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相 对 论 与 宇 宙 学 小 论 文

(学 术 学 位)

论文题目 (中文)　　暗物质存在的证据与可能的解释

论文题目 (外文)　　Evidence for Dark Matter

　　　　　　　　　and Its Possible Explanations

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暗物质存在的证据与可能的解释

摘 要

暗物质是现代宇宙学中最深刻的未解之谜之一。尽管它无法被电磁波直接探测，但天文学观测表明，它对星系旋转、引力透镜和宇宙微波背景辐射等现象产生了重要影响。本文首先介绍了支持暗物质存在的三类主要观测证据，包括星系旋转曲线的异常、强引力透镜效应和宇宙大尺度结构的形成；随后，本文简要评述了当前主流的理论模型，包括 WIMP、轴子、MACHO 以及修改引力理论等。尽管尚未直接探测到暗物质粒子，但多种实验正在进行中。通过综述观测数据与理论发展，本文展示了暗物质研究在现代物理中的核心地位与挑战。

关键词: 暗物质; 星系旋转曲线; 引力透镜; 弱相互作用大质量粒子; 宇宙微波背景辐射

Evidence for Dark Matter and Its Possible Explanations

Abstract

Dark matter is one of the most profound mysteries in modern cosmology. Although it cannot be directly detected via electromagnetic interactions, astronomical observations suggest that it plays a crucial role in various phenomena, such as galaxy rotation curves, gravitational lensing, and the cosmic microwave background. This paper first reviews three main types of observational evidence for dark matter: anomalous galactic rotation, strong lensing effects, and the formation of large-scale structures. Then, it briefly discusses several leading theoretical models, including WIMPs, axions, MACHOs, and modified gravity. While dark matter particles have not yet been directly detected, a number of experiments are underway. By surveying both observational and theoretical developments, this work highlights the central role and ongoing challenges of dark matter research in modern physics..

Key words: Dark matter; Galaxy rotation curves; Gravitational lensing; Weakly Interacting Massive Particles (WIMPs); Cosmic microwave background (CMB)

目　　录

第一章　介绍

1.1　参考文献示例

文章 FullyConvolutionalNetwork[1].

多篇文章引用示例[1-4]。

1.2　图像插入示例

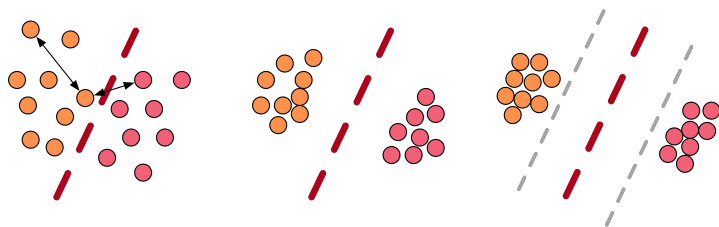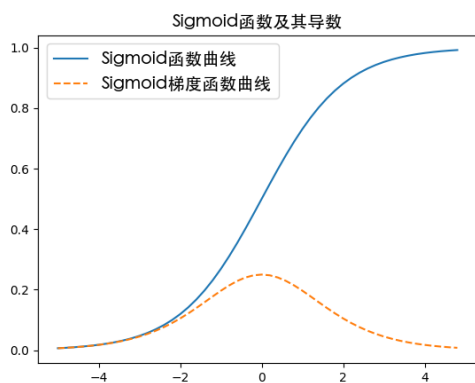图像位置在本项目的 Img 文件夹下，可以点上传后同本地上传，建议按照章节命名编号, 便于保存.

图 1.1 度量学习和分类问题的区别

如图 1.1

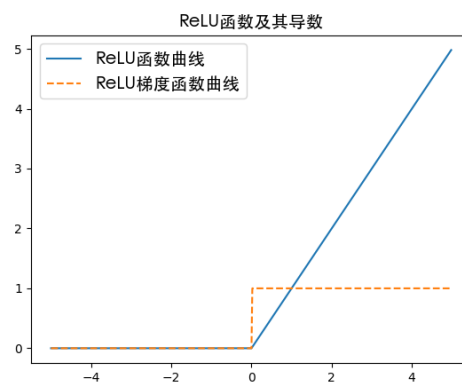## 1.3　多张图像插入示例

多张图像可以分别标记 Label, 方便后文引用.

(a) Sigmoid 函数与其梯度函数　　　　　(b) ReLU 函数与其梯度函数

图 1.2 常用的损失函数

如图 1.2b.

1.4　其他环境测试

定理 1.1 这是一个定理.

定义 1.1 这是一个定义.

例 1.1 这是一个例子.

证明 1 这是一个证明.

解 1 这是一个解.

初号字.
小初号字.
一号字.
二号字.

小二号字.

三号字.

四号字.

小四号字.

五号字.

小五号字.

六号字.

七号字.

公式

$$\frac{\partial \mathcal{L}}{\partial x_i} = \frac{\frac{\partial \mathcal{L}}{\partial \tilde{x_i}} - \tilde{x}_i \sum_j \frac{\partial \mathcal{L}}{\partial \tilde{x_j}}}{||x||_2}. \tag{1.1}$$

表格示例

表 1.1 部分模型在城市景观数据集上的表现

序号	模型框架	特征提取器	Acc	mAcc	mIoU
1	FPN	ResNet-50	95.81%	81.86%	74.51%
2	FPN	ResNet-101	96.01%	83.39%	75.80%
3	PointRend	ResNet-50	95.95%	84.05%	76.47%
4	PointRend	ResNet-101	96.23%	85.70%	78.30%
5	DeeplabV3+	ResNet-50	96.44%	86.96%	80.08%
6	DeeplabV3+	ResNet-101	96.57%	87.86%	80.97%

第二章 相关工作

第三章　解决方法

第四章　讨论

第五章 总结与展望

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