Fast and safe web services with axum

Goal

- Broad Overview about Rust and it's current usage
- Detailed example to illustrate some features
- Encourage audience to try it out

Outline

- About myself
- My way to Rust
- Rust Introduction

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- Tim Eggert
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- Recently moved to Baldenhain

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- Looking for a cozy place to talk about tech!

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- Sometimes Java, but too verbose…
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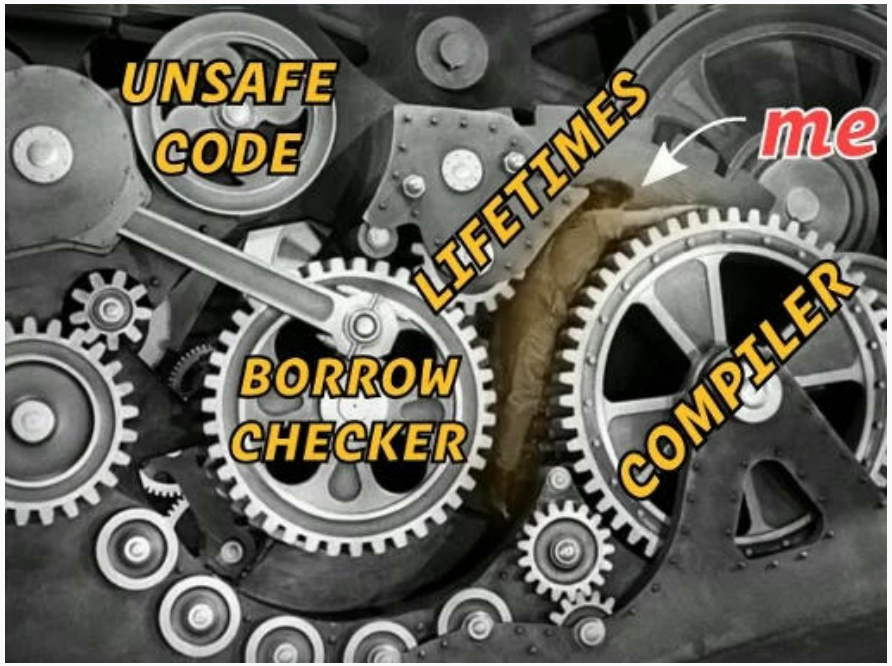

"A language empowering everyone to build reliable and efficient software."

— https://www.rust-lang.org

Disclaimer: I am a fan of Rust

Overview

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  - Major CPU architectures: x86, ARM,
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- Widely adopted own documentation standard
- Enterprise features for stability and maintainability

Origins

- Brainchild of Graydon Hoare
- Adopted + Sponsored by Mozilla in 2010
- Decision at Mozilla: Build new Browser Engine (Servo) from scratch based on Rust

Reliability: Memory Safety & Thread Safety

> "Rust's rich type system and ownership model guarantee memory-safety and thread-safety — enabling you to eliminate many classes of bugs at compile-time."
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Usage / Adoption

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- Databases (Meilisearch, Qdrant, ...)
- CLI Tools , Editors, Terminal Emulators, Shells, Language tooling (ruff, uv, ...)
- Deno (nodejs runtime competitor)
- Operating Systems (Redox OS, Linux Kernel)
- Cryptocurrency projects

... and many many more

Hello World

- Install Rust toolchain via rustup.rs:

```shell
curl --proto '=https' --tlsv1.2 -sSf https://sh.rustup.rs | sh
```

- Initiate a new project

```shell
cargo init hello_world
cd hello_world
cargo run
```

Hello World

```rust
fn main() {
  println!("Hello World!");
}
```

Rust Web Backend Frameworks

- Famous choices: Actix Web, Rocket, Warp, Axum, Rouille, Tide, …
- Framework Comparison
- For benchmark results, see the Tech Empower Web Framework Benchmarks

Initialize project

```Shell
cargo init todos
cd todos
```

Install dependencies

```Shell
cargo add axum
cargo add tokio --features full
cargo add serde --features derive
cargo add uuid --features v4 --features serde
cargo add serde_json
```

