Overseas Feature

海外 · 特稿

人工智能发展路径漫谈

文 | 泰德 · 普林斯

著名科幻作家阿瑟·C·克拉克说过这么一句话：任何足够先进的科技看上去都无异于魔法。

接下来，让我们聊聊时下一个大热的话题——人工智能（AI）。人工智能将走向何处？我会就此谈一些看法，但有言在先，我提出的一些设想目前来看可能显得过于魔幻了。但就像克拉

2016 年 4 月，物理学家霍金(右)与著名投资人尤里·米尔纳（左）联合公布了"突破摄星"计划。

克说的那样，如果设想不够魔幻，它所描述的技术就还不够先进。

所以呢，既然我们要思考的是人工智能未来的发展，就有必要思考一些看起来接近魔法的事。目前大多数人谈论的人工智能，主要是探索运用数字技术来解决问题的方法，这固然既有趣又有用，但我的兴趣还是在于从新的角度来

研究此前没有人想到的人工智能发展方向，那结果就很可能等同于魔法。

1-2- 很多

我以前有个朋友，我们会不时争论一下某个特定的范畴中包含多少组成元素这个问题。我的主张是，某个范畴可能由比如100万个元素构成。而我的这位朋友更有想象力，思考问题也比我更有效率。他总是告诉我，要解读这个世界，三个数量词足矣——1、2和很多。凡大于2的，不管是10、100万还是哪怕1000万亿，都可以用"很多"来概括。宏观地看，质变只发生在这三个数量级上，其他只是计数大小的问题，数字本身不会再告诉你太多其他的信息。

在为人工智能加以归类时，我这位朋友提出的这个"1-2-很多"法则很有用。简单地说，人工智能就可以分为"1、2、很多"这三类，具体来说：

第一类是"精益人工智能"（Lean AI），这相当于人工智能中的"1"。这种人工智能非常强大，又非常非常精细和有效率。这种智能的载体，可能只是10个细胞、10个原子，甚至1个原子。未来我们需要在很多场合用到这种人工智能，我会在后文中举出一些例子。

第二类是增强人工智能（Augmented AI），这相当于人工智能中的"2"。这种人工智能是人类大脑与科学技术相结合的产物，比我们目前最聪明的头脑还聪明许多许多倍。它赖以建立的基础还是人脑，但辅助技术也必不可少。这类似于残奥会短跑项目上的"刀锋战士"，用高科技刀片状假肢武装起来的残疾运动员可比我们普通人跑的快得多。

第三类是外星人级别的人工智能（Alien AI），这相当于人工智能中的"很多"。或许有人会说，我们根本没办法想象外星文明的水平，又如何去定义和实现它呢？这说的没错，但我们至少可以大胆地设想一下，并朝着这个方向不懈地努力啊。

划分出以上类别之后，我们再详细地谈谈每一种人工智能的特点。

加拿大科学家近期宣布研制出一款可以在人体血管内运行的纳米机器人，它能精准地锁定癌细胞并投递药物。

泰德·普林斯
佩斯领导力研究院创始人暨CEO

精益 AI 侧重微观尺度

现在精益制造和精益供应链概念已经比较普及了，中国人在这些方面非常擅长。所以，精益人工智能说不定会由中国人发明出来。

什么是精益人工智能呢？类比一个例子来说，最近我看了一个科普类视频，说的是一个细菌追猎另外一个非常小的细菌，后者可能是病毒。每当小细菌想逃，猎手细菌就会追随它调转方向并继续追踪。这个猎手完全无视附近其它的细菌，它的唯一目标就是吃掉小细菌。最后，它成功了。

这个猎手细菌估计是由十几二十个细胞构成的，算得上相当小，但它能够像大型动物那样有目的地行动，追逐小细菌并吃掉它。所以它其实是一个超小的、拥有相当智力的机器。在我看来，这就很像魔法了，所以我会把它当做精益人工智能的一个好例子。

再举一个与鸟类有关的例子。鸟不光是能飞，它们还会做一些相当惊人的事，比如可以以非常高的准确率将自己导航到几千公里以外的目的地。在不用GPS和手机地图的情况下，你说它们是如何做到的呢？这真是太惊人了。除此之外，还有很多种鸟会用纸片和树枝制造工具并使用它们。不但鸟类如此，现在我们还知道有些昆虫也能制造和使用工具，并且有成熟的社交生活。

