

Introduction

Website load times have been identified as a crucial factor to measure the performance of a website. With the information deluge on the Internet, user's patience levels have been continuously decreasing. Web usability guru, Jakob Nielsen says web users are constantly begging for faster page downloads.

According to the findings of the surveys conducted by Lightner, Bose and Salvendy (1996) and the Gvu (Graphic, Visualization and Usability) Centre at Georgia Institute of Technology (GVU, 1998), long download times have always been a major problem experienced by Web users. The survey by Pitkow and Kehoe (1996) also indicates that the most widely cited problem with using the world wide web was that it took too long to download Web pages (i.e. 69% of respondents cited this problem).

For e-commerce sites web loading times are even more crucial than other sites. It has been found that a delay of microseconds can potentially cause a significant loss of revenue. Tests at Amazon revealed similar results: every 100 ms increase in load time of Amazon.com decreased sales by 1% (Kohavi and Longbotham 2007). Google discovered that a change in a 10-result page loading in 0.4 seconds to a 30-result page loading in 0.9 seconds decreased traffic and ad revenues by 20% (Linden 2006)

In this paper we are calculating the number of users lost every second a website takes to load with data by plotting a curve between the percentage of visitors and the time taken for the website to download.

User patience levels

User patience levels have been constantly decreasing over the years. Zona research established in 1999 that one third of your visitors are lost if your site takes more than 8 seconds to download. Akamai found in 2006 one third of your users are lost if your website takes more than four second to download for broadband users. Broadband users are more impatient than dial up users.

Optimal page load times have decreased from 8 seconds to four seconds. A study by Fiona Fui-Hoon Nah in the University of Nebraska said that tolerable wait times have decreased to just two seconds. This sends out a powerful message to all sites, especially ecommerce sites, to have quick response times for internet users in today's climate where broadband connections and user impatience rule.

Effects of slow loading pages

The effect of slow loading pages not only affects your sales but have longer negative effects than what might be apparent. In 2006 Akamai established that 40% of online shoppers feel that the most influential factor for them to revisit a site is whether the website will load quickly. More than a quarter of dissatisfied shoppers are likely to develop a negative perception of the company. Faster web pages will also increase conversion. Consequently, fast loading web pages have a higher impact on long-term sales than perceived.

Research model and methodology

We are developing a mathematical model that will establish the relationship between the numbers of shoppers that leave the site for every second a web page takes to load.

From past data we see that a curve follows approximately a radioactivity first order decay equation (e-marketer's report in 2005). We will use the first order radioactive equation to approximate the number of users who leave a website. The rate of decay in a first order decay function is proportional to the number of users who are still on the website when it loads.

Another good thing about the first order curve is that it is used frequently as a model in non linear regression analysis. We do not have as many data points in our case to do a non linear regression for the curve. A regression is the preferred way when we have lots of points, not all describing a curve or a line and we want to find the best curve or line that would describe it.

To develop the mathematical model we are making the following assumptions:

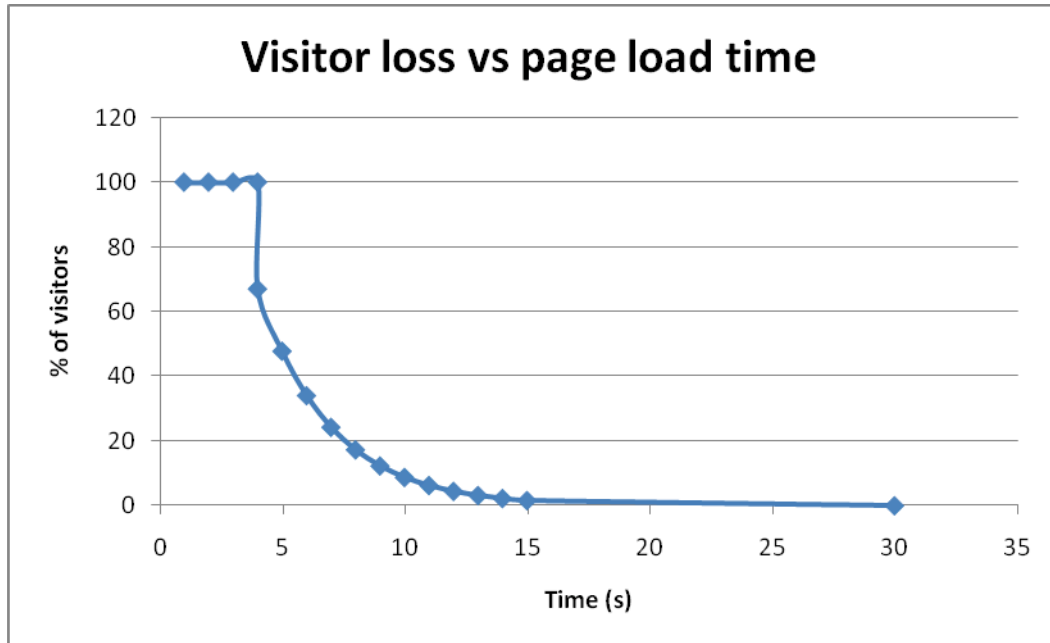
- The loss of the number of visitors to a site follows the radioactive first order decay from 4.001 seconds to 30 seconds. Immediately after four seconds there is a loss of one third of the visitors who abandon the site, based on the latest Akamai research.
- The optimal page load time is four seconds and before four seconds we assume there is no loss of visitors.
- The server times out in 30 seconds
- Since this is a negative exponential curve it never become zero, so we assume that a website loses 99.99% of the users at 30 seconds instead of 100 when the server times out.

The first order decay curve is:

$$N = N_0 \exp(-\Delta t)$$

So we take the data points and we get the following curve:

$$\text{Number of users} = 259.939 \exp(-0.338854 * t)$$



The y axis represents the percentage of users on the website and the x axis represents the time taken for the website to load.

Conclusion

Page load times are crucial for sales for an ecommerce site. In the future, this graph will become steeper and the optimal load time will fall as Internet connections throughout the world are improving. For optimal sales performance for an ecommerce site attention to even a millisecond of extra page time is important from a sales perspective.

References

- Akamai. June 2006. "Retail Web Site Performance: Consumer Reaction to a Poor Online Shopping Experience." [Akamai Technologies](#), (accessed May 30, 2008). This is a JupiterResearch abandonment survey commissioned by Akamai.
- Bouch, A., Kuchinsky, A., and N. Bhatti, "Quality is in the Eye of the Beholder: Meeting Users' Requirements for Internet Quality of Service," in *CHI 2000* (The Hague, The Netherlands: April 1-6, 2000), 297-304. Found that latency quality ratings drop off at around eight to 10 seconds.
- Farber, D., "[Google's Marissa Mayer: Speed Wins](#)," CNET Between the Lines, Nov. 9, 2006, <http://blogs.zdnet.com/BTL/?p=3925> (May 30, 2008).
- Galletta, D., Henry, R., McCoy, S., and P. Polak, "Web Site Delays: How Tolerant are Users?" *Journal of the Association for Information Systems* 5, no. 1 (2004): 1-28.
- Graphics, Visualization and Usability (GVU) Centre, 1998, GVU's user surveys. Georgia Tech Research Corporation, October 1998, available at: http://WWW.cc.gatech.edu/gvu/user_surveys/.
- Kohavi, R., and R. Longbotham, "Online Experiments: Lessons Learned," *Computer* 40, no. 9 (2007): 103-105. The Amazon statistic was taken from a presentation by Greg Linden at Stanford: <http://home.blarg.net/~glinden/StanfordDataMining.2006-11-29.ppt>.
- Linden, G., "[Marissa Mayer at Web 2.0](#)," Geeking with Greg, Nov. 6, 2006, <http://glinden.blogspot.com/2006/11/marissa-mayer-at-web-20.html> (May 30, 2008).
- Pitkow, J.E. and Kehoe, C.M., 1996, Emerging trends in the WWW user population. *Communications of the ACM*, 39(6), 106-108.
- Nah, F., "A study on tolerable waiting time: how long are Web users willing to wait?" *Behaviour & Information Technology* 23, no. 3 (2004): 153-163.
- Nielsen, J., *Designing Web Usability* (Indianapolis: New Riders, 2000), 48-49.