

The Lambda Calculus: Practice and Principle

Hugh Leather¹ and Janne Irgens²

¹ University of Edinburgh,
hughleat@gmail.com

² Number 15,
jannefirgens@gmail.com

Abstract. The Lambda Calculus has perplexed students of computer science for millennia, rendering many incapable of understanding even the most basic precepts of functional programming. This paper gently introduces the core concepts to the lay reader, assuming only a minimum of background knowledge in category theory, quantum chromodynamics, and paleomagnetism.

In addition, this paper goes on to its main results, showing how the Lambda Calculus can be used to easily prove the termination of Leibniz’ Hailstone numbers for all $n > 0$, to show that matrix multiplication is possible in linear time, and to guarantee Scottish independence.

1 Introduction

The fascinating story of the discovery of the Lambda Calculus is well known to all school children, but we here recount the essentials of the story for completeness. In the 27th century BC, Egyptian slaves were quarrying stone for the Pyramid of Djoser, northwest of Memphis. Buried deep in the sand, they unearthed a rare stele, complete with the full Lambda Calculus, written in hieroglyphics. At the time, none of the finest scholars of the ancient world could decipher the tablet and for many years it lay forgotten, a relic of a bygone era.

All that changed, however, when in 1929 Alonzo Church came upon the Djoser stele in the British Museum. In the decade before, Church had been working as a chorus girl in a music hall production of the Social Network during its long and infamous tour of the Middle East. There he had developed a passion for hieroglyphics and early Egyptian history. Thus it was that when he first laid eyes on the stone carvings, he instantly knew the significance of the markings and began fervently to decode them. He completed the work in 1932 with the paper, “A set of postulates for the foundation of logic”. His article was an instant success, reaching number one on the New York Times best seller list for twelve weeks running, and earning him a much coveted Turing Award³. The rest, as they say, is history.

1.1 Lambda Calculus Defined

But, what is the Lambda Calculus? Despite the usual confusion that surrounds it, this dainty and delightful logic can be perfectly described in one short sentence:

“The square of the hypotenuse is the sum of the squares of the other two sides.”

Or more formally:

$$E = mc^2 \tag{1}$$

Now that the reader is fully conversant with the calculus, the next section describes the importance of Lambda Calculus to circadian rhythm biology.

³ This seriously annoyed Alan Turing who did not win a Turing Award. In response, Turing changed his name to Benedict Cumberbatch and won an Oscar. Oscar didn’t really mind.

THE ADVENTURES OF

LAMBDA MAN

Origins

Story by Hugh Leather
Drawing by Janne Irgens



THIS IS MY CITY



MINE TO PROTECT



MINE TO WATCH OVER



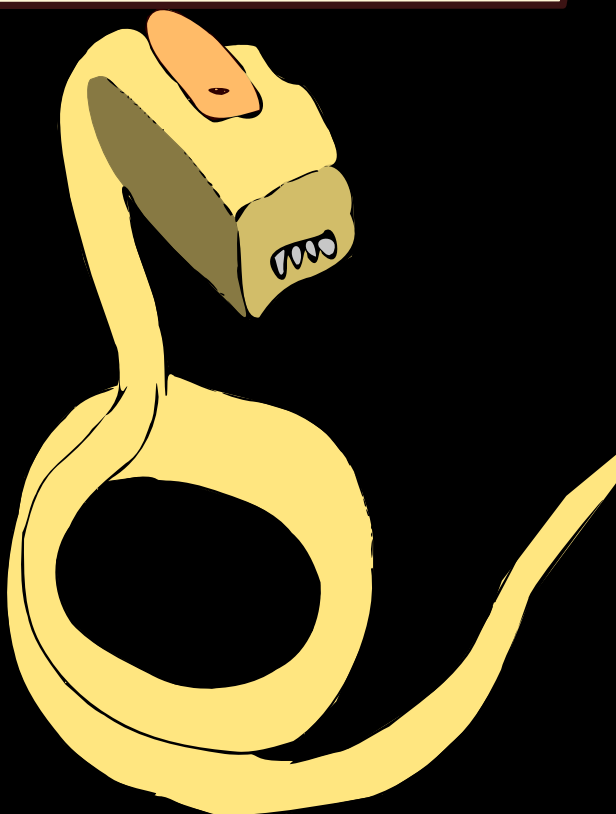
BUT IT WASN'T ALWAYS THIS WAY

ONE YEAR EARLIER:

