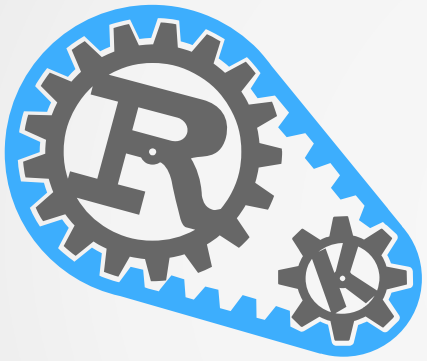
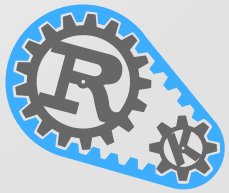
# Qt GUIs with Rust



## Rust Qt Binding Generator

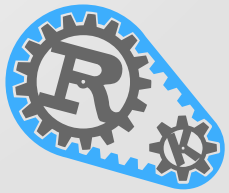
Jos van den Oever

- For Rust developers
- For Qt developers
- For developers of Qt
- For developers of $future_rust_ui

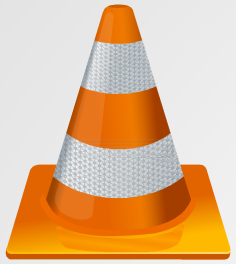


# Goals

- Find a way to write programs that combine Qt and Rust
- Small effort to create the tool
- Small effort to use the tool
- Simple with minimal dependencies
- *Good* Qt
- *Good* Rust



# What is Qt



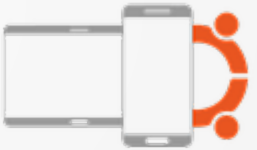
SAILFISH OS

LXQt

KRITA

LUMINA

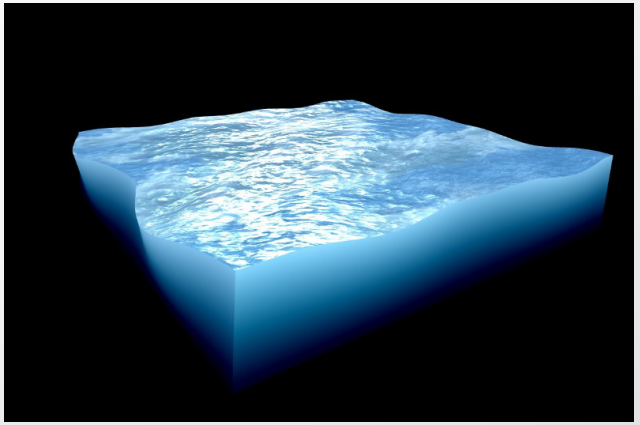
DESKTOP ENVIRONMENT



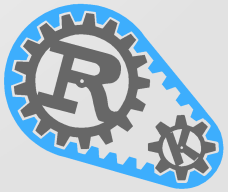
ubports

MAYA

QML



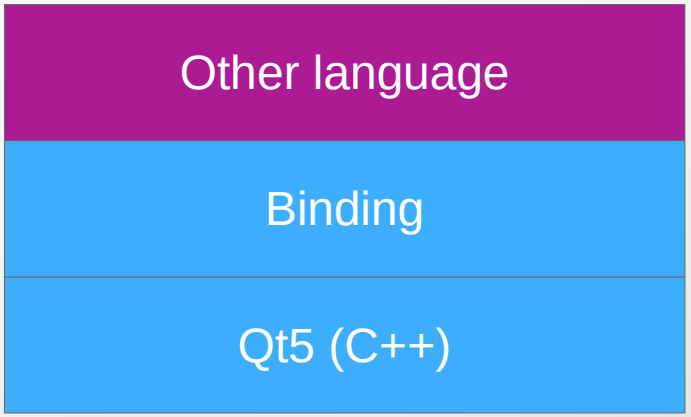
Plasma 5

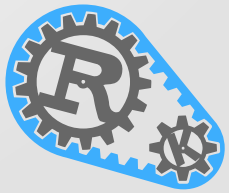



Qt
Qt
Qt
Qt
Qt

# Bindings for Qt5

- C#, Crystal, D, Go, Haskell, JavaScript, Java, Julia, Pascal, Python, OCaml, QML, Ring, Ruby, Rust,  D
- Why have bindings?
  - Use a familiar language
  - Combine with existing code

