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Original Article

Efficiency using computer simulation of Reverse Threshold Model Theory on assessing a “One Laptop Per Child” computer versus desktop computer

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ABSTRACT

The Reverse Threshold Model Theory (RTMT) model was introduced based on limiting factor concepts, but its efficiency compared to the Conventional Model (CM) has not been published. This investigation assessed the efficiency of RTMT compared to CM using computer simulation on the “One Laptop Per Child” computer and a desktop computer. Based on probability values, it was found that RTMT was more efficient than CM among eight treatment combinations and an earlier study verified that RTMT gives complete elimination of random error. Furthermore, RTMT has several advantages over CM and is therefore proposed to be applied to most research data.

Introduction

In qualitative genetics, Mendel assumed that factors affecting phenotypes are composed of several factors (Mendel, 1866). In quantitative genetics, Fisher and Bateson and Punnett assumed that factors affecting phenotypes are composed of infinite factors (Bateson and Punnett, 1905; Fisher, 1918). Mendel ignored data that did not follow his laws while Fisher ignored data that did not follow a normal distribution and call them ‘outliers’. This paper does not eliminate or assume normality in data. The Reverse Threshold Model Theory (RTMT) respects normality as only part of the truth and consider outliers can be valuable information. There was no elimination of outliers in this experiment.

Threshold was defined by Wright (1916) in his guinea pig analysis as the accumulation of small factors to some level that changes the phenotype and that can be classified visually. This paper reversed his way of thinking in that qualitative phenotypes can be explained by some limiting factor (LF) under Liebigs's Law of the Minimum. By transformation of the raw data into an LF, all random errors that always exist in the Conventional Model (CM) are eliminated (Faarungsang, 2009).

The RTMT model is an analytical concept recently introduced to solve the estimation of parametric problems where the assumptions do not follow normal statistical theory. Two sources of Internet Service Provider were compared, namely Kasetsart University (KU) and the home. While the averaged value of data transmission at KU was higher, by using RTMT, it was found that the home was the better source. However, RTMT has not been sufficiently applied in other contexts (Faarungsang, 2009, 2010) and no research has been reported to compare RTMT efficiency with CM. Thus this investigation assessed the efficiency of RTMT in comparison with CM based on the ratio of probability given by using the two models.

The study of threshold inheritance was first conducted by Wright (1916), who found that guinea pigs normally have four digits on their front feet and three digits on their hind feet. However, it was observed that some guinea pigs have extra digits based on several factors including genetic characteristics (Wright, 1916, 1933). The probability of an animal having several categorical traits was determined (Gianola, 1982, 1983) using a Bayesian statistical approach. Notably, a reverse based on the threshold model has never been reported.

The original concept of threshold assumes that some qualitative traits are composed of several small additive factors and behave in an accumulated fashion up to the threshold level. The qualitative appearance will change after the accumulated factor is below or above the threshold. The current investigation proposed a reverse concept to the original one. In this alternative concept, it is assumed that the quantitative traits that have been assumed to be composed of several small additive effects can be accumulated to a noticeable qualitative amount called the “threshold” quantity based only on

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one LF effect being present or absent in the model. Furthermore, the current study extended the terminology "threshold" to cover all things: quantitative traits, qualitative traits, the left hand side of model (traits) and the right hand side of model (effects). Furthermore this study assumed that all things do have their own thresholds which may or may not be apparent. Thus, while all things do have an infinite number of factors to yield effect under given conditions, there will only be a few factors (namely LFs) that truly cause effect. By this, it is implied that the LF and threshold are considered to be the same. If specific conditions change, another factor that previously was not significant may change to be the next LF and thus cause the research process to enter into an endless mode by nature.

The concept of LF was reported by Taylor (1934) who based it on Leibig's Law of the Minimum. In animal nutrition, the first LF is lysine and the second LF is methionine. This means that even if an animal is fed with nutritious food abundantly, it will not grow up as well as it should with lysine and methionine, respectively.

