The Scientific Arguments against Water Budget Tiered Rate Billing

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Version 1.04

Feb 20, 2015

Abstract

This discussion is short scientific brief of the longer Western Municipal Water District analysis paper found at www.brettfleisch.com/WMWD.pdf. In this paper, we provide arguments that the customer's budget is undecidable and provide an inductive proof that the cost of N ccfs of water has ~N possible prices. This makes the price of N ccfs of water subject to a discriminatory policy which WMWD calls a "budget". We assert the customer's budget is what is called in theoretical computer science : OPT (i.e. a local optimum). Because OPT is undecidable and WMWD provides OPT when the bills are printed, customers must guess OPT and then adhere to it. Not only is the pricing asserted to be illegal and/or unethical to use, it is due to the inductive proof that the water's price is not based entirely on consumption but the ratio of OPT to consumption. The guesswork required for the customer to adhere to the budget must also be either illegal or unethical to expect as well. OPT is not computable before the end of the period of measurement and is undecidable until WMWD provides the correct answer to customers.

WMWD Approach

In this paper we examine the intersection of computer science with budget-based tier rate billing. In this paper, Western Municipal Water District (WMWD) policies, a small water provider in Southern California, are analyzed for the science and billing concerns that affect customers. This paper is concerned with how computer science affects water policies and budget-based tier rate billing.

The WMWD "Water Demand Model" begins with a significant problem. By default WMWD tosses the customer's land out by deprecating the amount of land owned to a fraction of its value. A table is used to calculate the customer's irrigated land use. This is exceptionally poor scientific work. The default does not use satellite measurements. In the author's case, this showed less than half the irrigated land using the WMWD table versus satellite measurements that approximate the property size for watering more accurately; more than twice the original value was decided later. This indicates a gross inaccuracy in the science. Increasing the irrigated land by a factor of two indicates a problem in the scientific approach.

The "Water Demand Model" also has "weather microzones of .06 miles square" that measure whether there was precipitation in the area. This is incorporated into the formula on a daily basis through a secure link to the microzone measuring site. This allows weather changes to be accurately updated "for every account in the District" on a daily basis. This provides an aspect of

real time reporting to adjust the amount of water a customer can use daily if it rains out. The accuracy of this science has not been published nor geared for accuracy in reports this author is aware of. The problem with the bad science is the amount of overage costs for the customers until corrected.

PRESENT CONCERNS

A basic idea in water conservation is to set goals for customers to achieve by conserving water. Responsible water use means the customer 1) understands what water the property uses by examining past bills that measure water use and 2) the customer attempts to stay within the limits of a *budget*. Once the customer's irrigated land and indoor use are understood by both parties, the basic idea is to stick within the water budget. The customer understands how much water the household uses and knows how much the budget should reflect as *invariants* of the property.

Example [2] sets an expectation of a water budget based on the invariants of the property such as indoor and outdoor size of the property. The variants of the property include values that the customer cannot know about *a priori* and cannot budget for. This includes the amount of precipitation that month or the amount sunny days versus cloudy days. The customer cannot reasonably be expected to know these factors in advance. Moreover, when rain occurs it is advantageous to turn the water off. This largely depends on how much water was measured within your "microzone". Directly across the street or 30 miles away may have received measurably less precipitation; that customer may not have turned the water off assuming there was only drizzle. This variation in human behavior cannot be predicted, cannot be legislated and cannot be expected to be met as part of a budget unless it is a small perturbation in a water scheme. Microzones make the calculation of the budget undecidable. This leads to pricing problems.

Example [3] and [4] show much larger variations in the Water Budget column than expected. These are larger variations than the customer can react to. Consequently, the customer was penalized even though within the residence and able to turn the water off. A cloudy day could have been penalized as drizzle and pushed the water budget lower. Less days between readings could have decreased it as well. The budget the customer must meet is not pre-announced; this is because the Water Company can't predict it accurately.

The most significant problem in the WMWD formula is the use of 1) water is a factor, 2) the budget as another factor, but 3) the same water use as last month having a variable cost. This is because the budget may have changed from under the customer's feet from the previous month as in [3][4] The customer is charged different prices each month for roughly the same water use -- in a highly variable budget and further in a penalizing manner(in different tiers).

The outcome of this is that each customer (depending on microzone) is charged a different amount for the same number of gallons of water. In a pricing model, the same commodity has a different price for different customers. It is not clear how legal this is. The amount varies per month, per customer and there is no fixed prices for the commodity. The larger the outdoor property, the more the budget is expected to

be for water. Smaller properties may be more sensitive to variations in weather as the budgets are slashed and higher tiers are used to penalize the same use.

