Co-dfns Report

Dyalog '23 – Aaron Hsu – aaron@dyalog.com

AGENDA

Lots of new people are here, so let's set the stage...

TABLE OF CONTENTS

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01

WHY

What are the goals of the project?

Problem

How do we expand the capabilities of APL so that it can be used by more people in more places for more problems?

SOLUTIONS?

PERFORMANCE
Make APL faster for more problem domains

INTEGRATION
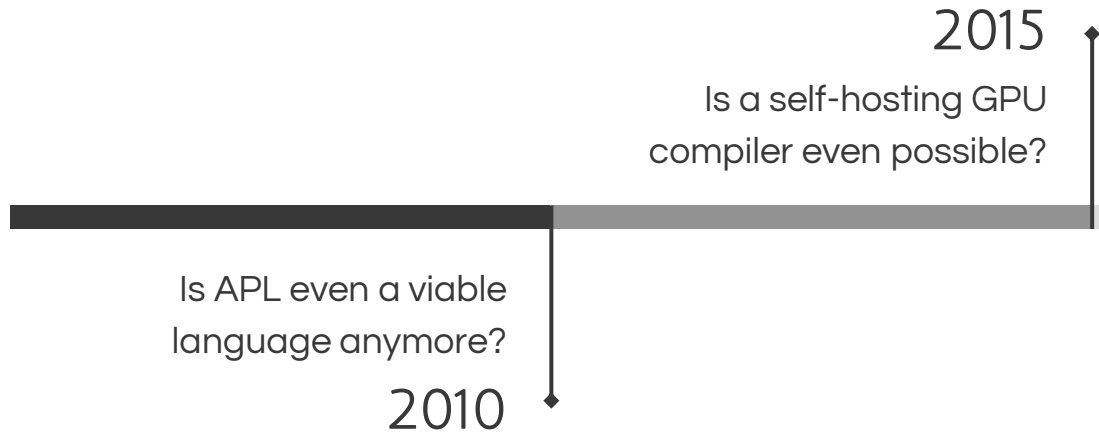Make APL easier to integrate into your stack

RESEARCH
Tackle hard problems using APL

EDUCATION
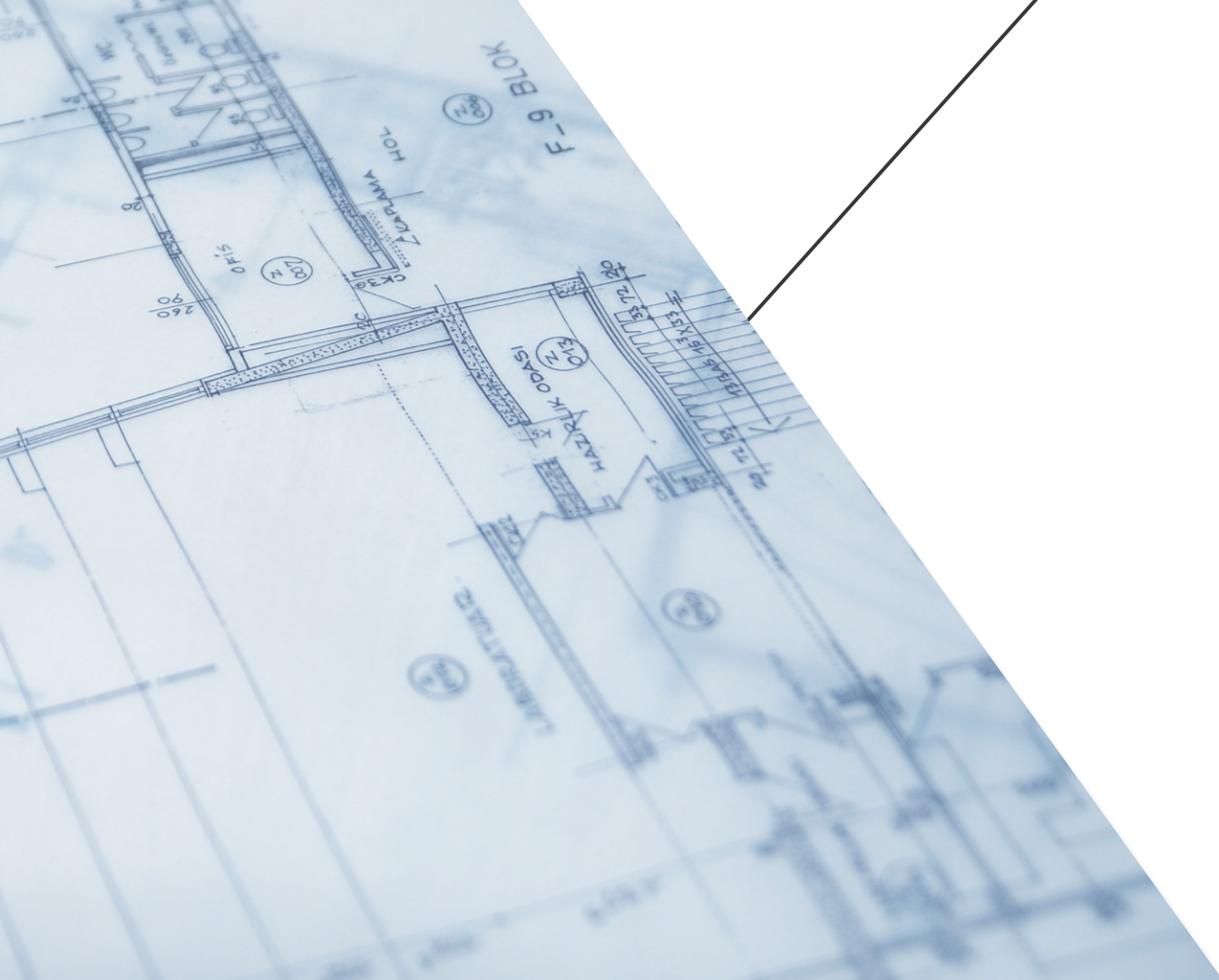How can people learn to use APL in more ways?

