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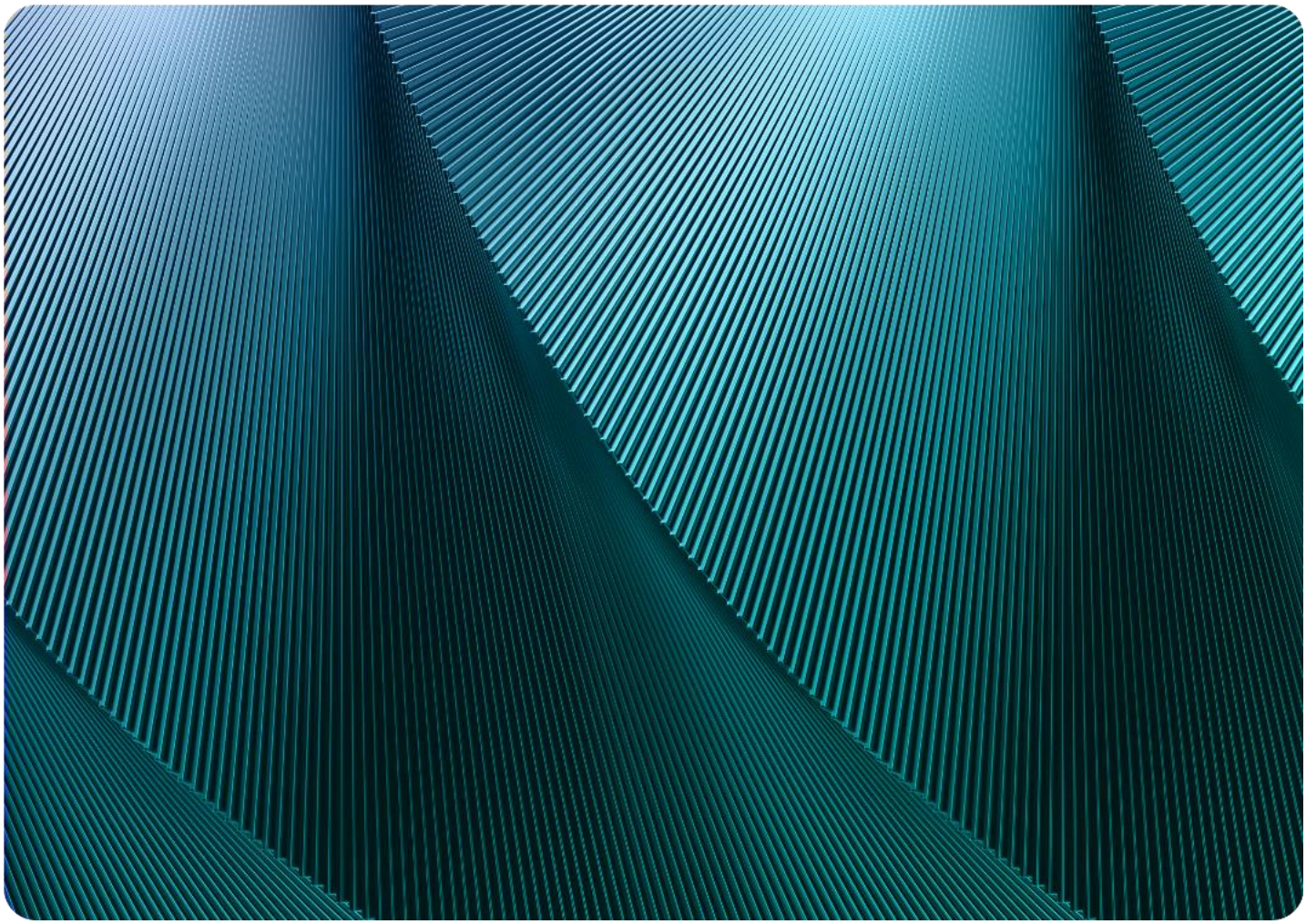
Course Outline Details

Computer Vision for Artificial Intelligence

This introductory course provides hands-on experience with machine learning concepts, techniques, and real-world applications.



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Course Outline

Week starting on / Module	Module Topic
Week 1	Mod 01: Introduction to Computer Vision
Week 2	Mod 02: Digital Image Fundamentals and Processing
Week 3	Mod 03: Machine Learning Integration in Computer Vision
Week 4	Mod 04: Neural Network Foundations for Visual Processing
Week 5	Mod 05: Convolutional Neural Networks for Image Analysis
Week 6	Mod 06: Advanced Neural Architectures for Computer Vision
Week 7	Mod 07: Object Detection and Recognition Systems
Week 8	Mod 08: Advanced Detection and Real-Time Processing
Week 9	Mod 09: Video Analysis and Temporal Processing
Week 10	Mod 10: Generative Models and Advanced Visual AI
Week 11	Mod 11: Visual Data Acquisition and Sensor Integration
Week 12	Mod 12: Autonomous Systems (Agents) and Computer Vision
Week 13	Mod 13: Computer Vision in Production Systems
Week 14	Mod 14: Ethical Implications and Responsible Development
Week 15	Mod 15: Course Review & Future Trends
Week 16	Mod 16: Final Project Presentations

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Course Outline Details

Module 01: Introduction to Computer Vision & Course Setup

- Welcome, orientation, and team formation with a focus on course requirements
- Definition, scope, and evolution of computer vision within AI systems
- Historical development and key technological milestones
- Fundamental principles and terminology of visual processing systems
- Applications across industries and their technological requirements
- **Development Environment Setup**: Computer vision development platforms, cloud environments (Jupyter, Google Colab, AWS, Azure), version control with GitHub, essential libraries and frameworks
- **Hands-On Activity**: Setting up development environment and exploring real-world computer vision applications