The meaning of the RTMT concept has been discussed (Faarungsang, 2009; 2010; Faarungsang and Pannoppha, 2007, 2009) but its application has not been reported. The core rationale and concept of RTMT is summed up as follows. In all statistical models, the left hand side (LHS) contains a single variable to represent a reasonable key performance index (KPI). The variable on the LHS can be composed of an infinite number of variables or effects, which most statisticians would place on the right hand side (RHS) of their models. The effects of the RHS that are not clearly stated and will always be assumed to be randomly and independently distributed and are summed as the random errors. Both the LHS and RHS are based on assumptions using a common scientific method that may not be correct. It may be better to assume that even if there are infinite components on the RHS of the model, only a few effects can play an important role at the same time under a specific condition. These effects can be called the LFs or threshold characters. The quantitative effects on the RHS of the model by itself can be considered as the LHS. Transformation of it into an LF or threshold may fit with nature better than following the conventional approach. This is called reverse thinking and has been coined as part of the RTMT concept as presented in this paper. Events on the RHS of the model may have joint effects called interactions based on their behavior being both synergistic and antagonistic. Most things occurring in reality contain only a few LFs at the same time. After a change in specific conditions, the next LF would appear which causes an infinite loop of research on the same topic. It cannot be guaranteed that the old LF will return while the new LF exists. The task of all valuable research is simply to define the LF and then make use of it.

This paper reports an attempt to prove that RTMT is more efficient than CM by using Monte Carlo simulation in the "One Laptop Per Child" (SSS/OLPC) data.

Materials and methods

All CMs, including the threshold models for categorical traits, can be explained by Eq. (1):

$$Y = Xb + Za + e \quad (1)$$

and in conjunction, this investigation introduces an analytical concept of nature by using Eq. (2):

$$P = T + d \quad (2)$$

where: Y is a vector of the experimental unit key performance index, X is an incident matrix specific to fixed effects, b is a vector of fixed effect parameters, Z is an incidence matrix specific to random effects, a is a vector of random effect parameters, e is a vector of random effects assumed to be randomly influenced by Y, P is a vector of phenotypes of an individual experimental unit, T is a vector of transformed threshold effects affecting the experimental unit P with LF theory and d is a vector of disturbance distance deviated by transformation methods, causing error to P, but not necessarily randomly distributed as required in the CM.

A factorial experiment in a completely randomized design was used with three factors—computer type (CT), storage type (ST) and version type (VT). Each factor was composed of two levels and all treatments were composed of 10 replications. Two variables were used—boot time (BT) and ping time (PT). The CT was composed of two types—the OLPC and a market desktop. The ST was composed of two types—good storage (Kingston brand) and bad storage (Apacer brand). The VT was composed of two types—version 1 and version 2. For the OLPC, the two specifications were English and no English. For the desktop, the two versions were Intel and AMD. In total, there were 80 records in eight treatment combinations with 7 degrees of freedom available to be tested under the CM.

The laptops used in this study were two OLPCs located at Kasetsart University, Kamphangsaen, Thailand. The OLPC was used because it had several advantages over the others. First, it is a worldwide, well-known project. Second, it has an open source that can be verified by anyone at no charge. Third, it does not take a long time to do an experiment on it while it may take a long time to cultivate 80 animals or plants. Fourth, random errors on it can be easily controlled and they have very small effects.

Each treatment consisted of 10 samples randomly drawn from the four machines. BT and PT were measured and the data were transformed using the methods given by Faarungsang (2009, 2010). Statistical analysis was done using Matvec and R (Wang, 1990; R Core Team., 2014, respectively).

Efficiency (defined as the ratio of probability of CM compared to RTMT) was tested by replacing experimental units among treatments at 20%, 40%, 60%, 80% and 100%, respectively.

Data size effect was investigated using computer simulation with Matvec for 20% of the replacement data. The data size was increased to 200 and 2000 records.

OLPC is a computer project for poor children and its mission is to empower the world's poorest children through education (The OLPC Wiki, 2016). SSS/OLPC is an embedded Linux system to allow OLPC to run like a super computer by eliminating its existing LF. SSS/OLPC was awarded the World Cup for Computer Implemented Invention (GotoKnow, 2015; OLPC, 2015; Slackware, 2015; World Cup of Computer Implemented Inventions, 2015).

Results

The mid values of BT and PT among treatments were used as thresholds for data transformation. The mean values of BT and PT are shown in Figs. 1 and 2, respectively. The histograms of BT and PT are shown in Figs. 3 and 4, respectively, and indicate that all samples did not follow the normality assumption as is required by CM.

