THE POWER OF *TURBO* PROLOG™

The Natural Language of Artificial Intelligence

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Introduction

PROLOG IS THE COMPUTER LANGUAGE OF THE FUTURE; A NUMBER of implementations have been available for the personal computer for some years. Unfortunately, none have gained widespread use, nor are they likely to, as they are interpreters, not compilers. They are also extremely obtuse in operation.

For Prolog to succeed, a fast compiler is needed. A compiler lets the user create "stand alone" programs. To generate the support needed for success, the compiler should be from a software conglomerate with exceptional success in marketing languages, like Turbo Pascal. And what would be a better ploy than calling it *Turbo Prolog*? But only Borland could do that!

As it happens, Borland's massive campaign to sell Turbo Prolog is under way. What is Turbo Prolog and why is it so great? Quieting an advance brochure on the package gives us a good idea:

"The astonishing fact is that Borland's Turbo Prolog gives you a $4 billion value for only $99.95.

"More than 4 billion U.S. dollars have already gone into the Japanese efforts to develop a fifth-generation supercomputer.

"Prolog is probably the most powerful computer programming language ever conceived—which is perhaps why our Japanese friends chose Prolog to be their supercomputer's implementation language.

"Without being rude about their efforts, we are pleased and proud to announce that they're not even *close* to achieving the performance that

Turbo Prolog now brings to your standard IBM PC."

Prolog, as a language concept, moves us much closer to the natural language interface that computers *should be* instead of the awkward-to-communicate-with number crunchers they are now. While the very term "artificial intelligence" is greatly misunderstood by the lay person, the relational possibilities it opens up have fantastic potential. Prolog gives us a good boost along that road.

This book is structured for several levels of software users. The novice will discover how to make his or her investment worthwhile. The immediate user will find information on getting the most out of all the features, including many tips not in the instruction book. For the advanced user with a modicum of programming familiarity, the practical secrets of more esoteric use are revealed.

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Chapter 1

The Quest For Artificial Intelligence

THE HUMAN BRAIN IS A WONDROUS ORGAN. IT AVERAGES ONLY about three pounds soaking wet. And "wet" truly describes it, because brain tissue has a higher percentage of water than any other part of our body.

This soggy little computer, consisting of somewhere around 100 *billion* cells, has enabled a frail organism called "Man" to reign supreme over this world. Who would have thought, in the beginning, that such a soft and squishy animal with no fangs to speak of and no claws worth mentioning would so thoroughly gain ascendancy? An animal that was blind, deaf, and devoid of the sense of smell compared to its larger and stronger competitors.

A thing called "intelligence" (being the old-fashioned natural kind) was the secret. How could a poor saber-toothed tiger, fierce and cunning as it was, compete fairly with a being that had such weird thoughts as, "There's that old saber-toothed tiger down there. I'll just stand up here on this cliff and pound it dead by throwing down all these heavy rocks." Or: "He's in that little cave and I know there's only one way out. I'll just pile all this dry brush in front of the entrance and barbecue the scudder. Smoked tiger meat, yum, yum."

Or pity the poor mastodon, rumbling along innocently in all its long-haired, elephantine glory, when suddenly the earth opens up. Dying, the beast looks up to see these mostly hairless creatures standing around their pit-trap discussing the latest recipe for mastodon burgers.

Shinnying up trees, throwing rocks, devising traps for game, taming and using fire—all these and more were tasks that the three-pound organic computer excelled at. No other species was able to remember and associate facts like Man could. It made a huge difference. In less than 100,000 years—a mere blink of an eye in the evolutionary time frame—we went from practically last place to number one seed. No other animal is currently even in contention.

EXTENDING OURSELVES

David Ritchie, in his excellent *The Binary Brain: Artificial Intelligence in the Age of Electronics*, discusses the real reason for our triumph. We succeeded against all the odds, he points out, because Man used his (and her) big brain to do such things as domesticating fire and making sophisticated tools.

Tigers shivered desperately in their lairs during the cold winters heralding the onset of this ice age or that; they didn't think to drag in dead wood and start a fire. Man did that, and sat toasty-warm in the cave until it was time to thaw out some quick-frozen saber-tooth for lunch.

