Jancy

LLVM-based scripting language for IO and UI programming

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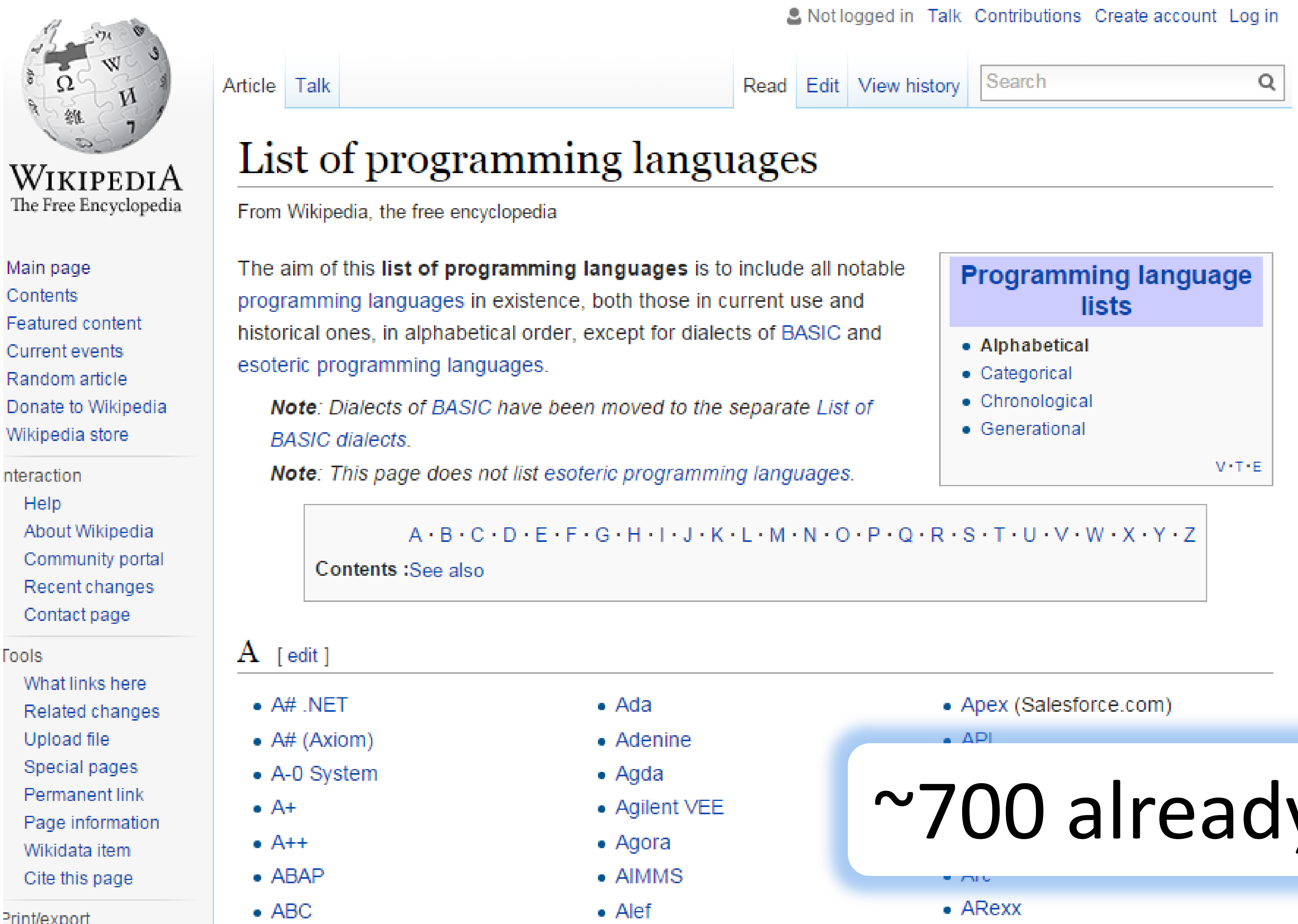
Overview

- Why?
- 2 main Jancy features
- Compiler design and how we use LLVM
- Questions

Why?! Do we need more?