以前人们都以为动物中只有人才会制造和使用工具并具备成熟的社交能力，其它生物是不可能做到这些的。因为人类拥有真正的大脑，其他动物的脑容量非常小，无法获得做这些事的能力。显然这些人想错了，后来的科学发现表

明，虽然鸟类甚至昆虫的大脑很小，但它们也有精益智能。我们还不知道产生这种智能的原理，所以它看起来很像是魔法。

今年4月，物理学家霍金与著名俄罗斯投资人尤里·米尔纳（Yuri Milner）共同提出了"突破摄星"（Breakthrough Starshot）计划：提前将邮票大小的克级自动化太空飞行器发射到近地轨道，使其张开纳米光帆，然后从地球上用激光照射光帆，使飞行器在几分钟内加速到光速的1/5，这样可使其在20年内飞抵半人马座的比邻星并传回图像。从理论上说这个计划是可行的，但必须解决很多目前看来难度极大的挑战。在控制这种微小飞行器飞行的环节，看来是用得上精益人工智能的。有趣的是，在这个计划中，人类研究"微小"人工智能的目的是研究"巨大"的星球。

还有，科学家发明了用于医疗的纳米机器人，这种机器人小到可以被注射到人体中，然后利用其携带的药物杀死癌细胞，这一技术显然也要用到精益人工智能。除此之外，精益人工智能还有非常多的应用领域，如运输、采矿等。

以目前人类的科技水平而言，研发精益人工智能还是一个巨大的挑战，可能需要结合数学运算、VR等大量前沿技术。

增强 AI 的马太效应

有越来越多的证据表明，目前人类只自主运用了自身全部智力的一小部分，还有很多思维活动没有被纳入到有意识的管理中。也就是说，事实上人类还有大量的智力有待开发运用，所谓"傻瓜天才"群体的存在就证明了这一点。达斯汀·霍夫曼在电影《雨人》中出演的角色就是一个傻瓜天才：他看上去智商很低，但是在数学计算方面具有超乎常人的能力。这个角色在生活中存在大量原型，他们通常具备成为优秀的数学家或艺术家的能力。

人类大脑具备惊人的能力，但大多数人并不知道如何充分调动使用。我们可以采用人为手段来激发大脑的潜能，比如药物、智力训练甚或发明某种特定的机器，来提高大脑自然智能
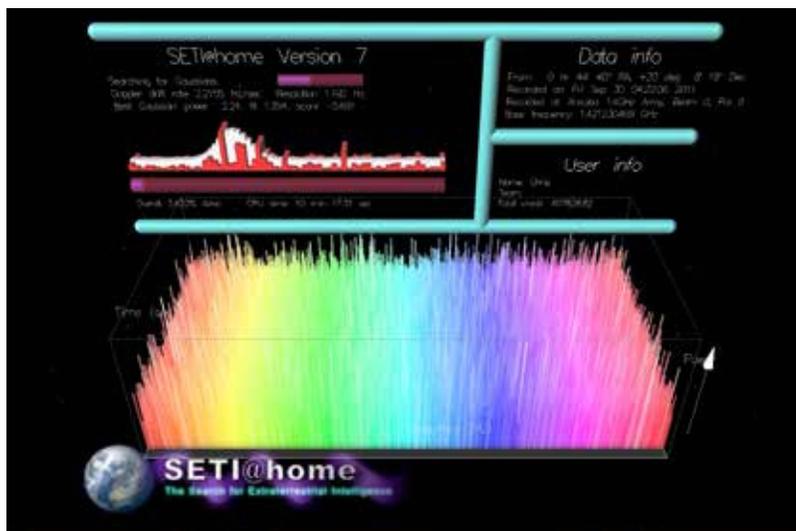
科学家发现，大脑中的神经胶质细胞在思考过程中发挥着重要作用，大脑的90%是由这种细胞组成，它们彼此间通过化学信号而不是电信号进行交流。

的效率。科技与大脑的结合可能会使我们掌握无与伦比的智能，这种技术与实体的结合形式类似于时下流行的增强现实（AR）。

过去人们认为大脑思考是通过神经元放电相互交流来实现的，现在这方面的研究有了新的进展。科学家发现，大脑中的神经胶质细胞在思考过程中发挥着重要作用，大脑的90%是由这种细胞组成的，它们彼此间通过化学信号而不是电信号进行交流，更具体的工作原理现在还不得而知。一旦这方面的研究取得进展，就可以人为地促进这种思考过程，让普通人也能获得傻瓜天才在某个领域的超常能力。不管使用药物还是机器激发这种能力，我们都将获得超出平常的增强人工智能。

