**AC52012 Research Methods**

**Statistics Assignment: Sampling Distribution and Hypothesis Testing.**

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Disclaimer 1: All the scripts are in the script folder with same name as the name of the exercise the correspond to. Each script made under the assumption that it can run on its own, thus I repeat commands like reading the data into a data frame at every script.

Disclaimer 2: The commands that read that data from the txt files into a data frame contain the full path of the files on my personal computer. In order to run them the path needs to be changed first.

Exercise 1

1. This is the easiest part of the exercise. In order to read the txt data into a data frame we use the following command :

*ceodata=read.delim("C:/Users/Loukas/Downloads/ceo-compensation-2014.txt", header = TRUE, sep = "\t", dec = ".")*

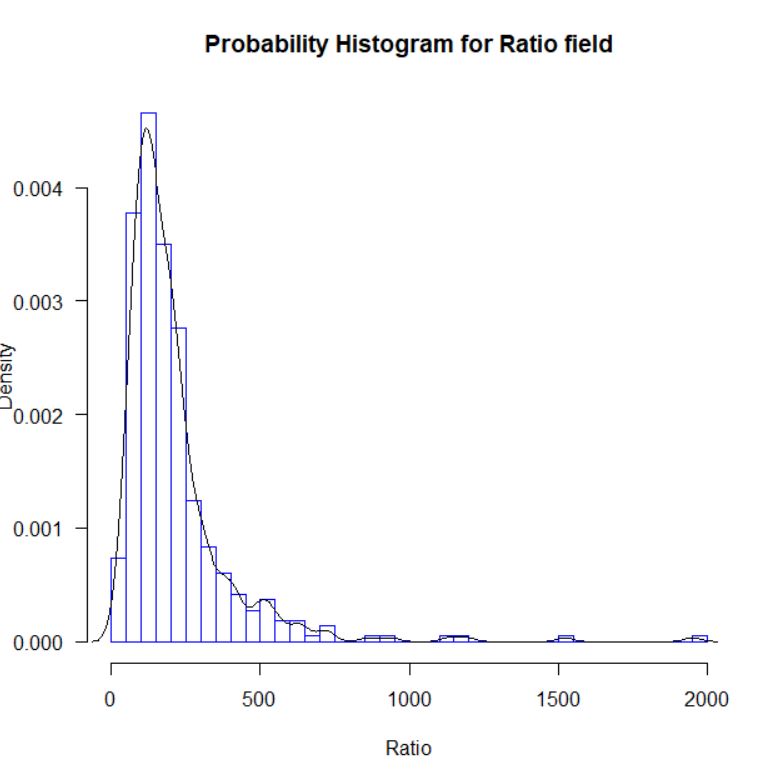
caudate is the name of our preference for the data frame. We also state that the first line is the header and contains no actual values, that values in the file are separated by tab and that decimals use “.” .

1. In order to plot the probability histogram for the Ratio fields we will use the following commands :

*hist(ceodata$Ratio,main="Probability Histogram for Ratio field",xlab="Ratio",border="blue",col="white",xlim=c(0,2000),las=1,breaks=50,prob = TRUE)*

*lines(density(ceodata$Ratio))*

The first command creates the probability density histogram for the Ratio variable while the second creates the density curve for this histogram, which is useful as we can better observe the distribution of the sample. The following screenshot depicts the histogram after executing the commands above:



By observing the distribution we can see that it approximates a normal distribution although it is a bit skewed to the right. We can also observe that there are some outliers in the sample which take extreme values of up to 2000 while the mean value appears to be much lower.

We will now repeat the same process for the Ceo\_Compensation\_($000) field:

*hist(ceodata[,7],main="Probability Histogram for Ceo Compensation field",xlab="Compensation",border="red",col="white",xlim=c(0,2000),las=1,breaks=50,prob = TRUE)*