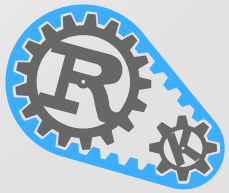


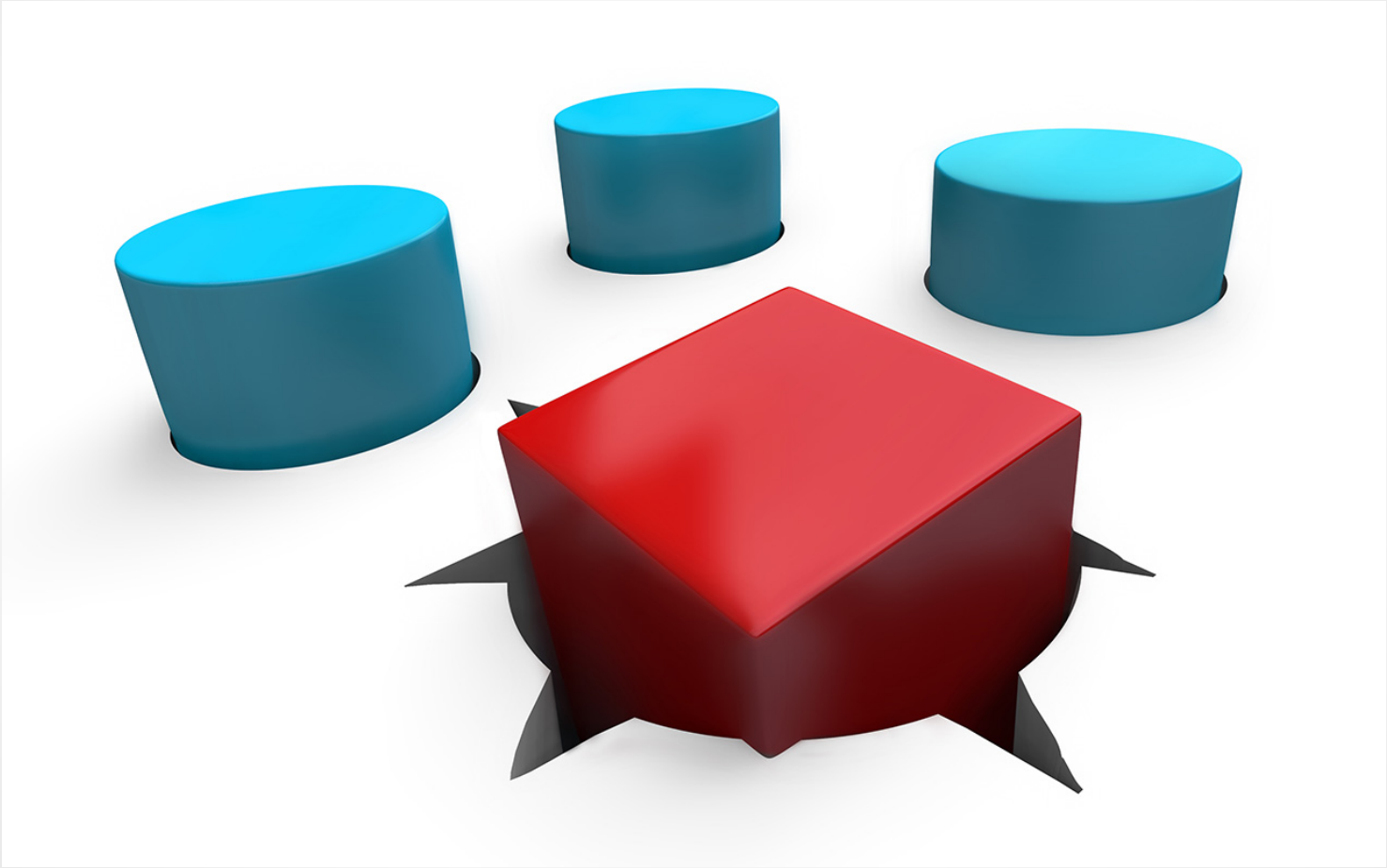
# Rust selling points

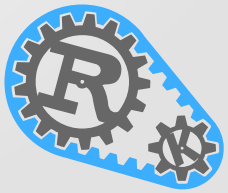
- safety
  - (de)allocation
  - bounds checking
  - concurrency
  - error handling
- algebraic data types (enum)
- macros
- cargo

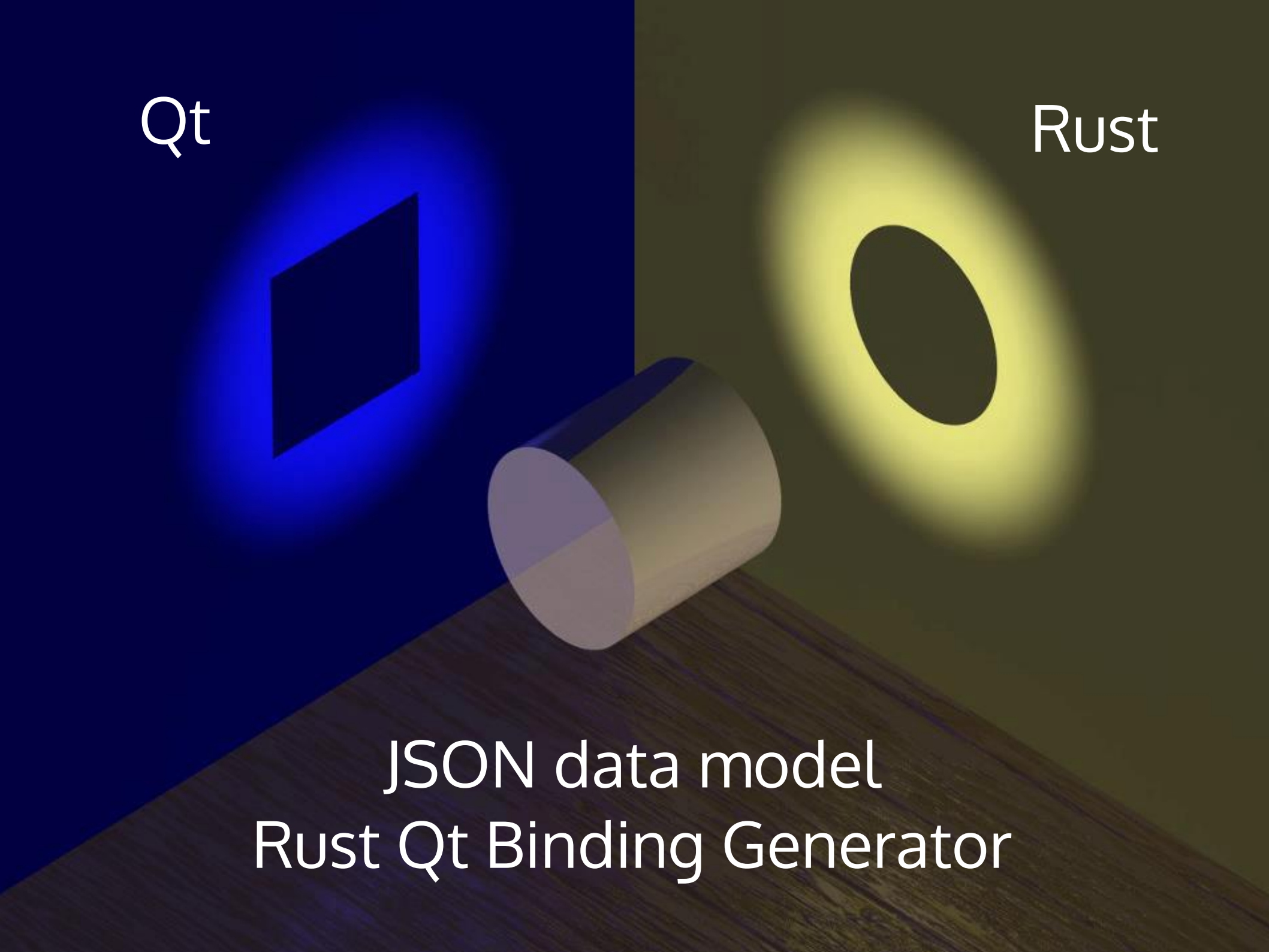
*wrap Qt API in Rust: round hole / square peg*