Our ancestors effectively extended their reach, something we continue to do today. The carefully controlled flames at cavern mouths extended the ability of early *homo sapiens* to produce heat in times of chill. The spears and arrows soon invented made the ability to reach out and kill game animals greater.

This concept of extension continues today. Such things as radar extend our vision hundreds of miles, automobiles extend our limbs so that we can run at 55 miles per hour, and guided missiles have vastly increased our facility in projecting deadly force far beyond spears and arrows.

Overall, however, these *augmentations* to human capabilities are good. We don't grow wings, but we can fly. We don't have gills, but it is possible to breathe under water for protracted periods of time. We have walked on the face of the moon, something no other animal can even conceive of, much less do!

Not bad at all, but there are limits.

PUSHING THE NATURAL LIMIT

Back to that three-pound mass of watery, Jello-like tissue for a moment. Nature boxed herself in with us (at least for a few thousand more years of evolutionary time). There's no area for expansion. No more room at the inn.

The brain also is so fragile that, outside our heads, it can not support its own weight. Lay a naked brain down on a table and it tends to bulge and spread out, so it's protected behind a wall of bone, cushioned securely in its dark, warm nest, taking care of business and minding the

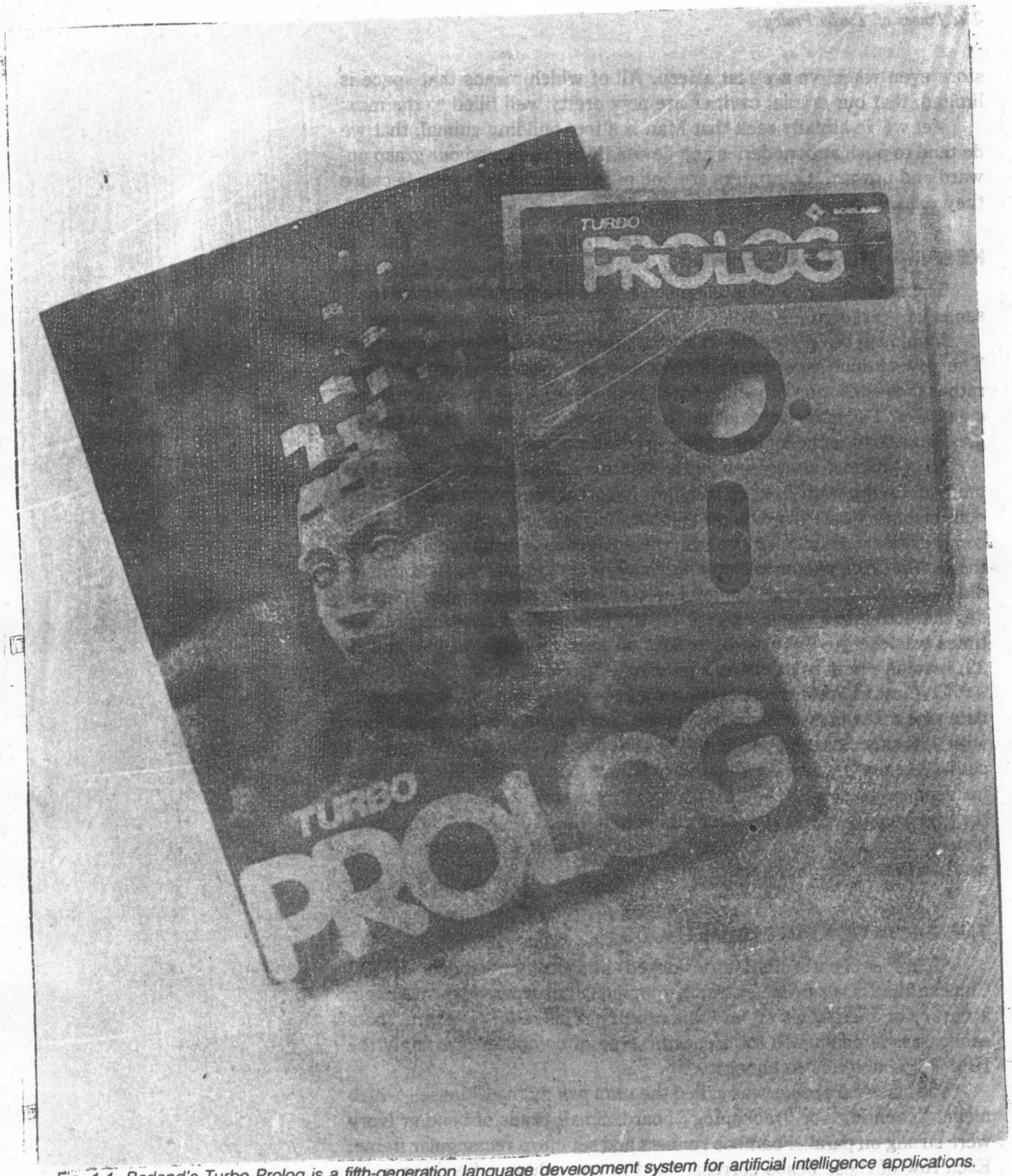

Fig. 1-1. Borland's Turbo Prolog is a fifth-generation language development system for artificial intelligence applications.

store even when we are fast asleep. All of which means that space is limited, that our cranial cavities are now pretty well filled to the max.

Yet we've already seen that Man is a tool-building animal, that we do tend to push at boundaries and devise things to extend our grasp onward and upward. Computers are one of the greatest of these, because they expand our brains.

KEEPING TRACK OF THINGS

The quest for artificial intelligence started in a fitfully lit cavern thousands of years ago.

Man's big brain brought with it an inherent problem of accounting. The now-extinct saber-toothed tiger had no possessions other than a rather nice collection of well-gnawed bones in its lair. It was not an accumulator. The human animal is. Tools, clothing, weapons, baubles, bangles, and beads—the articles piled up in the caves.

