The Selection of the Correct Accuracy Level Using
The Optimal Precision and Accuracy Method

Y Kerlooa
Master of Information System Department, Faculty of Post Graduate,
Universitas Komputer Indonesia, Jl. Dipatiukur No. 112-118, Bandung, Indonesia

Email: kerlooa@unikom.ac.id

Abstract. This research discusses the importance of selecting the correct value of sensor precision and computational accuracy in production equipment in coffee farmer cooperatives. Accuracy levels that are too low or too high will reduce the effectiveness of mechanization and automation in this field. This research used The Optimal Precision or Accuracy method which based on MSB-First Interval Bounded Variable Precision (MFIBVP) technique. Based on data obtained during the survey in this study, the optimal precision level curve is obtained, so that the optimal precision level can be determined in sub processes that are naturally difficult to determine. In conclusion, The Optimal Precision and Accuracy Method can be used to determine the right accuracy level needed at each stage of the process in a production system.

1. Introduction
The term precision or accuracy of a computer system has often been regarded as the same thing and is the thing that it's quality cannot be lowered. Zadeh [1-5] considers that one of the causes of computational difficulties in applications that require very close interaction with a time-limited environment is due to the presumption or tradition in the field of science that bases the assessment of quantitative truth, precision, and categorical truth. Yet in reality, we live in a world that is broadly and generally inaccurate, not easily ascertained, and difficult to categorize precisely. To obtain precision and certainty requires cost or sacrifice, while often we close our eyes to this reality so we cannot see the magnitude of sacrifice that must be paid to obtain and process data with high precision and low uncertainty.

The accuracy of a system is related to the success of the system in delivering the required final results. System precision in measuring and processing data can determine the accuracy of the final results of the system, but it is not the only thing that determines. Precision has limits that are inherent in the ability of measuring devices and the encoding techniques of the quantities. Encoding of real numbers 1/3 on floating point binary numbers 16, 32, 64, 128 bits or whatever the length of a finite bit still contains precision errors. The accuracy of the computational system can still be maintained by using an algorithm that can tolerate existing uncertainties.

In the environment of people's agricultural cooperatives, this problem is a sure thing to happen. The yields from cooperative members are of heterogeneous quality and still contain high levels of impurities, in the form of leaves, branches or twigs, and other objects that have no economic value. This causes a weighing process that has high accuracy, instead of providing good benefits, provide a big problem and can cause losses on the side of the cooperative manager. For example, currently many digital scales on the market use a load cell sensor with a maximum load around 200kg generally and
use an ADC HX711 device which is an analog-to-digital component with 24-bit precision [6]. It will produce a precision scale 200 kg divided by 2 power of 24, or equal to 0.01192092895508 grams. A level of accuracy that will be very difficult for the cooperative officers in the field to handle and has the potential for long-term disputes over crop payments. Based on this fact, we are trying to determine the optimal level of precision to be used in the agricultural sector, especially when weighing crop production. The data collection and research survey was carried out in a coffee plantation cooperative in Desa Cikeris, Kelurahan Cikandang, Kecamatan Cikajang, Kabupaten Garut, Provinsi Jawa Barat.

2. Method

2.1. The MSB-First Interval-Bounded Variable Precision Technique

This technique, initially, was developed in the area of Architectural and Logic Units (ALU) design with the aim of making computer systems that can adapt in real-time system environments by regulating the precision level of numbers processed by the ALU [7-12]. The initial idea of this technique was the incomplete nature of data in the real world which was stated by Zadeh’s previous work [1-5].

Basically, this technique tries to do a serial calculation of the Most Significant Bit (MSB) of the data and produces a pair of numeric values, which are the boundary values of the actual calculation results, if the calculation is done completely for all bits of the data. The idea for this paper, taken from the MFIBVP technique is the fact that if we process the most important part of the data first, results with high accuracy from the process can be obtained quickly. In the world of computing, the most important part of numerical data is the rightmost bit, or Most Significant Bit (MSB).

Figure 1 shows an example of the difference in speed at which a calculation is made, with its corresponding accuracy at each stage of the calculation of 50 pairs of operands, between the adder unit of the MSB-First Interval-Bounded Variable Precision (MFIBVP-Adder) and the conventional adder unit (Carry Propagate Adder dan Carry Lookahead Adder).

