An Open-Source Kit to Co-create Hardware and Software Engineering Skills

UMBC Ethical Software Research Lab
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Caribou
COFFEE
CARIBOU
MEDIUM ROAST
GROUND


STOP

Outline

- Fundamentals
- Examples
- The Kit

The UMBC Ethical Software Lab

Mission: To verify the ethicality of software applications and software intensive products independently and impartially on consumer devices as they are used in the real world and give users clear and concise information regarding terms of service, privacy policy, and the use of their data and hardware resources.

Vision: Be the trusted and go-to lab for reliable, independent, and accurate ethicality verification of software applications and software intensive products for users, consumers, and software developers and be a valued educational resource for how to use software while maintaining well-being, ethical use, and privacy.

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Software starting today must be conceived of, designed, architected, built, and managed to be ethical, reliable, and beautiful

The Seven Attributes of Ethical Software

1. It only does what it says it does
2. It protects the user's privacy
3. It does not use hardware or software to monitor the user environment
4. It does not fingerprint their software or hardware ID without their consent
5. It doesn't use their data for profit without their consent
6. It does not consume their computational resources without need or consent
7. It consumes computational resources in energy efficient and sustainable way

We are looking and welcome feedback and passionate collaborators

The Kit

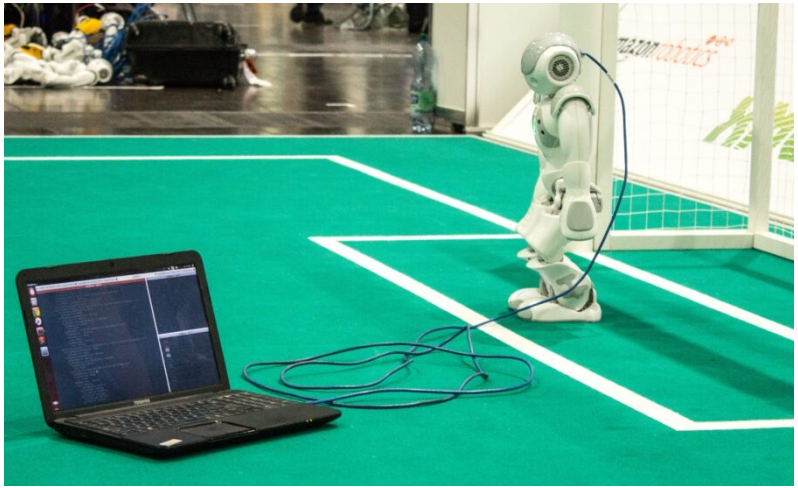
An open-source and collaborative online resource for teaching engineering concepts while holistically incorporating ethics and hands-on activities

Ethics

Ethics in Engineering

- Ethics is individual morals pooled and communally accepted based upon a framework
- Legal doesn’t always equate to ethical
- Designs must start and always consider ethics to be truly beneficial

