Transformation of Expression Ratio

MBI401-High throughput Data Generation & analysis

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Transformations of the expression ratio

- The expression ratio is a relevant way of representing expression differences in a very intuitive manner.
- For example, genes that do not differ in their expression level will have an expression ratio of 1.

Transformations of the expression ratio

However, this representation may be unhelpful when one has to represent up-regulation and down-regulation.

For example, a gene that is up-regulated by a factor of 4 has an expression ratio of 4 (R/G = 4G/G = 4).

However, for the case where a gene is down regulated by a factor of 4, the expression ratio becomes 0.25 (R/G = R/4R = 1/4).

Thus up-regulation is blown up and mapped between 1 and infinity, whereas down-regulation is compressed and mapped between 0 and 1.

$$Up-regulation \xrightarrow{mapped} [1,\infty]$$

$$Down-regulation \xrightarrow{mapped} [0,1]$$

- To eliminate this inconsistency in the mapping interval, one can perform two kinds of transformations of the expression ratio, namely, inverse transformation and logarithmic transformation.

Inverse or reciprocal transformation

However, this method also has a problem in that the mapping space is discontinuous between –1 and +1 and hence becomes a problem in most mathematical analyses downstream of this step.

$$Fold\ change = \begin{cases} T_k & if\ T_k \geq 1 \\ -1/T_k & if\ T_k < 1 \end{cases} \quad e.g.: \quad Fold\ change = \begin{cases} 4 & when\ T_k = 4 \\ -4 & when\ T_k = 0.25 \end{cases}$$

Logarithmic transformation

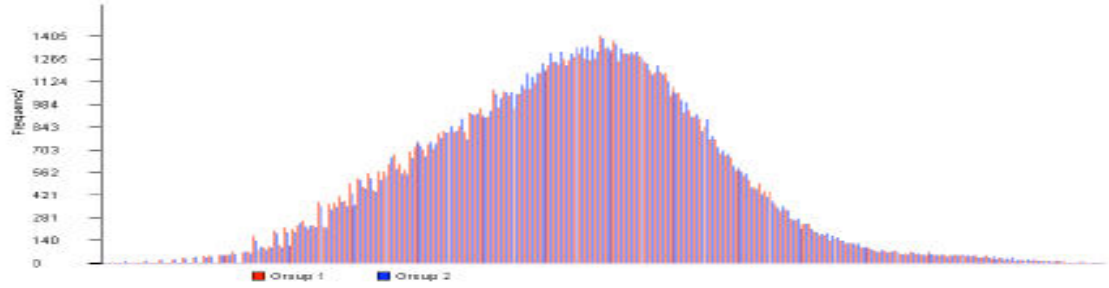
- A better transformation procedure is to take the logarithm base 2 value of the expression ratio (*i.e. log2 (expression ratio)).*
- *This has the major advantage that it treats differential* up-regulation and down-regulation equally, and also has a continuous mapping space.
- For example, if the expression ratio is 1, then log2 (1) equals 0 represents no change in expression. If the expression ratio is 4, then log2 (4) equals +2 and for expression ratio of log2 (1/4) equals -2. Thus, in this transformation the mapping space is continuous and upregulation and down-regulation are comparable.

Logarithmic Transformation

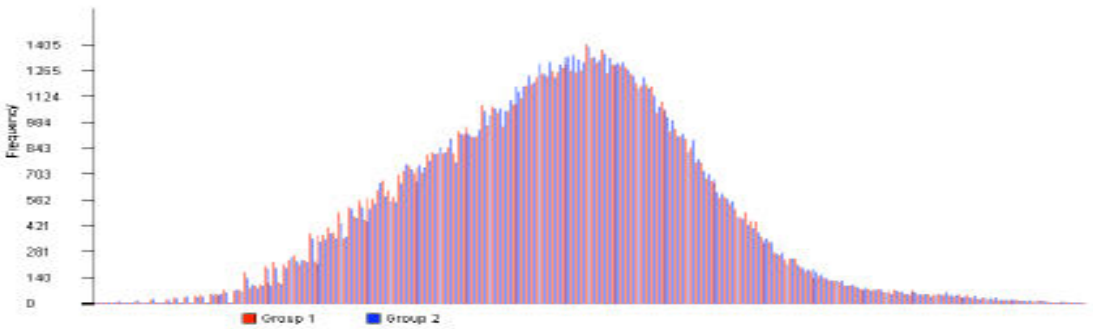
Log Transformation

§ Log transformation makes the distribution of microarray data symmetrical and normal (e.g. fits Gaussian distribution)

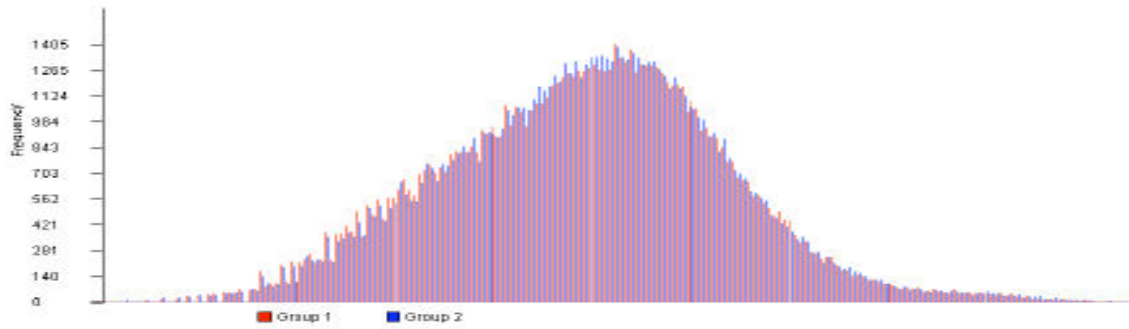
No Transformation



Log Base 2



Log Base 10



Log Base e

References

- Madan Babu, M., 2015. *An Introduction to Microarray Data Analysis*. [online] Mrc-lmb.cam.ac.uk. Available at: <http://www.mrc-lmb.cam.ac.uk/genomes/madanm/microarray/> [Accessed 3 December 2015].
- Log Transformation Dr. Jaideep Chaudhary