# TSGL: A Thread-Safe Graphics Library for teaching students about parallel computing

**Joel Adams, Patrick Crain, Chris Dilley, Mark Vander Stel, Dept of Computer Science, Calvin College**

***https://github.com/Calvin-CS/TSGL***

## Abstract

Computer Science educators face the challenge of teaching their students about parallel computing. When a program solves a problem by breaking it into pieces and then solving those pieces in parallel, it can be hard for students to understand exactly what is happening behind the scenes.

TSGL is an open source, C++ graphics library created to help Computer Science educators better communicate the ideas of parallel computing to their students. It includes a variety of examples that educators can use in order to help their students understand the ideas of parallel computing. These ideas include: dividing a problem among multiple threads, livelock, deadlock, various parallel patterns, and others. By helping students visualize these abstract topics, TSGL has been shown to improve student learning.

## Objectives

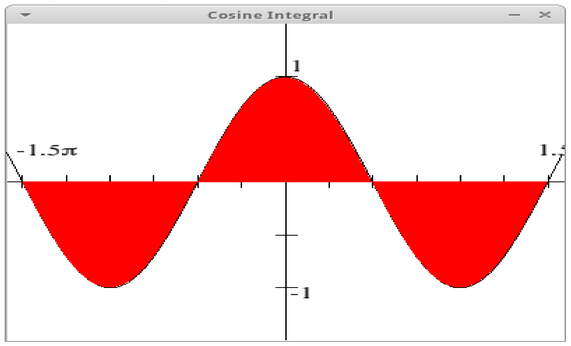
- Get TSGL to work well on all platforms (Windows, Mac, Linux)
- Enhance existing features of the library
- Make videos that walk people through the process of installing the library
- Create a wiki that will teach people how to write programs that use TSGL
- Make it easy for users to extend the library with new features and functionality
- Discover and fix bugs in TSGL
- Get the library in users' hands!

## Examples

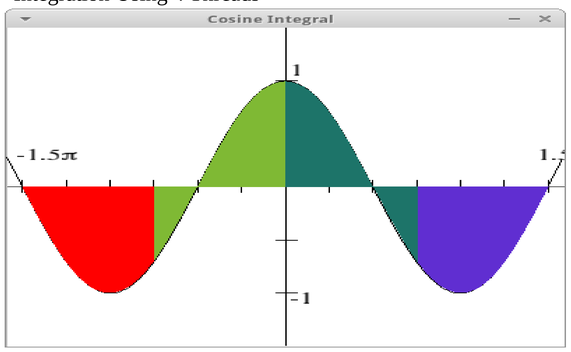
### Cosine Integration:

This visualization of the Cosine function illustrates how integration can be parallelized. Each different-colored portion shows the amount of work done by one thread.