Understanding Ethical Design in Technology



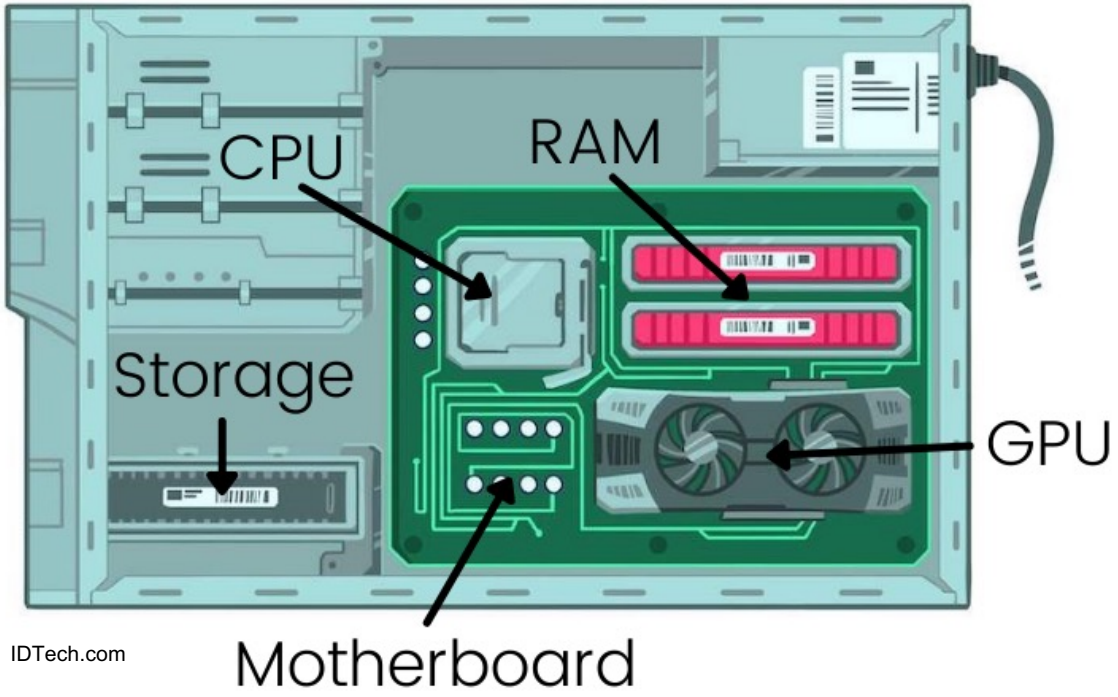
Key Ethical Considerations

- Data Privacy
- User Rights
- Usability
- Access
- Accessibility
- Societal Impacts
- Resource Usage
- Costs

Demystifying Technology

Anatomy of a Hardware Device

- Processor
- Memory
- Storage
- Networking



IDTech.com

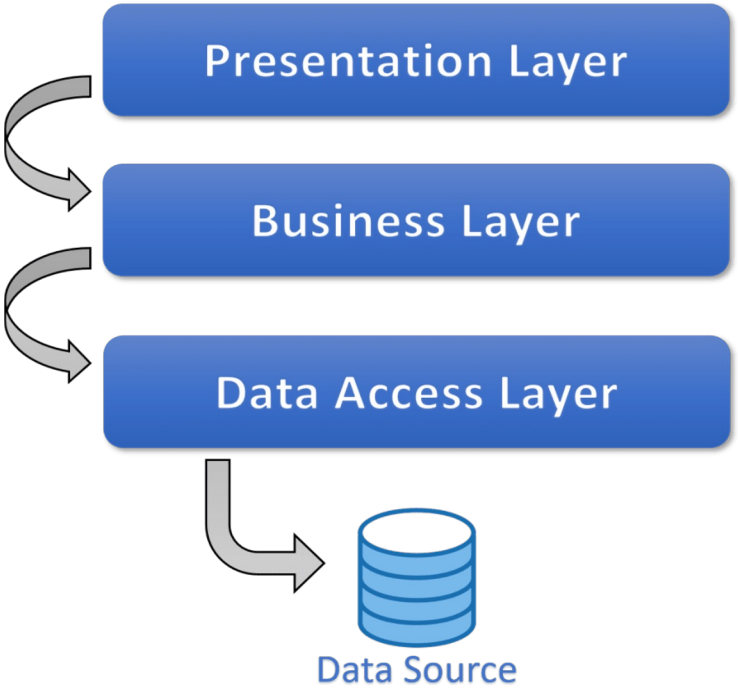
Anatomy of a Software System

1. Presentation / User Interface Layer
The user-facing parts - what you see and interact with.

2. Business Layer
Where the core software functions and features are implemented.

3. Data Access Layer
Code for securely interacting with databases and other data sources.

4. Database / Data Source Layer
Storage and management of data the system relies on.



Activities of Software Engineering

- See the Problem
- Conceive a Solution
- Create an Architecture
- Implement the Architecture
- Evaluate and Adapt the Architecture Over Time