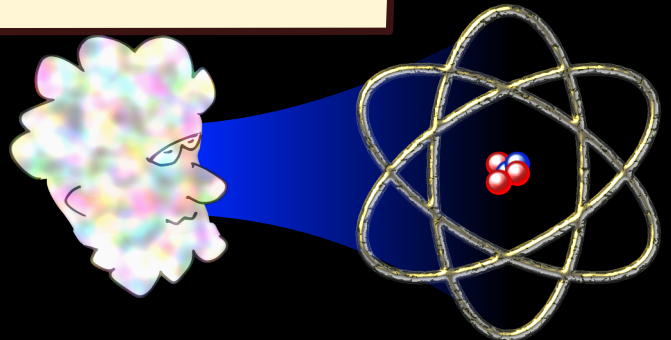


I WAS TEACHING HASKELL TO THE UNDERGRADS, JUST LIKE EVERY YEAR

AN ACCIDENT WITH A RADIOACTIVE
ETHERNET CABLE MOMENTARILY
CONNECTED MY FRONTAL LOBES TO
THE INTERNET



I KNEW EVERYTHING



ALSO I REALLY LIKED CATS

OBVIOUSLY,
I STARTED
TO FIGHT
CRIME

THE MOB
HAD COME
TO MY CITY.

THE NATIONAL
THE NEWSPAPER THAT SUPPORTS AN INDEPENDENT SCOTLAND

Drugs All Over Edinburgh

New Boots Warehouse

Nicola Sturgeon says she is super chuffed with all the jobs and stuff and reckons this will really stick it to the Tories (who suck by the way). Local resident Bobby McBob, said this is a dream come true since he hasn't been able to find Valium in his local corner shop for years.

Cameron marries Pig

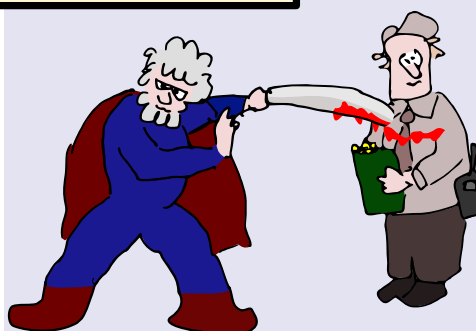
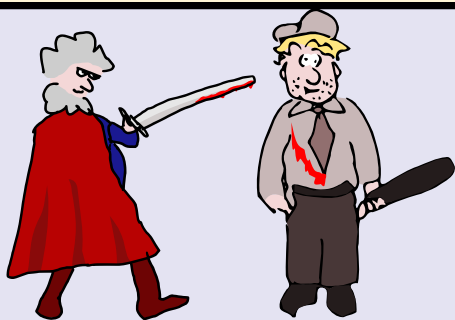
Nobody in politics was surprised to find that David Cameron has married his long term love. Ex-wife Samantha said that she wished the new couple the very best and hoped that they have beautiful Tory piglets together.



WITH MY NEW SKILLS IT WAS EASY TO FIND THE WAREHOUSE THE MOB WAS USING TO HIDE ITS DRUGS

GOOGLE: FIND DRUGS NEAR ME

CREEPING THROUGH UNNOTICED WAS EASY



THESE FOOLS DIDN'T EVEN UNDERSTAND LINEAR TYPES

I BURNED ALL THE MOB'S DRUGS

MY CITY WAS SAVED

THE NATIONAL
THE NEWSPAPER THAT SUPPORTS AN INDEPENDENT SCOTLAND

No Drugs in Edinburgh

Mass Murder - Police stumped

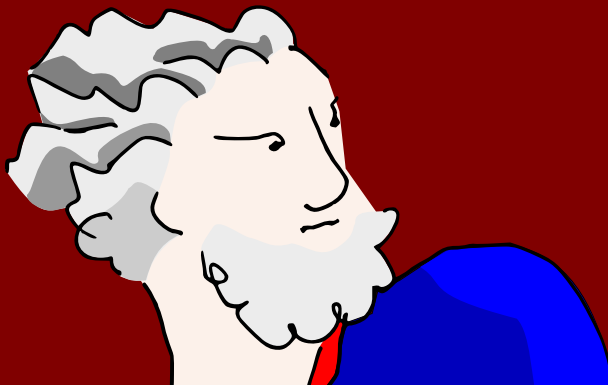
Security guards at the new Boots warehouse were ambushed and killed last night. CCTV footage showed a caped, sword wielding madman in blue rampaging through the warehouse shouting "Death to drug dealers!" Police say they are currently following up leads, but nobody believes a word of it.