SOME HISTORY

2015

Is a self-hosting GPU
compiler even possible?

Is APL even a viable
language anymore?

2010

SOME HISTORY

—

2020

APL is cool, but is it fast?

How do I use this Co-dfns thingie?

2022

02

WHAT

What is the Co-dfns project?

Co-dfns

A compiled APL implementation...

- Written in APL
- Compiles to the GPU
- Designed to self-host on the GPU
- Integrated closely with the interpreter

1401

APL Compiler Source Lines of Code

824

APL Runtime Source Lines of Code

8418

C Kernel Source Lines of Code

Co-dfns features

Hackability
Makes it easy to extend, change, and update

Offline Parser
Static analysis, type checking, learning, etc.

Portability
Performance portable runtime and APIs

Written in APL
Demonstrates APL applied to non-traditional domains

03
STATUS

——

What's been kickin' chicken?

WE JOYFULLY WELCOME

徐志睿

Aurelia
Zhi Rui Hsu

1 OCTOBER, 2023
5.48pm | 6 lbs 14 oz | 19 inch

Aurelia

Is a Latin name meaning "golden one" or "of the golden line"

Like her sisters Mikaela and Saraqael, she is named for one of the seven archangels - the Angel Uriel.

Uriel is the Angel of Wisdom and Light - he is regarded as an angel with deep ties to Earth and humanity, whereas the other archangels primarily fulfill duties in heaven.

The Archangel Uriel is also traditionally credited as the Angel who stood at the gates of Eden with a fiery sword, checked the doors of Egypt for lamb's blood during the plague, and brought Noah the message of the impending worldwide flood.

Zhi means "aspire to", "wish to", or "ideal".

Rui means "wisdom", "astute", or "farsightedness".

徐志睿

V4

High performance on GPUs
Limitations in core array functions
Errors can be opaque and confusing
Not easy to retarget
Non-GPU workloads can be slow

Upcoming V5+

Full core language support
Much better errors
Faster for more workloads
Target more backends (JS, C, WASM)

Progress

Finished

APL runtime rewrite
APL in APL (Primitives)
Parsing/Debugging Updates

Doing

Core performance tweaks
Runtime hardening
New feature verification

Upcoming

New backend ports
Integration tutorials

ASSUMPTIONS

DFNS

No error guards
Full support for operators

NAMESPACE

One top-level namespace
Closed (no global refs)

CORE ONLY

No system functions,
spanw&, etc.

