



APL MOOC

An online course for university students



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```
~$> cat /etc/group | grep aplmooc
```



Dani Adham

<https://github.com/danii06>

dani.adham@helsinki.fi



Hex

<https://github.com/Hexadecimaaal>

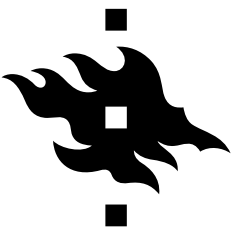


Sergey Ichtchenko

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~\$> whoami

Hi! I'm Sergey.



- BSc in Mathematics at the University of Helsinki (2022-2024)
- MSc in Mathematics at the University of Oxford (2024-2025)
- Cyber security consultant at WithSecure (F-Secure)
- Novice APLer

Contact: @PixelSergey / sergey@sergey.fi

~\$> whoami

{ω-ο. [̃ | ω-ι⁻¹+ω×2} 5

~\$> whoami


```
{ω-ο. [̃|ω-ι-1+ω×2} 5
```

1	1	1	1	1	1	1	1	1
1	2	2	2	2	2	2	2	1
1	2	3	3	3	3	3	2	1
1	2	3	4	4	4	3	2	1
1	2	3	4	5	4	3	2	1
1	2	3	4	4	4	3	2	1
1	2	3	3	3	3	3	2	1
1	2	2	2	2	2	2	2	1
1	1	1	1	1	1	1	1	1

A/

multiline
comment

/A



Other languages have
an unfair advantage





They are taught in
schools



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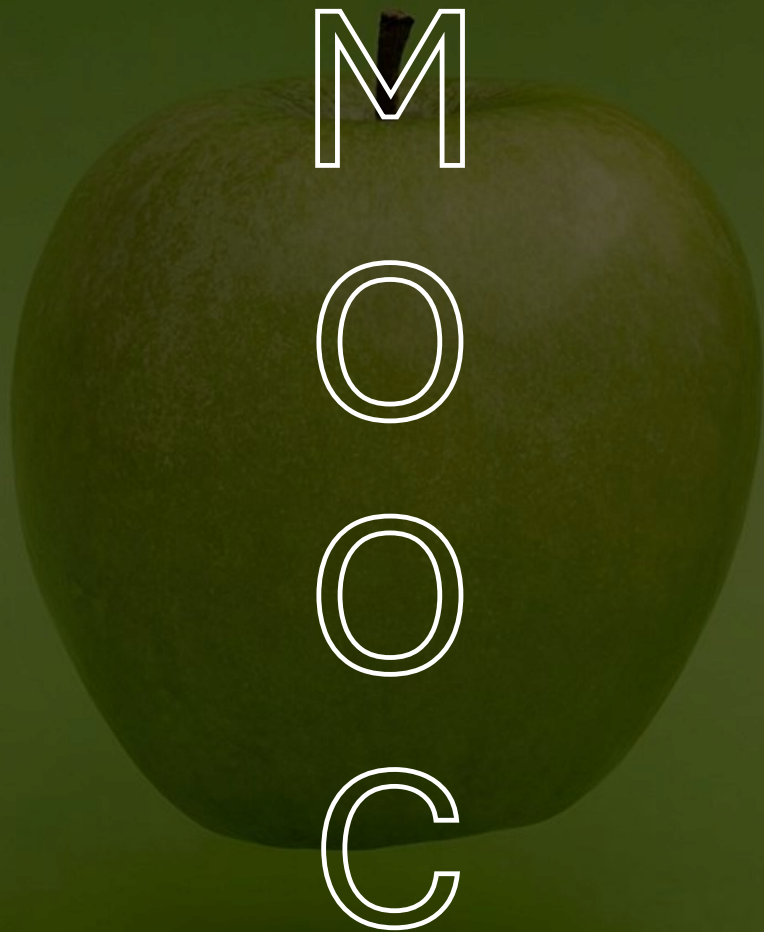
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MOOC.fi



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Massively
Open
Online
Course



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HIGH-QUALITY AND OPEN COURSES FOR EVERYONE!

The courses are hosted by University of Helsinki MOOC Center. No prior knowledge is required — beginners can start to learn programming basics from the Introduction to Programming course, or start to get familiar with artificial intelligence from the course Elements of AI.