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List of programming languages

From Wikipedia, the free encyclopedia

The aim of this **list of programming languages** is to include all notable programming languages in existence, both those in current use and historical ones, in alphabetical order, except for dialects of BASIC and esoteric programming languages.

> ***Note***: *Dialects of BASIC have been moved to the separate List of BASIC dialects.*
>
> ***Note***: *This page does not list esoteric programming languages.*

Programming language lists

- **Alphabetical**
- Categorical
- Chronological
- Generational

V · T · E

A · B · C · D · E · F · G · H · I · J · K · L · M · N · O · P · Q · R · S · T · U · V · W · X · Y · Z

Contents : See also

A [edit]

- A# .NET
- A# (Axiom)
- A-0 System
- A+
- A++
- ABAP
- ABC

- Ada
- Adenine
- Agda
- Agilent VEE
- Agora
- AIMMS
- Alef

- Apex (Salesforce.com)
- ARexx

~700 already!!

Wanted! (for IO Ninja)

- IO
  - Safe pointer arithmetic
  - High level of source compatibility with C
  - Built-in incremental lexer generator

Wanted! (for IO Ninja)

- IO
  - Safe pointer arithmetic
  - High level of source compatibility with C
  - Built-in incremental lexer generator
- UI
  - Properties
  - Events
  - Excel-like “reactive“ evaluation

Jancy Design Goals

- Embedded scripting language
- Statically typed
- C-family language syntax
- ABI-compatible with C
- Garbage collected (accurate GC)
- LLVM as back-end

Other interesting features

- Const-correctness
- Multiple inheritance
- Partial application
- Schedulers
- Exception-style syntax over error code checks
- Dual type modifiers
- Bigendian integers
- Bitflag enums
- Break-n/Continue-n
- Hex literals

Handling binary data (wrong)

```
public class IPv4Packet {
    private static final int IP_TOS_POS = 1;  // type of service
    private static final int IP_LEN_POS = 2;  // total packet length
    private static final int IP_ID_POS = 4;   // the packet id
    private static final int IP_FRAG_POS = 6; // the frag flags and offset
    // ...
    public int getTypeOfService() {
        if (_isReadTOS == false) {
            myTOS = myPacket[myIPHdrOffset + IP_TOS_POS] & 0x0f;
            _isReadTOS = true;
        }
        return myTOS;
    }
    public int getFragmentFlags() {
        if (_isReadFragFlags == false) {
            _isReadFragFlags = true;
            myFragmentFlags = ByteUtils.getByteNetOrderTo_uint16(
                myPacket, myIPHdrOffset + IP_FRAG_POS) >> 13;
        }
        return myFragmentFlags;
    }
    // ...
}
```

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Handling binary data (wrong)

```java
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                myPacket, myIPHdrOffset + IP_FRAG_POS) >> 13;
        }
        return myFragmentFlags;
    }
    // ...
}
```

Handling binary data (right)

Step #1 – Define data layout

```
struct IpHdr
{
    uint8_t m_headerLength : 4;
    uint8_t m_version      : 4;
    uint8_t m_typeOfService;
    // ...
}

struct IcmpHdr
{
    uint8_t m_type;
    uint8_t m_code;
    bigendian uint16_t m_checksum;
    // ...
}
```

Handling binary data (right)

Step #2 – Access buffer

```
printIpHdr (void const* buffer)
{
    IpHdr const* ipHdr = (IpHdr const*) buffer;

    print ($"IP version = $(ipHdr.m_version)\n“);
    // ...

    if (ipHdr.m_protocol == IPPROTO_ICMP)
    {
        buffer += ipHdr.m_headerLength * 4;
        IcmpHdr const* icmpHdr = (IcmpHdr const*) buffer;

        print ($“ICMP type = $(icmpHdr.m_type)\n“);
        // ...
    }
}
```

Handling binary data (right)

