



第〇讲：深度学习课程介绍

An Introduction to Deep Learning Course

张盛平

s.zhang@hit.edu.cn

计算学部
哈尔滨工业大学

2021 年秋季学期



人工智能与深度学习



人工智能技术的冲击

柯洁与AlphaGo三番棋



柯洁

VS



AlphaGo

5月23日、5月25日、5月27日柯洁三连败

腾讯体育



新一代人工智能发展规划



时政 > 今日头条

国务院：中小学应设置人工智能课程，逐步推广编程教育

2017-08-27 19:58 央视新闻客户端

近日，国务院印发《新一代人工智能发展规划》（以下简称《规划》），明确指出人工智能成为国际竞争的新焦点，应逐步开展全民智能教育项目，在中小学阶段设置人工智能相关课程、逐步推广编程教育、建设人工智能学科，培养复合型人才，形成我国人工智能人才高地。

2030年发展为世界主要人工智能创新中心

在我国人工智能技术的总体发展规划中，也明确提出了我国新一代人工智能“三步走”发展战略：

2020年，人工智能总体技术与应用与世界先进水平同步，人工智能产业成为新的重要经济增长点，人工智能技术应用成为改善民生的新途径；

2025年，人工智能基础理论实现重大突破，部分技术与应用达到世界领先水平，人工智能成为我国产业升级和经济转型的主要动力，智能社会建设取得积极进展；

2030年，人工智能理论、技术与应用总体达到世界领先水平，成为世界主要人工智能创新中心。

中小学设置人工智能课程，推广编程教育

《规划》提出，实施全民智能教育项目，在中小学设置人工智能相关课程，逐步推广编程教育，鼓励社会力量参与寓教于乐的编程教学软件、游戏的开发和推广。支持开展人工智能竞赛，鼓励进行形式多样的人工智能科普创作。

其中，在2017年《义务教育小学科学课程标准》中就曾提出，为进一步加强小学科学教育，2017年秋季开始，小学科学课程起始年级调整为一年级。原则上按照小学一、二年级每周不少于1课时安排课程，三至六年级的课时数保持不变。

高校增加硕博培养，形成“人工智能+X”模式

《规划》指出，要进一步完善人工智能领域学科布局，设立人工智能专业，推动人工智能领域一级学科建设，尽快在试点院校建立人工智能学院，增加人工智能相关学科方向的博士、硕士招生名额。

鼓励高校在原有基础上拓宽人工智能专业教育内容，形成“人工智能+X”复合专业培养新模式，重视人工智能与数学、计算机科学、物理学、生物学、心理学、社会学、法学等学科专业教育的交叉融合，培育高水平人工智能创新人才和团队。



Google Brain Team

Google Brain Team

Make machines intelligent. Improve people's lives.

Research Freedom

Google Brain team members set their own research agenda, with the team as a whole maintaining a portfolio of projects across different time horizons and levels of risk.

Google Scale

As part of Google and Alphabet, the team has resources and access to projects impossible to find elsewhere. Our broad and fundamental research goals allow us to actively collaborate with, and contribute uniquely to, many other teams across Alphabet who deploy our cutting edge technology into products.

Papers Accepted to ICML, 2017

- Accelerating Eulerian Fluid Simulation With Convolutional Networks
- Conditional Image Synthesis with Auxiliary Classifier GANs
- Deep Value Networks Learn to Evaluate and Iteratively Refine Structured Outputs
- Device Placement Optimization with Reinforcement Learning
- Geometry of Neural Network Loss Surfaces via Random Matrix Theory
- Intelligible Language Modeling with Input Switched Affine Networks
- Large-Scale Evolution of Image Classifiers
- Learned Optimizers that Scale and Generalize

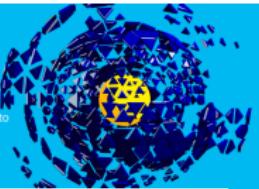
Source: <https://research.google.com/teams/brain/>



Microsoft Artificial Intelligence

Artificial Intelligence

Pursuing computing advances to create intelligent machines that complement human reasoning to augment and enrich our experience and competencies.