[Our courses →](#)



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Automatic grading



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Official study credits



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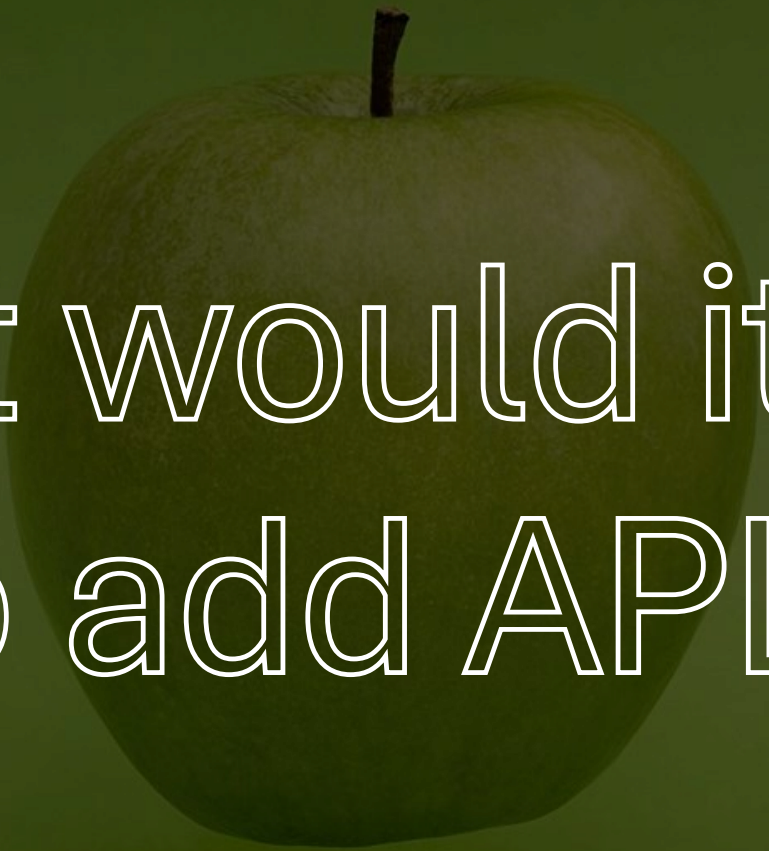

$$5\text{cr} / 180\text{cr} = 2.778\%$$



Haskell
Python
Algorithms
Databases
etc



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What would it take
to add APL?



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My story with APL



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Inspiration

tutorial.dyalog.com



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Dyalog APL Tutor

Unit:

7. Vector Generating Functions

Phase: **Tutorial Text**

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**Roaming (from Unit 0,
Text, Page 1)...**

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ZARK

The Final Word in APL

"I like the idea of the function," said one of the creators of APL, "but I think it should start at 0. When I count, I always go: '0, 1, 2, ...' I think most actuaries and computer people tend to count that way too. Actuaries talk about age 0 and duration 0. Computer guys start their loop counters at 0 and then increment by 1."

"But those folks are in the minority," argued a second creator. "Why not just subtract 1 from the indexes generated by monadic ι ? For example:"