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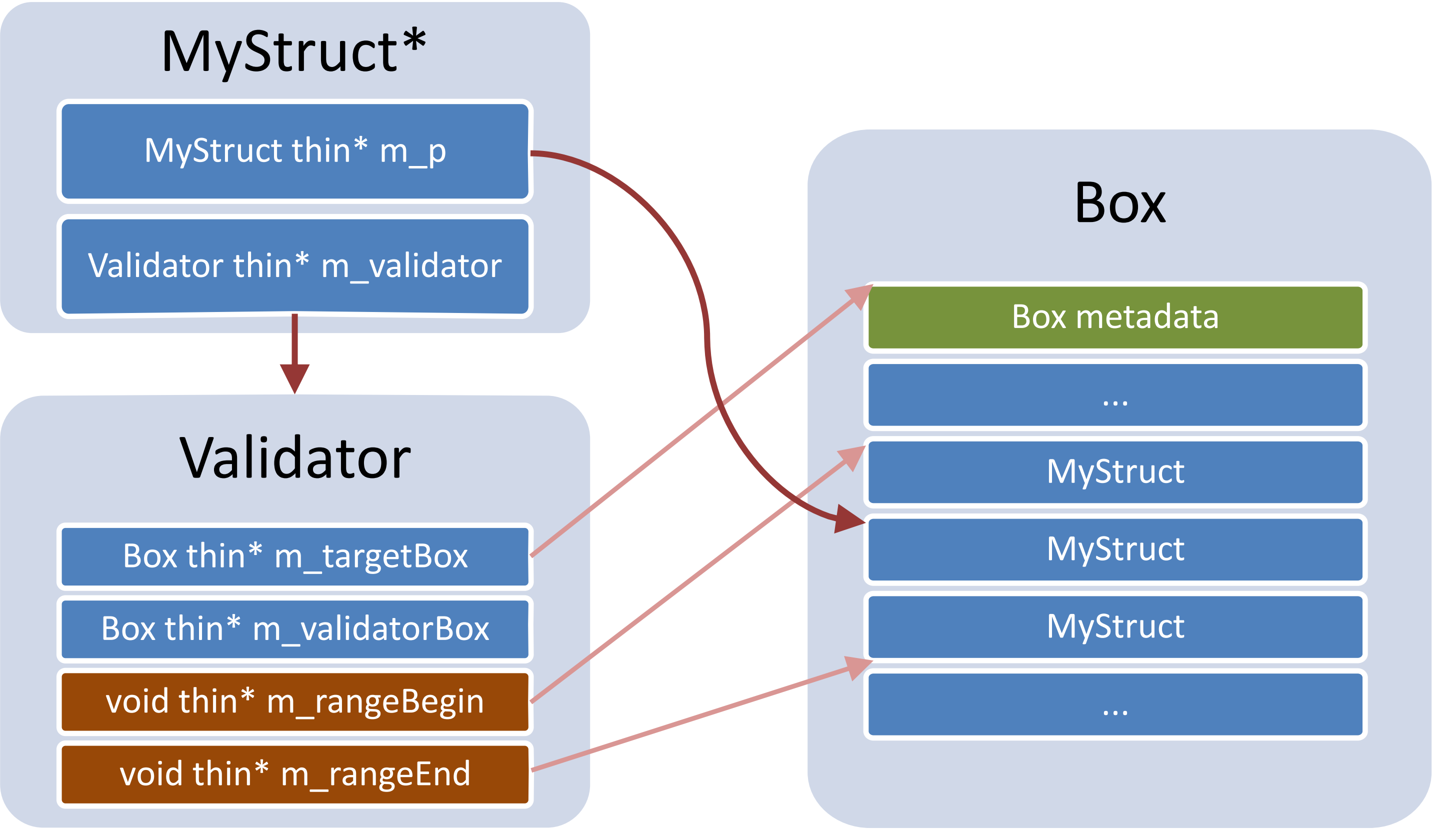
        print ($“ICMP type = $(icmpHdr.m_type)\n“);
        // ...
    }
}
```

How is pointer arithmetic safe?

Fat pointers, obviously

```
MyStruct* p;
```



Loads/stores are bounds checked

Pointer dereference

```
foo (char* p, size_t i)
{
    p += i;
    *p = 10; // <-- range is checked
}
```

Array indexing