Focus Areas

Machine learning	Human language technologies	Perception and sensing
Developing and improving algorithms that help computers learn from data to create more advanced, intelligent computer systems.	Linking language to the world through speech recognition, language modeling, language understanding, spoken language systems, and dialog systems.	Making computers and devices understand what they see to enable tasks ranging from autonomous driving to analysis of medical images.
AI, people, and society	Systems, tools and platforms	Integrative intelligence
Examining the societal and individual impacts on the spread of intelligent technologies to formulate best practices for their design.	Integrating intelligent technologies to create interactive tools such as chatbots that incorporate contextual data to augment and enrich human reasoning.	Weaving together advances in AI from disciplines such as computer vision and human language technologies to create end-to-end systems that learn from data and experience.
Cyberphysical systems and robotics	Human AI collaboration	Decisions and plans
Developing formal methods to ensure the integrity of drones, assistive robotics and other intelligent technologies that interact with the physical world.	Harnessing research breakthroughs in artificial intelligence to design technologies that allow humans to interact with computers in novel, meaningful and productive ways.	Reasoning about future events to enable informed collaborations between humans and intelligent agents.

Source: <https://www.microsoft.com/en-us/research/research-area/artificial-intelligence/>



Facebook AI Research (FAIR)



"We have incredible people in FAIR who are making significant progress in AI, but to really move the bar it's equally as important to be outward focused. To push the envelope, push the science and technology forward, we must be actively engaged with the research community. We publish a lot of things we do, distribute a lot of code on open-source, and engage deeply with academia to drive the progress."

— Yann LeCun, Director of AI Research

Source: <https://research.fb.com/category/facebook-ai-research-fair/>



MIT-IBM Watson AI Lab

MIT-IBM Watson AI Lab

The MIT-IBM Watson AI Lab is focused on fundamental artificial intelligence (AI) research with the goal of propelling scientific breakthroughs that unlock the potential of AI. The Lab is focused on advancing four research pillars: **AI Algorithms**, the **Physics of AI**, the **Application of AI to industries**, and **Advancing shared prosperity through AI**.



IBM | MIT

Watch introduction

Research pillars

Now hiring

The MIT-IBM Watson AI Lab is hiring! Our Lab is a place where scientists, professors and students collaborate to drive the frontiers of AI.

Tackling AI's biggest barriers

MIT and IBM put their "minds and hands" together to progress AI.

Press release

IBM plans to make a 10-Year, \$240 million investment in new lab with MIT to advance AI algorithms, hardware and software, and apply it to solving problems that matter.

Read blog

Source: <http://mitibmwatsonailab.mit.edu>



百度深度学习实验室—2013 年

The screenshot shows the homepage of the Baidu IDL website. At the top, there is a banner featuring the Baidu IDL logo and the tagline "Relentless for Ultimate Intelligence". Below the banner, a large graphic displays the letters "IDL" with a neural network structure overlaid. To the right of the graphic, the slogan "We make things happen amazingly" is visible. A "Learn More" button is located at the bottom right of the graphic area. The main navigation menu includes links for 首页 (Home), IDL研究方向 (IDL Research Directions), IDL团队 (IDL Team), IDL新闻 (IDL News), 人才招聘 (Recruitment), and 联系我们 (Contact Us). Below the menu, there is a section titled "IDL介绍" (Introduction to IDL) which contains a brief description of the lab's history and mission. The footer of the page includes social media links for Google+, Facebook, LinkedIn, and YouTube.

Baidu IDL 百度深度学习实验室
Relentless for Ultimate Intelligence

We make things happen amazingly

Learn More

首页 IDL研究方向 IDL团队 IDL新闻 人才招聘 联系我们

IDL介绍

百度深度学习实验室
Relentless for Ultimate Intelligence

作为百度正式成立的首个前瞻性研究机构，深度学习实验室（Institute of Deep Learning, IDL）成立于2013年1月19日。2014年7月1日，为打造百度的技术领先地位、加强对未来技术的投资和积累，百度研究院正式组建成立。现下设四个实验室：深度学习实验室（IDL）、大数据实验室（Big Data Lab, BDL）、增强现实实验室（Augmented Reality Lab, ARL）和硅谷人工智能实验室（Silicon Valley Artificial Intelligence Lab, SVAIL）。研究院当前由百度高级总监林元庆领衔，IDL聚集了数百名杰出的研究技术人员，在语音、图像和自然语言处理等领域取得了一系列突破性成果。目前，IDL在语音识别、图像识别、自然语言处理、推荐系统、搜索、广告等众多领域取得了显著进展。

Source: <http://idl.baidu.com>



360 人工智能研究院—2015 年

The screenshot shows the homepage of the 360 Artificial Intelligence Institute. At the top left is the logo 'AI 360人工智能研究院' and '360 Artificial Intelligence Institute'. At the top right are navigation links: 首页 (Home), 研究方向 (Research Directions), 技术输出 (Technology Output), 新闻动态 (News Dynamics), and 关于我们 (About Us). The central feature is a large graphic with the text '360人工智能' and '360 ARTIFICIAL INTELLIGENCE' below it. The background is dark blue with a curved band of various icons representing different AI applications like text classification, speech recognition, and video analysis. Below the main title is the tagline '万物互联，让智能硬件具备自主学习能力 安全生活，解决日常家居安全和出行安全'.