增强智能研究还可以利用到仿生学技术。我们知道，章鱼除了正脑之外，每一条触手上还有一个附脑，附脑的神经元系统能够指挥每条触手独立动作。章鱼不但会使用工具，有先进的社交能力，还会想办法从我们认为不可能逃脱的地方逃走。由此可见，章鱼的各大脑之间能够很好地配合，从而产生很高的智能。在研究增强智能技术的时候，我们也应该参考大自然中拥有不同大脑结构和思维方式的动物。

总之，增强智能是人工智能发展的一条合理途径，它让人工智能的载体不只限于机器。这

因在于它认为最多可能存在11维空间。如果这个理论是对的，那么宇宙中还有八个我们看不到的维度，至少是不能轻易地看到。如果在比三维空间更多维度的空间存在智慧生命，他们的智力形式和结构是怎样的？他们是如何思考的，又如何看待我们人类呢？

可能有些人觉得研究这些想法太不现实，纯粹是浪费时间。但研究纯科学就是需要满怀探索精神，研究的很多课题最初看上去都是没有用的，而最后的结果证明它们非常有用。哪怕我们能找到上面提出的这些问题的部分答案，就可能让我们学会完全不同的思考方式，开启人工智能研究的新篇章。

平行宇宙中的智能　很多人听说过平行宇宙理论，这种理论认为，存在大量从某个宇宙中分离出来，与原宇宙平行存在、既相似又不同的其他宇宙，平行宇宙的数量可能是无限的。这个理论给我们提供了另外一个研究新型人工智能的途径：如果确实存在其它宇宙，那些宇宙中存在什么样的智能形式呢？

在我们生活的这个宇宙中有一些基本的物理常数，比如真空中的光速是一个恒定的数值，它不会随测量地点、测量时间及所用的测量仪器和材料的不同而发生变化。科学家们猜测，在其他平行宇宙的物理法则中，这些常数可能是不同的，那里可能不适合生命存在，但也可能更适合与我们完全不同的其它形式的生命生活，在深海海底光线无法到达的极端环境中生活的那些生命就是一个旁证。这些生命探索外界的感觉方式，包括视觉、触觉、嗅觉、听觉、味觉等，和我们完全不同。如果确实如此，那么问题来了，在平行宇宙中不同物理常量下生存的智能生命长什么样？它们的智能遵循什么原理，是何种结构？

总而言之，这种"1-2-很多"法则能进一步打开研究视野，开辟人工智能研究的更多方向。这并不是说现在主流的人工智能研究没有价值，它们当然很有价值。但如果我们想找到全新类型的智能，必须大胆开拓新的空间，尝试新的方法，这样才能获得更有趣、更有用的人工智能。◼

种智能具有一定的优势，因为它源于人类自身的智力，而且科学家对人的大脑已经有了一定了解。一旦弄清楚神经胶质细胞的工作原理，我们很可能找到其它目前尚不可知的提高增强智能的途径。

实行宇宙拿来主义

或许你听说过SETI@home，这是一个利用全球联网的计算机共同搜寻地外文明的科学实验计划，很多科幻电影的情节中都提到过这一点。能够到达地球的外星人肯定具有极高的智力水平，这属于那种"很多"级别的人工智能，或者叫超级人工智能。如果我们能学会像外星人那样思考问题，人类的整体智力水平将有巨大的提升，这也是研究人工智能的一个路径。

外星人是如何思考问题的呢？目前没人知道，毕竟我们都没见过外星人。从何处着手破解这个问题呢？一个可能的方法是，去想象外星人生存的极端环境，然后尝试想象并弄清楚具有什么样智力水平的生物才能在那种环境中生存下来。目前我能想到的有多维空间和平行宇宙这两个角度。

多维空间中的智能　你听说过弦理论吗？这是一个物理学假说，目前还没有得到证实，说不定永远都无法证实。这个理论非常有趣，部分原

左图: 在科幻电影《星际穿越》中，男主角穿越黑洞到达五维空间，并得到了其中高智慧生物的帮助。
右图: 参与 SETI@home 的志愿者可以利用自己电脑多余的处理器资源运行一个免费程序，来分析射电望远镜收集到的数据。这个项目自 1999 年 5 月 17 日正式运行，于 2005 年关闭，一共吸引了 543 万用户参与，他们的电脑累计工作时间长达 243 万年，但是没有发现存在外星文明的直接证据。图为 SETI@home 软件的运行界面。

"If your AI is not magic, it's not AI"

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Did you ever hear of the famous American science fiction writer called Arthur C. Clarke? He invented a famous phrase, namely "Any sufficiently advanced technology is indistinguishable from magic."