*lines(density(ceodata[,7]))*

![Chart, histogram

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDgRXhpZgAATU0AKgAAAAgABAE7AAIAAAAHAAAISodpAAQAAAABAAAIUpydAAEAAAAOAAAQyuocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAExvdWthcwAAAAWQAwACAAAAFAAAEKCQBAACAAAAFAAAELSSkQACAAAAAzg5AACSkgACAAAAAzg5AADqHAAHAAAIDAAACJQAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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hpanN0dXZ3eHl6g4SFhoeIiYqSk5SVlpeYmZqio6Slpqeoqaqys7S1tre4ubrCw8TFxsfIycrS09TV1tfY2drh4uPk5ebn6Onq8fLz9PX29/j5+v/EAB8BAAMBAQEBAQEBAQEAAAAAAAABAgMEBQYHCAkKC//EALURAAIBAgQEAwQHBQQEAAECdwABAgMRBAUhMQYSQVEHYXETIjKBCBRCkaGxwQkjM1LwFWJy0QoWJDThJfEXGBkaJicoKSo1Njc4OTpDREVGR0hJSlNUVVZXWFlaY2RlZmdoaWpzdHV2d3h5eoKDhIWGh4iJipKTlJWWl5iZmqKjpKWmp6ipqrKztLW2t7i5usLDxMXGx8jJytLT1NXW19jZ2uLj5OXm5+jp6vLz9PX29/j5+v/aAAwDAQACEQMRAD8A+kaKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKjuJhb20szAlY0LkDvgZqSqup/8gm8/wCuD/8AoJqZO0Wyoq8kjxi5/ao8L211LA+h6uWicoSBFgkHH9+u++H3xR0D4jWkr6O0kNxDzJazgCRR68ZBH0NfOHgX4q6D4HttV0/WPCaazNLqEsqzsI/lBwNvzKT2/Wu0+Dtle698QNf8a2ujNo2kT2kiwxoCqsxIIx2PAPStIpWvurXv8v6REvxv+p9HUV8x/C/wjqXxDvPEP9p+KdYtbK01GQJDbXJBLZ7k5OMY4FdFrs2rfEH4ut4DstZu9M0bSbfNzJaviWVhgfe7Gkk3yrq9fla49Fd9F/nY96rjvCfxI07xd4o1nQ7KzuoZ9IKiWSbbtfOfu4JPbvXnnh281b4ZfGS18G3er3WraNqkJa3a8YNJEwGc7u/Ix+Ncj4M8G3njL4r+MrRNavdKsVmBuDZMFeU87RuIOMc/nSjrJW2af3ppA9Iu+6a+5n1FRXhvw21jV/C3xH1/wHqWrSX9pa27XFpdXZ3NEAcDce45yfpXnXiG9hv5dZu7fxb4j17Wbd5JFOlAxWkKjJGeDlR656Ck2lZrZq40ndp73sfS/jXxfaeB/DE2t6hbzXEELBTHBjcc/Ugdq0NB1eHX9AsdWto3jivYEnRJMblDAEA47814FrHiG/8AE37KBvdVlae6WcQtI3V8DqfzqFvh3rtl8IbPxfF4u1SLVLSxjnht1cLAkYAwuwDkheOap2hz82ya/Ile9y8u7ue3+MPGK+EILSR9I1HU/tUvlhbGLeY+nLeg5qle/EnTrH4iWPg+WyuzeXsfmJMAvlqMZwec/pXj/j7xpqWv/CfwTrK3M1rc3NwVnMEhTeQQOcHvjP41ra8c/tTeHCev2Qf+gGmotT5X3a+6NxSl7nMu1/8Ayax6noXjiHW9b1XT30nUdPXTCd91dxbIpQD1Q55FaHhvxTpniu0uLrRZvPt4J2gMmMBmXGce3NeEeHEuvEPiD4made6nfLAkchj2Tn5MEnAzkAVg/Dr4eS6t8JNa13TdZ1SHUIJJo4beK4KxZXad2Bzu/Gs4y93mf8qf3mko+9yr+Zo+raK8DvfibNN+zXa3VvO39r3QTTUO47zICFY565IBNeq/DnR7nQvh/pVlfzy3F0IQ8skrl2LNz1PsQK0cbOS7aev9L8zO+kX3/r8ytqHxH07T/iRZ+DZbO6a9vE3pOu3y1GM885/SpvHfj6w8A2Nndala3Fyt3OIEFvtyCe5yRxzXifxd1XWtG/aE0y+8M6d/aWpRWw8m28tn3/LzwpB6VzvxF8