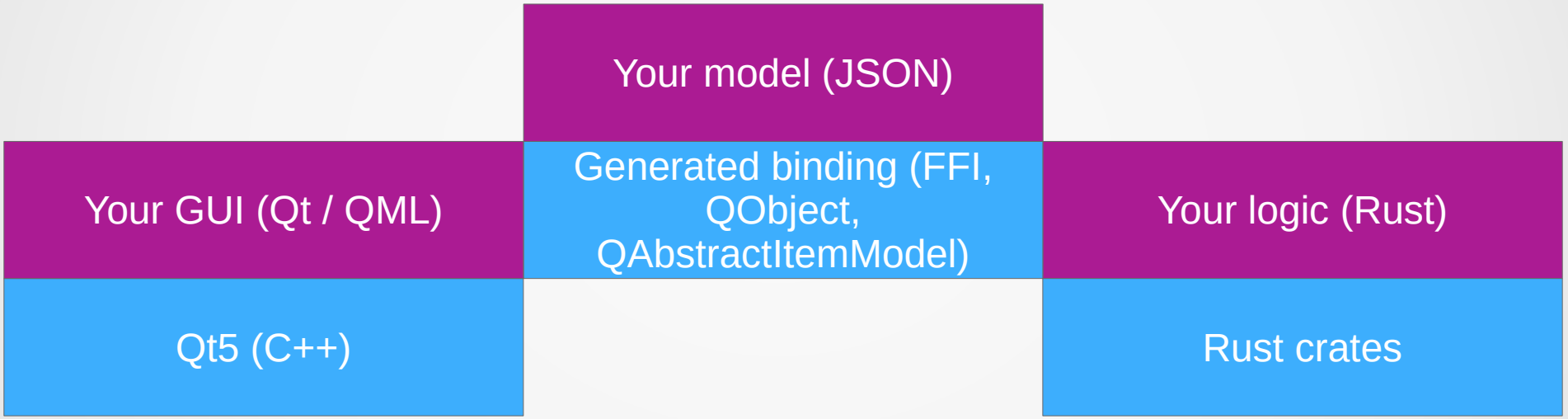
# Wrapping Qt API in Rust

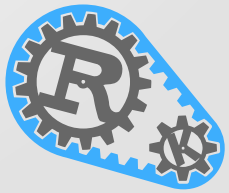





Qt
Rust
JSON data model
Rust Qt Binding Generator

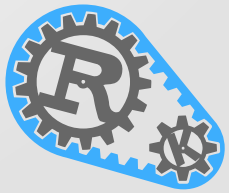
# Turn the binding around



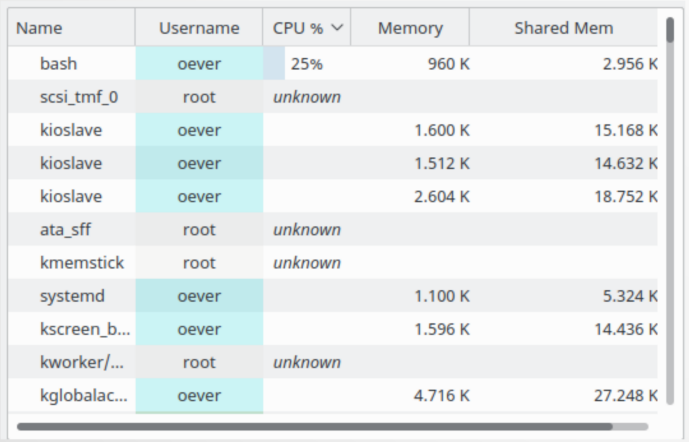
# The core of Qt: QObject

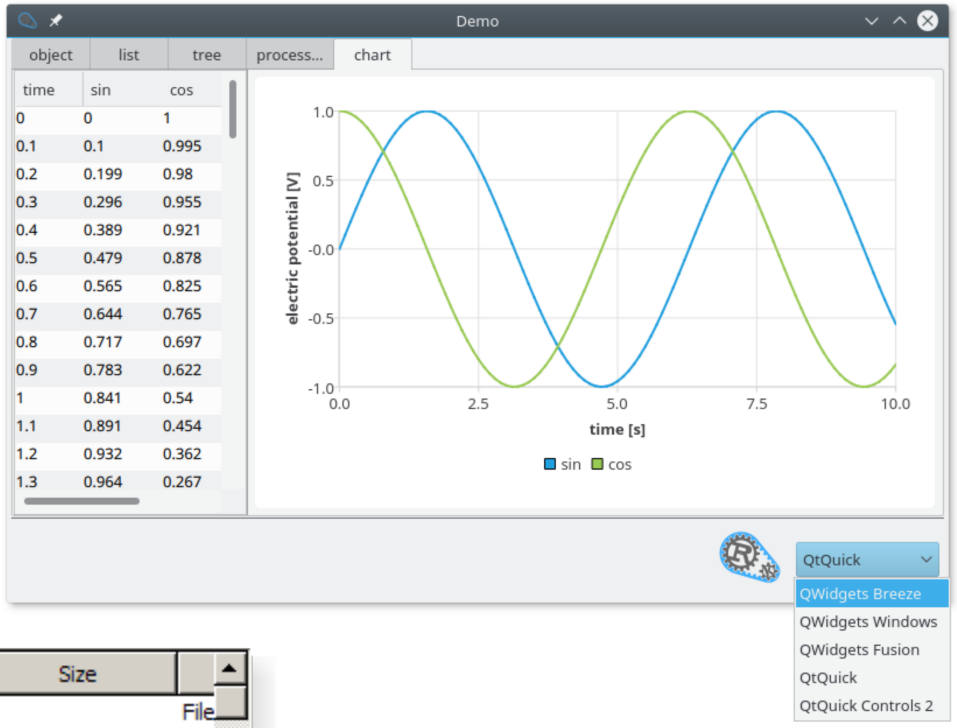
- Signals and slots
  - a.ka. events and listeners
  - loosely coupled: disconnect if one party is destroyed
- Memory management
  - hierarchical ownership
- Object properties
  - runtime introspection via QMetaObject

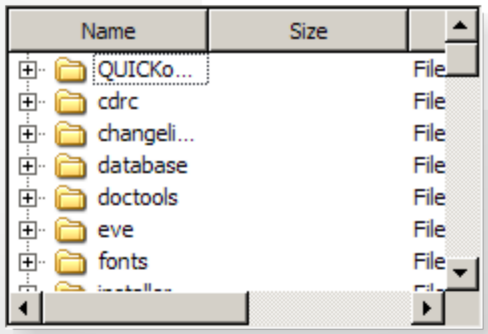


# The core of Qt: QAbstractItemModel

- Base class for providing data to lists, trees and tables
- Used *everywhere* in Qt
- Notoriously hard to implement



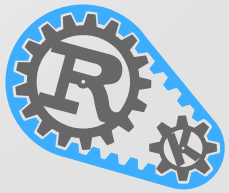



# Bits and pieces

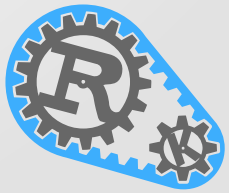
- Model description in JSON
- Generated
  - Binding.h
  - Binding.cpp
  - interface.rs
- Your Rust code compiled in to static library, e.g. librust.a
- Imported into Qt with “#include <Binding.h>” or

```
“import RustCode 1.0;”
```

