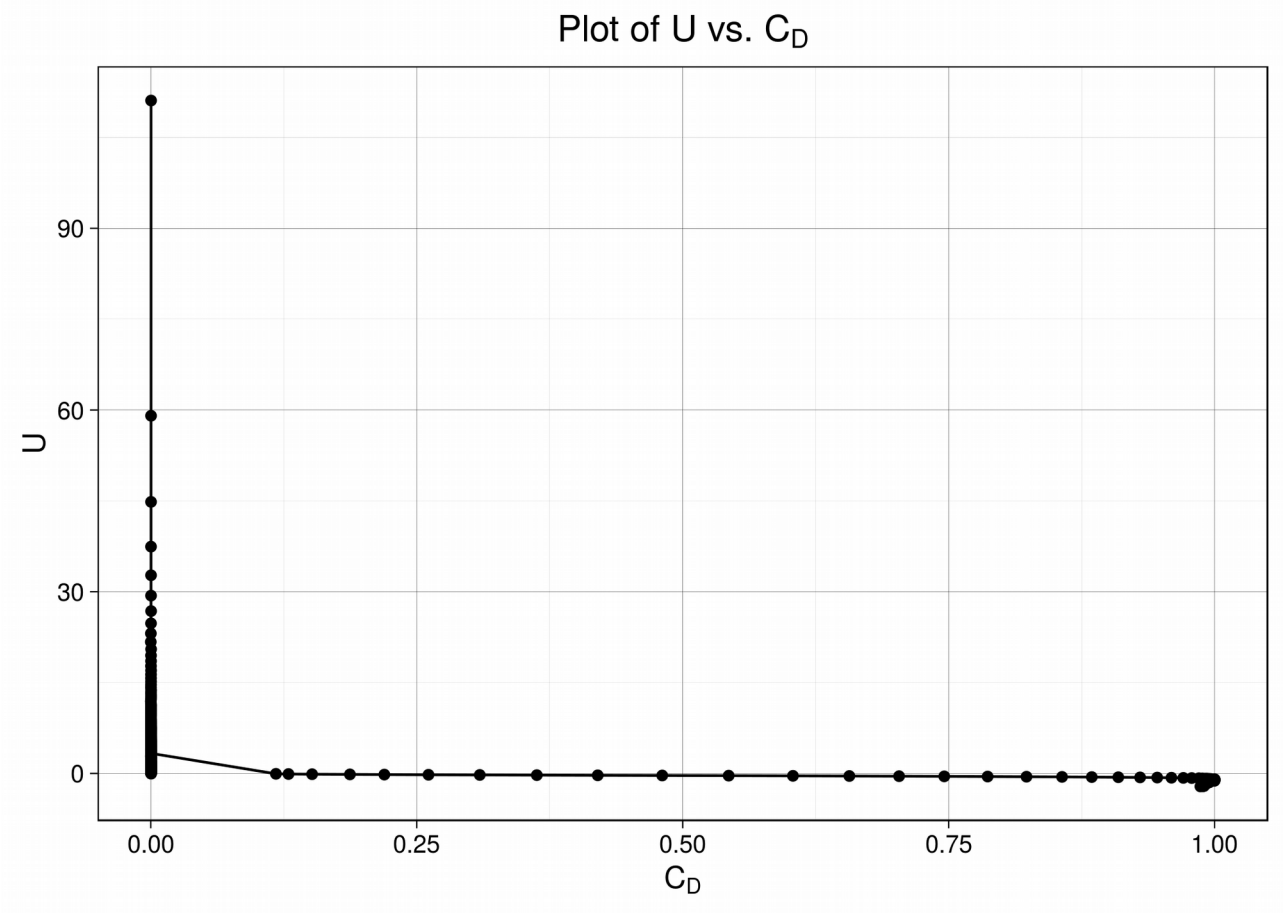

Figure 2: Overall view of the data with U plotted against C_D on a linear scale.