This article is about artificial intelligence (AI). Right now AI is really hot. Where is it headed? I'm going to make some suggestions. But what I'm going to suggest is that if what I suggest doesn't appear to be magic, the technology that uses it isn't advanced enough to be considered magic. That means AI has got to be magic to meet my criterion.

Here's an example, this time a British scientist named Sir Fred Hoyle, He actually was awarded a Nobel Prize for his research into cosmology. But what many people remember him for is his famous science fiction novel called "The Black Cloud". The story is about a giant black cloud that surrounds all of Earth shutting off the Sun's rays and causing all humans to be very scared about the impact of this on agriculture and the health of the Earth.

But it turns out that this black cloud was actually a living being. However in this case the living being was made up of trillions upon trillions of tiny particles that together made up this massive cloud that encompassed the Earth. And each of these trillions of particles was communicating with each other. In fact the cloud was ultra-ultra-intelligent. It was unimaginably advanced technology. So of course, to the people on Earth it looked just like magic.

So if we really want to think about AI and where it's going us really need to think of things that would otherwise be magic.

So you see I'm not so interested in the types of AI that most people are talking about now. Mainly that includes digital assistants to answer questions, to help you with medical diagnoses and to find new facts. Now these are all very interesting and useful. But my interest is in finding new approaches to AI that have never been discovered before. So the result will appear to be magic.

I used to have a friend and occasionally we would have an argument about how many things there might be in a certain category. I would say to him that maybe there would be a million of these things in this category. My friend, however, was much more imaginative and at the same time a more efficient thinker than me. He would always tell me that there are only three numbers in the world, one, two and

many. Once you get over two things that is many, whether it is 10, 1 million or a thousand trillion. It was the principle that counted, not the number which after all doesn't tell you much.

So when I think of AI I want to think of my friend's principle of number. How can we categorize the power of AI no matter how it is constructed? One, two, many of course! So we will call it the One-Two-Many approach for convenience. And here's a bit more detail just in case you're a bit confused about this classification.

Lean AI (LAI): That's the One of AI. It's very powerful but very, very lean and efficient. For example, what if I could make a fantastically intelligent machine using just 10 cells? Or 10 atoms? Or maybe one atom? There's going to be lots of occasions we want LAI. I'm going to give you some examples below, just in case you're a bit doubtful about the idea.

Augmented AI (AugI): That means my brain plus something else that makes it ultra-ultra intelligent beyond our wildest imaginings. But here it's the Two because it just my brain and something to help it to get to the AugI level. It's kind of like a disabled runner using special blades to enable him to run much faster than a normal person, two things, a body and a helper, or a brain and a helper.

Alien AI (ALI): That means AI which is at the level of an advanced alien. That's the Many of AI. Of course it's so far off that you might justifiably think that there's no way we can even imagine it, let alone define and construct it. But we could have fun trying, right? And maybe even if we don't construct ALI, it would teach us how to get there even if we can't finish it.

In any case I don't think anyone would argue that it's not worth having ALI. And if you could actually achieve ALI, wouldn't that be a huge achievement? Make you rich and famous? Get you the Nobel Prize? Or something else, just a lot of satisfaction, as long as it were used for the good of humans?

So let's think about where AI is going in terms of these labels and see where the One-Two-Many approach leads us.

Lean AI: Doing Everything with (Almost) Nothing

I'm sure you have heard of lean manufacturing and lean supply chains. China is very good at these things. So maybe Chinese people will be able to achieve LAI too. But what is that?

Here's an example. I recently watched a science video. It showed a bacterium chasing a really small bacterium, maybe even a large virus. Every time the little guy tried to get away, the bacterium turned with him and continued to chase him. The bacterium ignored all the other bacteria nearby. Its aim was the eat the little guy. And in the end it did.

Now how many cells were in that bacterium? 10? 20? That's lean. Yet it was able to chase down this like guy and eat it. That's what big animals do. Yet this animal was tiny. It was an ultra-tiny machine that was amazingly intelligent. It sure looks like magic to me so I'm going to accept this as a good example of LAI.

Let's take another example. Birds. Birds do some pretty amazing things other than fly. They can navigate with pinpoint accuracy to precise points thousands of miles away. Without a mobile phone too! That's really impressive.