As civilization slowly evolved and became more complex, there was more and more stuff to keep track of. No other species has the horrendous inventory control problems that Man has engendered for itself. Such complexities were much more than the minds of our primitive forebears, the Cro-Magnon people in Neolithic times, were originally meant to handle. Once they ran out of fingers and toes, that was the end of it—it all degenerated into a vague concept called "many." The Einstein of those times was the guy born with six toes on each foot. He could count to 22, reaching new frontiers in higher math!

Civilization, however, demanded a good deal more sophistication in database management and information retrieval. For a barbarian king with a freshly captured palace full of gold pieces, even 22 just wouldn't cut it. The mathematician who had to stop at 20 or 22 was likely to have his head subtracted. Reading and writing was invented. Then followed the increasingly desperate quest for computational devices. Throughout history there have been men and women of vision who recognized the need to *extend* our intelligence.

THE FIRST COMPUTING METHODS

A number of early cultures developed simple computing devices. The Chinese abacus is a prime example, remaining unsurpassed in speed and accuracy of operation well into this century. This reign of several thousand years is unequaled for a specific type of computer. Certainly the IBM PC is unlikely to equal it.

The classical abacus was called the *suan pan* by the Chinese—which meant "counting" or "reckoning" board. Small beads of bone or ivory were strung on parallel bamboo runners and set into a rectangular frame. Each row of these beads corresponded to one column of written num-

bers. It was an incredibly powerful tool for rapidly adding and subtracting large numbers. The proficient operator could blaze along, accompanied by a flurry of tiny clicks as beads were flipped in this or that column. It was a truly astounding manual *mind extender.*

The ancient Incas of South America made their business computers out of rope. The *quipu* was a set of knotted cords similar to the cat-o'-nine-tails that old-time ship masters used to encourage recalcitrant sailors. This provided a database management system as well as rudimentary calculation.

The Romans found their calculator even closer to home—the human hand! Because of their extremely cumbersome system of numbers, Julius Caesar and his contemporaries evolved a very elaborate system of "finger" arithmetic. As David Ritchie points out (pun, as ever, intended) in *The Binary Brain*, counting on one's fingers in Imperial Rome was a sign of education rather than the opposite.