The ranges in BT and PT are shown in Figs. 5 and 6, respectively, and indicate that the assumption of homogeneity of variance was not met in this study. The range in BT for the eight treatment combinations was 12.7, 230.15, 28.45, 222.26, 6.18, 55.86, 1.55 and 54.2, respectively. The range in PT for the eight treatment combinations was 1.08, 2.01, 0.62, 9.38, 3.53, 0.87, 0.80 and 1.86, respectively.

The efficiency of CM compared to RTMT is shown in Table 1 and Fig. 7. Clearly, the F-value decreased from 170.34 to 0.11 while the probability value increased from $2.2 \times e^{-16}$ to 0.74. Comparatively, under RTMT, the t-value decreased from 9.49 to 0.00 and the

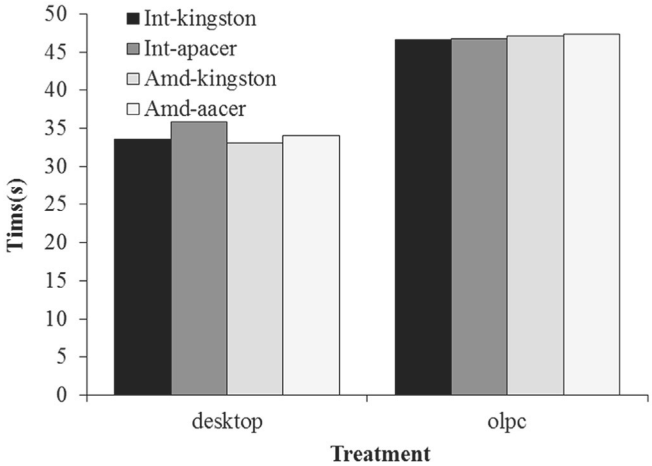

Fig. 1. Mean boot time for desktop computer compared to "One Laptop per Child" (OLPC) computer for four different computer and storage type configurations (int-kingston, int-apacer, amd-kingston and amd-apacer).

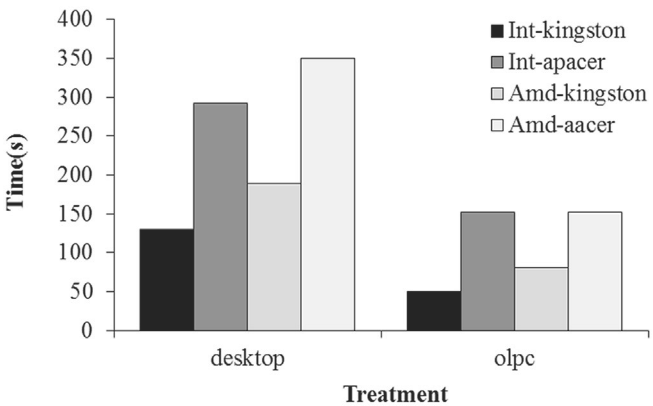

Fig. 2. Mean ping time for desktop computer compared to "One Laptop per Child" (OLPC) computer for four different computer and storage type configurations (int-kingston, int-apacer, amd-kingston and amd-apacer).

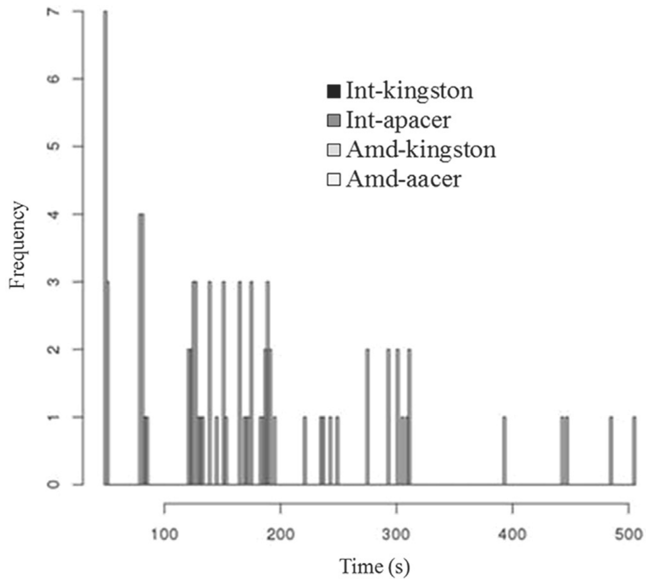

Fig. 3. Histogram of boot time for four different computer and storage type configurations (int-kingston, int-apacer, amd-kingston and amd-apacer).