```
( $\iota$ 5)-1  
0 1 2 3 4
```



Creator 2



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Dyalog APL Tutor

Unit:

7. Vector Generating Functions

Phase: **Read Problems**

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[Roaming \(from Unit 0, Text, Page 1\)...](#)

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The Final Word in APL

Try to figure out what the expression below does. Press the Enter key to see if you are correct.

```
      ⍋7
1 2 3 4 5 6 7
      ⍋5
DOMAIN ERROR
      ⍋5
      ⍋
      ⍋5.4
DOMAIN ERROR
      ⍋5.4
      ⍋
      ⍋0

      5-⍋10
4 3 2 1 0 -1 -2 -3 -4 -5
      2×5-⍋10
8 6 4 2 0 -2 -4 -6 -8 -10
```



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Dyalog APL Tutor

Unit:

7. Vector Generating Functions ▼

Phase: **Write Problems** ▼

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**Roaming (from Unit 0,
Text, Page 1)...**

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ZARK

The Final Word in APL

Construct an expression that will solve the following problem. Click the Test button (or press Enter) to test your solution. Click the Submit button to submit it. Test as many expressions as you like. If you give up on a problem, click the Show Solution button. The answer will be displayed.



Given a vector named LIST, generate one random number between 1 and the length of LIST.

[Go on](#) [Stay here](#)

Here are some valid expressions:

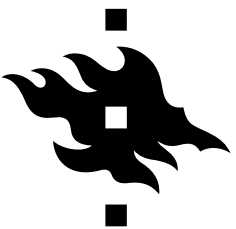
`?ρLIST`
`1?ρLIST`



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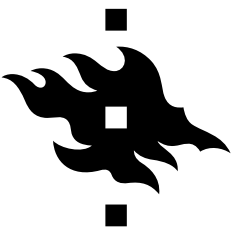
✦ THE PLAN ✦

- 7 chapters of content
- **Review** + read exercises + write exercises in each chapter
- Write exercises award points, enough points gives you a grade (and CREDITS)
- Final chapter is about software development, implementing a larger project
- Uses TryAPL/Dyalogscript/Dyalog/Ride
- Cover most APL glyphs



THE PLAN

- Free and open for everyone worldwide
- Finnish (maybe European?) students can get credits
- Credit-hungry students + free credits = EXPONENTIAL GROWTH OF APL'ERS
- If feedback is good, we can make a part 2 (as many MOOCs)





aplmoooc.fi



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Course

- 0 - The wonderful world of APL >
- 1 - Getting your toes wet >
- 2 - Array programming >
 - 2.1 - Assignment
 - 2.2 - Vectors
 - 2.3 - Arithmetic operations on vectors
 - 2.4 - Higher dimensional space
 - 2.5 - Nested arrays
 - 2.S - Summary
 - 2.R - Read exercises
 - 2.W - Write exercises
- 3 - Functions >
- 4 - Vector functions >
- 5 - Higher dimensions >
- 6 - Everything else you need to know >
- 7 - Programming in APL >

You might wonder, why would we want to put a bunch of numbers inside a vector? Is it just to organise data? Let's say you mistakenly bought a bunch of measuring equipment from America, and only found out later that all the readings are in Fahrenheit. Terrible news! After about 2000 milliseconds of googling about it, you found this formula to convert it into Celsius:

$$\text{Celsius} = (\text{Fahrenheit} - 32) * 5 / 9$$

To test it out, you looked up the current room temperature reading, which says 72.1. Doing the calculation in APL:

```
(5 × 72.1 - 32) ÷ 9
22.27777778
```

Great! What's not so great is that the temperature sensor has been left generating data for the whole week, and there are a bunch of readings to convert to Celsius.

```
TEMP_F ← 71.2 71.4 73.3 73.0 73.1 72.8 72.5
```

You are going to spend ages plugging the data from this one sensor, and you have 200 of them lying around! Fortunately, APL is designed to deal with data assorted in a vector. You can:

```
TEMP_CELSIUS ← (5 × TEMP_F - 32) ÷ 9
21.77777778 21.88888889 22.94444444 22.77777778 22.83333333 22.1
```





Course

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```

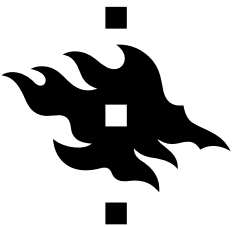
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```
□ ← TEMP_CELSIUS ← (5 × TEMP_F - 32) ÷ 9
21.77777778 21.88888889 22.94444444 22.77777778 22.83333333 22.11111111
```



Course structure

0. The wonderful world of APL
1. Getting your toes wet
2. Array programming
3. Functions
4. Vector functions
5. Higher dimensions
6. Everything else you need to know
7. Programming in APL



1. Getting your toes wet

- Immediate execution mode (tryapl.org)
- Arithmetic operations on scalars
- Typing APL glyphs
- Order of execution
- Error handling

2. Array programming

- Assignment operator
- 1D vectors and arithmetic operations
- Higher dimensional space
- Nested arrays

3. Functions

- Dfns
- Math functions
- Relational and logical functions
- Recursion
- 3-trains
- NO TRADFNS

