Examples of Undergraduate Research Projects
in Computer Science and Engineering

The following are examples of recent or current undergraduate research projects.

Area: Computer Architecture
Title: Battery-life aware power management for smartphones
Advisor: Dr. R. Teodorescu
        Implement a client/server system for collecting usage profiles of Android-based smartphones. The goal is to build a power management system that anticipates power drain of different applications and adjust phone characteristics base on their usage.

Area: Network Security
Title: Web security for cloud based password management
Advisor: Dr. A. Arora
        Find insecurities in existing websites such as mint.com. Design highly secure zero knowledge protocols for making such web services more secure.

Area: Geometric Modeling
Title: The Nature of the Isosurface Fractal Dimension
Advisor: Dr. R. Wenger
        An isosurface is a geometric surface constructed from volumetric data such as CT or MRI scans. The fractal dimension of a surface measures the space "filled" by the surface. Investigate the fractal dimension of isosurfaces.

Area: Human computer interface
Title: The iBrutus open-world spoken dialog system
Advisor: Dr. Rajiv Ramnath
        iBrutus is a spoken-dialog system for any public setting, such as Ohio Stadium or the OSU medical center. This human-computer interface can be used in many different roles, including a stadium usher or an information kiosk. Research topics within iBrutus include artificial intelligence, audio signal processing, computer vision, and software engineering.

Area: Computer game development and Networking
Title: Mobile games with serious outcomes
Advisor: Dr. Rajiv Ramnath
        Building cross-platform iPhone/Android gaming and application frameworks. In addition to the interesting technology and application areas, such as STEM education, health and wellness, students research how to build persuasive applications and scalable application frameworks.

Area: Computer Vision
Title: Automatic Visual Surveillance
Advisor: Dr. J. Davis
        Develop and test computer vision algorithms related to intelligent computer surveillance and monitoring.

Area: Medical Image Processing and Analysis
Title: Scatterplot zoo
Advisor: Dr. R. Machiraju
        The first step when analyzing complex data from gene expression studies is to examine scatterplots of potentially interesting relationships. Create an interactive, web-based tool to automatically generate dynamically labeled scatterplot matrices (SPLOM). Using this tool, researchers can upload their own data, or they can download gene expression study data directly from the NCBI GEO website into the application.

Area: Medical Image Processing and Analysis
Title: Transcription factor networks for cancer
Advisor: Dr. R. Machiraju
        In collaboration with Prof. Gustavo Leone we are cataloging and "constructing" a complex network of transcription factors and their targets that play an important role in salient pathways of cancer.   Transcription factors modulate and influence the generation of proteins and there is enough evidence to indicate cross-interactions and not just correlations. Undergraduate researchers can help curate these interactions from literature and build tools to reconstruct and query these networks.

Area: Medical Image Processing and Analysis
Title: Biomarker development and patient stratification
Advisor: Dr. R. Machiraju
        In collaboration with Dr. Charles Shapiro, Oncology, OSU we are exploring the integration of histology images and molecular expression towards the development of biomarkers,   patient stratification and sub-typing, and prediction and prognosis. Constructed tools will focus on image annotation, analysis for associating image features with mRNA and microRNA (various molecular expression signatures).

Area: Medical Image Processing and Analysis
Title: Tool building for bioinformatics
Advisor: Dr. R. Machiraju
        There is a need to build several computational tool libraries that are needed for larger projects. Graph layout tools, routines for finding associations/correlations to name a few   are often needed. Undergraduate researchers will be   used in various tool building exercises and the focus is on software engineering. Processing, D3 and other Java based platforms will be employed.

Area: Software Engineering
Title: Searching for a needle in a haystack.
Advisor: Dr. B. Weide
        Consider the specification of a data type called PartitionableArray, which is parameterized by a predicate P on the element type. It has either the usual array accessor operation [ ] or set/get operations (using which individual array elements may be observed and updated), plus an operation that tells you how many elements satisfy P and an operation that returns the index of some element that satisfies P (assuming there is at least one). Develop a representation for which each of the PartitionableArray operations executes in constant time.

Area: Software Engineering
Title: A new performance-dominant representation for graphs
Advisor: Dr. B. Weide
Consider the specification of a data type called UndirectedGraph, which has a comprehensive set of operations of the kind you would expect to see for graphs. It turns out that, for each of the standard graph representations (adjacency matrix, adjacency list, and edge list), there is at least one operation for Graph that takes linear time in the number of vertices or the number of edges. Develop a representation for which each of the Graph operations executes in constant time.

Area: Software Engineering
Title: Automated validation for synchronous reactive embedded systems
Advisor: Dr. P. Sivilotti
Automate the generation of interesting test cases as well as automate the execution of these test cases to expose implementation flaws.

Area: Software Engineering and Security.
Title: Preventing scripting attacks.
Advisor: Dr. P. Sivilotti
Develop software to prevent cross-site scripting attacks by developing a sub-language of HTML with strong security guarantees.

Area: Software Engineering and Algorithms
Title: Connecting people and events: Multi-modal routing and dynamic user-generated content.
Advisor: Dr. P. Sivilotti
Develop software for the shortest-path transportation problem involving walking, buses, transfers, etc.

Area: Software Engineering
Title: File harvest: Targeted, legal crawling and downloading of online media.
Advisor: Dr. P. Sivilotti
Combine the flexibility of interactive web browsing with the convenience of automated off-line web crawling for interesting content.

Area: Computer Game Design and Development
Title: Hierarchical maze generation with a "fun" fitness function
Advisor: Dr. R. Crawfis
Perfect mazes have the characteristic that any starting point can reach any ending point. Hierarchical maze generation is a tiling of mazes that is itself a perfect maze. Each cell can be connected to a neighbor by knocking down a single wall. The research question is which wall produces the most interesting or fun maze?

Area: Computer Game Design and Development
Title: Procedural rock generation
Advisor: Dr. R. Crawfis
Massive game worlds need a large variety of interesting rocks. This work developed a framework for the procedural generation of rocks including fractures and fractal subdivisions.

Area: Computer Game Design and Development
Title: Tile-able Poisson point distributions for games
Advisor: Dr. R. Crawfis
  For the distribution of plants and other vegetation, Poisson point placement works well but is expensive. Generate a large distribution of plants and other vegetation using a rich set of Wang tiles.

Area: Computer Game Design and Development
Title: Games for physical therapy
Advisor: Dr. R. Crawfis
  Stroke patients can regain better mobility with an intense physical therapy routine over a two week period. This is prohibitively expensive for a vast majority of the population. Using the Microsoft Kinect with a game being developed as a replacement for PT allows this therapy to be migrated into the home.

Area: Computer Game Design and Development
Title: Tile-able terrain for games
Advisor: Dr. R. Crawfis
  Create individual tiles of terrain that are Wang tile-able. Associate with each tile a set of characteristics such as chock point, sniper location, ambush, serene and peaceful, etc. Then use these to tile a game with the desired flow of activity.