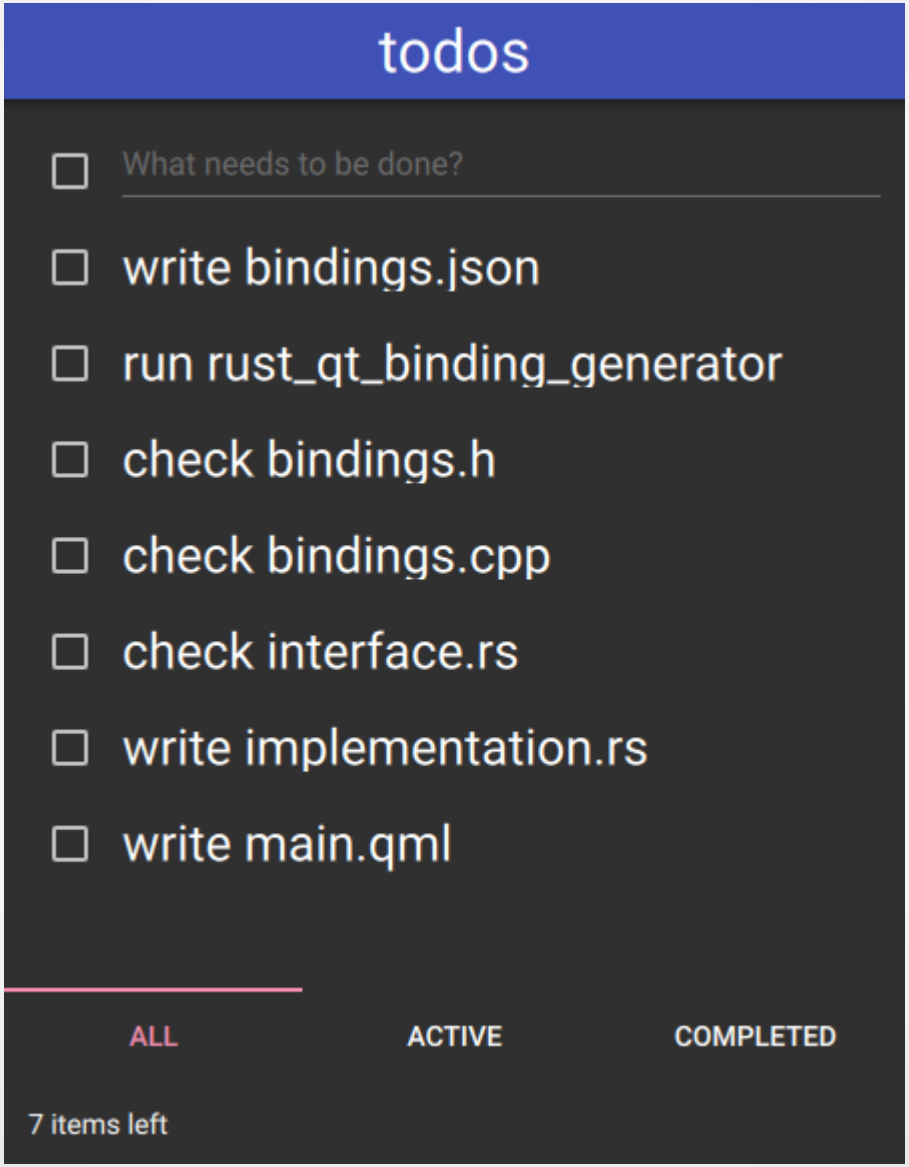


# QML

- Qt Modeling Language
- Declarative user interface markup language with JavaScript logic
- Qt Quick: 2D and 3D scene graph
- UI for Nokia Meego phones, Ubuntu phone, Sailfish, KDE Plasma Desktop, KDE Plasma Mobile
- Designed for efficiency on graphics cards (not unlike webrender)

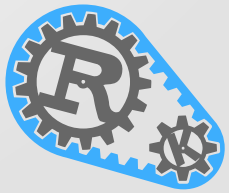


# Step 1: write bindings.json

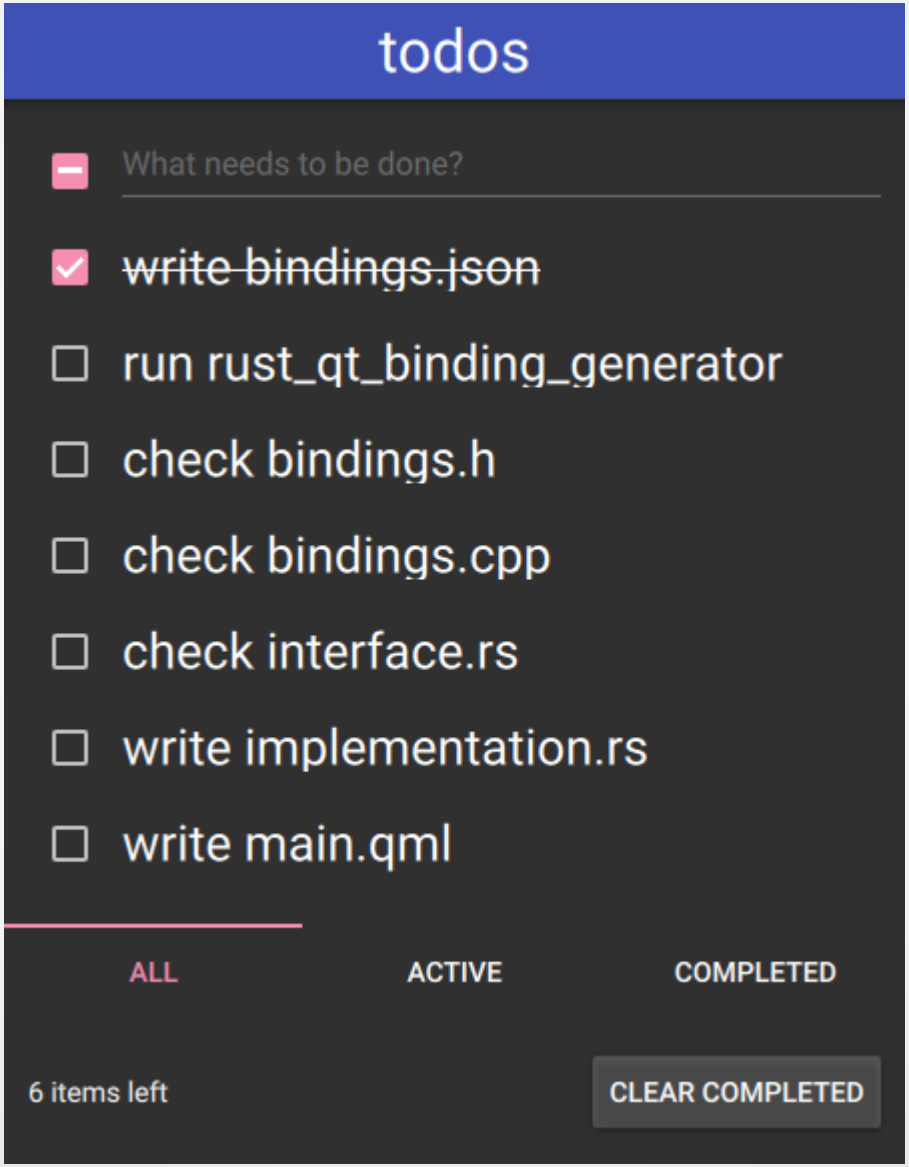


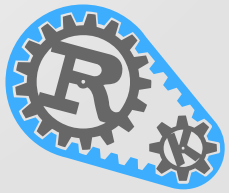
# Step 1: write bindings.json

```
"objects": {
        "Todos": {
            "type": "List",
            "properties": {
                "count": {
                    "type": "quint64"
                },
                "activeCount": {
                    "type": "quint64"
                }
            },
            "itemProperties": {
                "completed": {
                    "type": "bool",
                    "write": true,
                    "roles": [ [ "display" ] ]
                },
                "description": {
                    "type": "QString",
                    "write": true,
                    "roles": [ [], [ "display" ] ]
```