Problems with Budgets

Computer scientists have well understood theoretical problems that give an indication as to why WMWD policies would be impossible for customers to adhere to. Reference [5] discusses the problem with customers predicting budgets even with the assistance of computing devices. Specifically:

> ...is that many real-world systems are chaotic, that is infinitesimal differences in their conditions at one moment in time can turn into enormous differences at a future time. This is why forecasting the weather is difficult: a small error in measurement at one weather station today (caused, perhaps by a butterfly flapping its wings) can completely change tomorrow's weather a thousand miles away. The problem with predicting the future here is that the current state cannot be measured to sufficient accuracy.
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> So if the future is inherently, fundamentally impossible to predict, what do we mean when we talk about prediction in the context of knowledge discovery? The answer is that predictive models are not predicting a previously unknown future, but are predicting the recurrence of patterns that have existed in the past. It's desperately important to keep this in mind.

Past performance does not necessarily predict the future and the Turing test suggests it is not possible to calculate the correct budget *a priori*. "In computability theory and computational complexity theory, an **undecidable problem** is a decision problem for which it is known to be impossible to construct a single algorithm that always leads to a correct yes-or-no answer[6]". Determining the correct budget, even for WMWD, is undecidable and therefore customers cannot be expected to be able to determine how much water should be rationed.

In brief, it is computationally undecidable to compute the budget *a priori* given WMWD's factors and consequently impossible for customers to know what their budget is nor adhere to it monthly. The budget WMWD calls a "budget" is similar to an OPT in theoretical computer science. It is the "best" one can hope for given the parameters of the problem.

Example

In example [2] and [4] roughly the same amount of water was used. The Bar charts on each bill indicate that in fact roughly the same about of water was used each month. While there was a variance, for the purposes here let's assume they are the same amount.

Notice the tiers for the billing in [2] versus [4] are substantially different. Because the customer's budget was varied considerably the water had substantially different billing tiers. This indicates that the same product (water) has different pricing per month of the year billed for the same amount of conservation. It is unclear if this is legal.

WMWD calculates the water budget when it prints the bills and does not know what the customer's budget is each month. Again, the budget is computationally undecidable. As, mentioned earlier, it is equivalent to OPT (optimum) for each customer.

Factors that Nail the Customer and lower the Budget

WMWD calculations given in [7] explain the basic methodology to calculate the water use for the "water budget". Overall there are two factors. One factor is too much rain because too much rain can reduce the outdoor water budget. Another factor is too little rain because that can reduce the indoor water budget. Both of these declarations, reduction of the indoor budget and declaration of emergency are by administrative fiat of the Board of Directors of the water company or the General Director.

Undecidability and Water Budgets

What does it mean to have an undecidable water budget? What are the implications for the use of water in WMWD territory? Determining the correct budget, even for WMWD, is undecidable and therefore customers cannot be expected to be able to determine how much water should be rationed. This focus of undecidability has to do with the outdoor water budget and the "Water Demand Model" that has "weather microzones of .06 miles square". This means the microzones measure whether there was precipitation in the area. This is incorporated into the formula on a daily basis through a secure link to the microzone measuring site. There are no mentioned audits of the correctness of the microzones, the security of the returned values, the security of the subcontractor's methods.

If a budget cannot be determined at the beginning of the month *a priori* the lack of science is clearly indicated in the approach. The approach insists the customers be *predictive*. Customers are expected to adhere to the budget despite not knowing what the budget is. How can one adhere to a budget that is varying, unpredictable, and at best a guess from the customer to adhere to it?

> In computability theory, an **undecidable problem** is of a type of calculation which requires a yes/no answer, but where there can not possibly be any

> computer program that always gives the correct answer; that is any possible program would sometimes give the wrong answer or never give any answer at all. More formally, an undecidable problem is a problem whose language is not a recursive set; see decidability. There are uncountably many undecidable problems, ….[8]

One of the most famous problems that is undecidable is *the halting problem*. "In computability theory, the **halting problem** is the problem of determining, from a description of an arbitrary computer program and an input, whether the program will finish running or continue to run forever"[9].

WMWD budgets are undecidable because the outdoor water budget is couched with invariants that cannot be accurately predicted and therefore cannot be adhered to. If WMWD cannot compute the budgets at a minimum 30 days before the budget must be adhered to, the budget is not a budget. It is the optimum consumption amount based on the rain that has already fallen. Since WMWD knows the rain has fallen, the date for which the customer can apply the on-off sprinkler safeguards has already passed because WMWD is at the end of the billing cycle; the budget cannot be adhered to. The budget is an OPT value, the best one can hope to achieve; it is undecidable in theory at the beginning of the month.

Proof by Induction that Prices vary

Fair pricing of the commodity should be provided to customers. Consider a customer using **N'** ccf of water with a budget of **N.** This implies the price will be computed from Tiers 1 and 2, as expected. Consider the same customer using **N'** ccf of water with a budget of **N-1.** This implies 1 ccf of water goes into Tiers 3/4/5. Consider the same customer using **N**' ccf of water with a budget of N-1, N-2, N-3, N-4, etc. for each of the cases. Each creates 1 ccf, 2 ccf, etc.up to N-1 ccf that goes into Tiers 3/4/5 This shows that the same amount of water can have ~ **N** prices for the **N'** ccfs of water.