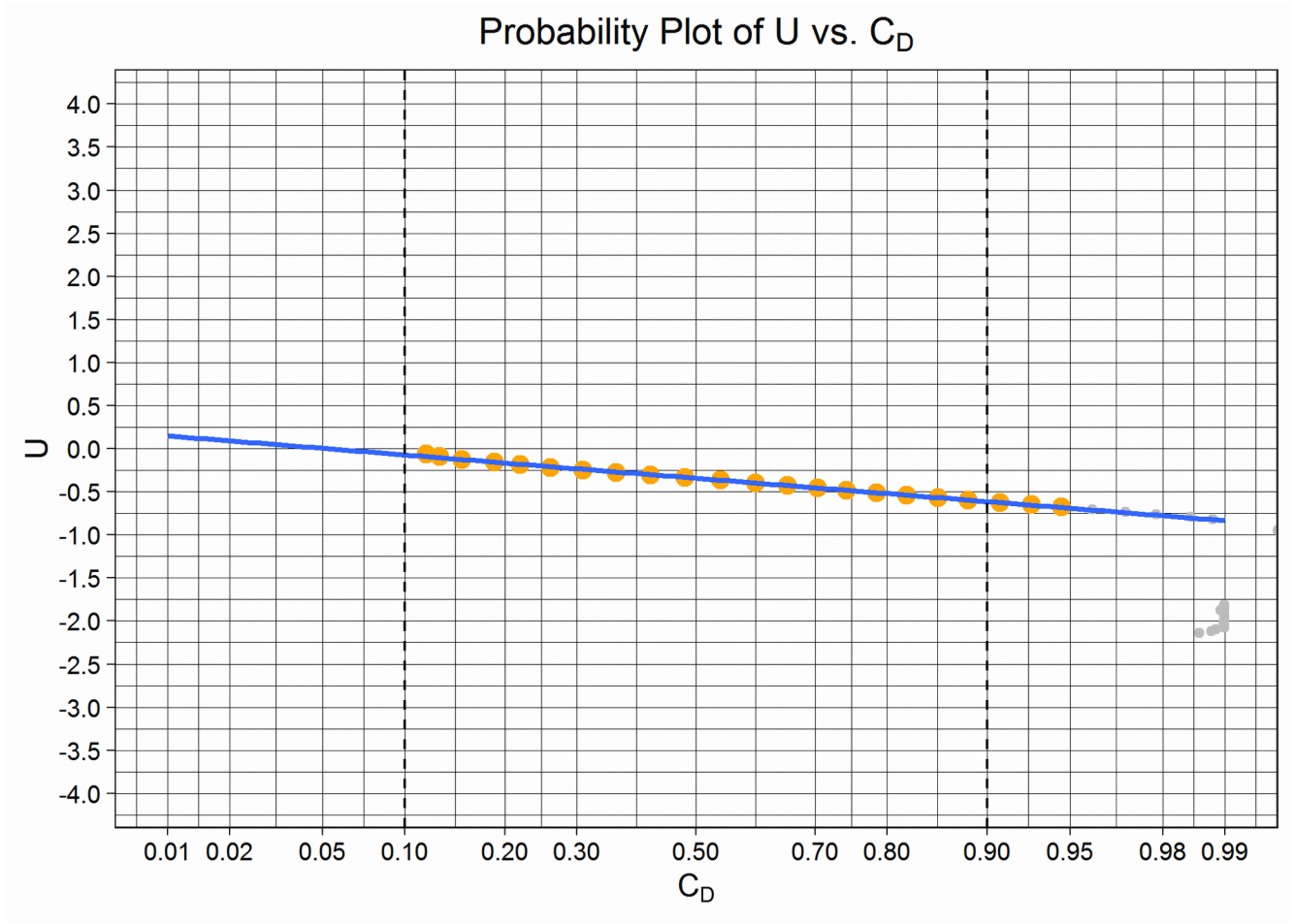

Figure 3: Probability plot of U vs. C_D with default ranges of x and y.