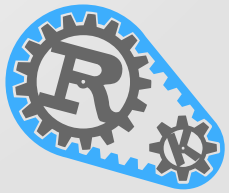
# Step 2: rust_qt_binding_generator



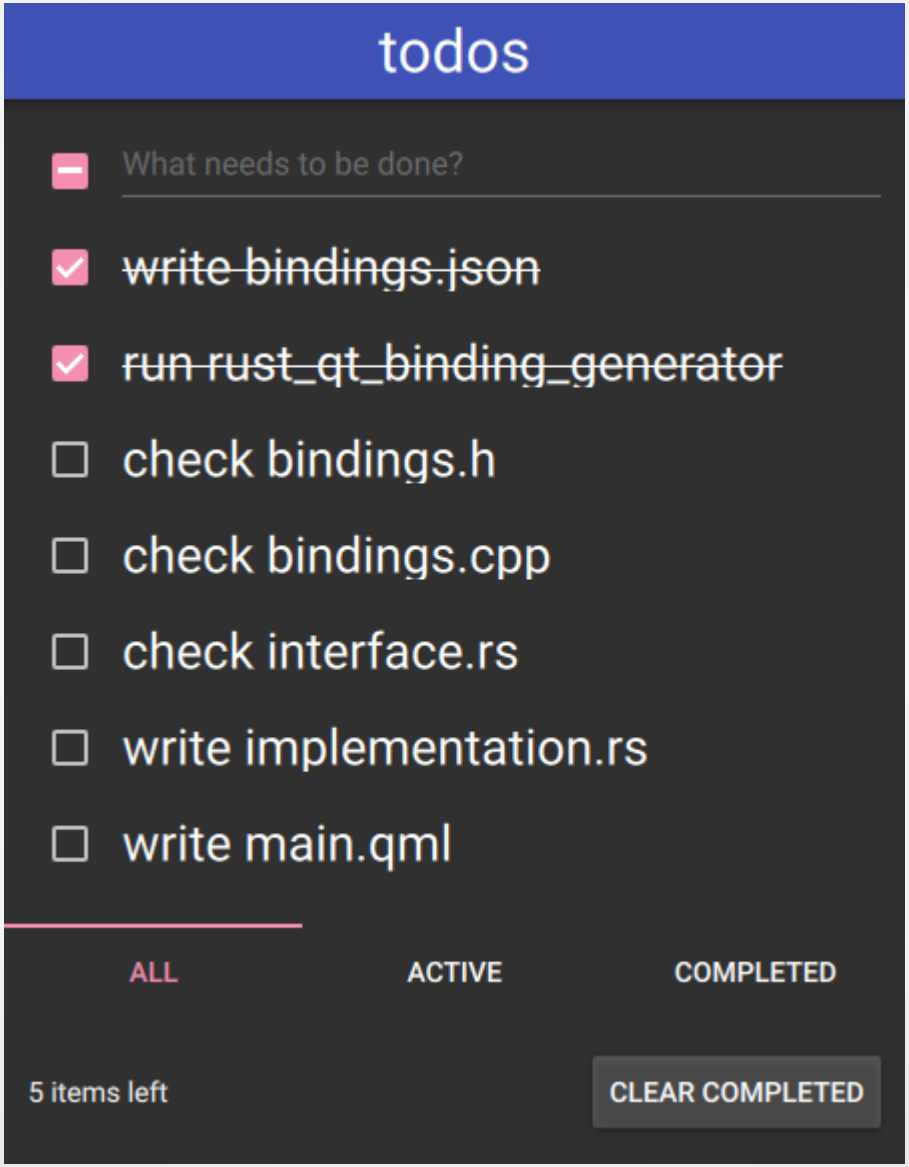



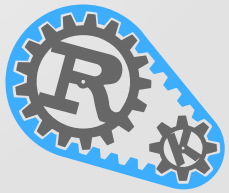
# Step 2: rust_qt_binding_generator

- `rust_qt_binding_generator binding.json`
- Simple command-line executable to be used in any build system, e.g. `CMake` or `build.rs`
- Generates `interface.rs`, `Binding.h` and `Binding.cpp`
- Generates initial `implementation.rs`



