模擬人生的方法

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最近大家都在高喊雲端運算，談虛擬化 (Vitualization) 、負載平衡 (Load Balancing) 等等。其實這些技術的基本原理，在 2、30 年前就已存在。例如我的博士論文題目是平行模擬 (Parallel Simulation)，係以多部計算機來模擬離散的事件 (Discrete Event) ，在負載平衡上就下了極大的工夫。

平行模擬最大的問題是，許多部計算機要共同模擬一個現象，彼此必須協調，相當困難。例如用 10 部計算機模擬一個系統在 100 分鐘內的變化，這些計算機必須依時間的次序來模擬事件 (Event)，因此要協調，避免後發生的事，被先模擬到。我們的研究顯示，協調的成本甚高。

1980 年代的有一天我突發奇想，做了另類思考，如果將前述 100 分鐘的模擬，切成十份，第一個 10 分鐘由第一部計算機模擬；第二個 10 分鐘由第二部計算機模擬，以下類推。所有計算機平行模擬時，彼此之間不需要做任何協調。當它們全部完成運算後，再將所有 10 分鐘的結果依序串接回來，就完成整個模擬程序。我將這個方法叫作 Time-Division Algorithm，發表於 ACM Transactions on Modeling and Computer Simulation 這個雜誌的創號刊，頗受矚目。

有不少學者持續我的研究，但將這個方法改名為 Time-Partitioning Algorithm。這個方法其實並不容易使用。你必須先預測系統在第 10 分鐘時，處於何種狀態，如此第二部計算機才能正確的模擬第二個 10 分鐘。這當中有一些數學理論，不在此說明。

在電話公司工作時，我曾用 Time-Division Algorithm 來模擬電信交換機的效能。後來我有點走火入魔的想，是否可以用這種方法快速模擬人的一生。例如針對一個 20 歲的人，我們先假設他在 30 歲時的狀況 (由關西摸骨算命師提供)，再同時模擬他 20~30 歲及 30~40 歲發生的事，豈不有趣？其實狄更斯 (Charles John Huffam Dickens；1812~1870) 在《小氣財神》(A Christmas Carol) 這部小說，就用 Time-Division Algorithm 對主角 Scoorge 的一生快速模擬，然後讓聖誕精靈分段放給 Scoorge 看。

做模擬研究的人，都會忍不住去偷嚐「模擬生命」這個禁果。我 20 年前的一位好友傑佛森 (David Jefferson) 就是如此。傑佛森超級有個性，喜歡開跑車飆速，也很會「國罵」。我大部分的「美國俚語」，是向他學來的。他在 UCLA 升等為常聘副教授 (Tenured Associate Professor) 沒多久，打電話告訴我：「Jason, I fxxking left UCLA.」原來他一升等就決定換工作，跑去一家公司玩耍子去啦。

傑佛森發明了一種很特殊的平行模擬方法，叫做 Time Warp，時間可以倒捲回來的意思 (不過 Len Klenirock 好像也獨立想出類似的方法)。Time Warp 的計算機不互相協調，各自亂跑 (這和傑佛森的個性很像)。當一部計算機發現跑過頭時，就將時間倒退，並取消 (undo) 超前模擬的事件。傑佛森這怪咖後來想到要模擬生命。他闖入了生物領域，進行人工生命 (Artificial Life) 的模擬，我一點都不驚訝。

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A Method for Life Simulation

Recently, everyone has been making a lot of noise about cloud computing, virtualization, load balancing and so on. In fact, the basic principles of these technologies have been in development for the past two or three decades. For example, the topic of my doctoral dissertation was Parallel Simulation, using multiple computers to simulate discrete events; as a result of that, I put great efforts into load balancing.

The most critical issue in parallel simulation was the extreme difficulty to simulate a phenomenon by massively coordinating computers together. For example, if 10 computers are used to simulate the changes of a system within 100 minutes, these computers must simulate events in the order of occurrence. Therefore, they must coordinate to avoid simulating the later event in advance. Our research showed that the cost of coordination was very high.

One day in 1980s, I got a fanciful idea that led to an alternative thought. If I cut the aforementioned 100-minute simulation into ten pieces, the first 10 minutes will be simulated by the first computer, the second 10 minutes will be simulated by the second computer, and so on. If all computers are simulated in parallel, there would be no need to coordinate with each other. After all of them have completed the calculation, all the 10-minute results are serially connected in order to complete the entire simulation program. I called this method Time-Division Algorithm, which was published in the first issue of ACM Transactions on Modeling and Computer Simulation and attracted much attention.

A number of scholars have continued my research, renaming the method to Time-Partitioning Algorithm. This method is actually not easy to use. You must first predict the state of the system at the 10th minute, so that the second computer can correctly simulate the second 10 minutes. There are several mathematical theories involved, which are not explained here.

When I was working for a telephone company, I used the Time-Division Algorithm to simulate the performance of telecommunication switches. Later, I got a little carried away and wondered if I could leverage the same method to quickly simulate a person's life. For example, for a 20-year-old adult, let's first assume his condition by the age of 30 (provided by a fortune teller in Kansai), and then simultaneously simulate what happens to him between 20 and 30 years old as well as between 30 and 40 years old. Isn't it amusing? In Christmas Carol, Charles John Huffam Dickens (1812~1870) used the Time-Division Algorithm concept to quickly simulate the life of the protagonist Scrooge, and later the Ghosts of Christmas showed Scrooge the moments in his past, present, and future.

Those who do simulation research can't help but taste the forbidden fruit of "life simulation". It was just the case with David Jefferson, a good friend of mine who I first met 30 years ago. Jefferson has a strong personality. He likes to drive sports car at high speed and is good at using swear words. I learned most of "American slang" from him. Not long after he was promoted to tenured associate professor at UCLA, he called me and said, "Jason, I fxxking left UCLA." It turned out that he decided to change his career once he was promoted, and went to a company to play around with his ideas.

Jefferson invented a special parallel simulation mechanism called Time Warp, which means virtual time can be rolled back (but Len Klenirock seemed to have come up with a similar method independently). The computers in Time Warp simulation don't coordinate with each other and run in an un-preconfigured manner (which is very similar to Jefferson's personality). When a computer detects that it has gone too far, it rewinds time and cancels (undo) the events that were simulated ahead of time. Jefferson-the-geek later thought of life simulation and broke into the biological field by simulating Artificial Life, which didn't surprise me at all.

Dr. Jason Yi-Bing Lin / Lifetime Chair Professor

Dr. Lin is currently a lifetime chair professor of the Department of Computer Science at National Chiao Tung University and Winbond chair professor. He is an ACM Fellow, IEEE Fellow, AAAS Fellow and IET Fellow. His research interests include Internet of Things, mobile computing, and system simulation. He has developed an Internet of Things system called IoTtalk, which is widely used in smart agriculture, smart education, smart campus, and other fields. He has a variety of interests, such as art, painting, and writing, as well as voyaging through science, technology, and humanities.