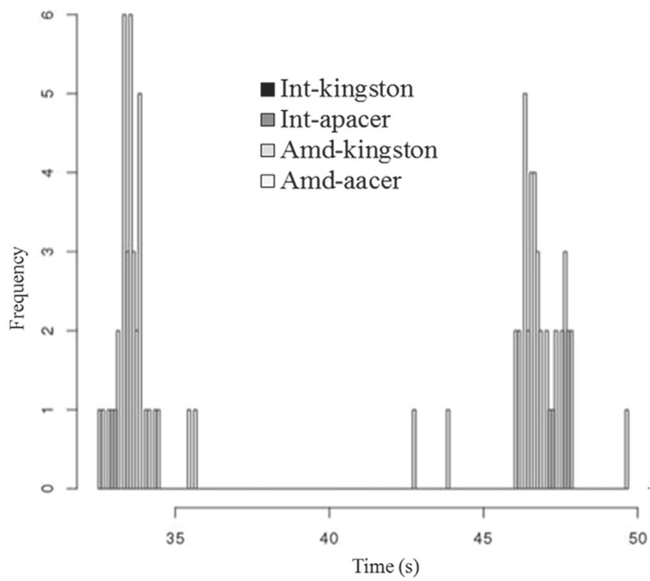

Fig. 4. Histogram of ping time for four different computer and storage type configurations (int-kingston, int-apacer, amd-kingston and amd-apacer).

probability value increased from 0.00 to 1.00. The turning point at which RTMT achieved a higher efficiency than CM took place with 20% data replacement. Thus, it can be concluded that the RTMT model is the better choice and can detect the difference at an earlier stage.

The effect of data size is shown in Table 2 and Fig. 8. Increasing the data size tended to increase the efficiency of analysis under RTMT. It was found that 200 records were needed to detect a small difference. A higher number of records did not increase the efficiency by much.

The mean values of BT for the eight treatment combinations were 129.64 s, 292.36 s, 188.46 s, 350.38 s, 49.68 s, 152.51 s, 80.59 s and 151.56 s, respectively. The mean values of PT for the eight treatment combinations were 33.59 s, 35.79 s, 33.08 s, 34.08 s, 46.67 s, 46.76 s, 47.06 s and 47.30 s, respectively (Figs. 1 and 2, respectively).

Discussion

The computer simulation results in Table 2 indicate that to have the higher efficiency using the RTMT model, the data size should be 20 to 200. In the current study, the data size for the eight treatments was 80. The results for RTMT given in Table 1 are highly efficient and can detect differences better than the CM results starting at 20% contamination.

Reasons why RTMT is more efficient than CM are: 1) if there is no incorrect classification, then RTMT can eliminate all the random errors that always exist in CM; and 2) RTMT does not require normality in the sample data while CM assumes that the random errors are normally distributed, though in the current experiment, it was shown that the true data were not normally distributed and outliers did not exist. If outliers are eliminated, then the analysis in CM will be biased.

There are several advantages of RTMT over CM. First, CM analysis requires the normality assumption, which is not necessary under RTMT. Second, costly devices may be needed to measure

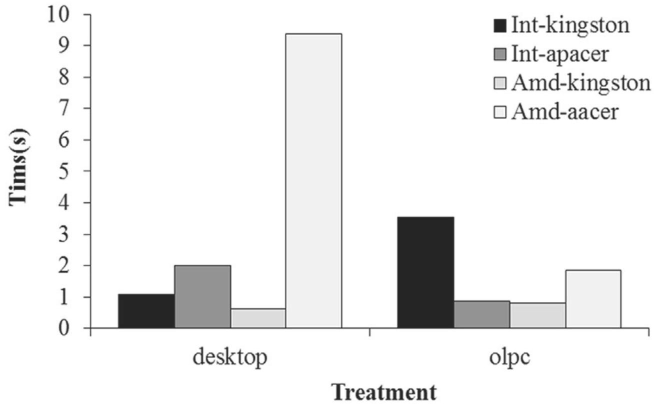

Fig. 5. Ping time for desktop computer compared to "One Laptop per Child" (OLPC) computer for four different computer and storage type configurations (int-kingston, int-apacer, amd-kingston and amd-apacer).