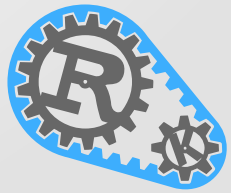
# Step 3: check bindings.h



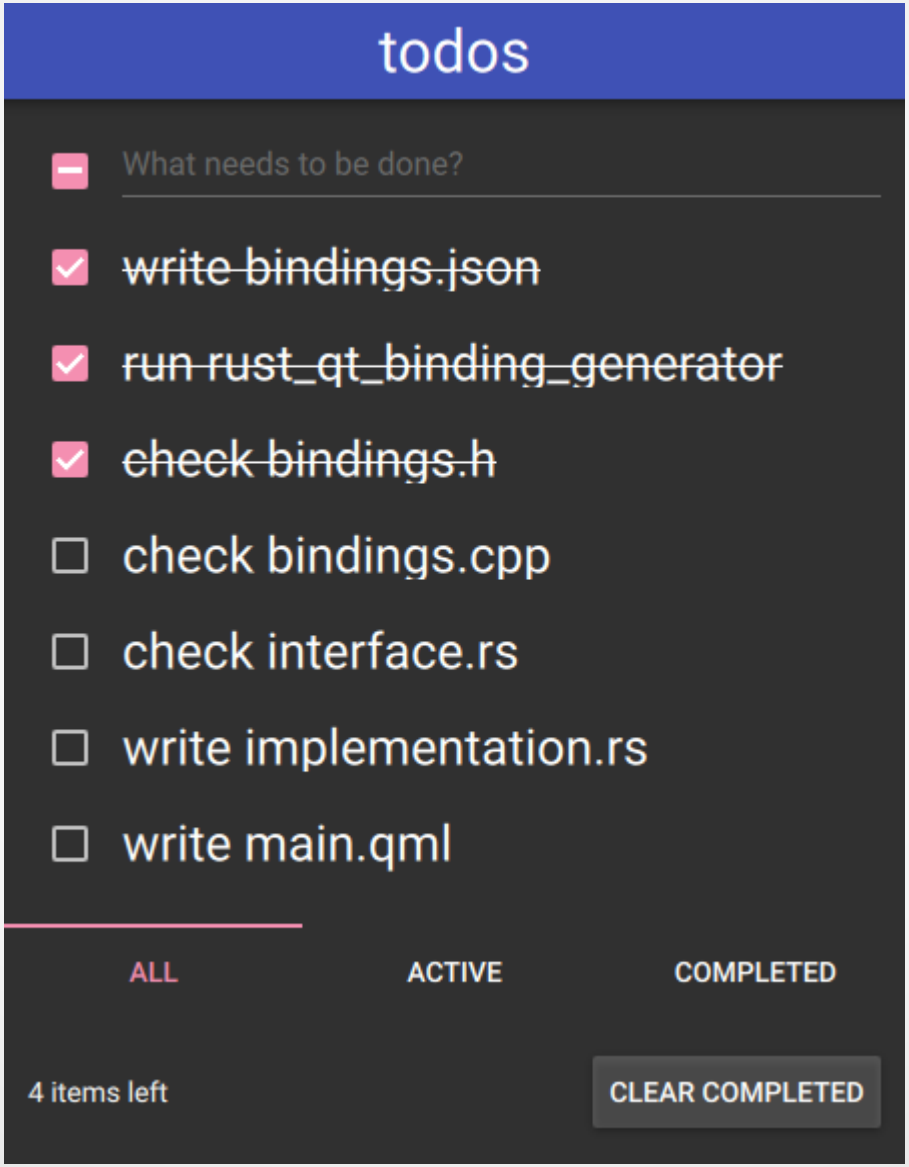



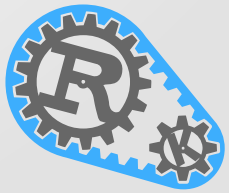
# Step 3: check bindings.h

```
class Todos : public QAbstractItemModel
{
    Q_OBJECT
public:
    explicit Todos(QObject *parent = nullptr);
    ~Todos();
    Q_PROPERTY(quint64 activeCount READ activeCount NOTIFY activeCountChanged FINAL)
    Q_PROPERTY(quint64 count READ count NOTIFY countChanged FINAL)
    quint64 activeCount() const;
    quint64 count() const;
    QVariant data(const QModelIndex &index, int role) const override;
    Q_INVOKABLE QVariant completed(int row) const;
    Q_INVOKABLE bool setCompleted(int row, const QVariant& value);
    Q_INVOKABLE QVariant description(int row) const;
    Q_INVOKABLE bool setDescription(int row, const QVariant& value);
```



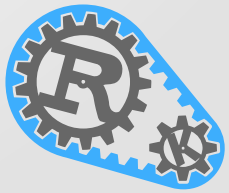
# Step 4: check bindings.cpp



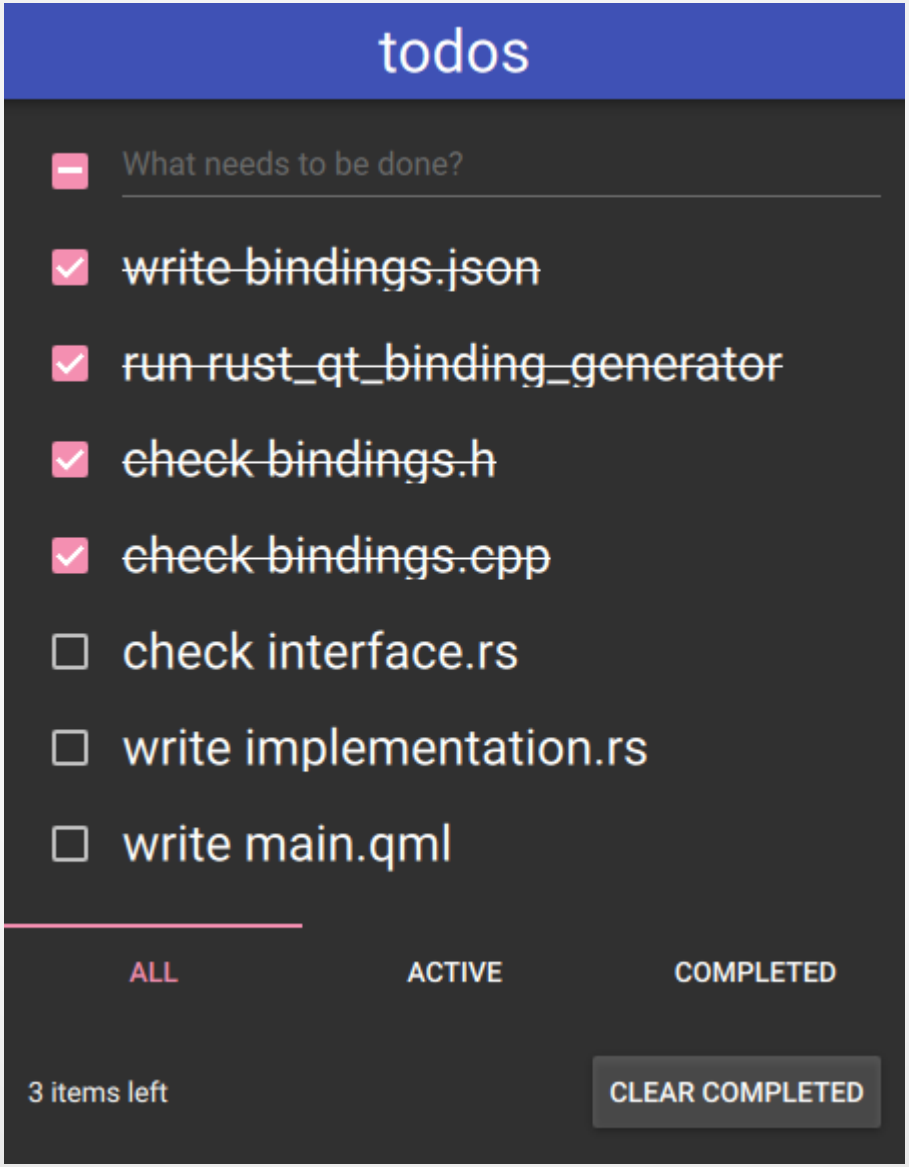



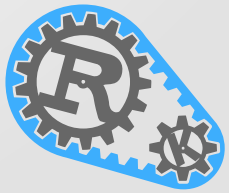
# Step 4: check bindings.cpp

```
extern "C" {
    void todos_free(Todos::Private*);
    quint64 todos_active_count_get(const Todos::Private*);
    void todos_data_description(
            const Todos::Private*, int, QString*, qstring_set);
    bool todos_set_data_description(
            Todos::Private*, int, qstring_t);
};
QVariant Todos::data(const QModelIndex &index, int role) const
{
    Q_ASSERT(rowCount(index.parent()) > index.row());
    switch (index.column()) {
    case 0:
        switch (role) {
        case Qt::DisplayRole:
        case Qt::UserRole + 0:
            return completed(index.row());
        case Qt::UserRole + 1:
            return description(index.row());
        }
    case 1:
        switch (role) {
        case Qt::DisplayRole:
        case Qt::UserRole + 1:
            return description(index.row());
        }
    }
    return QVariant();
}
```