Language

Primitives
All the "core" squiggles
(⊟ @ ⬦)

Datatypes
bool8, int16, int32, float64
char8, char16, char32
Complex

Nested Arrays
Full support for nested arrays
Host allocated

High Rank
Ranks of any size

LIMITATIONS

Selective Assignment
Trains
Trad-fns
Error guards
Inverse
Execute
⎕IO
Format
@ ▤ ("New" squiggles)

Cool Stuff

I-Beam FFI
Platform Portable FFI

Auto-GPU
No need to manage GPU manually

Axis for All
Any dfn can receive an axis
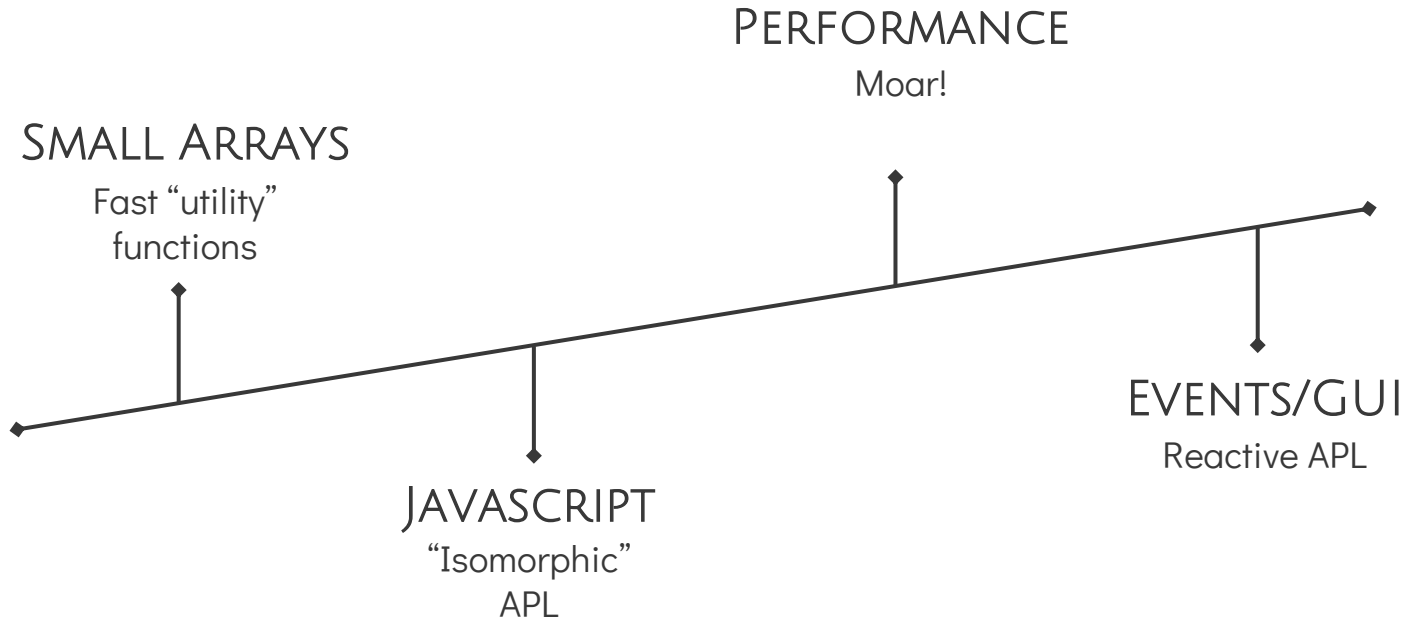
Integration
Directly with DWA
Easy C API

Embeddable
Runtime is lightweight and embeddable

Errors
Rich error messages and TBT stack traces

Future Work

Performance
Moar!

Small Arrays
Fast "utility"
functions

Javascript
"Isomorphic"
APL

Events/Gui
Reactive APL

Known Regressions

Axis Op

Some primitives missing support

Nested

~~Bug in stranding~~

Rank

~~Rank is broken right now~~

Characters

~~DWA import/export isn't working yet~~

04

How

How do I use Co-dfns?

INSTALLATION

———

Co-dfns

Depends On

Compiler

OS Compiler   ArrayFire

Runtime   Core

INSTALL STEPS

OS COMPILER

Visual Studio, GCC, Clang

ARRAYFIRE

Make sure the PATH is set!

CO-DFNS

Grab it from Github

MKΔRTM

———

Builds your runtime for your
OS/compiler
Ship the `codfns.dll` with your app

FIX

———

`'fname'codfns.Fix ⎕SRC namespace`
Produces a `fname.dll`
Links `fname.dll` into your workspace

Shipping/Distribution

AF*.DLL

ArrayFire runtime used by codfns.dll

Codfns.DLL

Modules are linked and built against this DLL

Module.DLL

The DLL you build for your code via codfns.Fix

Dyalog NS

The namespace created by codfns.Fix if needed

DEMO(-LITION)

Linux Gotcha

```
LD_LIBRARY_PATH=.:/opt/arrayfire/lib64

$ echo /opt/arrayfire/lib64 >
/etc/ld.so.conf.d/arrayfire.conf
$ sudo ldconfig
```

Thanks

Questions?

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