Unicode Support for GCC
Rust Frontend

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Outline

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Who am I

Raiki TAMURA

Undergraduate student at Kyoto University, Japan

Participated Google Summer of Code 2023 (GCC)

My interests are compilers and low-level programming
About My Project

- I worked on Unicode support for GCC Rust as a GSoC2023 project
  - Google Summer of Code is a global, online program focused on bringing new contributors into open source software development. GSoC Contributors work with an open source organization on a 12+ week programming project under the guidance of mentors. ([https://summerofcode.withgoogle.com/](https://summerofcode.withgoogle.com/))

- And now, I am working on supporting the new Rust mangler in GCC Rust
Unicode in Rust

- Non-ASCII newlines and white-spaces can be used
- `#![crate_name="..."]` accepts Unicode alphabetic and numeric characters
  - Note that Unicode alphabetic characters include non-ASCII codepoints
- More characters can be used for identifiers
  - e.g. Gödel, ぼげ, 안녕하세요
Unicode in Rust: Identifiers

Rust adopts the syntax of identifiers defined in UAX #31

- Also adopted by ECMAScript, C++ (C++23), Python (3.0), etc.

After being tokenized, Identifiers are normalized to NFC

https://doc.rust-lang.org/reference/identifiers.html
Implementation

There are other frontends supporting Unicode

- libc++/: C preprocessor with lexer
  - C++ adopts the same syntax of Unicode identifiers as Rust
- gcc/go/: Go frontend
Implementation is divided into 3 parts

1. Modify the lexer to accept Unicode characters
2. Implement `#![crate_name="xxxx"]` attribute
3. Modify the manglers to handle Unicode identifiers
Implementation: the Lexer part

In order to look up character properties, we reuse some functions in libcpp/

For other missing properties, we generate a header file from Unicode data files

```
make-rust-unicode.py
UnicodeData.txt, ...
```

```
rust-unicode-data.h
```
const std::map<uint32_t, std::vector<uint32_t>> DECOMPOSITION_MAP = {
    // clang-format off
    {0x0050, {0x0041, 0x00300, }},
    {0x0051, {0x0041, 0x00301, }},
    {0x0052, {0x0041, 0x00302, }},
    {0x0053, {0x0041, 0x00303, }},
    {0x0054, {0x0041, 0x00300, }},
    {0x0055, {0x0041, 0x00303, }},
    {0x0056, {0x0041, 0x00302, }},
    {0x0057, {0x0041, 0x00301, }},
    {0x0058, {0x0045, 0x00300, }},
    {0x0059, {0x0045, 0x00301, }},
    {0x005a, {0x0045, 0x00302, }},
    {0x005b, {0x0045, 0x00303, }},
    {0x005c, {0x0045, 0x00300, }},
    {0x005d, {0x0045, 0x00303, }},
    {0x005e, {0x0045, 0x00302, }},
    {0x005f, {0x0045, 0x00301, }},
    {0x0060, {0x004f, 0x00300, }},
    {0x0061, {0x004f, 0x00301, }},
    {0x0062, {0x004f, 0x00302, }},
    {0x0063, {0x004f, 0x00303, }},
    {0x0064, {0x004f, 0x00300, }},
    {0x0065, {0x004f, 0x00303, }},
    {0x0066, {0x004f, 0x00302, }},
    {0x0067, {0x004f, 0x00301, }},
    {0x0068, {0x004f, 0x00300, }},
    {0x0069, {0x004f, 0x00303, }},
    {0x006a, {0x004f, 0x00302, }},
    {0x006b, {0x004f, 0x00301, }},
    {0x006c, {0x004f, 0x00300, }},
    {0x006d, {0x004f, 0x00303, }},
    {0x006e, {0x004f, 0x00302, }},
    {0x006f, {0x004f, 0x00301, }},
    {0x0070, {0x004f, 0x00300, }},
    {0x0071, {0x004f, 0x00303, }},
    {0x0072, {0x004f, 0x00302, }},
    {0x0073, {0x004f, 0x00301, }},
    {0x0074, {0x004f, 0x00300, }},
    {0x0075, {0x004f, 0x00303, }},
    {0x0076, {0x004f, 0x00302, }},
    {0x0077, {0x004f, 0x00301, }},
    {0x0078, {0x004f, 0x00300, }},
    {0x0079, {0x004f, 0x00303, }},
    {0x007a, {0x004f, 0x00302, }},
    {0x007b, {0x004f, 0x00301, }},
    {0x007c, {0x004f, 0x00300, }},
    {0x007d, {0x004f, 0x00303, }},
    {0x007e, {0x004f, 0x00302, }},
    {0x007f, {0x004f, 0x00301, }}
    // clang-format on
};
Implementation: `#[crate_name]` attribute

Generate a codepoint table of Unicode alphabetic and numeric

Use it to validate values of the attribute

```rust
for (Codepoint &c : uchars)
{
    if (!(is_alphabetic (c.value) || is_numeric (c.value) || c.value == '_'))
    {
        error = Error (UNDEF_LOCATION,
        "invalid character %<s%> in crate name: %<s%>",
        c.as_string ().c_str (), crate_name.c_str ());
        return false;
    }
}
```

https://github.com/Rust-GCC/gccrs/blob/7c0daba10e43586df2ede9cd4037c50b85648e6a/gcc/rust/rust-session-manager.cc
Implementation: the Mangler part

Modify the default (legacy) mangler to handle Unicode

- legacy mangling scheme escapes non-ASCII characters as their codepoints

Implement the new mangling scheme (v0)

- identifiers are encoded as Punycode
- This part is now in progress
Mangling Schemes

- There are two mangling schemes: legacy and v0
  - You can pass options to switch a mangling scheme:
    - `rustc -C symbol-mangling-version=v0`
    - `gcc -frust-mangling=[legacy | v0]`
- v0 was introduced to rustc on 2019 and it is used in the Rust for Linux project
## Mangling Schemes: legacy vs v0

<table>
<thead>
<tr>
<th></th>
<th>Legacy</th>
<th>v0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prefix</strong></td>
<td>_Z</td>
<td>_R</td>
</tr>
<tr>
<td><strong>Characters</strong></td>
<td>A-Z, a-z, 0-9, _, $, .</td>
<td>A-Z, a-z, 0-9, _</td>
</tr>
<tr>
<td><strong>Contains type info</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Unicode identifiers</strong></td>
<td>Escaped as $XX$</td>
<td>Punycode</td>
</tr>
</tbody>
</table>
Example: legacy and v0

Example: fn 関数() {}

legacy: _ZN7example15_\$u95a2\$u6570\$17hb64df414284d985b

v0: _RNvCsjZmpILMU2JV_7exampleu7kdvt68h
Example : legacy and v0

Example: fn 関数() {}

legacy: _ZN7example15_$u95a2$$u6570$17hb64df414284d985b

v0: _RNvCsjZmpILMU2JV_7exampleu7kdvt68h

- non-ASCII characters are escaped in legacy
- In v0, they are encoded as Punycode
Summary

As a result of GSoC 2023, gccrs supports Unicode

Rust compilers use Unicode normalization and Punycode encoding

Implementing the new v0 mangler to gccrs is in progress
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List of References