ToDo Example

Static Axum Server

```rust
use axum::{response::IntoResponse, routing::get, Router};

#[tokio::main]
async fn main() {
    let app = Router::new().route("/todos", get(list_todos));
    println!("Server running on http://127.0.0.1:3000");
    let listener = tokio::net::TcpListener::bind("0.0.0.0:3000").await.unwrap();
    axum::serve(listener, app).await.unwrap();
}
```

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ToDo Example

handler function to list Todos Rust

```rust
async fn list_todos() -> impl IntoResponse {
    // Just return a static string for now
    return "Todos";
}
```

ToDo Example

Add a TodoItem type / struct Rust

```rust
use serde::{Deserialize, Serialize};
use uuid::Uuid;

#[derive(Serialize, Deserialize, Clone)]
struct TodoItem {
    id: Uuid,
    title: String,
    completed: bool,
}
```

ToDo Example

Return static TodoItem as JSON Rust

```rust
use axum::Json;

async fn list_todos() -> Json<Vec<TodoItem>> {
    let todo = TodoItem {
        id: Uuid::new_v4(),
        title: "First Todo".into(),
        completed: false,
    };
    return Json(vec![todo]);
}
```

ToDo Example

Add shared state Rust

```rust
use tokio::sync::RwLock;

#[derive(Default)]
struct AppState {
    todos: RwLock<Vec<TodoItem>>,
}
```

ToDo Example

Add shared state Rust

```rust
use std::sync::Arc;

#[tokio::main]
async fn main() {
    let state = Arc::new(AppState::default());
    let app = Router::new()
        .route("/todos", get(list_todos))
        .with_state(state);
    ...
    axum::serve(listener, app).await.unwrap();
}
```

ToDo Example

Use AppState in list handler Rust

```rust
use axum::extract::State;

async fn list_todos(State(state): State<Arc<AppState>>) -> Json<Vec<TodoItem>> {
    let todos = state.todos.read().await.clone();
    return Json(todos);
}
```

ToDo Example

Add `POST /todos` Rust

```rust
use std::sync::Arc;

#[tokio::main]
async fn main() {
    let state = Arc::new(AppState::default());
    let app = Router::new()
        .route("/todos", get(list_todos).post(create_todo))
        .with_state(state);
    ...
    axum::serve(listener, app).await.unwrap();
}
```

ToDo Example

Add a request type for TodoItem Rust

```rust
#[derive(Serialize, Deserialize, Clone)]
struct TodoItemCreateRequest {
    title: String,
    completed: bool,
}
```

ToDo Example

Add `create_todo` handler function — Rust

```rust
async fn create_todo(
    State(state): State<Arc<AppState>>,
    Json(payload): Json<TodoItemCreateRequest>,
) -> Json<TodoItem> {
    let mut todos = state.todos.write().await;
    let todo = TodoItem {
        id: Uuid::new_v4(),
        title: payload.title,
        completed: payload.completed,
    };
    todos.push(todo.clone());
    Json(todo)
}
```

ToDo Example

Add `DELETE /todo/{id}` Rust

```rust
use axum::routing::delete;

#[tokio::main]
async fn main() {
    let state = Arc::new(AppState::default());
    let app = Router::new()
        .route("/todos", get(list_todos).post(create_todo))
        .route("/todos/{id}", delete(delete_todo))
        .with_state(state);
    ...
    axum::serve(listener, app).await.unwrap();
}
```

ToDo Example

Add `DELETE /todo/{id}` — Rust

```rust
use axum::{extract::Path, http::StatusCode};

async fn delete_todo(
    Path(id): Path<Uuid>,
    State(state): State<Arc<AppState>>
) -> StatusCode {
    let mut todos = state.todos.write().await;
    if let Some(pos) = todos.iter().position(|todo| todo.id == id) {
        todos.remove(pos);
        StatusCode::NO_CONTENT
    } else {
        StatusCode::NOT_FOUND
    }
}
```

ToDo Example

Building a release version

```
$> cargo build --release
```

Shell

```
$> ls -lah ./target/release/todos
-rwxr-xr-x@ 1 tim  staff   1.8M Jan 11 00:33 ./target/release/todos*
```

Additional Notes

- Weekly newsletter: “This week in Rust”
- Wide Editor support: (RustRover, VSCode, Emacs, Vim, Zed, …)
- Deep Dives: Crust of Rust
- Books: Which ones?