But trying to figure MCLVIII measures of wheat at VI drachmas plus 4 percent Imperial sales tax minus 1 1/2 percent for payment within 30 days was not easy. Whether on fingers or paper, it was unwieldy at best. Obviously a further extension of the human mind was needed.

Here's a surprise. Arabic numbers really came originally from India! Indian culture is often overlooked by us "moderns," but when Alexander the Great invaded India over 2000 years ago, they were already an old, highly advanced culture. They were the ones who finally turned him back, too.

Regardless, this numbering system had a big advantage over Roman numerals because of its concept of *place value*. One column stands for the ones, the next column for tens, the next for hundreds, and so on. It's simple, grammar-school stuff for us, but it rocked the literate persons of Europe back on their heels. It revolutionized calculation. Ritchie gives an interesting example. Take the problem of multiplying MMMCCCCLVII (3458) by CCCCLIX (159). Employing the "Arabic" system, pen, and paper, a mathematician could get the answer in 30 seconds or so. A Roman, waggling his fingers like a maniac, might manage it in 10 minutes.

In a few hundred years, Man came spitting and swinging out the other side of the Dark Ages. From the Renaissance down to our own time, the demand for increased abilities to calculate and keep track of things has multiplied in quantum leaps.

The expanding of frontiers was one very important impetus to this development. The fascination with the sea and the men who went down to it in ships is a case in point. As explorers ventured out of the Mediterranean "pond" into the vastness of the Atlantic, accurate navigation tables became of the utmost importance. Down through the 19th century, many thousands of men and women lost their lives because of inaccurate