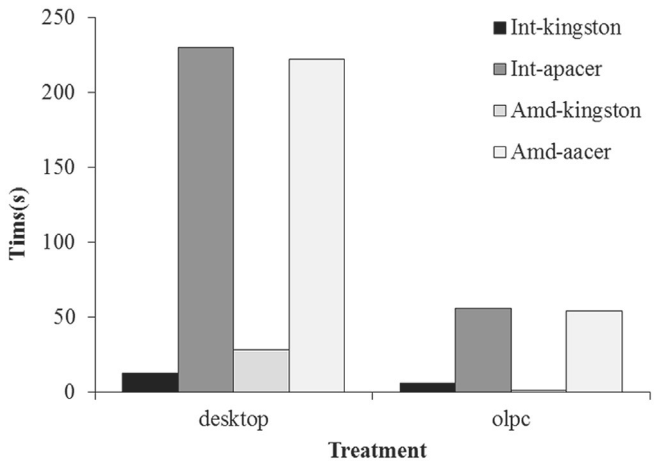

Fig. 6. Boot time for desktop computer compared to "One Laptop per Child" (OLPC) computer for four different computer and storage type configurations (int-kingston, int-apacer, amd-kingston and amd-apacer).

Table 1
Efficiency of Conventional Model (CM) compared to Reverse Threshold Model Theory (RTMT) based on probability, t-value and F-value of the two models (for 1 degree of freedom, $F = t^2$).

Simulation (%)	CM		RTMT	
	F-value	Probability	t-Value	Probability
0	170.34	0	9.49	0
20	43.27	0	9.68	0
40	16.01	0	7.56	0
60	6.07	0.02	5.09	0
80	1.37	0.24	2.56	0.01
100	0.11	0.74	0	1

variables in CM while only a simple classification is used in RTMT. Third, a large dataset and statistical program are required to analyze data in CM compared to a small dataset ($n = 10–20$) for RTMT using Matvec (Wang, 1990). Fourth, it was verified that RTMT has higher efficiency and is more sensitive in detecting the difference at an earlier stage and gave the correct results for the simulation. The effects of the violation of normality and equality in variance were studied but the details are not provided here as they were outside the objectives of the current investigation. A range

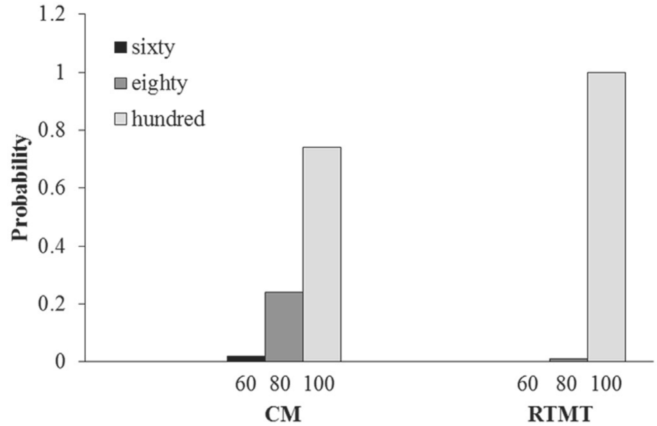

Fig. 7. Probability of Conventional Model (CM) and Reverse Threshold Model Theory (RTMT) based on sample size (20%, 40%, 60%, 80% or 100% replacement, with options not presented having 0 probability).

Table 2
Probability and t-value to verify data size effect on Reverse Threshold Model Theory using computer simulation.

Data size	20	200	2000
t-Value	1.26	4.05	12.84
Probability	0.21	0	0

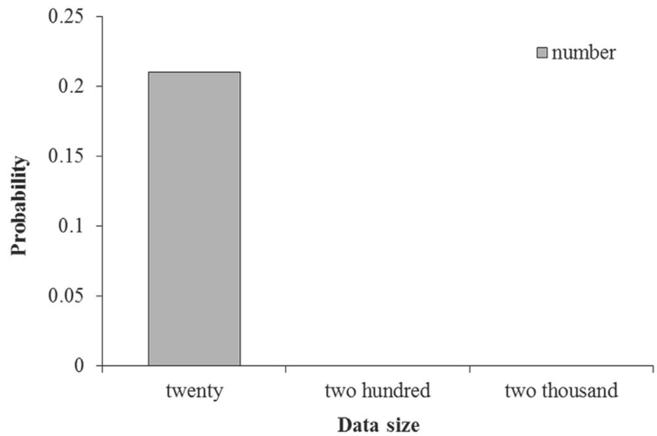

Fig. 8. Probability to certify data size effect on Reverse Threshold Model Theory based on computer simulation.

was used instead of the variance because none of the sample data followed a normal distribution.