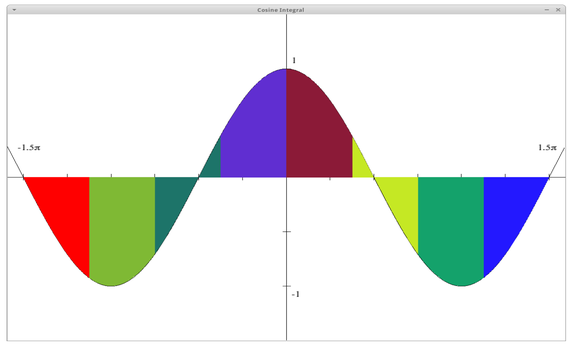
Integration Using 1 Thread




Integration Using 4 Threads

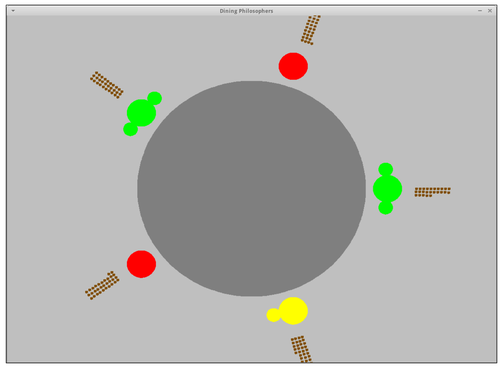



Integration Using 8 Threads



### Dining Philosophers:

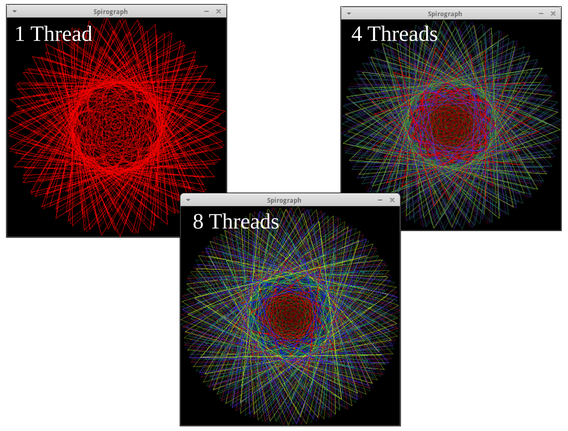
In this classic problem, N philosophers (5 here) sit around a table, each thinking for a random length of time and then wanting to eat. To eat, a philosopher (the larger circles) needs two chopsticks (the smaller circles), but there are only five, one between each philosopher. The challenge is to devise an algorithm that guarantees no philosopher will starve.



This visualization also includes a legend explaining what the colors represent:

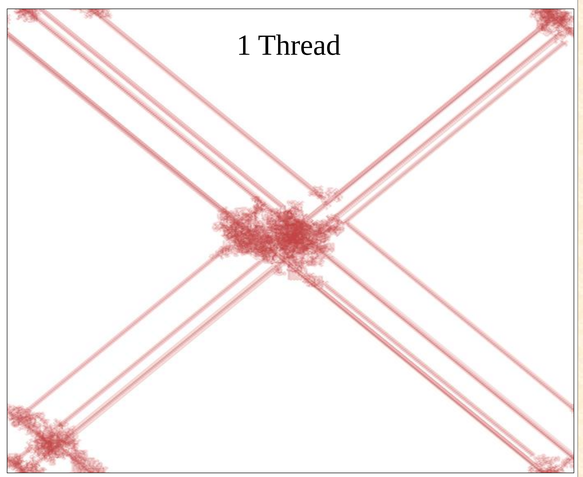

### Line Chain:

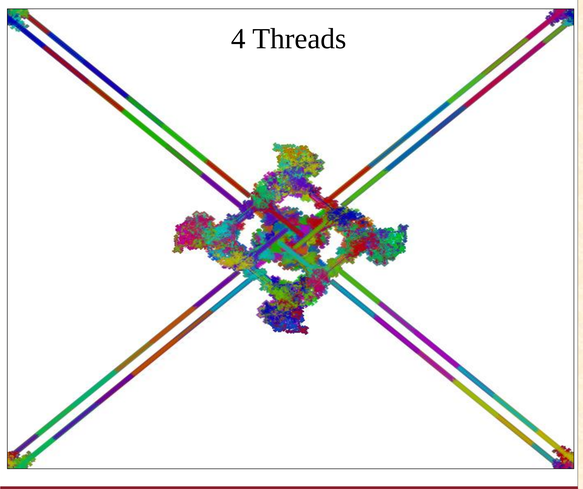
Each thread draws an oscillating geometric pattern using a different color.




### Langton's Ants:

Langton's Ants illustrates emergent behavior from a few simple rules. In this visualization, each "ant" is a thread that draws the ant's path using a unique color as it follows the rules.




## Conclusions

TSGL provides an easy-to-use library for creating 2D visualizations of parallel computations, using real-time rendering to show how different threads are performing different parts of the computation. It allows Computer Science educators to teach students about parallel computing through the use of fun and creative visualizations.



This work made possible by NSF DUE #1225739.