But we now know that there are many kinds of birds that can actually construct and use tools, made out of things like cardboard and sticks. Now we know that insects can construct and use tools too and also have sophisticated social skills and techniques.

We used to think that the only animals that could use tools were humans and that we could do that because we had really big brains. And only big brains like humans allowed an animal to possess our advanced social skills. Other animals weren't supposed to be able to do that because their brains were so tiny, they didn't have enough mental horsepower to pull off this prodigious feat.

But we were wrong! Birds and even insects have LAI too with tiny brains. How do they do it? We have no idea. So it looks like magic too. I'm going to accept that as another example of LAI.

The famous Russian and imaginative billionaire Yuri Milner has recently proposed a mission to the stars using a 5 ounce package accelerated to almost the speed of light by a laser. In principle it should work. But this payload is tiny and yet it's going to have to deal with unimaginable challenges getting to the star it is targeting, and then coping maybe with landing on an alien planet. That's one really big LAI challenge. So that's one place we could use it.

Or how about ultra-small pills that are injected into people to diagnose and maybe even cure you of a particular disease. That's going to need LAI too. So as you can see there are numerous applications for LAI. Medicine, transportation, research, mining and so on.

But as I have said we don't know how bacteria and birds do their own LAI. We need to find out. It's a huge challenge. Whoever finds the answer is going to be very famous and probably very rich. Before anything else we need LAI. Start small and lean. Then the stars.

Somehow we're going to have to construct LAI. Maybe we have to start trying to do it computationally using math and virtual reality to see how tiny machines could be so smart. Or we're going to have to try making ultra-smart nano-machines. But we need to start on it no matter how it's done.

Augmented intelligence (AugI): Making much more from what you already have

There's increasing evidence that humans use only a small fraction of their total potential intelligence. Much of our thinking and use of our intelligence is unconscious. We do not direct much of that intelligence. So in fact have vastly more intelligence than we actually use. We see this from disciplines such as behavioral economics and finance.

But there is one definite proof of this fact. It is through people called "idiots savants". These people often appear to be intellectually backward, even mentally defective but actually they have amazing intellectual abilities. These are often mathematical but sometimes artistic. This ability was highlighted in the American film "Rain Man" starring Dustin Hoffman. He was able to use his brain to regularly win in gambling casinos. The movie is based on a real-life person.

So the brain has amazing capabilities but the vast majority of us have never been able to use them. In fact our brain might have the best form of "artificial" intelligence because it's also natural intelligence. What if we could find out how to use this incredible ability?

Maybe there is a way, using either drugs, mental exercise, or even a machine or prosthesis we could use to unlock this ability? In that case we would not call it artificial intelligence since it is partly natural. Instead we would call it "augmented" intelligence, or AugI. It would be a little like augmented reality, which adds artificial reality to our natural reality.

How would we augment it? There is now a huge amount of research being conducted into brain studies using MRI (magnetic resonance imaging). This would be one way to start. Maybe the machine to augment our intelligence would be through a "hat" that fits over our head, as we sometimes see in science fiction films. Or it could be drugs or some other way.

But in any of these cases we would be augmenting our intelligence dramatically. So this would be another route to AI. In this case it's not the One. It's the Two, meaning our natural brain plus an assist from technology, either hardware, software or drugs.

One route to AugI would be a new understanding of the brain. We still don't have a real explanation of how the brain works.

We used to think that it was through neurons that work electrically and communicate with each other, just like a computer. But now it's obvious that this model is obsolete.

We now know that another class of cells, called glial cells, makes up 90% of cells in the brain. We used to think that these cells had no role in thinking but now it looks like they have huge role in that. But instead of communicating via electrical signals, they use chemical signaling. We really don't understand how this works. If we did we could start to use the brain in different ways for thinking maybe like idiots savants.

BTW in talking about AugI we should also remember that non-human animals can be an important model too. Do you know that the octopus doesn't just have one brain? And its brain is not really in its head. Actually it has 8 brains. That's because each of its tentacles has its own neurons and these are used for the same tasks humans use their own brain for.

In other words, rather than having centralized intelligence, octopuses have distributed intelligence. It works pretty well too! We know that octopuses also can use tools, have advanced social interactions and can escape places we think it's impossible to escape from. So in using AugI we should use different animals with different structures of intelligence and thinking.

AugI would be a totally new route to AI. It would have the massive advantage that it starts with natural intelligence, and we have some ways to understand that. If we find out enough of how glial cells work we could probably find other routes to AugI that we still don't know about.