afELxHb6Vb+NfCg0a0S8Ro5vs0se5sjjLMRUU/fUPN2f8A4Fb8iqnuuXkr/hf8z6PvPHMdp4u07Qho2pzG/jEgvIocwRZ7M2eK6mvCvE2oXsP7Qng+1hu50t5LSMtCspCNx3GcGuK8ZeIftXxT1mz+I2ua7odpC7Lp66YSq7c4UkY5BHOaE9F53/Bg1Zv5fij6nmmjtoHmndY441LMzHAA9ayvDXijTPFmnSX+izefapM0IkxgMVOCRntXk+iWJ1r4Ja7Zt41/t61VHeGe3+SaFQOI3PP+TXN/Bmzh8J/CjVPHgv715oY5oRZtL/o4O5QG24+9nHOabtFy5tkk/vBXko23bsfSlFfOvh3wH4j8b+BpfG1/4v1W31e4Ek9rBBJthQKThSuOelX7b4uas37Pt5qksw/tq2uDp4nwPmfs+OmeDRL3bp7q2nrp+YR95q2z6nvdFfNuoeAvEWifB6bxXb+LtVk1K6tVnureWbMRV8EheMqRnqD2qp4p1bU0/Zj8L3UOo3SXUk2GnWZg7fOerZyaJe7ddU0vvdgj7yTWzv8Agrn07RXk2i+B7nwt4cvPEt94wvW1GewIkuL6TdbwMcHcEGPoPrXh2tar9i0Vtc8N+JvFGq6nBMDPfnMdmrbv7pH5c0StGXK+m4R95JrqfZVFfN3xY17WtV0D4e3NlqM9ldagG3vDIVyfkGSBwaq+MdF8SeA/iXoNjpHjDVJptdXZcy3DqwUlsMVXGB1JHFOzvbza+aFdcql5X+R9N0jMERmY4VRkn0FfP2jW+q/D79oGw8PQa9f6nY6lbiSZb6TedxJGR0x07V7h4i09dV8N39k80sCzQMDJC2114zwfwqZP93zx8/wKXx8r8vxOI0j416Vr3jJtA0nRdWudlwbd75IQYEYHByc5Ar0mvmD4G6DbaY/iTxPNqN//AMSKecC3EwEc4VerjHJ961/CPhTXfi1pGoeLtX8VapYyGd0sbeyl2RoF5+YY5HIqtor0u/nsLq/WyPoiivA/DHjbWdW+D/i/TNZu3k1TQxJB9qU7WcDjPHTHSnfBjwLfeIPDui+Kdb8T6tM8Mm+C0FxiIqG6Pxluc96Erya6WTv5MTdlrvdr7j3lmVELOQqqMkk8AV5J4n/aP8HeHNVexhjvNVeMlZHs1XarDqMsRn8K6j4vahcaX8J9dubMssqwBQy9QCwB/Q1z3wX8EeHYfhjpt3JptreXN4jSTzzRiQsSx9emOnHpUJOTb6K34lOyS87/AIW/zOt8D/EPQfH+mm60K4y8ePNt5BiSIn1H+FdRXEaR8PfDXgPUNW8RaNbtDNNGzsm87EAGcAen1r5y/wCE803xbcalq/i/xfr2naj5jHT7XTkPkxrztDYHI6VTkr2Xa7/4HcFF2u++h9iUV4L4d+MOpL8BNR1q6bz9S0+U2cU7jHmkgbGI/Hp7Vnw/D3xHJ8Nx45PjHVhr7QC88rzB5GOu3ZjriiXu3b2Vvx1/ImPvJW3d/wAD6KrD8V+MNG8F6O2o6/drbxZwi9Wc+gArK+Ffi6Xxr8PdO1a6AFyymObHdlJXP44z+NeZfEG0i8UftJ6BoOsgyabDbiUQMSFkJJyP0H5UTjJTVNbv/hwjJODn2/4Y2NI/ac8Hanq0dncWt/YRu20XNwilB6Z2kn9K9it7iK6t457aRZIpFDI6nIYHvXKeJPhf4S8S6L/Z13pNvbopBSW2jWN1x7gc+nNcn8Wdcn+HHw703Q/CbNb3F2/2W2kLbmjUYyee/wA1F1a3W6S87jSu99OvyPW6K+d/FngvX/hf4Zt/F+l+LdUvLy3dGvobmTfFID12rj5RmofiPrWreJviB4DOh6rcaWdVs4nYwyHClnOeOhx7imldpLvb8LivZXe1rn0dRXzHe6H4h8N/Gy38HaT4v1U2urwK1xNPIHkAJOduRgdOwrpPh4dT8H/HbUvBw1i81PTDbiVftsm91JAbOfXt6UQ963nf8NwleKflb8dj3iivmLwroGtePPiv4s0uXxNqdhpcEgMyW0+HOc7QpOdo4PSuh8CeINV8A+PPEng7VtTn1OzsrR7y0kum3OMdAT3zn9KmLTipPS6v+pUk1JpdHY98or44Xxxp3iZdR1jxV4z16x1kyObG3sUPkRr/AABgBzXoM3jzU/E/7MeoahcXMyahaSfZ2uY2KNJjo3HTrTekHLtb8Qt7yj/Wh