The concept of RTMT is consistent with the concept of LF as it was presented earlier (Faarungsang and Parisuthikul, 2009; Faarungsang, 2010). The current study proposed that all models and events are not as complicated as they were originally perceived. At any moment for a specific incident, the model always consists of a few threshold effects that behave as LFs. Of course, it may contain an infinite number of factors that can influence the specified trait, but those factors do not have a significant effect on the phenotypes in the current situation. Only after the situation has changed with time will other unnoticeable factors become the next LF under RTMT. Simple transformation technology can be applied again to these following simple models to eradicate random errors completely and provide a higher, efficient estimator.

OLPC is a low cost laptop with a low performance processor and low memory but its BT is several hundred percentage points lower than for a high cost and high performance desktop because its BIOS is Linux which takes no time to load the kernel, whereas the market PC needs a long time to load the kernel during the booting process. The PT on the OLPC is higher than for the PC because the graphic performance is so low and becomes an LF. To remove this LF, the author used an NX server several year ago and this suggests that all other problems can be solved in the same way.

Most researchers have owned at most only one OLPC. In the current study, the second OLPC was donated by a student. The results from the current study showed that the two OLPCs gave near-identical results for both BT and PT while the results on the two desktops were very different.

RTMT was used to solve the OLPC problems. In this study it was shown that PT under OLPC was very slow and became an LF under RTMT. The solution to make the OLPC run faster than a super computer was to get rid of this LF by using an NX Server based on a donation from the Animal Husbandry Association of Thailand (AHAT). With the AHAT NX server, the LF of the OLPC had no effect and instead had the fastest internet connection with the most powerful processor, making OLPC run faster than most powerful super computer. Any other problem can be solved in the same way. The steps are as follows. First, find out what is the LF in RTMT and then get rid of the LF in the model. This can be applied to the current android technology in the market today; it can compete with a super computer easily by getting rid of the LFs, namely the keyboard and the “DOSBOX” (known also as a “stupid box”). RMIT could be used to explain this approach for any problem in the world.

In fact, CM is only a special case of RTMT under seven conditions: 1) the LF in the model has zero effect; 2) the random errors follow a normal distribution; 3) variance among the treatments is equal; 4) the effects in model accumulate additively; 5) the threshold level is located at infinity; 6) data were obtained from low error experiments; and 7) all effects sum to a straight line. It is most likely that the seven conditions will never happen. Thus, RTMT is always the best choice for all research papers.

RTMT can be applied to data analysis in various areas and some examples are provided below.

RTMT can be used to explain why many people succeed in their work. If CM is applied to intelligence quota (IQ) analysis, it is not possible to determine why people with a low IQ may succeed more than a person with a high IQ. On the other hand, RTMT can verify that person's success may be based on some LF in their profile. Most people's success does not rely on any quantitative value index but is based on some major effect not explained under CM.

It is known that the a male human's genome consists of 22 pairs of autosomes plus an X chromosome plus a Y chromosome while the female genome consists of 22 pairs of autosomes plus two X chromosomes. If CM were used to detect differences between males and females based on IQ, weight, height or other quantitative traits, it may not be possible to detect the difference, while RTMT can detect the difference It is known that all things in the world are different, but sometimes CM cannot detect certain differences when the sample size is small or the random error is big.

GMO technology also follows the RTMT concept. It is known that there are around 30,000 genes in the human genome. Genetically modified organisms play a role as there are only a few loci that can be a candidate gene and where a major result can be expected.

Several decades ago, the author believed that a selection index was the best linear predictor (BLP). It was proven at that time that BLP was higher in efficiency than any other method such as Independent Culling Levels (ICL). At present, the term “BLP” may not be true and does not fit the true data. Considering two traits in pigs—average daily gain (ADG) and back fat thickness (BFT)—BLP would assume that the two traits follow a bivariate normal distribution with an infinite number of genes in additive effects. However, based on RTMT, the author assumed that most infinite numbers of genes do have zero effects on ADG and BFT. Only a few genes behaving as LFs are taking action and having a threshold effect on ADG and BFT. Assuming that only one gene controls ADG and one gene controls BFT, then ICL will be the best method of selection for pigs and not BLP. If a pig is selected, this implies that the pig has both good genes. Under BLP, random errors will play an important role in the selection and reduce its efficiency.