We can't ignore the intelligence mechanisms we already have. They give us a head start on finding out more about AI. It's likely that the future of AI is not just disembodied computers which are totally separate from us. It's just as likely that AI will be some form of AugI. So we need to follow this route too.

Alien AI (ALI) – We've got to learn how to think like aliens if we want to find them

You've probably heard about SETI – the search for extraterrestrial intelligence. These days it's a big deal with lots of films about it. Aliens are probably really, really intelligent, at least if they can get here from

the stars. So if we learned how they think, that would give as another route to AI and presumably a huge boost to our own intelligence.

But how do aliens think? That would be pretty useful to know right? If we could discover that, it would give us yet another route to AI. This is the Many of AI since we would have to think of AI that was super-intelligent, much smarter than any AI we have ever thought of.

Where would you even start in trying to crack this problem? After all, we've never seen an alien so have no idea how they think. But one way would be to imagine the extreme environments in which they would exist and try to image and figure out how an intelligent being would need to think in order to be able to function in those environments. Here are a few ideas on how to do that:

-) Intelligence in multiple dimensions
-) Intelligence in multiple universes

Intelligence in multiple dimensions: Did you ever hear of string theory? It's a new theory of physics. It hasn't been proved yet and maybe never will; be but it's an intriguing theory. Partly that's because it predicts there are 11 dimensions. So if the theory were true, then we have 8 dimensions here in our universe that we can't see, at least easily.

But it also implies there may be other universes where you see some or all of them and not necessarily the dimensions we see. And there could well be alien life forms living in those other dimensions. How would they look to us? More importantly, how would they think? What would be the form and structure of the intelligence of an alien living in other dimensions?

Now you might think that's all too theoretical and not useful to us. But pure mathematics is full of findings that looked to be useless at the time that later turned out to be very useful indeed. And actually if we can figure some answers to the question, it would probably give us some radical new ways of thinking which would, in that case, open up new approaches to AI.

So how would you conduct that research? I am sure there's a variety of methods but there are two that occur to me immediately. I think you could simulate intelligence in other dimensions both mathematically and computationally. Maybe some virtual reality would help too. But I am certain that it would yield some results which would probably be radical and could lead to new forms of AI being discovered.

Intelligence in multiple universes: I am sure you have heard of the theory of the multiverse; that is numerous other universes, maybe even an invite number. We don't have to worry about whether it's true because it provides another way for us to research new forms of AI. If there were indeed other universes, how would intelligence look in them?

Have you heard of the physical constants? These are some of the basic values of certain phenomena in our universe. They include things such as the speed of light and the strength of gravitation. But scientists have speculated that maybe in other universes these constants might be different. In those cases these universes might be totally different. They might not be able to host life, or intelligence. But maybe they can host other forms of life that are radically different to ours'.

But here's the issue. What would intelligent life look like in other universes with different physical constants? That would be another approach to exploring AI. Then we would be looking at the nature and structure of intelligence in environments that are massively different to our own.

This approach could also include looking at different universes where senses might be totally different. For example there's no sense of sight, touch, smell, hearing and taste. What then?

Again I think this could all be explored both mathematically and computationally to provide totally new approaches to AI. Maybe researchers could examine animals or humans that lack some of their senses to see what happens then. There are animals, insects and bacteria that live in extreme environments that might give us some clues. Animals that live deep in the sea where there is no light for example.

Creating the Magic

So the One-Two-Many approach takes us in different directions to traditional AI. That's ok, the more the merrier, as English speakers say.

I'm not saying that traditional AI is not worth doing. It certainly is. But there's room for new and fresh approaches if we want to find radical new types of intelligence. Some researchers need to be doing that too. That's how we're going to make the most interesting and useful progress eventually.

Dr. E. Ted Prince, the Founder and CEO of the Perth Leadership Institute, located in Florida in the US has also been CEO of several other companies, both public and private. He is the author of two books: "The Three Financial Styles of Very Successful Leaders" (McGraw-Hill, 2005) and "Business Personality and Leadership Success", Amazon Kindle 2011 as well as numerous other publications in this area. He is a frequent speaker at industry conferences. He works with large corporations globally on leadership development programs and coaches senior executives and teams in the area of financial leadership. He has held the position of Visiting Professor at the University of Florida in the US in its Graduate Business School and is currently a Visiting Professor at the Shanghai University of Finance and Economics in China.