9DUV8var4V1+z+C1l46fxfqz6lbwwyRxecBEqEqACMZJAI5JNdD8SfGPiSX4LeGtTtJbiGG+H/EyurYYdVHA57Z5py92/k0vvJj71uzTf3bn0BRXzZ8OLzRX8a6fJ4R+I9+UPFzp2uAs1wcfdQ8fXj0rb+MN/ZTeNoLDV/F+o29v5QEek6LGROXPQs4zjP06UpaW8wi738j3ckKpJOABkmsDTfGuk6z/bH9jyNe/wBkkrP5S53MFztX1PGK8N+EWrapqOueJ/B19easlh9lZoVvpM3MGPVsDk5rN+C3hGN4fFWsrquoxy6S08ccKTYjlzEw3OMckdc0npd9OW/42GtvO9v1PoXwf4rXxdpMl8ml3+mCOZovKvotjnGPmA9Oa36+dvA/jm/8M/ADW9be4kubxL+SKB55C+GIG3r29qSH4e+I5PhuPHJ8Y6sNfaAXnleYPIx127MdcVUrRu+itf5q4o3dl1bdvkz6Kor5x8e+O9Q8Tfs46brcVxLa3zTrHM8EhQllfa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iiigArn/FvhqTX7e1lsLlbTUbCYT2s7ruUMOoYd1I4PeugooA5XQvC+oR+I5fEHiW7trrUjD9nhW0jKRQpnJwGJOTxnJ7Cuqoop+QdbhRRRSAKKKKACiiigAooooAKKKKAOM8eeEtZ8U3Gm/2de2MdnayGSa0vI3aO4PGA2xgSBjpWhplh4kdZLTxA+iPpzwmPyrC3lRhnjHzORjGe1dHRSSSVg63PPB8P9bk0xfDt1q9q/hxJt4RYSLho924RFs7dv8PTOO+ea1dX8J6gmv2+t+FLu1s7xLf7NNHdxM8UsY+7kKQcjnHPc111FP8Ar9A/r9TjLb4fRN4Y1Ox1W5+0X2qSGe4ukXG2XOVKjsFOMZzwOc02y8I65eappk3irUrO6t9JO61jtYWQyOOjyFickYHTA612tFC0d1/Vtgeqt/Wu4UUUUAFFFFABRRRQAUUUUAFZ97oGkajKZb7SrG5mIx5k1sjt+ZFaFFAHDaD8NLLS/BuoaHci2Zr2V3M8EIQjJyv5ECi08G65eXelr4p1Ozu7LSWD28dtCyPK6/daQkkEjAPy45ruaKFpt5fhsD1VvX8dzir3wlrlnrmo3nhTUbK1g1QA3MN3Cz7X5BdNpGCQe+RwKLj4dQJ4RsdM0y6MN9p8wuYLyRQSZs5ZmA/vZOcepxiu1oo2Vv602Dd3OU0Xwxqf/CSf2/4ovbW6vo4fIt47OJkiiXucMSdxzzzjgV1dFFAeYUUUUAFFFFABRRRQAUUUUAcjceGNY0zWr7UPCV5Yw/2kwe6gv4ndA4AG9NhBBIABzkcCq8nw6jPhQWEd4Rqa3X25b0rnFwTy2PQ5Ix6Gu2opdB31OS0nwxqsviSPXPFd5Z3V1bwmG2is4mSNAfvMdxJLHJHXHtWY/gTXYLS80TTNWtINAvJS7I0LG4hU/eRGztxx3B716BRT/r9Rf1+hyGreC5kk0m88K3EFhe6VH5EQnjLxSRYxsYDBx34I5Aq34X8MT6TfX+q6vcx3eragw86SJNsaKv3UQHnA5PJJyTXSUU7sVlawUUUUhhRRRQAUUUUAFFFFABXEzeEdc0rxFqWpeEdRsYI9UIe5t7+FnVZAMb02kEEgDrnpXbUUrDucMPhuieD005L4nU0uvtwv2Qf8fBPLYxjByRj0NXNJ8MarL4kj1zxXeWd1dW8JhtorOJkjQH7zHcSSxyR1x7V1tFPr/Xa35C3X9d7/AJnn7+BNdgtLzRNM1a0g0C8lLsjQsbiFT95EbO3HHcHvWjq3guZJNJvPCtxBYXulR+REJ4y8UkWMbGAwcd+COQK6+ijZA9Xf+tTm/C/hifSb6/1XV7mO71bUGHnSRJtjRV+6iA84HJ5JOSa6SiigAooooAKKKKACiiigArM8SaS+u+GdQ0uKVYXu4GiEjDIUkYzitOik1dWGm07o5rVPCK6r4Ig0KW48ua3ijEVyi/ckQYDgH3qlp/hPWLzxBZ6r4uv7O6fTkK2kNnCyJuIwXbcSS2MjjA5PFdlRVX1bJsrcpwU/gfXbSTVLLw9q1paaTqkjPKksLNLAWGH8og455PzA8mrupeBdmm6OPDs8dnf6Mf8ARZZk3Iyn7yuBzgkA8Y6V2FFLZW9Pw2G9Xf1/Hc5PSfCFw15qeo+KLi3vb/UYTbSC3jKRRxYxtUHJ5xk5J5rJTwDrdxp8Gganq1pN4et5d4RIWFxIgORGzZ245xwAcd69CooWjuD1EVQihVGABgCloooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKCQoJJwB1JorjPivqFxp/wAPb1rVmRp3S3Z1OCiuwUnPbANJt20GtXqXbn4ieF7W6e3l1Mlkbazx20rxg/76qV/WujhniuYUmt5ElicZV0YEMPUEVn6ZpFhb+G4dOhtoltGhCtGFG1sjnPrXLeIZv+EJ0PSfDnhb/RZtRufs1vJIS4gBBZmGc9ADgdM44xTejt8iVqrneUV529/r/hDxLZaXqWsza1a6pBIY7i5ijSSGVADgbFUFTkdRmuSt9c8bn4WweM5PE8huVZALL7PF5MqlguX+XdnnPBFK6/r1sVZnuNFeZtqXiHw54k0L+0Ndm1KDW0fzLaWKNVt32bh5ZVQcA8fMTxWXoM/jjV/BEnieXxTJFLAXaKzFtF5UqKT987d2SP7pHSntdvpuG9rddj2CivJdZ+Jqam+gWkWuweGIdTshfXF9MyKyDHCJ5gKk5I6g8ZqonxFuodJ8U6bp3iWDXJ9P083dnqsPls3ORtcKNmQVz06EUS929+l/w3CPvNW62/HY9loryr+0vFmgt4b1W/119RTV51guLF4Y1iiLIzAoQobgrjknrVKDxPqGpapfR6l46PhrWIrtooNHuooUicBsJ99d7hhg5Vu5xim1Z27f8D/MX2eb+uv+R7FUF5eW9hatcXsywwrgF3OAMnA/WuC8X67d2V9Baap4ttfDkAthIs1u8Rmupe6qkgb5Rx2yc1xuqa1q3jH4M3E15qd1BNZapHbtJ5CI9wBcKql1Zflbo2AByPTipv2/rWxSWqT6/wCVz2xNStZL4WaOxnMQmA8tsbTnB3Yx26ZzVquA0jVdT07xxHo13qc15ZwaLHcMZY0DM5Z8sdqjsAPwrMs7/wAU+IPDNz4ysPEEtrEoaa10tIIzC0a84clS+SPRhzTbS9Nfza/QlJv8PxVz1KivLf8AhIfEHi3xNolppOqvo9nf6Qt3cGGJGdH3N93epHbHOeK6LwBq2qXi6vputXX2240u9a3F0yhWlXAILBQBn6AU7P8AP8Hb8w6X/rVXOwooopAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFZ+u6NbeIdDutLvt3k3MZRivVcjqPcVoUUmrqzGnZ3OCEXxFsdPfSbW20i7RB5cOpy3bRuE6BjDsIyB/tVHP8NZLXwvZQ6ZfCbWbC5N7HdXAO2aY53bhk7Q2WHfGe9eg0U/Pr3F5dDgo/DfiPxD4gt9X8UxWVidPgeO2tbSdpg7uMF2cquOg4wenWqkXgLV0+DUXhYtbf2gnl5PmHy/ldWPOM9Ae1ekUUrK1v63uNN3ucX4k8L3+oal4bvIDCItJ3G43OQTmPb8vHPP0riPAtr401P4df2XpyaedOu5JFF9LOyy26FuVEe0hvruHWvayAQQRkHqKhtLO2sLcQWNvFbwqciOJAqj8BT732YdFbp/X6nCah4BudIl0e+8JwWdzcaZaiya2vTsSeLH94BtpyAeh6Ypbvw/4q13wtr1pqdtpGnyXtu0FraWpLhSR95pdqk5PbbxivQKKJe8mn1/UI+6010t+BxmueFNR1HSfDVvbNAJNMu45pyzHG1Y3U445OWHpWX4k0Hxjr9jfaLeaXod1a3RKLqhnaOWND0bythyy5/v8AOO2a9Hooerd+rv8Al/kJe6kl0/r9TzaTwf4h0XxMdQ0W20/WI57KK1c385iaApu+ZcI2c7unHQVRtfh34lh8Ea7otxPZT3N1fi9tpwxUSN5okIZcHbyMdTXq9FD1/rzv+Y1pa3l+Ct+RxOleG9YfxjHrWsQ2sKNpKWcsUMxkw6s5OCVGRhhWXF4W8XaTo114V0ePTn0aYlIb6Sdlmt426r5W0hiBxncK9Koosn/XncV3/XkrHGaR4Lm0XxZpl1bOjWFjpK2WWb52cMTnHoc+tXvC+gXmj6xr9zdmIx6hemeHYxJC4A544NdLRTu739fxd/zDpb+tFYKKKKQBRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQB//Z)