Wadler Wins Turing Award

Professor Philip Wadler of Edinburgh University has won the prestigious Turing award for computer science. When asked for a comment, the committee said "Well, it's his birthday and so we thought he'd probably like to see this headline in this comic."

TODAY

BUT CRIME NEVER SLEEPS, MY JOURNEY HAD JUST BEGUN



DON'T MISS THE NEXT EPISODE: LAMBDA MAN VS THE GOTO GUY IN STORES 2026

2 Conclusion and Further Work

This paper has two major contributions. The first is that we are the first researchers to the best of our knowledge to have found a bonefide use for Comic Sans in a scientific paper⁴. The second, arguably more important contribution, is that we have wished Phil Wadler a very happy sixtieth birthday. In the future we hope that while we are exploring more uses for Comic Sans, that Phil has a jolly good time.

We would also strongly recommend that, no matter how much Phil wants to have a washboard stomach and to fight crime, he does not experiment trying to make a radioactive ethernet cable. And, under no circumstances should he go inserting ethernet cables anywhere other than ethernet sockets.

References

1. Hendrik Pieter Barendregt. *The lambda calculus*, volume 3. North-Holland Amsterdam, 1984.
2. Henri Bergson. *Laughter: An essay on the meaning of the comic*. Macmillan, 1914.
3. John L Bowman, Hajime Sakai, Thomas Jack, Detlef Weigel, Ulrike Mayer, and Elliot M Meyerowitz. Superman, a regulator of floral homeotic genes in arabidopsis. *Development*, 114(3):599–615, 1992.
4. Alonzo Church. A set of postulates for the foundation of logic. *Annals of mathematics*, pages 346–366, 1932.
5. John Clueless and Hope Itworks. 101 dubious ways to improve your h-index. In *Proceedings of the 1901 Conference on Unlikely Ways to Get Ahead (CUWGA '01)*, Jan 1901.
6. Alexander Collins, Christian Fensch, and Hugh Leather. Auto-tuning parallel skeletons. *Parallel Processing Letters (PPL)*, 22(2):1240005–1–16, June 2012.
7. Alexander Collins, Christian Fensch, and Hugh Leather. Optimization space exploration of the fastflow parallel skeleton framework. In *HLPGPU '12: Proceedings of High-Level Programming for Heterogeneous and Hierarchical Parallel Systems*, January 2012.
8. John Harris. *Wonderwoman and Superman: The Ethics of Human Biotechnology*. Oxford University Press, 1992.
9. Sabine Hummert, Stefan Schuster, and Christian Hummert. Batman - the dark knight: A game theoretical approach. In Hamid R. Arabnia, George A. Gravvanis, and Ashu M. G. Solo, editors, *FCS*, pages 29–34. CSREA Press, 2010.
10. Stephen Kyle, Igor Bohm, Bjorn Franke, Hugh Leather, and Nigel Topham. Efficiently parallelizing instruction set simulation of embedded multi-core processors using region-based just-in-time dynamic binary translation. In *LCTES '12: Proceedings of the ACM SIGPLAN/SIGBED 2009 Conference on Languages, Compilers, and Tools for Embedded Systems*, June 2012.
11. Stephen Kyle, Hugh Leather, Bjorn Franke, Dave Butcher, and Stuart Monteith. Application of domain-aware binary fuzzing to aid android virtual machine testing. In *Proceedings of the 2015 International Conference on Virtual Execution Environments (VEE'15)*, March 2015.
12. William F. Ogilvie, Pavlos Petoumenos, Zheng Wang, and Hugh Leather. Fast automatic heuristic construction using active learning. In *LCPC '14: Proceedings of the Workshop on Languages and Compilers for Parallel Computing*, September 2014.
13. Volker Seeker, Pavlos Petoumenos, Hugh Leather, and Bjorn Franke. Measuring qoe of interactive workloads and characterising frequency governors on mobile devices. In *IISWC '14: Proceedings of the 2014 IEEE International Symposium on Workload Characterization*, October 2014.

⁴ We acknowledge the pioneering work done by Simon Peyton-Jones rehabilitating this font in presentations. We also admit that “to the best of our knowledge” really means “we haven’t the faintest idea and don’t want to do any research into the matter”. To the best of our knowledge we are the first to ever make such an admission.