7. From looking at the linear plot, decide on a suitable range for the y-axis on the probability plot
    1. Edit *lo_y* and *hi_y* in **parameters.csv**
    2. Save **parameters.csv** and run the script again to regenerate the plots
    3. Repeat until you are happy with the range of U values plotted (Figure 4)

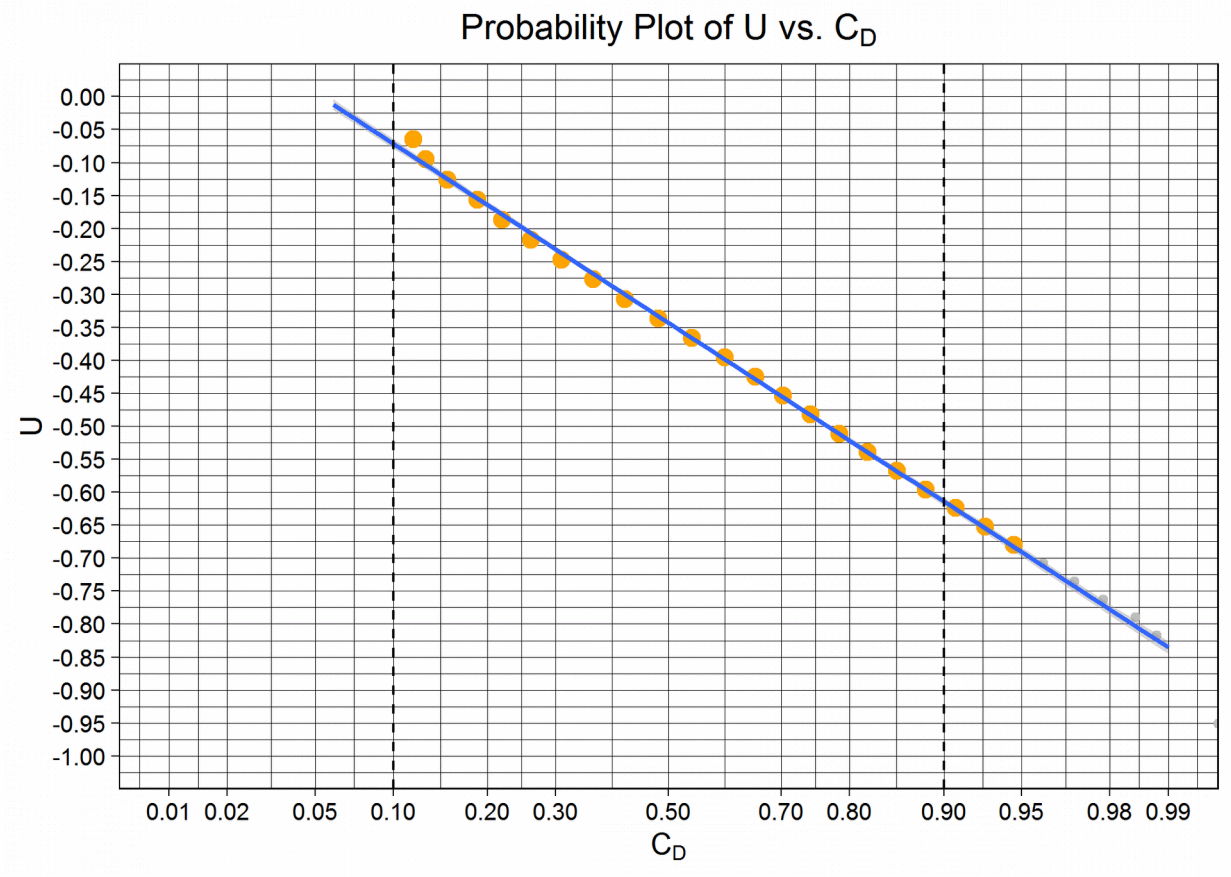

Figure 4: Probability plot of U vs. C_D with range of y-axis adjusted to encompass the linear data by editing lo_y *and* hi_y.

8. From the probability plot, decide on the range of x-values that encompass the linear portion of the curve
    1. Note that the x-axis is transformed to probability from 0-1 instead of 0-100%
    2. Typically the data will be more-or-less linear from some point to about $C_D = 0.95$
    3. Edit *lo_x* and *hi_x* in **parameters.csv,** save and run the script again
    4. Repeat until you are happy with the probability plot (Figure 5)