The price of water is not based entirely on consumption but the ratio of OPT to consumption. OPT is undecidable so the prices are nondeterministically assigned per month and consequently the price of the consumption varies. Thus, stated another way, the price of N ccfs of water with a budget B less than the consumption N, if B<N, varies per customer. This varies per month, per microzone, per frequency of meter reading and per customer.

As another example, consider the exact same house evaluated with a microzone 30 miles away. First, compute the budget using the microzone assigned by WMWD. Second, compute the budget using the microzone swapped from the 30 mile away microzone. It is asserted the different weather produces potentially different budgets. The cost for even the same month of water varies per the same customer with this proof..

Undecidability and Water Pricing Summary

WMWD is responsible for fair pricing of the commodity it provides. We have observed the budget is tied to the individual customer's calculation of the commodity price. Nonetheless, the budget is undecidable

and the indoor water budget equally so. This is because the administrative whims and their expected change date and its disclosure can make the drought percentage also undecidable (in non theoretical terms -- but based on when the disclosure occurs). Moreover, this violates the tenets of Tier 1 water supply which the consultant report calls “essential indoor water use”. The budget could be called OPT (for optimum) as a better name.

A pricing scheme that is unfair to customers because it discriminates based on the customer or his/her purchases may be unfair and thus illegal. This report has discussed unfair pricing policies that penalize customers unfairly with an undecidable water budget and an indoor water budget that can be altered by administrative fiat. The pricing schemes this report observes are much like driving to a gasoline station and buying ten gallons of gas at the pump in a Jaguar vs a Honda. The approach WMWD uses advocates charging different prices because the Jaguar uses more gas per gallon and can't be made to conserve for the same amount of commodity.

The legality of unequal water pricing per customer/(or equally well called a household/street address) remains questionable in terms of Federal laws. This may need additional legal opinions from the Department of Justice. But OPT is impossible for the customer to adhere to or predict each month. The guesswork required for the customer to adhere to the budget must also be either illegal or unethical to expect as well. OPT is not computable before the end of the period of measurement and is undecidable until WMWD provides the correct answer to customers. The price of the water is based on undecidable factors. We also proved that N ccfs of water can have ~N prices depending on the budget.

Even a concern as simple as when WMWD reads meters influences the number of days in the billing cycle and thus the budget that month. In fact, the number of days in the month are less a concern for a customer than when the meter is read over the measurement period. A mere variation in the number of days in the billing cycle not being known, standardizable and plannable for is a concern whether you might be thrown into a higher tier of unsustainable water use that month.

REFERENCES

[1] http://www.mresearch.com/pdfs/19.pdf

[2] www.brettfleisch.com/WMWD-10.pdf

[3] www.brettfleisch.com/WMWD-11.pdf

[4] www.brettfleisch.com/WMWD-12.pdf

[5] https://skillicorn.wordpress.com/tag/turing-machine/

[6]http://en.wikipedia.org/wiki/Undecidable_problem

[7]http://www.brettfleisch.com/WMWD-response.pdf

[8]http://en.wikipedia.org/wiki/List_of_undecidable_problems

[9]http://en.wikipedia.org/wiki/Halting_problem

see also

www.brettfleisch.com/WMWD-8.pdf

www.brettfleisch.com/WMWD-9.pdf

BIOGRAPHY

Professor Brett D. Fleisch served as Associate Professor of Computer Science and Engineering at the University of California, Riverside. He was promoted to tenure in 1997. He received the Ph.D. degree in Computer Science from UCLA in July 1989. He received the B.A. degree in Computer Science at the University of Rochester, the M.S. degree in Computer Science at Columbia University in 1981 and 1983, respectively. He joined the UCLA computer science department in September 1983 where he served as Research Assistant in the Locus group. His dissertation was entitled "Distributed Shared Memory in a Loosely Coupled Environment".

In the past, Fleisch has served as a consultant and summer employee at Xerox Corporation's, Webster Research Center, IBM Corporation's Thomas J. Watson Research Center, the Educational Testing Service in Princeton, New Jersey, The College Board (West Coast offices) and the State of California, Department of Motor Vehicles. In addition, he has also worked at Hewlett-Packard Laboratories, Carnegie-Mellon University, Locus Computing Corporation, and has served as a teaching assistant in the UCLA Computer Science Department. In January 2003 he recently spent a six month sabbatical period at the University of Illinois, Chicago.

Fleisch was Program Director for NSF, CISE Computer Systems Research Program in 2004-2007 as IPA. His research interests are in operating systems, distributed systems, mobile systems, computer security, DSM, fault-tolerance, reliability and availability. Dr. Fleisch has been funded by the National Science Foundation, Digital Equipment Corporation, International Business Machines Corporation (IBM), Hewlett-Packard Laboratories, Computer Marketplace Incorporated, Sun Microsystems, the Office of Naval Research and the UC Micro program. Dr. Fleisch was a member of the ACM, IEEE Computer Society, and USENIX while professionally active.

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