```
bar (size_t i)
{
    static int a [] = { 10, 20, 30 };
    int x = a [i]; // <-- range is checked
}
```

Dynamic sizeof/countof

```
foo (int* a)
{
    size_t count = dynamic countof (a);
    for (size_t i = 0; i < count; i++)
    {
        // do something with a [i]
    }
}
```

Are bounds checks enough?

- Dangling pointers?
- Unions?
- Reinterpret casts?
- Pointer-to-fields increments?
- Downcasts?

Are bounds checks enough?

- Dangling pointers – impossible in Jancy
- Unions
- Reinterpret casts

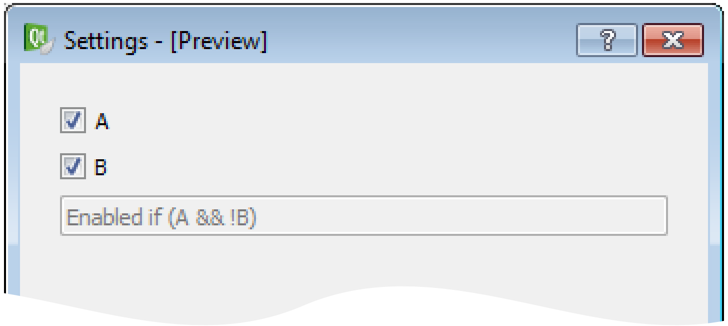
only when safe

- Pointer-to-fields increments – range-controlled
- Downcasts – dynamic casts

```
foo (Parent* a)
{
    Child* c = dynamic (Child*) a;
    // ...
}
```

Reactive Programming for UI

- Automatic propagation of changes
- Observer/Observable pattern
- Our goal: Excel-like re-evaluation for UI
- Our workhorses:
  - Multicasts & events
  - Properties



☑ A

☑ B

Enabled if (A && !B)

```
m_editBox.m_isEnabled =
    m_checkBoxA.m_isChecked &&
    !m_checkBoxB.m_isChecked;
```

Reactive Programming for UI

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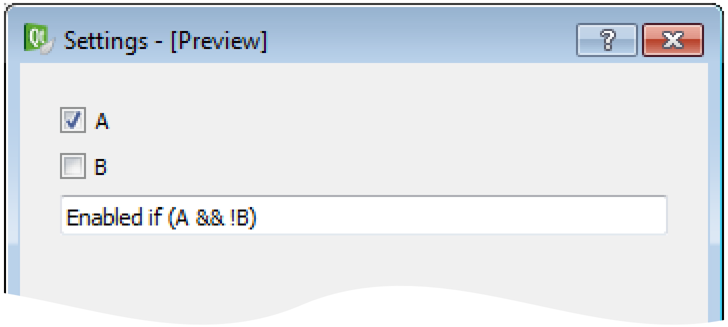


☑ A

□ B

Enabled if (A && !B)

```
m_editBox.m_isEnabled =
    m_checkBoxA.m_isChecked &&
    !m_checkBoxB.m_isChecked;
```

Multicasts & events

```
class C1
{
    event m_onComplete ();

    work ()
    {
        // ...
        m_onComplete (); // OK, 'call' is accessible from C1
    }
}

foo (C1* c)
{
    multicast m (int);
    m += bar;
    m += baz;
    m (100);  // <-- foo (100); bar (100);

    c.m_onComplete (); // <-- error, 'call' is inaccessible
}
```

Bindable properties

```
int bindable property g_bindableProp;
```

```
g_bindableProp.set (int x)
{
    if (x == m_value)
        return;

    m_value = x;
    m_onChanged (); // compiler-generated event is 'm_onChanged'
}
```