Ten steps to learn to become a software engineer

1. Mastering a Language
2. Hands-On Coding
3. Explore Diverse Technologies
4. Problem-Solving Focus
5. Version Control
6. Documentation
7. Continuous Integration
8. Algorithmic Proficiency
9. Online Portfolio
10. Soft Skills

Activities of Hardware Engineering

- See the Problem
- Conceive a Solution
- Create a Product Design
- Send for Manufacturing
- Start Working on Next Product

Open-Source Software and Hardware in Education

Open-Source Platforms

- Write, Run & Share code online for 60+ languages https://onecompiler.com
- JSON: a lightweight data-interchange format https://www.json.org/json-en.html
- PostgreSQL https://www.postgresql.org
- MariaDB Server https://mariadb.org
- World Bank Open Data https://data.worldbank.org
- U.S. Government's Open Data https://data.gov

Computing Fundamentals

- CSIO
  - Compute
  - Store
  - Input
  - Output

Data Fundamentals

- ARC
  - Attributes
  - Relationships
  - Collections

Database Fundamentals

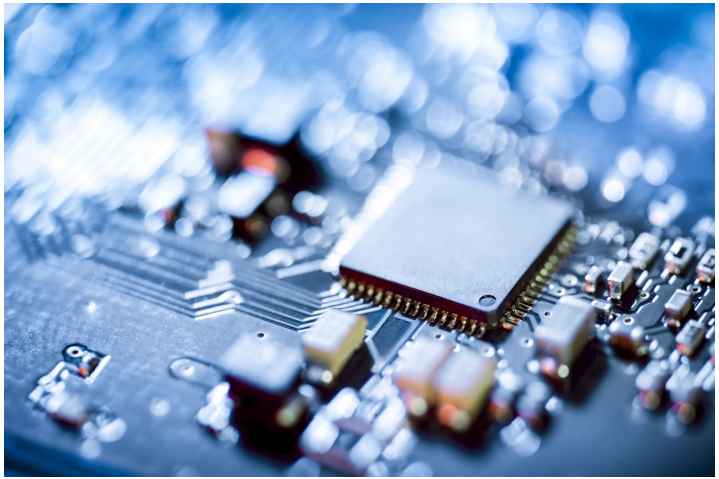
- CRUD
  - Create
  - Read
  - Update
  - Delete

Ten steps to learn a new programming language

1. Select the Right Language
2. Strong Foundation
3. Hands-On Practice
4. Syntax Deep Dive
5. Explore IDEs
6. Understand Data Structures
7. Error Handling Skills
8. Build Real-world Applications
9. Framework Navigation
10. Join Coding Communities

Ten Steps to Learn How to Build a Hardware Device

Step 1: Basics of Hardware
Step 2: Types of Hardware
Step 3: Assembly Basics
Step 4: Understanding What Each Part Does
Step 5: Start with Simple Projects
Step 6: Complex Circuits
Step 7: Programming Hardware
Step 8: Sensors and Actuators
Step 9: Communication Protocols
Step 10: Troubleshooting and Debugging



Examples

What is an Algorithm?

Definition

- A set of instructions or a step-by-step procedure to perform a task or solve a problem.
- Fundamental to all aspects of computer science: from data analysis to software development and artificial intelligence.

Importance of Algorithms

- Building blocks for all computer and software operations.
- Enable the processing of data, execution of tasks, and decision-making in automated systems.
- Example: Searching, Sorting

Example of a Simple Algorithm - Linear Search

Problem: Finding a target value within a list.
Also known as Sequential Search

How Linear Search Works:

- Sequentially checks each element of the list until a match is found or the whole list has been searched.
- Best-case scenario: The target is at the beginning of the list.
- Worst-case scenario: The target is at the end of the list or not present.

Real Life Use Case:

Linear Search is applied when you are searching for a contact in your phonebook

Example of a Simple AI/ML Algorithm

How AI Learns to Recognize Dogs?