# Step 5: check interface.rs

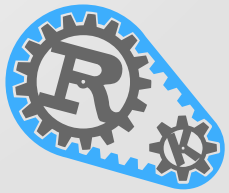


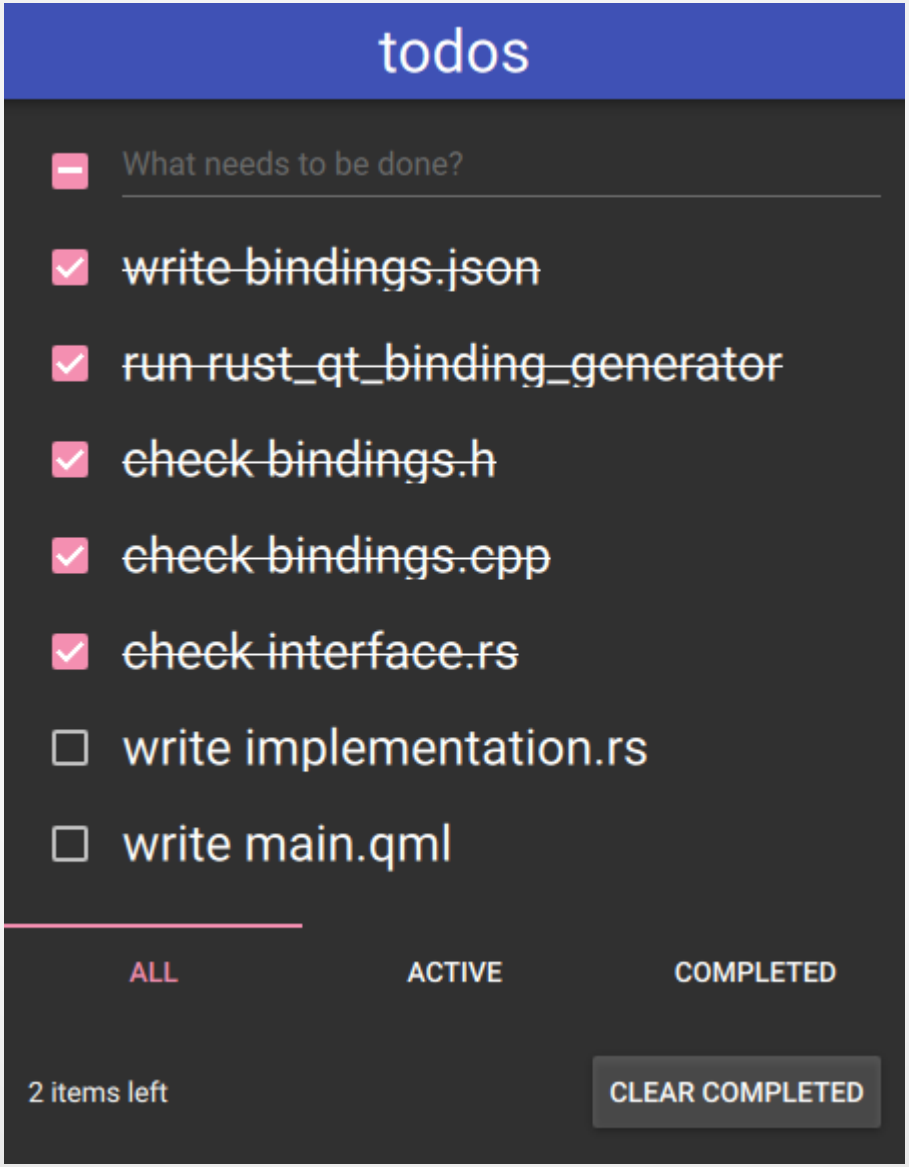
# Step 5: check interface.rs

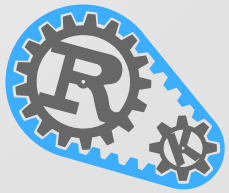
```
pub trait TodosTrait {
    fn new(emit: TodosEmitter, model: TodosList) -> Self;
    fn emit(&self) -> &TodosEmitter;
    fn active_count(&self) -> u64;
    fn count(&self) -> u64;
    fn insert_rows(&mut self, row: usize, count: usize) -> bool { false }
    fn remove_rows(&mut self, row: usize, count: usize) -> bool { false }

    fn completed(&self, item: usize) -> bool;
    fn set_completed(&mut self, item: usize, bool) -> bool;
    fn description(&self, item: usize) -> &str;
    fn set_description(&mut self, item: usize, String) -> bool;
}
```