```
onPropChanged ()
{
    // ...
}

foo ()
{
    bindingof (g_bindableProp) += onPropChanged;
    g_bindableProp = 100; // onPropChanged will be called
}
```

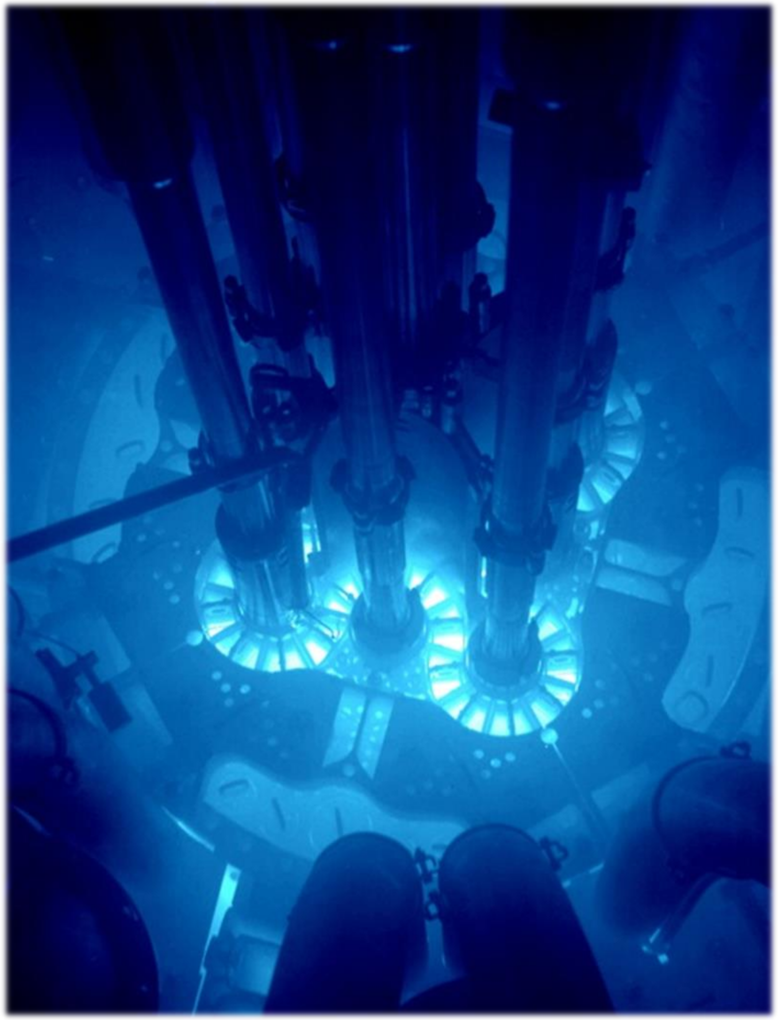
Dilemma

- We want Excel-like re-evaluation

Dilemma

- We want Excel-like re-evaluation
- Implicit observers are hard to control

Solution – reactors!



Solution – reactors!

```
reactor TcpConnectionSession.m_uiReactor ()
{
    m_title = $"TCP $(m_addressCombo.m_editText)";
    m_isTransmitEnabled = m_state == State.Connected;
    m_actionTable [ActionId.Disconnect].m_isEnabled = m_state != State.Closed;
    m_adapterProp.m_isEnabled = m_useLocalAddressProp.m_value;
    m_localPortProp.m_isEnabled = m_useLocalAddressProp.m_value;
}
```

Solution – reactors!

```
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    m_localPortProp.m_isEnabled = m_useLocalAddressProp.m_value;
}
```

Automated, but controlled

```
reactor m_uiReactor ()
{
    m_title = $"TCP $(m_addressCombo.m_editText)";
    m_isTransmitEnabled = m_state == State.Connected;
    // ...

    onevent m_transmitButton.m_onClicked ()
    {
        // handle start button click...
    }