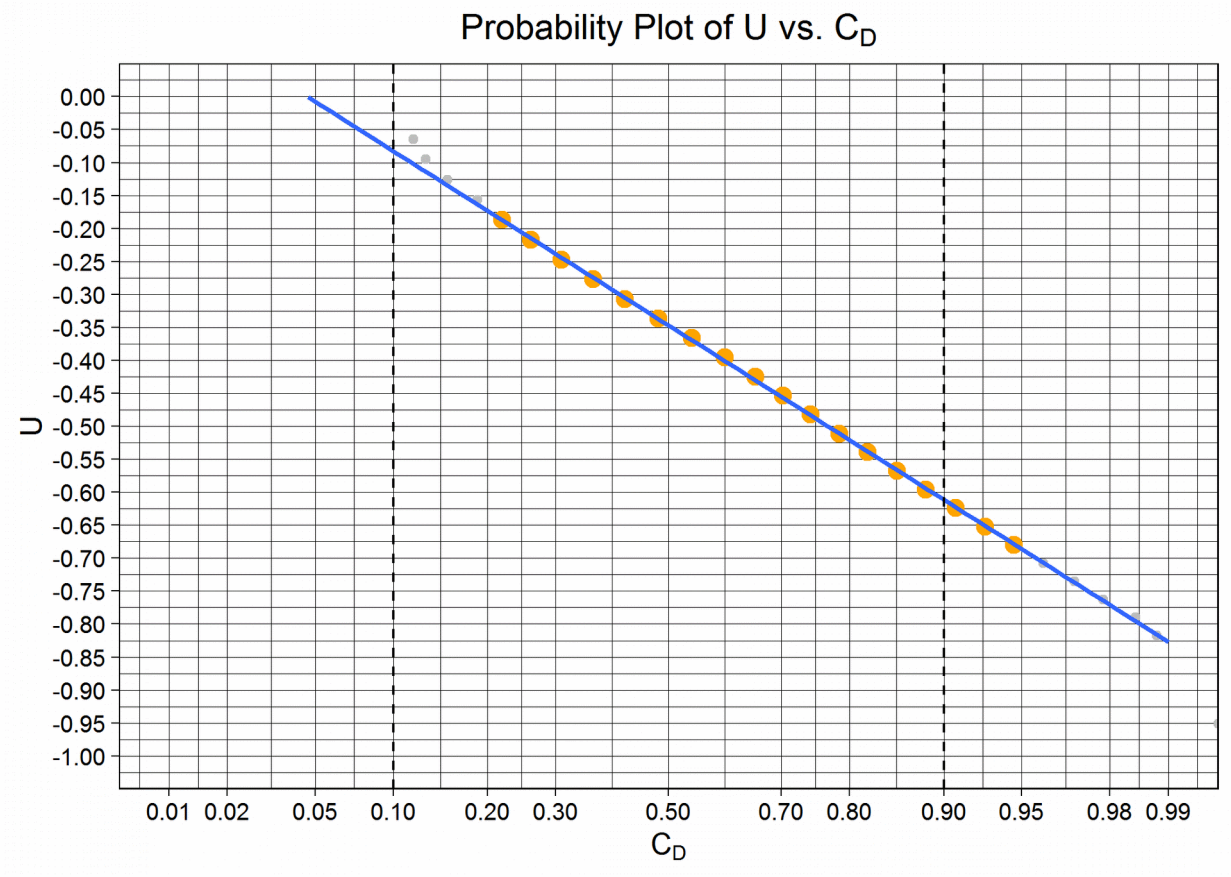

Figure 5: Probability plot of U vs. C_D with range of data used to generate the linear regression line adjusted by editing lo_x *and* hi_x.

9. In this example the final values in **parameters.csv** are below (bold values were changed from the defaults):

Parameter	Description	Value	Units
V_p	Pore volume	10.9	mL
tStar	Time for one V_p	3300	s
L	Core Length	30.48	cm
lo_x	Lowest value of linear C_D	**0.2**	cm
hi_x	Highest value of linear C_D	0.95	cm
lo_y	Lowest U to plot	**-1**	cm^{3/2}
hi_y	Highest U to plot	**0**	cm ^{3/2}

10. Save your plot and use it to read off the values of U_{10} (i.e. the U value at $C_D = 0.10$) and U_{90} (i.e. $C_D = 0.90$)
11. Use the values of U_{10}, U_{90}, V_p, tStar and L to calculate the dispersion coefficient as described in the laboratory procedure