Module 02: Digital Image Fundamentals and Processing How Computers “see” Images

- Computational representation of visual information: pixel structures, color models, and image formats
- Understanding how computational systems process visual data
- Digital image processing techniques: filtering, enhancement, and edge detection
- Integration with machine learning workflows and data pipelines
- **Lab Exercise**: Implementing fundamental image processing operations using standard libraries and frameworks

Module 03: Machine Learning Integration in Computer Vision

- Review of machine learning fundamentals: supervised and unsupervised learning paradigms
- Machine learning pipeline components: data preparation, algorithm selection, model development
- Dataset considerations and evaluation methodologies for computer vision applications
- Integration patterns between traditional computer vision and machine learning approaches
- **Hands-On Lab**: Implementing classification algorithms for visual data analysis

Module 04: Neural Network Foundations for Visual Processing

- Comparison of classical machine learning versus deep learning approaches for visual data
- Neural network architecture fundamentals: neuron structures, layer organization, activation functions
- Training methodologies: loss functions, optimization strategies, and performance evaluation
- Training optimization: addressing overfitting, regularization techniques, and hyperparameter management
- **Lab Exercise**: Lab Exercise: Image Classification Lab Chihuahua or Muffin. Students will clone the github repository https://github.com/patitimoner/workshop-chihuahua-vs-muffin

Module 05: Convolutional Neural Networks for Image Analysis

- Core concepts of convolutional architectures: convolution operations, pooling strategies, feature mapping
- Understanding how convolutional networks learn hierarchical visual representations
- Applications in image classification and object recognition tasks
- Foundational architectures and their contributions to the field
- **Hands-On Lab**: Implementing convolutional neural network solutions for image classification Lab Chihuahua or Muffin with CNN Students will clone the github repository https://github.com/patitimoner/workshop-chihuahua-vs-muffin

Module 06: Advanced Neural Architectures for Computer Vision

- Study of influential architectures and their design principles
- Transfer learning concepts and implementation strategies
- Understanding when and how to apply pre-trained models effectively
- **Integration Focus**: Preparing for advanced applications in subsequent modules

Module 07: Object Detection and Recognition Systems

- Fundamental principles of object localization and classification
- Traditional detection approaches: template matching and feature-based methods
- Modern detection architectures and their implementation patterns
- **Lab Exercise**: Implementing object detection using contemporary frameworks and datasets

Module 08: Advanced Detection and Real-Time Processing

- Advanced detection algorithms and their architectural innovations
- Real-time processing considerations and optimization strategies
- Performance evaluation methodologies for detection systems
- **Lab Exercise**: Developing advanced object detection solutions with performance optimization

Module 09: Video Analysis and Temporal Processing

- Video processing fundamentals: temporal analysis, motion detection, background modeling
- Techniques for analyzing temporal sequences and motion patterns
- Integration with generative approaches for video synthesis
- Three-dimensional reconstruction and immersive technology applications
- **Hands-On Lab**: Implementing video analysis solutions using computer vision frameworks

Module 10: Generative Models and Advanced Visual AI

- Overview of generative approaches in computer vision: foundational architectures and applications
- Advanced model architectures for visual generation and manipulation
- Understanding the role of generative models in contemporary computer vision systems
- Integration with other AI domains for comprehensive visual intelligence
- **Lab Exercise**: Experimenting with generative approaches for visual content creation

Module 11: Visual Data Acquisition and Sensor Integration

- Overview of image capture technologies: RGB cameras, depth sensors, thermal imaging, stereo systems
- Understanding acquisition parameters: resolution, frame rate, field of view, and sensor characteristics
- Introduction to complementary sensors: LiDAR, radar, and their integration with visual systems
- Calibration principles and setup considerations for computer vision applications
- **Hands-On Activity**: Analyzing different imaging system outputs and understanding their characteristics

Module 12: Autonomous Systems (Agents) and Computer Vision

- Introduction to autonomous systems and intelligent agents
- Types of autonomous agents: mobile robots, drones, autonomous vehicles
- How computer vision enables autonomy and decision-making
- Integration patterns with robotics and Internet of Things systems
- Techniques for enhancing autonomous systems with computer vision capabilities
- Case studies across autonomous vehicles, robotics, and intelligent systems
- **Hands-On Lab**: Developing computer vision solutions for autonomous system applications

Module 13: Computer Vision in Production Systems

- Deployment considerations for computer vision systems
- Edge computing and mobile computer vision applications
- Performance optimization and real-time constraints
- Integration with enterprise systems and cloud platforms
- **Lab Exercise**: Deploying computer vision applications to production environments

Module 14: Ethical Implications and Responsible Development

- Ethical frameworks for computer vision technology development and deployment
- Privacy, security, and societal considerations in visual AI systems
- Future trends and technological directions in computer vision
- Responsible innovation practices and their implementation
- **Case Study Analysis**: Examining ethical implications through real-world scenarios

Module 15: Course Review and Final Project Presentations

- Comprehensive review of fundamental computer vision principles covered throughout the course
- Review of machine learning integration and neural network architectures for visual processing
- Review of object detection, video analysis, and generative models applications
- Integration review: connecting theoretical foundations with practical implementations

Module 16: Final Exam Week

- **No class sessions**
- **Final Exam Administration**: Comprehensive assessment of course learning outcomes or
- **Final Assignment Submissions**: Course portfolio and any remaining project deliverables due

Teaching Methods and Strategies

- Total Course Duration: 96 contact hours; 16 weeks
- Weekly Contact Time: 6 hours
- Weekly Structure:
    - Lecture: 2-3 hours
    - Lab: 3-4 hours