We can observe that the distribution is similar of that of the ratio field. It approximates a normal distribution and is a little skewed to the right. Moreover there seem to be some outliers.

1. In this step, we need to calculate the mean, the standard deviation, the median and the variance of the CEO compensations and ratios. To do so we will use R’s built-in functions mean(), median(), sd() and var().

The results are shown in the table underneath:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mean | Median | Standard Deviation | Variance |
| Ratio | 207.9101 | 160 | 185.4684 | 34398.54 |
| CEO Compensation | 1409.802 | 1193.335 | 1131.589 | 1280495 |

These built-in functions of R are based on the following mathematical equations:

Mean:



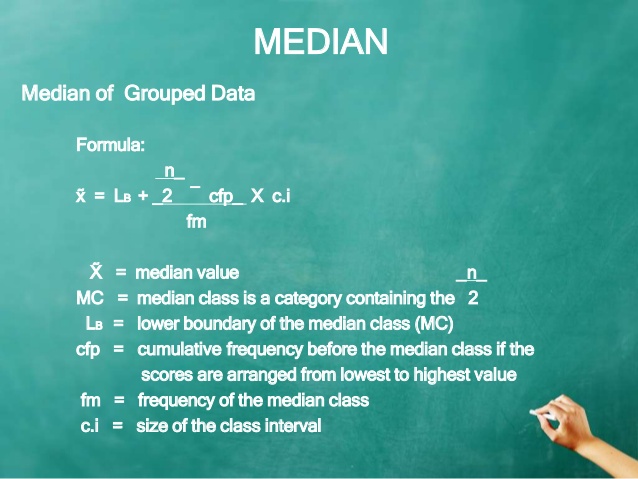
Variance:



Standard Deviation:



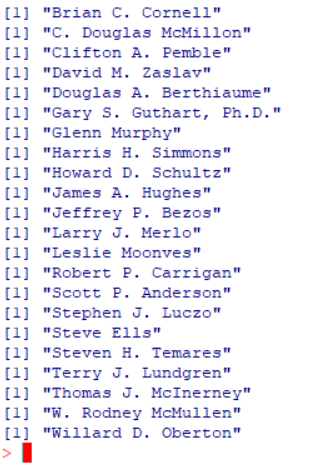
Median:

 Source: SlideShare.com

1. There are many different methods to find outliers. None is perfect because there is no standard mathematical definition of what an outlier is. Moreover, if a value is an outlier or not depends on the context of our analysis. As a result, we will call the outliers as potential outliers in our example.

In any case, in order to find the potential outliers of our variable we will make a custom R function that uses the Percentiles method. If a value is lower than the lower bound which is the 0.025 percentile or higher than the higher bound which is the 0.975 percentile it is considered a potential outlier. In casual terms, if a value is higher than 97.5% of the values or lower than 97.5% of the values then it is considered a potential outlier.

After executing the 1d.R script we get the output of potential outliers which is the following:



1. In theory we know that the median is a resistant measure(is not affected by outliers that much), while the standard deviation and mean are non-resistant(they are greatly affected by outliers). We suppose that this is also the case with our dataset. In the next step we are going to see how they differ after removing the outliers and verify it.
2. In this step we will create a function called RmOutliers. This function takes a data frame and returns a subset of it, without outliers in the columns of Ratio and CEO\_Compensation($000).