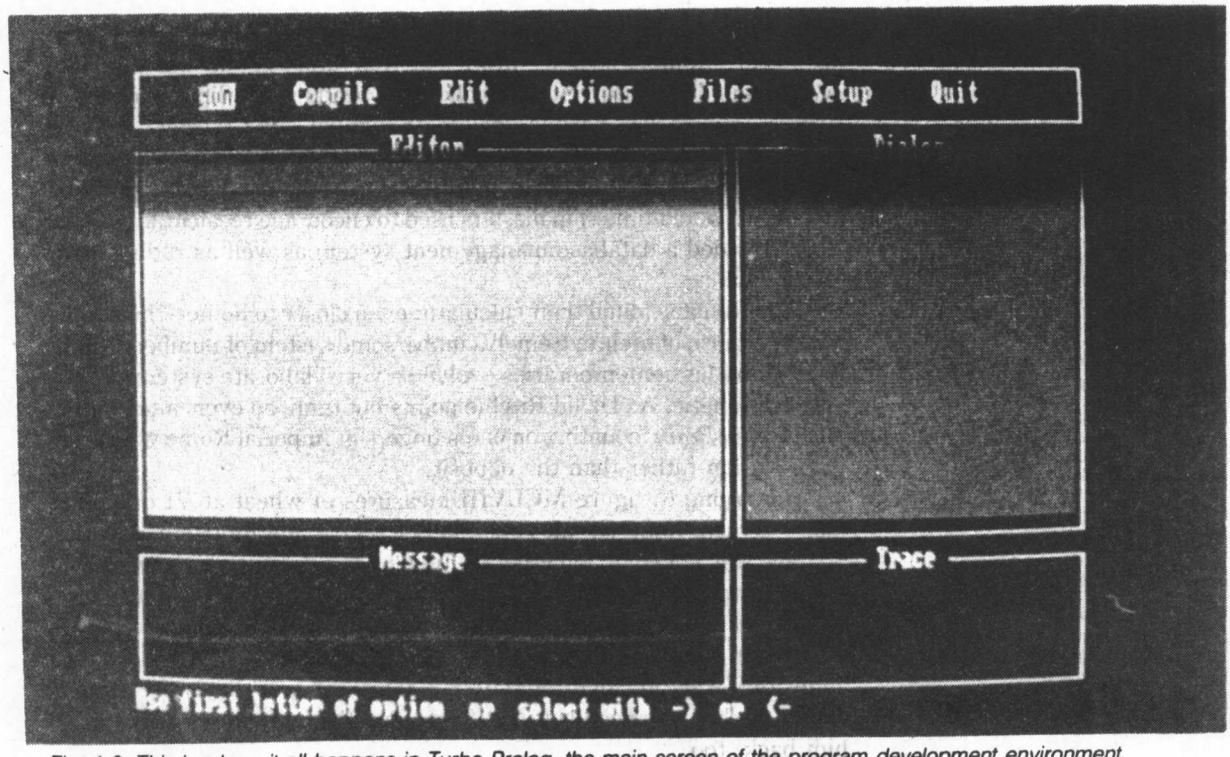

Fig. 1-2. This is where it all happens in Turbo Prolog, the main screen of the program development environment.

figures in navigation tables. Often the loud cracking of hull planking being broken as the vessel ran afoul of a storm-swept reef was the last sound many seafarers heard. A few perhaps even had the time to realize in horror that a minor error in course at the beginning of a long voyage could put them many hundreds of miles off at its finish.

Yet the sheer tediousness of the incredible mass of calculations required to construct such tables often emphasized human frailties. Attentions wandered, a number was transposed here, a decimal dropped there. Something better was needed.

CALCULATING MACHINES EXTEND THE MIND

As mathematicians roared along, expanding the boundaries of geometry, algebra, and number theories, the outcry for help became greater and greater. Isaac Newton yelled from more than pain when the apple hit his head. He realized the necessity of doing all the math to prove his theories, resulting in the development of calculus. You might say (*ahem*) that Newton fully comprehended the gravity of the situation.

The first to really achieve any success with a mechanical extension

of the human brain was William Schickard, ca. 1620. He was a professor of mathematics and astronomy. Among his friends was the famous astronomer Johannes Kepler. Schickard apparently succeeded in inventing a working calculating device that could add, multiply, subtract, and divide. He planned on sending Kepler one of the machines. Unfortunately, he died of the pestilence and his workshop was destroyed by fire with the device still inside. In those unsettled times of the Thirty Years' War, his invention was lost. Had scientists gotten this working calculator in the early 17th century, there is absolutely no telling the wonders we would know today. Mankind would certainly be much farther along on the road to the stars then we now are.

Later in that century, Blaise Pascal had better, though more limited luck. A French mathematician and philosopher who had considerable impact on civilization, Pascal's greatest achievement was in the field of math called "probability theory"; he also formulated Pascal's Law, which contributes mightily to the science of hydraulics.

Like all the mathematicians who had preceded him, Pascal bemoaned the orneriness of manual calculations. Even relatively simple problems could involve hours or even days of scribbling on paper. His back ached, his eyes turned blurry, his head hurt. Worse, no one had gotten around to inventing aspirin yet.

Pascal's answer was to design a device he named the *arithmetique*, a brass box the size of a loaf of bread, with eight dials on its face that one operated by using a stylus to input numbers on the dials. By entering ones, tens, hundreds, and so forth on the proper dial, calculations up into the hundreds of thousands could be performed. Alas, the *arithmetique* was less sophisticated than Schickard's lost machine. It could only add and subtract, and was unbelievably expensive as well—so much so that one could hire a whole cart of local mathematicians to do it manually for the same price.

Some 30 years later, around the turn of the 18th century, the German mathematician Gottfried Wilhelm Leibniz had his go at it. "It is unworthy of excellent men," he is reported to have said, "to lose hours like slaves in the labor of calculation that could be safely relegated to anyone else if machines were used." His invention, the Leibniz Wheel, was more powerful than Pascal's, being able to multiply and divide as well. David Ritchie describes it as "a cross between a slide rule and an old-fashioned meat grinder." But, like Pascal's device, it was expensive and only a few wealthy dabblers were willing to pay the price for the relatively minor aid it offered. Leibniz died in 1716, ignored by his countrymen and outshone in the field of mathematics by his English rival, Sir Isaac Newton.

Yet Leibniz is really an unsung hero. His invention inspired other