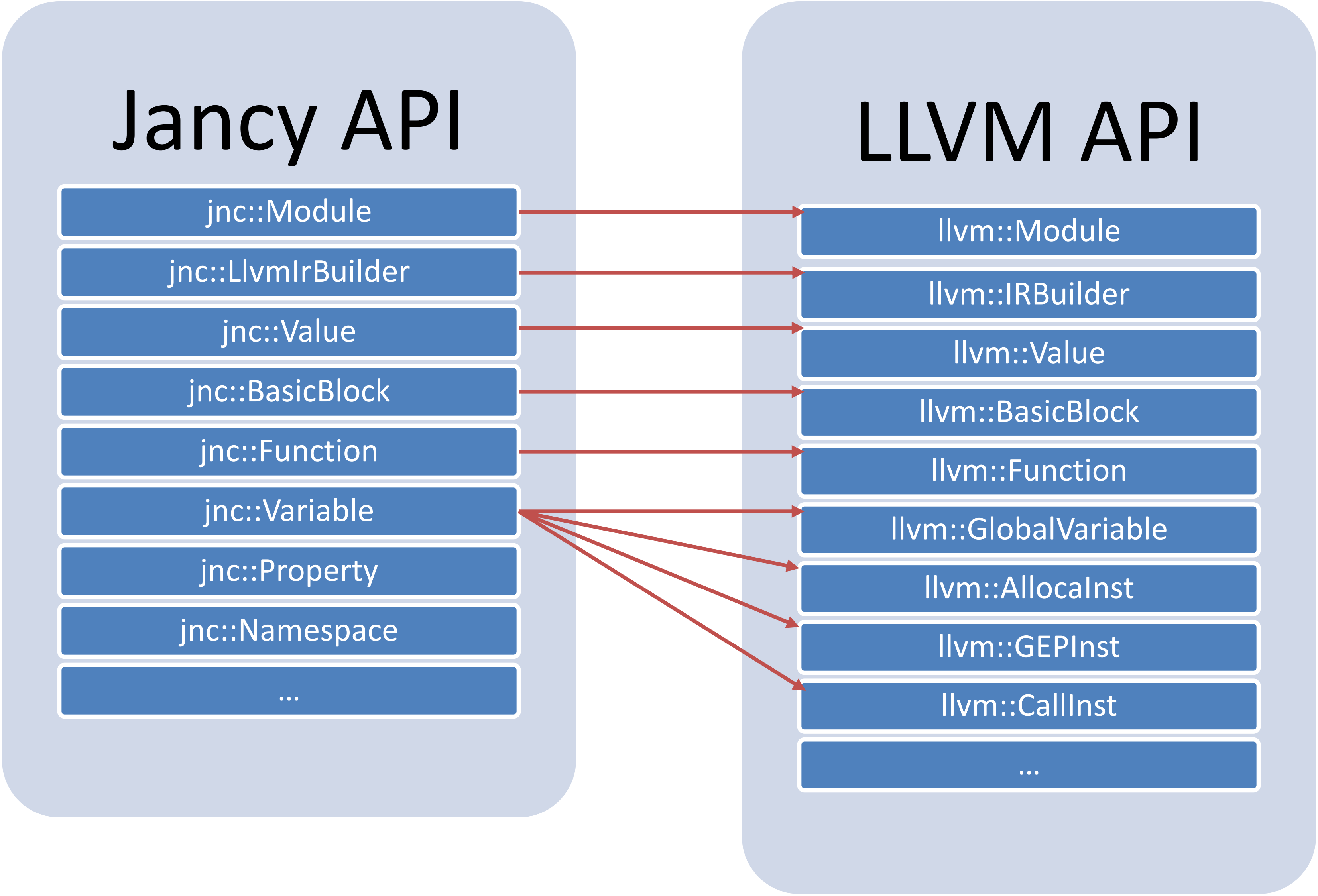
    onevent (m_userEdit.m_onChanged, m_passwordEdit.m_onChanged) ()
    {
        // handle login change...
    }
}
```