After running the script 1f.R, we will again calculate the mean(),median(),sd() and var() but not for the ceodata data frame but for the no\_outliers one which is the result of the RmOutliers function. The results are shown in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Mean | Median | Standard Deviation | Variance |
| Ratio | 184.783 | 158 | 108.012 | 11666.59 |
| CEO Compensation | 1299.088 | 1183.802 | 626.1005 | 392001.8 |

We see that without the outliers the means as well as the standard deviation and variance saw a significant change. The median saw only a minor difference. These changes are expected. Standard Deviation and Mean are known to be non-resistant and are greatly affected by outliers while median is resistant and outliers have only a minor effect on it. We can confirm this from our example.

Exercise 2

1. Since the structure of the txt file is the same as in exercise 1, we use the same command as in 1a to read the data into a data frame, with the only difference being the data frame name which we set as salmondata.

*salmondata=read.delim("C:/Users/Loukas/Downloads/farmed-salmon.txt", header = TRUE, sep = "\t", dec = ".")*

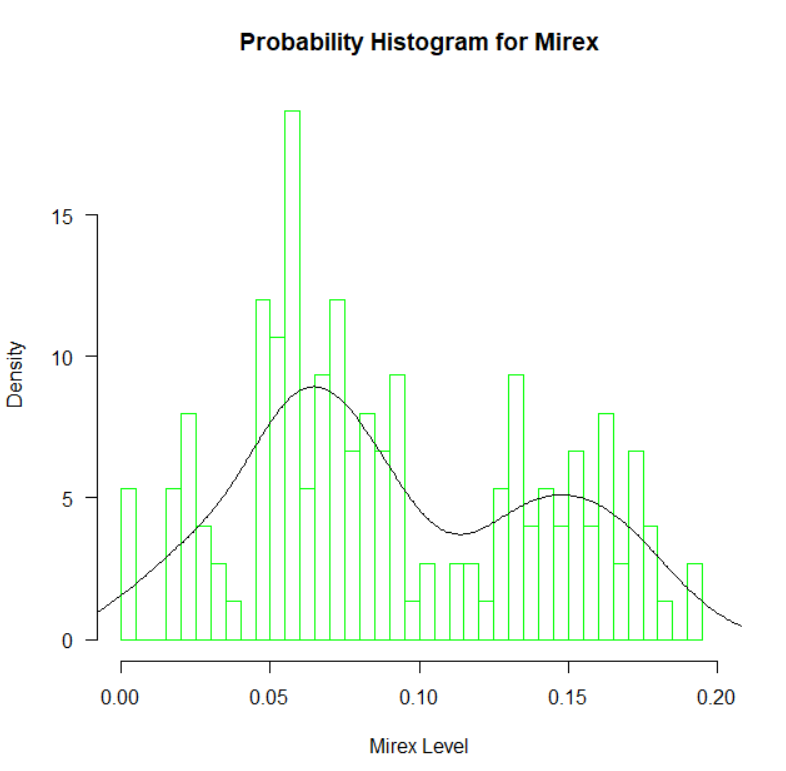
1. The process we follow is the same as in 1b exercise. We execute the commands:

*hist(salmondata$Mirex,main="Probability Histogram for Mirex",xlab="Ratio",border="green",col="white",xlim=c(0,0.2),las=1,breaks=50,prob = TRUE)*

*lines(density(na.omit(salmondata$Mirex)))*

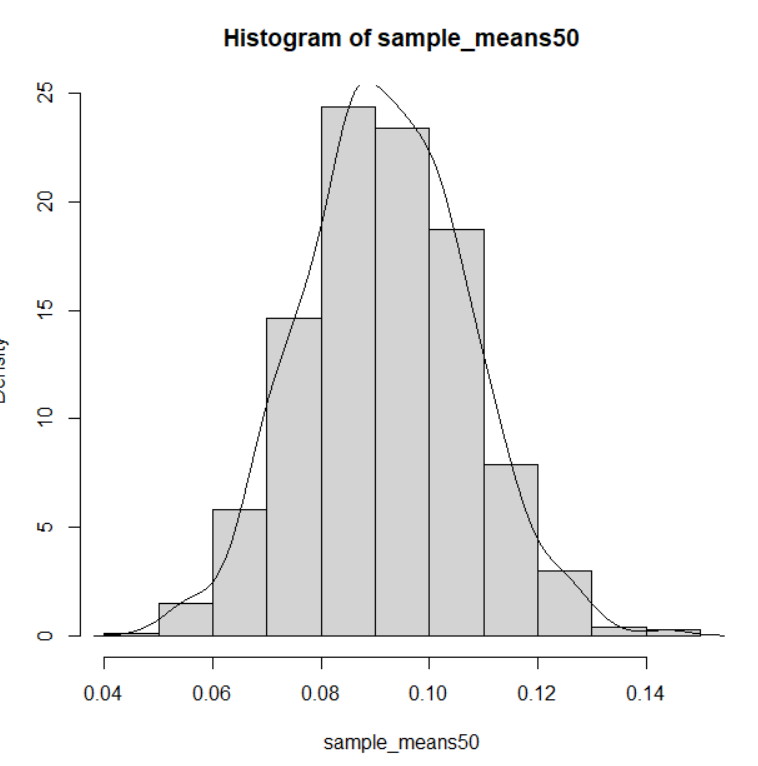
Since the values are smaller, we need to change the x-axis limits as well as modify the lines command in order to draw the density curve despite the missing values.