1. Train Model: Show the computer many photos of different dog breeds.
2. Create Model: The AI will find common features in the images for each breed.
3. Validate Model: Using those visual patterns, the AI forms a memory fingerprint for each breed so it remembers what a corgi, lab or poodle looks like.
4. Predict: When we show the AI a new dogs picture, it matches features to its breed memory fingerprints to identify which dog type it is!

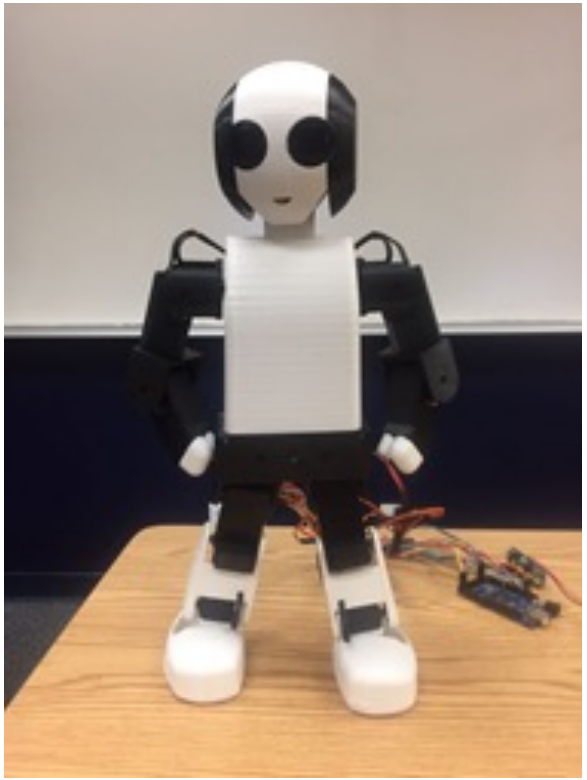
Example of Simple Hardware Device

USB Flash Drive – An Essential Portable Storage Device

- Definition: A small, portable device used for storing and transferring digital data.
- Common Names: Thumb drive, pen drive, jump drive.
- Applications: Storing and Transferring Documents, Photos, Files, Videos, music, and videos.
- Advantages: Portability, Plug and Use Convenience

Example of a Robotic Device

- HCTeR



Activities

Digital Nutrition Label

- **Purpose:** Provides transparency on software's data and privacy practices
- **Importance:** Helps users make informed decisions about their digital consumption
- **Key Components:**
  - Interruptions
  - Privacy
  - User Rights
  - Monetization
  - Device Resources

Digital Nutrition Labels Designs

Digital Nutrition Facts

Google Chrome

Version: 94.4.068 — For ages 12+

Evaluated on: January 1, 2023

Average Daily Interruptions	8
Privacy	
Access to (Camera, Mic, Photos, ...)	
Camera	Mandatory*
Microphone	Optional †
Photos	Not Applicable
Location	Optional* †
Data Collection and Sharing	Yes
Update Alerts (Terms of Service, Privacy Policy)	No
User Rights	
Ads Opt-Out	Not Allowed
Account Deletion	Allowed
User Data Export	Allowed

* A prompt may ask you to allow or reject this permission once or every time it's needed, based on the app's privacy settings.

† Not granting this permission may reduce app features.

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▶ **Monetization**	
▶ **Device Resources**	

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Analyze a Software Application or Product

- Consider the Notes app on your phone
- Analyze the four computing fundamentals: CSIO

Analyze a Hardware Device

- Consider your phone
- Identify ethical engineering implications

Take-Aways

- Software is eating the world; therefore, it must be ethical, reliable, and beautiful.
- Software has entered into most physical objects. We now have software-intensive products which includes your cooktop.
- Software engineering is as important as algebra, statistics, and basic calculus. Everyone must learn the basics.

Thank You

The Kit will be available next week

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