Tilton et al. (2012) proposed that micro RNA plays an important role in many biological processes, while earlier, it was simply one of many unknown factors and was accumulated in the random errors part of the model. Micro RNAs is really an LF that plays an important role as a new threshold in the new era model. After micro RNA has been fully studied, there will be a new LF to be addressed and so on. This concept is based on nature. Most papers appear to have followed the approach described by Tilton et al. (2012) indicating that RTMT can be used for explanation and analysis in any situation.

Frebolt (2012) reported using barley genetics to improve the root part of the plant and thus increase the yield. It was implied that genes controlling root growth were the LF at that time. However, after identifying and utilizing all those genes, other unknown genes were considered to play an important role in the shoot part to increase the yield.

Based on the two previous examples, researchers have a simple duty to identify the threshold or LF that influences what is being researched and then to create ways of eliminating that specific problem. Certainly, after the first LF is found, a second LF will always appear and more research is always needed.

In quantitative genetics, sire evaluation on threshold traits is very important but rarely investigated (Gianola, 1982). From 41 randomly selected papers in the Journal of Dairy Science during 1991, none applied data transformation nor investigated a threshold model. Among several reported in KU Journals, only one paper addressed data transformation for the analysis of milk production (Seangjun et al., 2009). There was only one report from the National Swine Research and Training Center of Thailand that applied a log transformation on the pig condition index (Chantsavang and Choungchai, 1980). Data transformation, violation of homogeneity of the variance and threshold traits phenomena should be treated more frequently. However, to date, it has been difficult to find such studies. This lack of empirical support may lead to biased interpretation in current research.

These examples show how the RTMT concept can explain various situations. More research is needed to explore the concept and its applications in order to gain deeper insights into its benefit.

Computer simulation can generate a normal distribution from 12 uniform distributions based on the Central Limit Theorem which states that the summation of an infinite number of independent distributions of any type will result in a normal distribution. However, in the real world such a thing would never happen. A distribution is never independent from others. In education, if a student can do question number 1, it is more likely the student will then progress to do question number 2 rather than question number 100. Mostly, the questions are not a measure of the true performance of student, but rather a measure of random errors. True events in the world are more likely to be composed of a few LFs and the distribution does not follow a normal distribution. In the current study none of the experiments followed it.

It does not make sense to concentrate on a significance level among treatments because it is proof that an increase in the sample size will increase the level of significance (Index of/rtmt, 2015). If a drug has a small effect on curing diseases currently prevented or reduced by doing exercise, but the research undertaken were on a sample size of one million and these research results were released, imagine how much damage could result if people stopped exercising and used the drug instead. Contrariwise, if exercise has a large effect on curing disease but the experimentation was undertaken on a small sample, then the results would most likely show no significant difference. The correct solution is to determine the LF in a model and make the key performance index the best for those specific conditions.

Natural phenomena fit RTMT better than they do CM. Consequently, all research reports need to be reanalyzed using the RTMT concept to identify the correct results and gain efficiency.

Based on the application of RTMT and Monte Carlo simulation using the Matvec software on the SSS/OLPC data at Kasetsart University, Kamphangsaen, Nakhon Pathom province, Thailand, RTMT was found to be more efficient at detecting the differences of effects in the model. Several earlier papers on RTMT that were reviewed supported this investigation. Thus, RTMT has high potential for researchers due to its simplicity and higher efficiency.

Conflict of interest

None.

References

Bateson, W., Punnett, R.C., 1905. Experimental studies in the physiology of heredity. Rep. Evol. Comm. Roy. Soc. 2, 99–131.

Chantsavang, S., Choungchai, V., 1980. Preliminary study on condition index of young pigs. In: National Swine Research and Training Center Annual Report 1980, Bangkok, Thailand. National Swine Research and Training Center, Bangkok, Thailand, pp. 57–67.