Source: <http://ai.360.cn>



腾讯 AI 实验室—2016 年

The screenshot shows the homepage of the Tencent AI Lab. The background is dark blue with abstract white wave patterns. At the top right, there is a navigation bar with links to 首页 (Home), 论文 (Papers), 新闻 (News), 合作 (Partnership), 招聘 (Recruitment), and language switches (En / 中). In the center, there is a logo consisting of a white cloud-like shape above the text "Tencent AI Lab". Below the logo, the slogan "Make AI Everywhere" is displayed, followed by the Chinese phrase "让 AI 无处不在". On the right side of the page, there is a vertical column of five small white dots. At the bottom left, there is a block of text in Chinese:

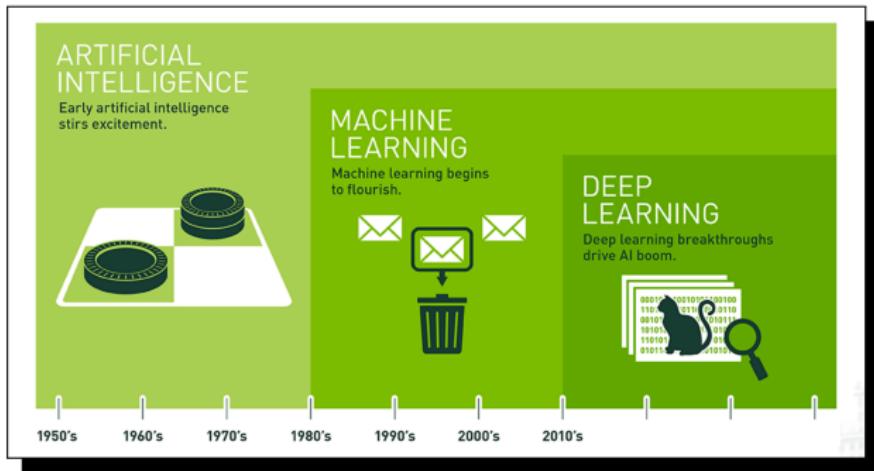
腾讯公司级AI战略蓄势待发，聚集全球数十位人工智能科学家、50位世界一流AI博士，专注机器学习、计算机视觉、语音识别、自然语言处理等人工智能领域的研究。基于腾讯亿万用户海量数据及在互联网各垂直领域的技术优势，立志打造世界顶尖人工智能团队。