```
m_uiReactor.start ();
// ...
m_uiReactor.stop ();
```

Implementation

- Main goal: embedded scripting
- Ragel-generated lexer as a front-end
- Table-driven generated top-down parser
- LLVM API to generate in-memory IR
- LLVM JIT to machine code
- Plugins for NetBeans IDE

jnc::Module vs llvm::Module



Jancy API

jnc::Module

jnc::LlvmIrBuilder

jnc::Value

jnc::BasicBlock

jnc::Function

jnc::Variable

jnc::Property

jnc::Namespace

…

LLVM API

llvm::Module

llvm::IRBuilder

llvm::Value

llvm::BasicBlock

llvm::Function

llvm::GlobalVariable

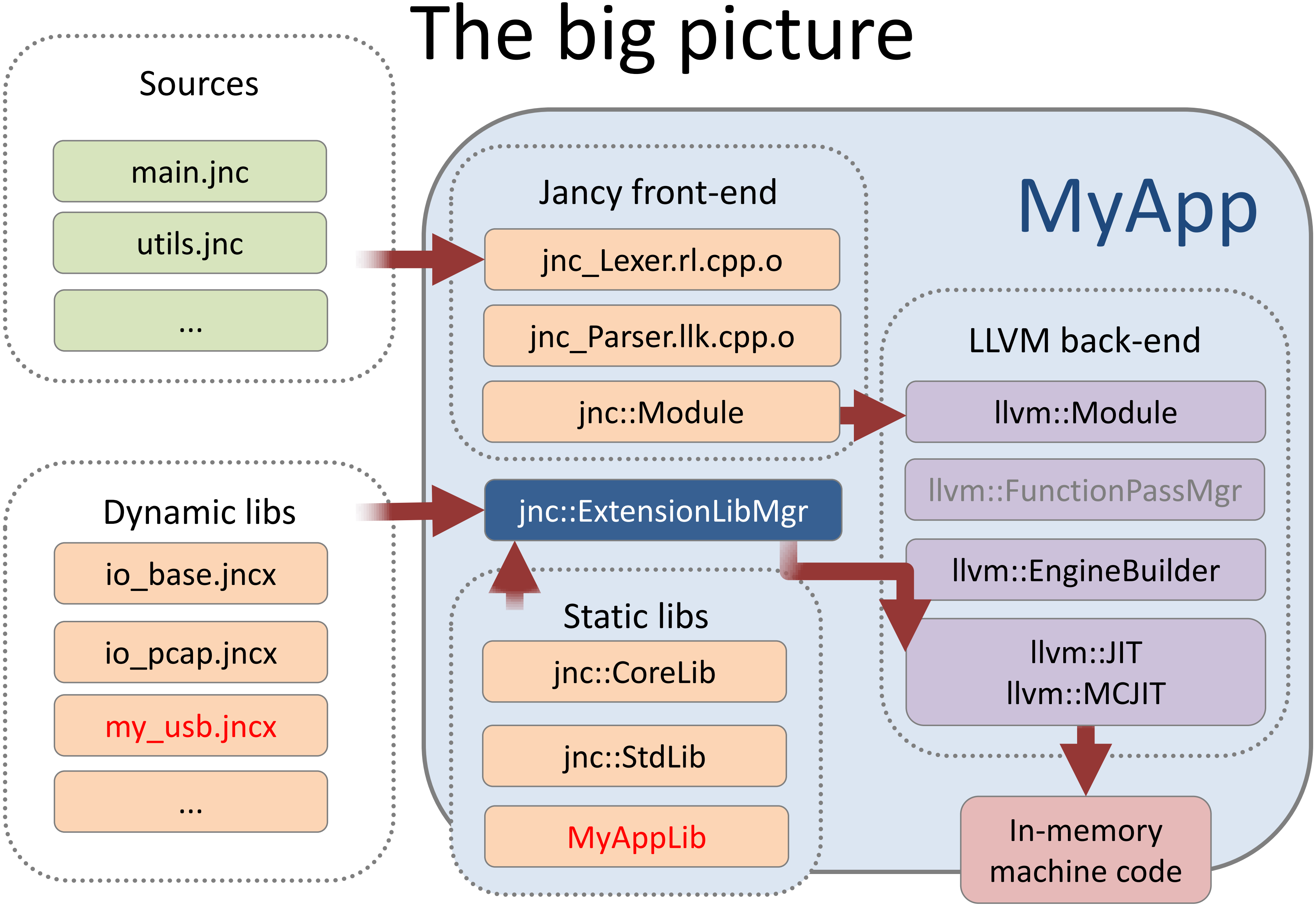
llvm::AllocaInst

llvm::GEPInst

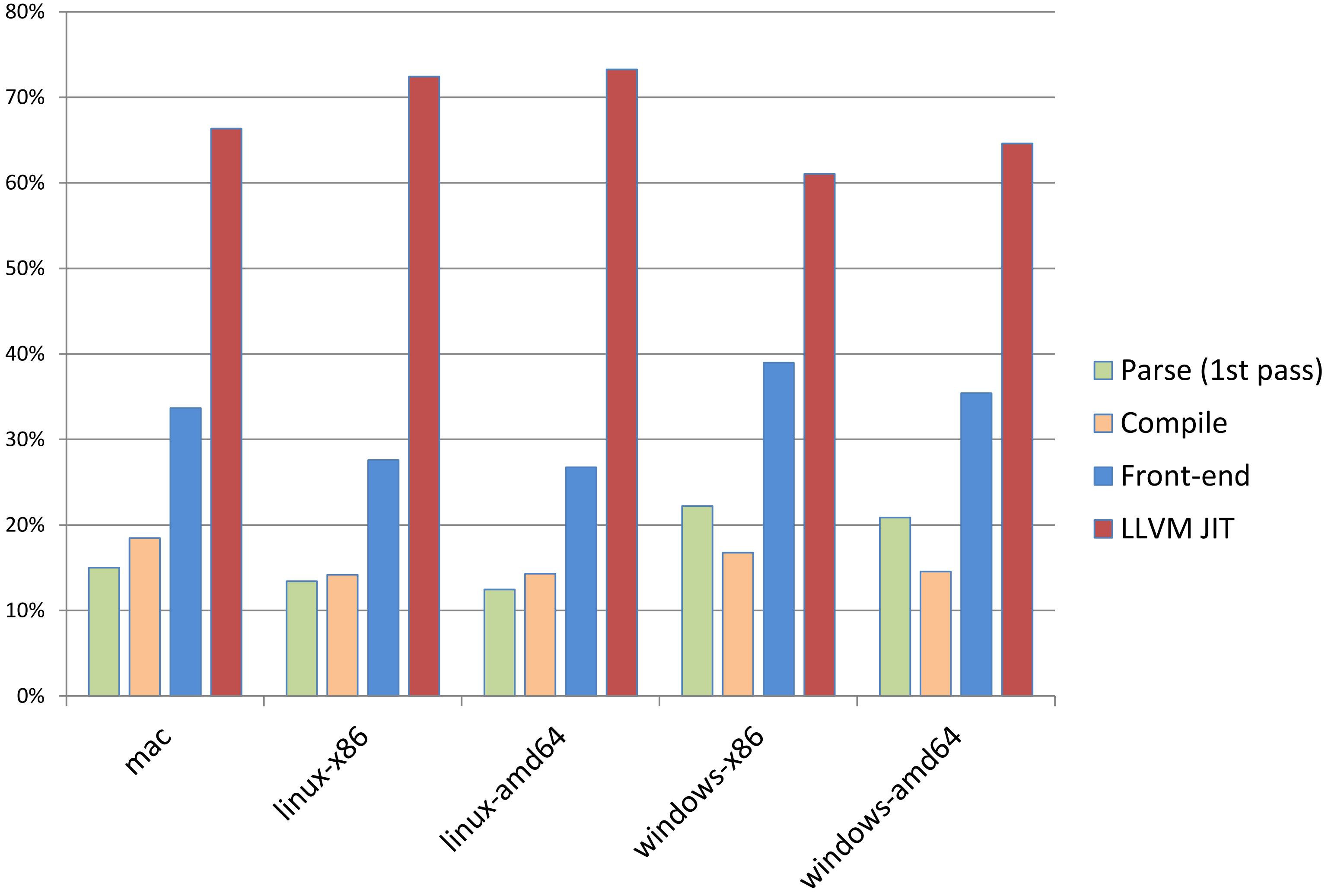
llvm::CallInst

…

The big picture



Where is time spent?



Summary

- Open source LLVM-based scripting language
- Offers unique features
- Used in a real-life product IO Ninja
- Comes with NetBeans-based IDE
- Live demo on the website
- Play, contribute, use in your projects

http://tibbo.com/jancy

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