The screenshot of the probability histogram is:



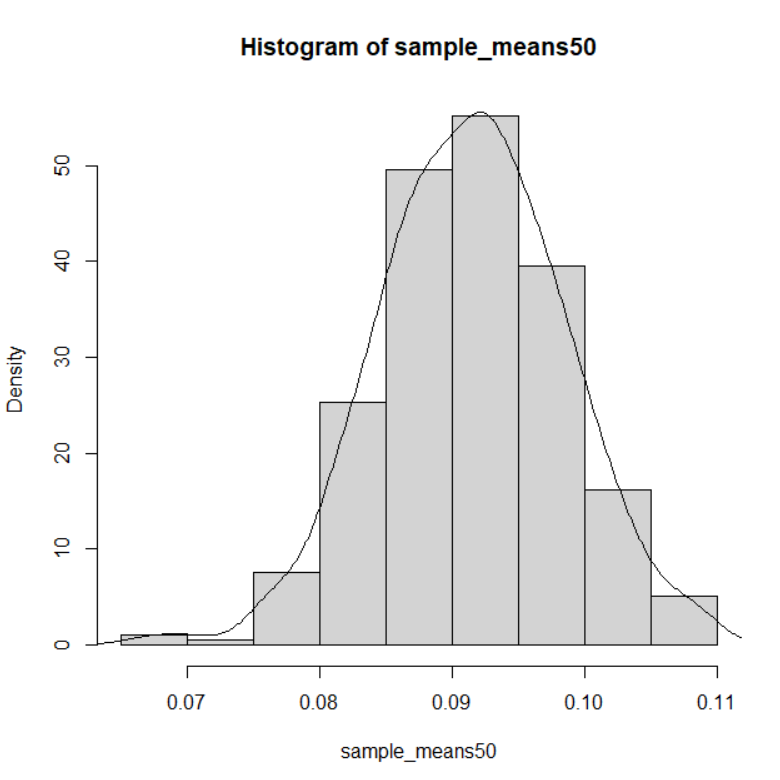
We can observe that our histogram has two distinct peaks, thus we have a bimodal probability distribution.

1. We use the sample function from R in order to get 10 random samples of Mirex. Since we must repeat this process 1000 times, we create an empty array of 1000 spaces where we will store the sample means and then loop through 1:1000 in order to fill the array. Finally, we make a histogram of the sample means as well as their density curve which we can see in the following screenshot:



We can see that the probability distribution’s shape is starting to look like that of a normal distribution.

1. We repeat the same process as in step C, but this time our sample size is 40. According to the Central Limit Theorem, for sample sizes n>30 we know that no matter the probability distribution of the sample, the sample means distribution approximates a normal distribution. Let us see our histogram for sample size n=40:



For sample size n=40 we can confirm the Central Limit Theorem, as our distribution approximates that of a normal distribution.

1. We will conduct a two-tailed hypothesis test of population mean with unknown variance with the method of critical values. To do so, we have to first calculate the critical values using R. The null hypothesis is that the population mean is equal to 0.08. If the t-statistic of our population means is between the critical values, then we cannot reject the hypothesis. If not, then we can reject the null hypothesis. The R script with the calculations can be found in the 2e.R file. The equation of the t-statistic is:     ¯x− μ0
   t = s∕√n--
   .

First, we calculate the standard deviation and the sample mean and afterwards the t-score. The t-score is 2.83. The critical values are +1.97 and -1.97. The t-score is not between the critical values, so we can reject the hypothesis that the Mirex mean level for the whole population of salmons is 0.08.

Disclaimer: During the calculations in R, I had some unexpected input errors. In order to not waste I used the variables upper and lower to help me do the calculations.