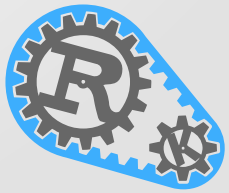
# Step 6: write implementation.rs



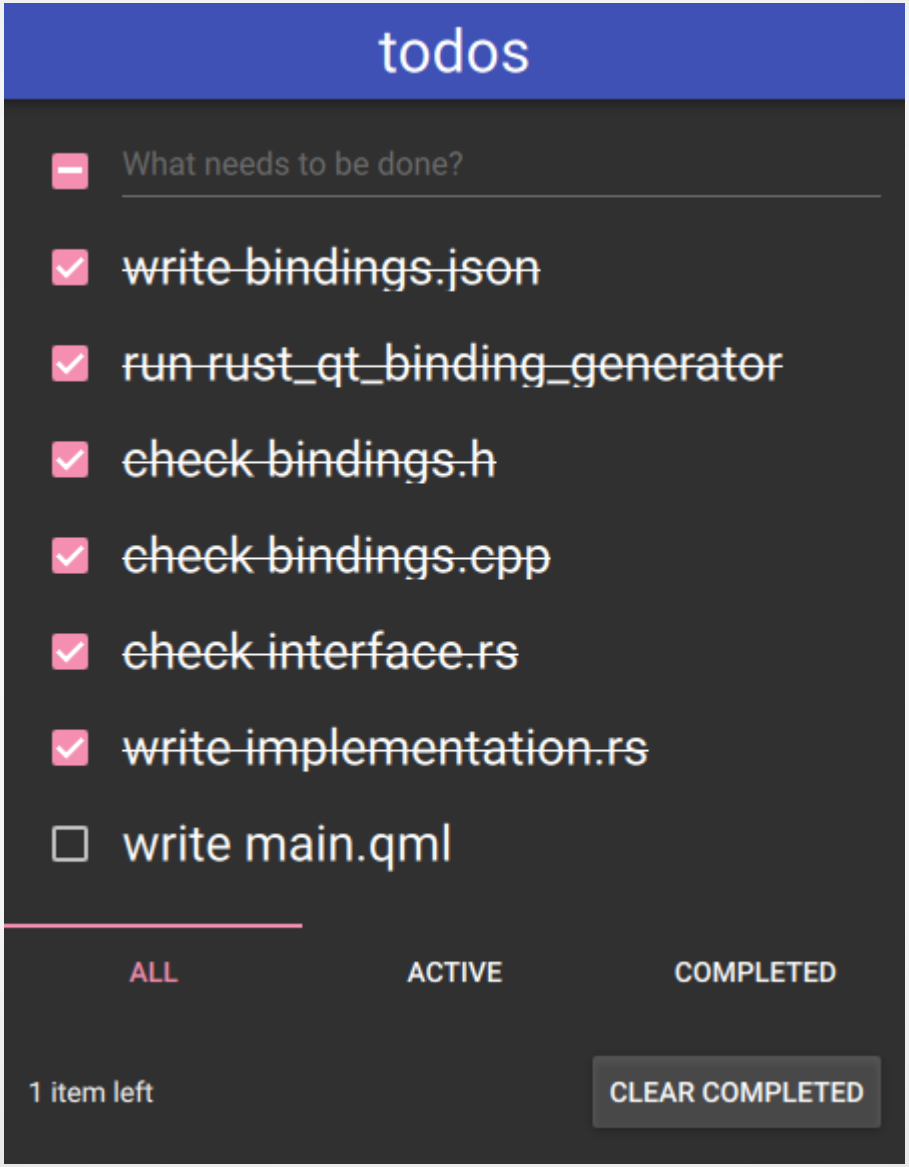



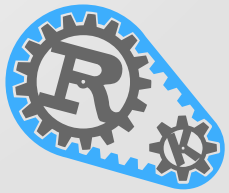
# Step 6: write implementation.rs

```
struct TodosItem {
    completed: bool,
    description: String,
}
pub struct Todos {
    emit: TodosEmitter,
    model: TodosList,
    list: Vec<TodosItem>,
    active_count: usize,
}
impl TodosTrait for Todos {
    fn active_count(&self) -> u64 {
        self.active_count as u64
    }
    fn count(&self) -> u64 {
        self.list.len() as u64
    }
    fn description(&self, item: usize) -> &str {
        if item < self.list.len() {
            &self.list[item].description
        } else {
            ""
        }
    }
    fn set_description(&mut self, item: usize, v: String) -> bool {
        if item >= self.list.len() {
            return false;
        }
        self.list[item].description = v;
        true
    }
```



# Step 7: write main.qml

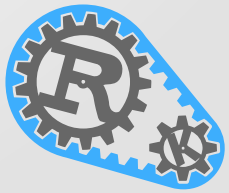


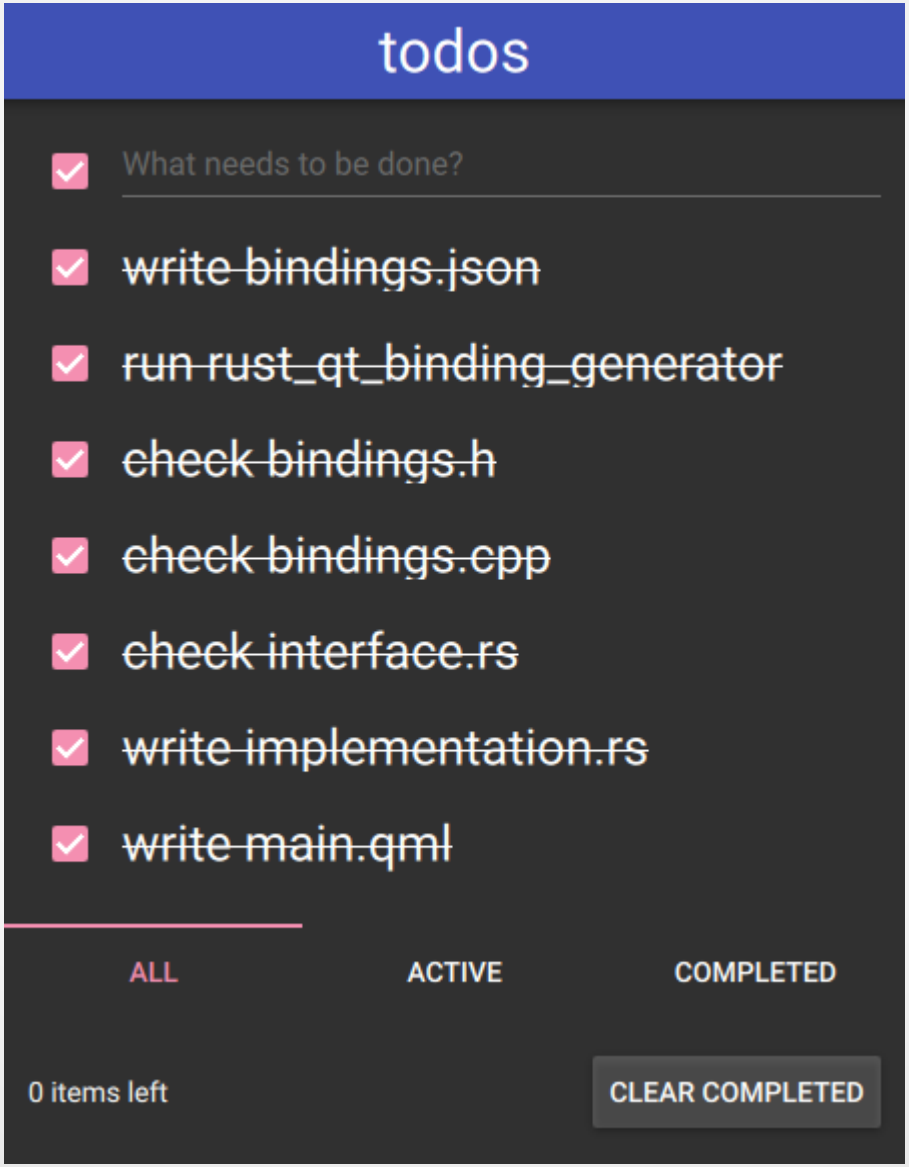
# Step 7: write main.qml

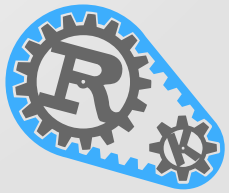
```
import QtQuick 2.9
import RustCode 1.0;

ApplicationWindow {
    Todos {
        id: todoModel
    }
    Component {
        id: todoDelegate
        Pane {
            CheckBox {
                checked: completed
            }
            Label {
                text: description
            }
        }
    }
    Flickable {
        ListView {
            model: todoModel
            delegate: todoDelegate
        }
    }
}
```



# Step 8: done!


todos
What needs to be done?
write bindings.json
run rust_qt_binding_generator
check bindings.h
check bindings.cpp
check interface.rs
write implementation.rs
write main.qml
ALL
ACTIVE
COMPLETED
0 items left
CLEAR COMPLETED



# Rust Qt Binding Generator

- Do not shoehorn Qt in a Rust API
- Wrap Rust code in QObject or QabstractItemModel
- Rust Qt Binding Generator does this for you
- *Good* Qt
- *Good* Rust