



# FreeCompilerCamp: Online Training for Extending Compilers

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## Abstract

- ★ **Problem:** Extending a compiler is a highly sophisticated and time-consuming task
- ★ Lack of training resources for researchers involved in compiler development.
- ★ Relying on expert trainers is not scalable.
- ★ **Goal:** design a scalable, extensible, and open online training platform for extending compilers.
- ★ Speedup up compiler research and development for High Performance Computing.
- ★ **Approach:** A website enabling anyone with internet access and a web browser to get training.
- ★ Play-with-docker as an online sandbox to allow learning by doing in real time.
- ★ Crowdsourcing to allow expert developers to contribute new tutorials.
- ★ Open-source and self-deployable on a private server, workstation or personal laptop.
- ★ Initial tutorials created to train users to learn how to extend the Clang/LLVM and ROSE compilers.

## Challenges and Solutions

Pain Points	Description	Proposed Solution
Accessibility	Paperwork to get accounts on suitable machines	Online sandbox terminal open to anyone
Installation	Many software packages are needed	Docker images
Effectiveness	Traditional text tutorials are not effective	Learning by doing, testing, certification
Content	One person/group cannot knows every detail	Crowd-sourcing to accept external contributions
Design trade-offs	One compiler cannot demonstrate all options	Hosting tutorials for multiple compilers
Costs	Hosting websites with containers costs money	Open-source, self-deployable framework
Security	Online websites have inherent risks	Containers + Cloud machines

Tab. 1: Pain points and solutions for training compiler developers

## Example Tutorials Based on Play-With-Docker

The screenshot shows the 'Free Compiler Camp Classroom' interface. It displays two steps of a tutorial for adding a new directive in OpenMP for Clang/LLVM.   
**Step 2 - Define the new directive:** This section explains the first step: letting the compiler identify a new directive. It provides instructions on updating the compiler files, specifically `OpenMPKinds.def` and `ParseOpenMP.cpp`. It shows how to define a new directive by modifying the `OpenMPKinds.def` file and adding a new case for `OMP_metadirective` in the `ParseOpenMP.cpp` file.   
**Step 3 - Implement parsing:** This section explains the second step: implementing the parsing of the new directive. It shows how to modify the `ParseOpenMP.cpp` file to handle the new directive, specifically by adding a new case for `OMP_metadirective` in the `ParseOpenMP.cpp` file.

Fig. 1: Example Tutorial for adding a new directive in OpenMP for Clang/LLVM

The screenshot shows the 'Free Compiler Camp Classroom' interface. It displays two sections: **Features** and **A. Overview**.   
**Features:** This section lists the features of the platform, including:   
 - Online interactive, self-paced learning platform using Play-With-Docker Engine: free, open, pre-configured, accessible via a browser.   
 - Crowd-source: Users can contribute and use their own tutorials.   
 - Cloud-based: self-deployable.   
 - Instructors or students can easily make customization and deploy it on any local server or even their own laptop.   
 - In the future:   
 - Include more tutorials about how to develop compilers for HPC.   
 - Design online examinations to help learners evaluate the effectiveness of their learning process.   
 - Improve overall appearance of FreeCompilerCamp.   
 - Retrieve files from the sandbox (via ssh or git).   
**A. Overview:** This section provides an overview of the tutorial for fixing a bug in ROSE. It shows the code for the `OMP_parallel` directive and explains how to fix the bug by adding a new case for `OMP_parallel` in the `ParseOpenMP.cpp` file.

Fig. 2: Example tutorial for fixing a bug in ROSE

## Technical Details

**FreeCompilerCamp.org:** A free and open online training platform to quickly extend compilers and help developers learn the skills of compiler development.

- ★ **Training Website** – provides a browser-based interactive interface with two panels, which is easy for user to learn and practice effectively. The left panel contains the training in text. The right panel connects with the Play-With-Compiler engine.
- ★ **Black colored window** can be clicked on and it will automatically be typed in to the appropriate terminal window.
  - Static command line instructions - which file to open to edit, which command to run for building, etc.
- ★ **Gray colored window** is code that a developer should type in themselves.
  - Code snippets that the developer update in the existing code, dynamic command line instruction, etc.
- ★ **Play-With-Compiler Engine** - built on top of Play-With-Docker, a docker playground for users to conduct experiments.
  - It creates a live terminal sandbox for real-time practice.
  - Alpine-based dockers → Ubuntu-based dockers
  - Docker tutorials → Compiler tutorials
  - Root user → Non-root user

## Conclusion & Future Work

- ★ Online interactive, self-paced learning platform using Play-With-Docker Engine: free, open, pre-configured, accessible via a browser.
- ★ Crowd-source: Users can contribute and use their own tutorials.
- ★ Cloud-based: self-deployable.
- ★ Instructors or students can easily make customization and deploy it on any local server or even their own laptop.
- ★ In the future:
  - Include more tutorials about how to develop compilers for HPC.
  - Design online examinations to help learners evaluate the effectiveness of their learning process.
  - Improve overall appearance of FreeCompilerCamp.
  - Retrieve files from the sandbox (via ssh or git).
- ★ Paper in Sixth SC Workshop on Best Practices for HPC Training and Education