Faarungsang, S., 2009. Data digestion on education system in learning and teaching animal breeding at Kasetsart University. In: National Conference on Genetics 2009. November 22–24, Thammasat University, Bangkok, Thailand. National Genetics Association of Thailand, Bangkok, Thailand, pp. 302–306.

Faarungsang, S., 2010. Reverse threshold model theory. In: National Conference on Statistics and Applied Statistics 2010. May 27–28, Holiday Inn, Chiang Mai, Thailand. National Statistical Association of Thailand, Bangkok, Thailand, pp. 111–117.

Faarungsang, S., Pannoppha, N., 2007. Self-sufficient and sustainable system (SSS) prototype to solve computer problems including One Laptop Per Child (OLPC). In: Asia, Africa and Australia Semifinal of the World Cup of Computer Implemented Inventions (CIIs) in 2008. Taipei, Taiwan, pp. 67–69.

Faarungsang, S., Parisuthikul, S., 2009. Statistical analysis using Matvec on colocation NX_servers performance. In: National Conference on Statistics and Applied Statistics 2009, May 21–22, A1 the Royal Cruise Hotel, Pattaya, Chonburi, Thailand. Faculty of Applied Statistics, National Institute of Development and Administration, Bangkok, Thailand, pp. 486–499.

Fisher, R.A., 1918. The correlation between relatives on supposition of Mendelian inheritance. Trans. R. Soc. Edinb 59, 399–433.

Frebolt, I., 2012. Genetic modification of barley for improved yield and stress tolerance (abstract no. 0-S1-0047). Abstracts. In: 15th International Biotechnology Symposium and Exhibition (IBS 2012). September 16–21, EXCO, Daegu, Republic of Korea. IBS 2012, EXCO, Daegu, Republic of Korea.

Gianola, D., 1982. Theory and analysis of threshold characters. J. Anim. Sci. 54, 1079–1096.

Gianola, D., 1983. Sire evaluation for ordered categorical data with a threshold model. Genet. Sel. Evol. 15, 201–224.

GotoKnow, 2015. Evidence of SSS/OLPC Succession to the World !!!. Retrieved from: https://www.gotoknow.org/posts/405938, 9 June 2015.

Index of/rtmt, 2015. Index of/rtmt. Retrieved from: http://supat.webatu.com/rtmt/, 9 June 2015.

Mendel, G., 1866. Versuche über Pflanzen-Hybriden. Verhandlungen des naturforschenden Vereines Brunn 4, 18–65.

OLPC, 2015. New OLPC Slackware 13.37 Released (fwd). Retrieved from: http://lists.laptop.org/pipermail/devel/2011-May/032077.html, 9 June 2015.

R Core Team, 2014. R: a Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/, 31 December 2014.

Seangjun, A., Koonawootrittriron, S., Elso, M.A., 2009. Characterization of lactation patterns and milk yield in multibreed dairy cattle population in central Thailand. Kasetsart J. (Nat Sci.) 43, 74–82.

Slackware, 2015. A Build for OLPC XO-1 was Published on May 2011 by Professor Supat. Retrieved from: http://wiki.laptop.org/go/Slackware, 9 June 2015.

Taylor, W.A., 1934. Significance of extreme or intermittent conditions in distribution of species and management of natural resources, with a restatement of Liebig's law of the minimum. Ecology 15, 374–379.

The OLPC Wiki, 2016. About OLPC. Retrived from: http://wiki.laptop.org/go/The_OLPC_Wiki, 13 December 2016.

Tilton, S.C., Tal, T.L., Scroggins, S.M., Franzosa, J.A., Peterson, E.S., Tanguay, R.L.A., Waters, K.M., 2012. Bioinformatics resource manager v2.3: an integrated software environment for systems biology with microRNA and cross-species analysis tools. BMC Bioinforma. 13, 311–328.

Wang, T., 1990. Matvec User's Guide. University of Illinois, Champaign, IL, USA.

World Cup of Computer Implemented Inventions, 2015. Semifinal for Asia, Africa and Australia. Retrieved from: http://www.invention-ifia.ch/cii/taipei.htm, 9 June 2015.

Wright, S., 1916. An intensive study of the inheritance of color and of other coat characters in guinea pigs with especial reference to graded variations. Pub. Carnegie Inst. 59–160.

Wright, S., 1933. An analysis of variability in number of digits in an inbred strain of guinea pigs. Genetics 18, 506–536.