![Figure 1. Performance comparison between the MFIBVP real-time adder vs Carry Lookahead Adder and Carry Propagate Adder on 50 pairs of 64-bit random numbers [12].](image)

It can be seen in Figure 1, that the performance of MFIBVP-Adder is fast in giving results with very high accuracy (the leftmost thick vertical line) even from the beginning of the addition steps. We take another basic principle from MFIBVP computational techniques, namely Interval-Bounded values. The principle of this technique is that each numerical value derived from the results of environmental sensor readings and computational processes basically has a pair of lower value limits and an upper value limit. For example, the result of measuring the weight of an object of \( W \) kg, actually has the potential for error due to the level of accuracy factor of the scales used, say, by \( \pm x\% \). This means that the actual weight of the object being weighed is between \( W (1-x\%) \) as the lightest
weight and $W(1 + x\%)$ as the heaviest possible weight. The desire and effort to eliminate this error value is an effort that can be wrong and counterproductive, because it should be adjusted to the stage of the process and application needs.

Based on this technique, at the stage of recording and computing data that is not yet 'clean', such as the condition of weighing the initial harvested product that still contains a lot of impurities, the accuracy of the scales needed does not need to be as high as when weighing the final product which is already pure and has a high economic value.

2.2. The Optimal Precision or Accuracy Method

We developed this method based on the MFIBVP principles previously described. The main purpose of this method is to determine the level of precision or accuracy that is relative to each stage of the process in a system and in accordance with the conditions in the field and user needs. This was taken so that the process of recording data and processing it can facilitate and benefit all parties.

The basic principle of the Optimal Precision or Accuracy Method is to conduct a survey of all members of the stakeholder concerned with a particular stage of the process. The survey asks for the lowest and highest level of accuracy desired. By averaging all the expected accuracy values, a precision or accuracy value for that stage will be obtained. It is very possible that there are stages of the process that cannot be surveyed. This is not a big problem, as long as the expected precision or accuracy values at several stages of the process are known. By plotting several known precision or accuracy values needed in several phases in a two-dimensional axis, we can obtain a line of precision or accuracy that can be seen in Figure 2 below.

![Figure 2](image_url)

**Figure 2.** The line of precision or accuracy values.

The X-axis in the figure is the process stage, the left side is the initial stage of the process, where the raw material still has a lot of impurities and is of low economic value. To the right, the process is higher and the product is also purer and has high economic value. The Y-axis shows the level of precision or accuracy needed (or generated) by the process steps, the higher the process’s step, the higher precision or accuracy required (or produced) by that particular process. These precision or accuracy values are obtained according to formula 1 below:

$$V_p = 1 / V_{ep}$$

Where $V_p$ = Precision or accuracy value of a particular process

$V_{ep}$ = Expected Precision or accuracy

The gradient of the line, or curve, connecting each precision or accuracy values in each process’s phase is the optimal precision or accuracy value in this particular system. With this line, we can predict the optimal precision or accuracy needed by a particular process that cannot be easily surveyed or determined.
3. Results and Discussion

The Optimal Precision or Accuracy Method has been applied to determine the precision or accuracy level of the weighing tool for weighing the harvested products used by a coffee plantation cooperative in Desa Cikeris, Kelurahan Cikajang, Kabupaten Garut, Provinsi Jawa Barat. We conducted a survey in the early stages of weighing the coffee fruits that still had skin and were still mixed with a few leaves and stems or twigs, as well as a survey in the final stages when the coffee beans had been roasted, ground and ready to be wrapped for sale to consumers. The results of the survey can be seen in the following Table 1.

Table 1. Survey’s result for two known process in a coffee plantation cooperative a.

| Phase                        | Maximum weight of product per pack | Average precision or accuracy expected |
|------------------------------|-----------------------------------|----------------------------------------|
| Weighing the coffee fruit b  | 100 kg                            | 0.5 kg Seller 0.5 kg Buyer             |
| Weighing the ground coffee powder c | 200 g                              | 1 g Seller 0.1 g Buyer                 |

a Survey conducted by asking farmers and cooperation administrator.
b The first process.
c The last process.

We use the term seller and buyer based on who sells and buys. For example, in the first stage, the sellers are the farmers who sell coffee beans to the cooperative officer (buyer). In the final stage, the seller is a cooperative officer and the buyer is the final consumer. If we average the different precision or accuracy values in the last stage, we will get a precision or accuracy of 0.55 grams. Based on formula 1 before, obtained precision or accuracy values for the initial process of 0.002 and for the final process of 1.88. If we plot these values into a graph, the Figure 3 is obtained.