Source: <http://ai.tencent.com>



人工智能与深度学习

深度学习是人工智能重要的理论基础



Source: <https://blogs.nvidia.com>



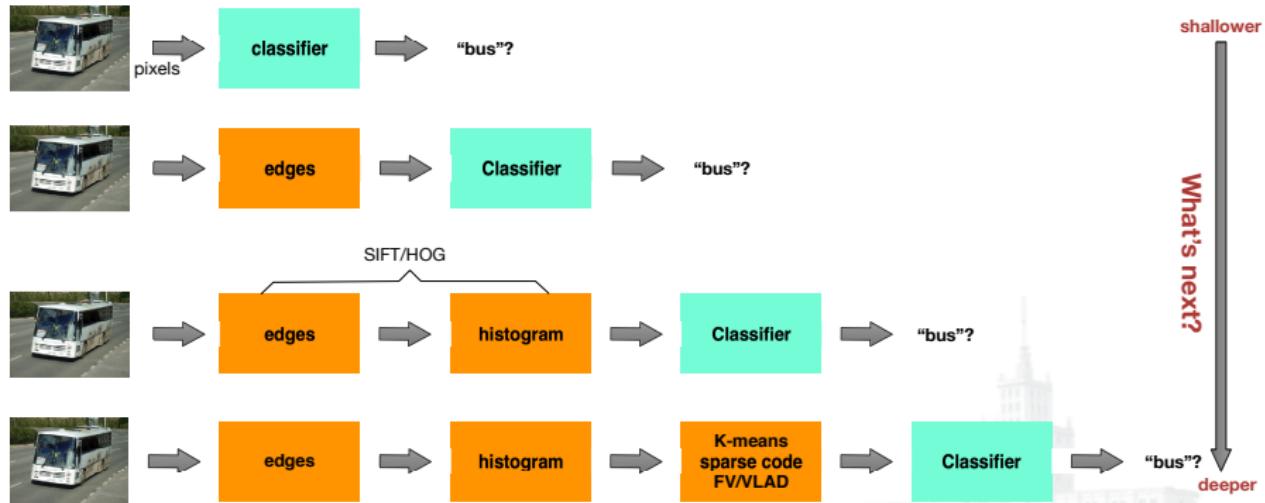
计算机视觉任务一图像分类

看图识物





计算机视觉任务一图像分类





深度学习的成功应用—图像分类

ImageNet Large Scale Visual Recognition Challenge (ILSVRC)

- 1000 个物体类别，120 万张训练，5 万张验证，10 万张测试
- 人眼的 Top 5 错误率大概在 5.1%

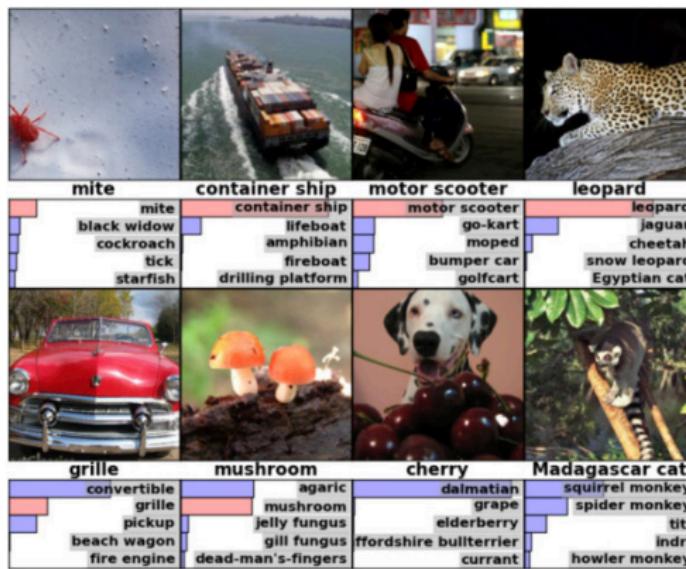




深度学习的成功应用—图像分类

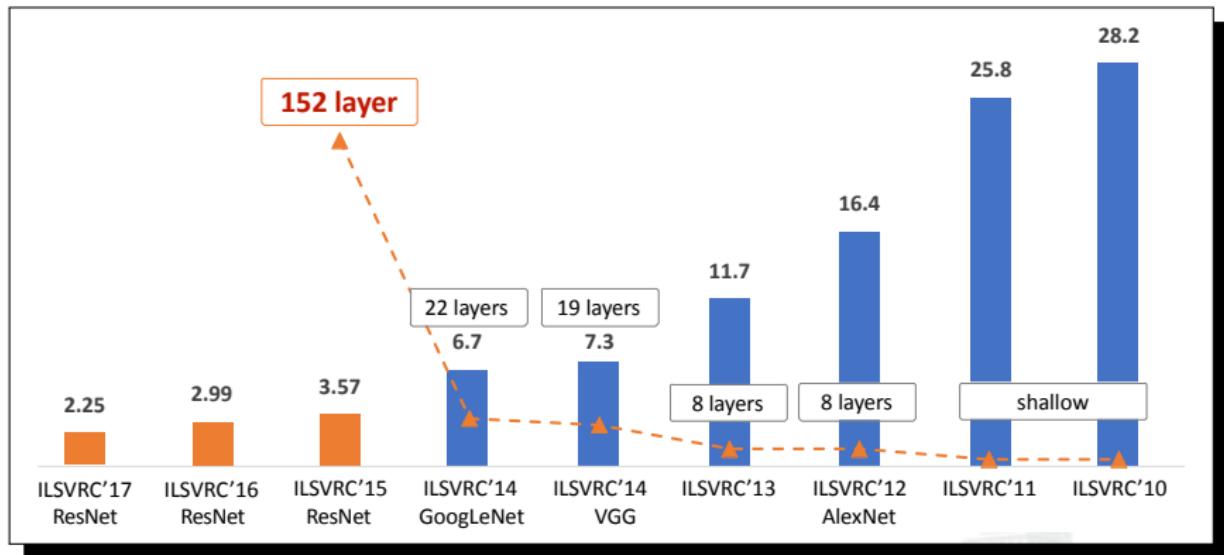
ImageNet Large Scale Visual Recognition Challenge (ILSVRC)