Based on the line of precision or accuracy displayed in Figure 3, the gradient value is 0.5%. This means that in all stages of the coffee bean processing process in this coffee plantation cooperative, the optimum precision or the right accuracy level for measurement of weight is 0.5% of the maximum weight of each container at that stage. For example, at the pulping stage of coffee beans, which cannot be easily surveyed for precision or accuracy because this process is carried out internally in the cooperative warehouse, it can be determined that the level of precision of weighing the final result of this stage is also equal to 0.5%. So that each batch of pulping process is considered correct, if each container of seed pulping is weighed with an accuracy tolerance of 0.5%, or 500 grams per 100 kg of seeds.
Based on these values, we can also determine the level of precision of the scales used at each stage of the coffee bean processing. For example, at the initial stage, optimal scales of 500 grams are required, while at the final stage (packing of ready-to-brewed coffee powder) is 0.55 grams. The use of scales that have the right level of precision is very important in the ease of operation and the accuracy of pricing at a particular stage of the process.

4. Conclusion
Based on this research, which conducted empirically, it can be concluded that the Optimal Precision and Accuracy Method can be used to determine the right accuracy level needed at each stage of the process in a production system. The fact that not all stages of production can be easily surveyed to determine the expected value of precision or accuracy, can be approached using this method with a line approach plot of two precision or accuracy values from two known processes or stages.

Acknowledgement
Author wishing to acknowledge the Vice Rector for Innovation, Development, Assets and Cooperation, Universitas Komputer Indonesia and the administrators of the Coffee Farmers’ Cooperative of Desa Cikeris, Kelurahan Cikandang, Kecamatan Cikajang, Kabupaten Garut, Provinsi Jawa Barat so that this research can be conducted.

References
[1] Zadeh, L. A. 1998. Soft computing, fuzzy logic and recognition technology. In 1998 IEEE International Conference on Fuzzy Systems Proceedings. IEEE World Congress on Computational Intelligence (Cat. No. 98CH36228) (Vol. 2, pp. 1678-1679). IEEE.
[2] Zadeh, L. A. 1996. Soft computing and fuzzy logic. In Fuzzy Sets, Fuzzy Logic, and Fuzzy Systems: Selected Papers by Lotfi a Zadeh (pp. 796-804).
[3] Yager, R. R., Zadeh, L. A., Kosko, B., & Grossberg, S. 1994. Fuzzy sets, neural networks, and soft computing (No. 006.33 F8).
[4] Zadeh, L. A. 1996. The role of soft computing and fuzzy logic in the conception, design and deployment of intelligent systems. In Proceedings of the Annual Conference of Biomedical Fuzzy Systems Association 9 (pp. 11-12). Biomedical Fuzzy Systems Association.
[5] Zadeh, L. A. 1999. From computing with numbers to computing with words. From manipulation of measurements to manipulation of perceptions. IEEE Transactions on circuits and systems I: fundamental theory and applications, 46(1), pp. 105-119.
[6] “Loadcell sensor 24 bit ADC - HX711 [4599]: Sunrom Electronics/Technologies.” [Online]. Available: https://www.sunrom.com/p/loadcell-sensor-24-bit-adc-hx711. [Accessed: 06-Feb-2020].
[7] Y. Y. Kerloozza and Kuspriyanto, “Real-Time dan Adjustable Computing,” E-Indones. Initiat. 2008 EII2008, May 2008.
[8] Kerlooza, Y. Y. 2004. Towards new real-time processor: the multioperand MSB-first real-time adder. In *Euromicro Symposium on Digital System Design, 2004. DSD 2004.* (pp. 524-529). IEEE.

[9] Y. Y. Kerlooza and Kuspriyanto, “Towards Real-Time Processor: Multioperand MSB-First Minimax Addition,” *Int. Conf. Electr. Eng. Inform. ICEEI2007*, 2007.

[10] Y. Y. Kerlooza and Kuspriyanto, “Towards Real-Time Processor: The Implementation of Multioperand MSB-First Adder Arithmetic Unit on the Computation of \(y = \sum a_i b_i\),” *Int. Conf. Electr. Eng. Inform. ICEEI2007*, Jun. 2007.

[11] Y. Y. Kerlooza, “Towards Real-Time Processor: Bounded Arithmetic A new horizon for faster and smarter computer,” *Semin. Nas. Mat.*, Dec. 2008.

[12] Kerlooza, Y. Y., Gondokaryono, Y. S., & Mulyana, A. 2010. MSB-First Interval-Bounded Variable-Precision RealTime Arithmetic Unit. *Journal of ICT Research and Applications*, 4(1), pp. 23-46.