- 1000 个物体类别，120 万张训练，5 万张验证，10 万张测试
- 人眼的 Top 5 错误率大概在 5.1%





深度学习的成功应用—图像分类



ILSVRC top-5 error (%)

Source: Kaiming He



深度学习的发展历程

- 自 2012 年起，深度学习（Deep Learning）在机器学习和人工智能领域取得了巨大的成功，特别是在图像分类、语音识别和文本处理等应用达到了前所未有的高性能，也推动了相关应用的产业化。
- 国外的大公司（Google, Microsoft, IBM, Facebook, Amazon 等）和国内的 BAT 等纷纷成立深度学习研究院或实验室。
- 深度学习本质上是多层神经网络（Neural Networks）。尽管神经网络的历史可以追溯到 19 世纪 50 年代，深度学习在最近几年兴起，得益于：并行处理硬件（GPU）和大量的数据。



课程简介



课程安排

- 课时：32 个课堂学时，16 个实验学时



课程安排

- 课时：32 个课堂学时，16 个实验学时
- 成绩



课程安排

- 课时：32 个课堂学时，16 个实验学时
- 成绩
 - 报告撰写 (20%)：约 5 次报告，各占 4%



课程安排

- 课时：32 个课堂学时，16 个实验学时
- 成绩
 - 报告撰写 (20%) : 约 5 次报告，各占 4%
 - 课堂展示 (10%) : 1 次课堂展示



课程安排

- 课时：32 个课堂学时，16 个实验学时
- 成绩
 - 报告撰写 (20%) : 约 5 次报告，各占 4%
 - 课堂展示 (10%) : 1 次课堂展示
 - 实验 (20%): 4 次实验，各占 5%



课程安排

- 课时：32 个课堂学时，16 个实验学时
- 成绩
 - 报告撰写 (20%) : 约 5 次报告，各占 4%
 - 课堂展示 (10%) : 1 次课堂展示
 - 实验 (20%): 4 次实验，各占 5%
 - 考试 (50%)



课程特点

- **更新发展快**—每年都有很多新的方法出现。本课程只是对深度学习基础知识进行较系统地学习，更多前沿知识需要关注本领域相关的学术会议



课程特点

- **更新发展快**—每年都有很多新的方法出现。本课程只是对深度学习基础知识进行较系统地学习，更多前沿知识需要关注本领域相关的学术会议
 - 偏**深度学习理论**的会议，包括
 - ICML
 - ICLR
 - NeurIPS



课程特点

- **更新发展快**—每年都有很多新的方法出现。本课程只是对深度学习基础知识进行较系统地学习，更多前沿知识需要关注本领域相关的学术会议
 - 偏**深度学习理论**的会议，包括
 - ICML
 - ICLR
 - NeurIPS
 - 偏**应用**的会议，包括
 - CVPR
 - ICCV
 - ECCV



课程特点

- **更新发展快**—每年都有很多新的方法出现。本课程只是对深度学习基础知识进行较系统地学习，更多前沿知识需要关注本领域相关的学术会议
 - 偏**深度学习理论**的会议，包括
 - ICML
 - ICLR
 - NeurIPS
 - 偏**应用**的会议，包括
 - CVPR
 - ICCV
 - ECCV
- **实践性强**—深度学习方法需要和某一个应用领域或任务结合，要能使用所学理论知识解决实际应用需求



知识储备

- 优化 Optimization
- 矩阵分析 Matrix Analysis
- 概率论 Probability Theory
- 机器学习 Machine Learning
- 模式识别 Pattern Recognition



推荐阅读

- Bengio 的 Deep Learning 课本
<http://www.deeplearningbook.org>
- Stanford CS231n course <http://cs231n.stanford.edu>
- Google 的 DL 课程
<https://classroom.udacity.com/courses/ud730/lessons/6370362152/concepts/63798118150923>
- Hugo Larochelle 的 DL 课程 http://info.usherbrooke.ca/hlarochelle/cours/ift725_A2013/contenu.html
- 吴恩达在<http://coursera.org>上的《神经网络和深度学习》课程（中文字幕）
- 李宏毅《机器学习/深度学习》
(2021)<https://www.bilibili.com/video/BV11K4y1S7AD/>



致谢

- 讲稿中很多资料或素材来源于网络，包括国外一些大学的相关课程、一些博客、维基百科等。后面不一一列举来源，在此一并表示感谢
- 引用网络资源时，由于本人的理解能力，可能存在一些偏差
- 本讲稿会经常更新