4. Vector functions

- Vector generating functions
- Reductions and scans
- Randomisation, grade up/down, windowed reduce
- All the different ways of selecting from a vector
- Searching in a vector

5. Higher dimensions

- Set operations
- Enclose/disclose/**nest**/each/tally
- Operations on different axes
- Transpose/reverse/rotate
- Cross-tabulation

6. Everything else you need to know

- String manipulation (partition, partitioned enclose, interval index)
- Inner and outer products
- Encode and decode
- Operators (repeat, masking)
- 4- and 5-trains

7. Programming in APL

- Installing Dyalog (RIDE? Dyalogscript? Idk yet)
- Tradfns, finally
- Interactivity
- File I/O
- Libraries
- Programming project

Bonus content

- Creating randomised audio data in APL
- Rotating an image
- Computer graphics in APL
- Minesweeper in APL and Python (pynapl)



This is all subject
to change*



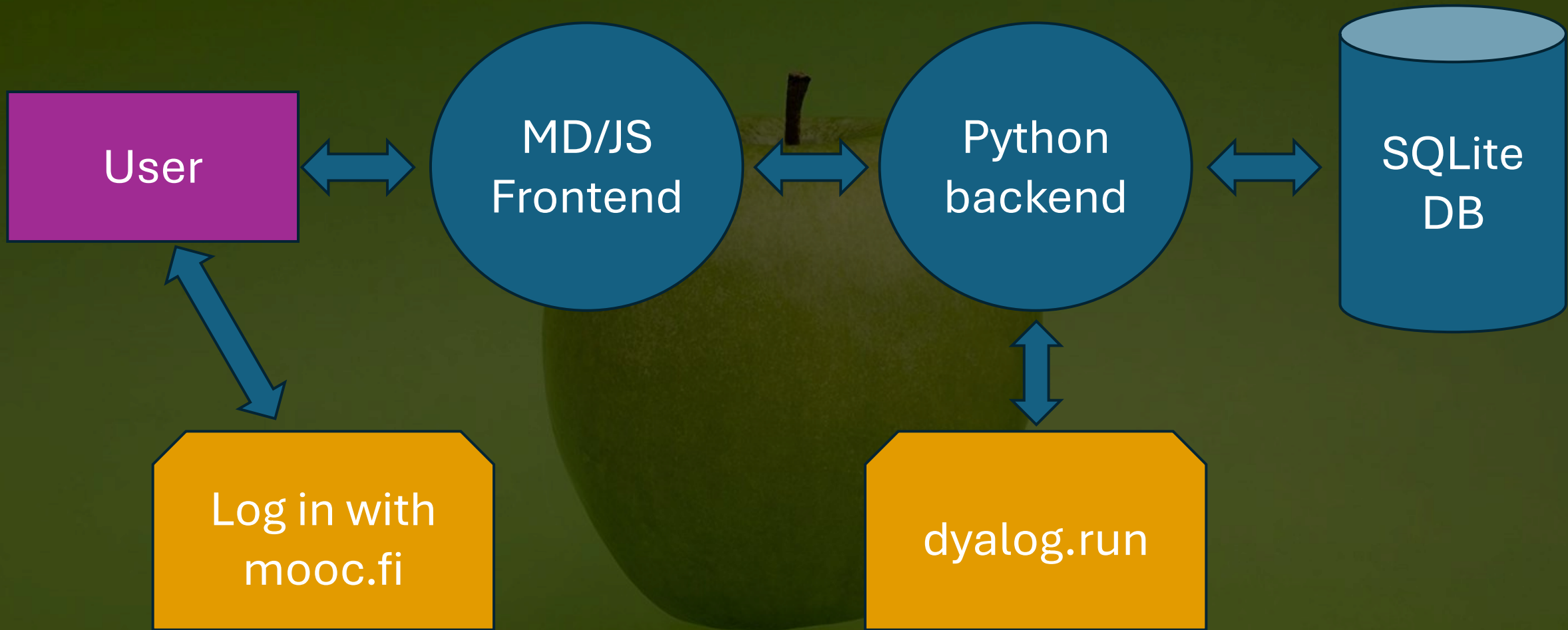
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The infrastructure



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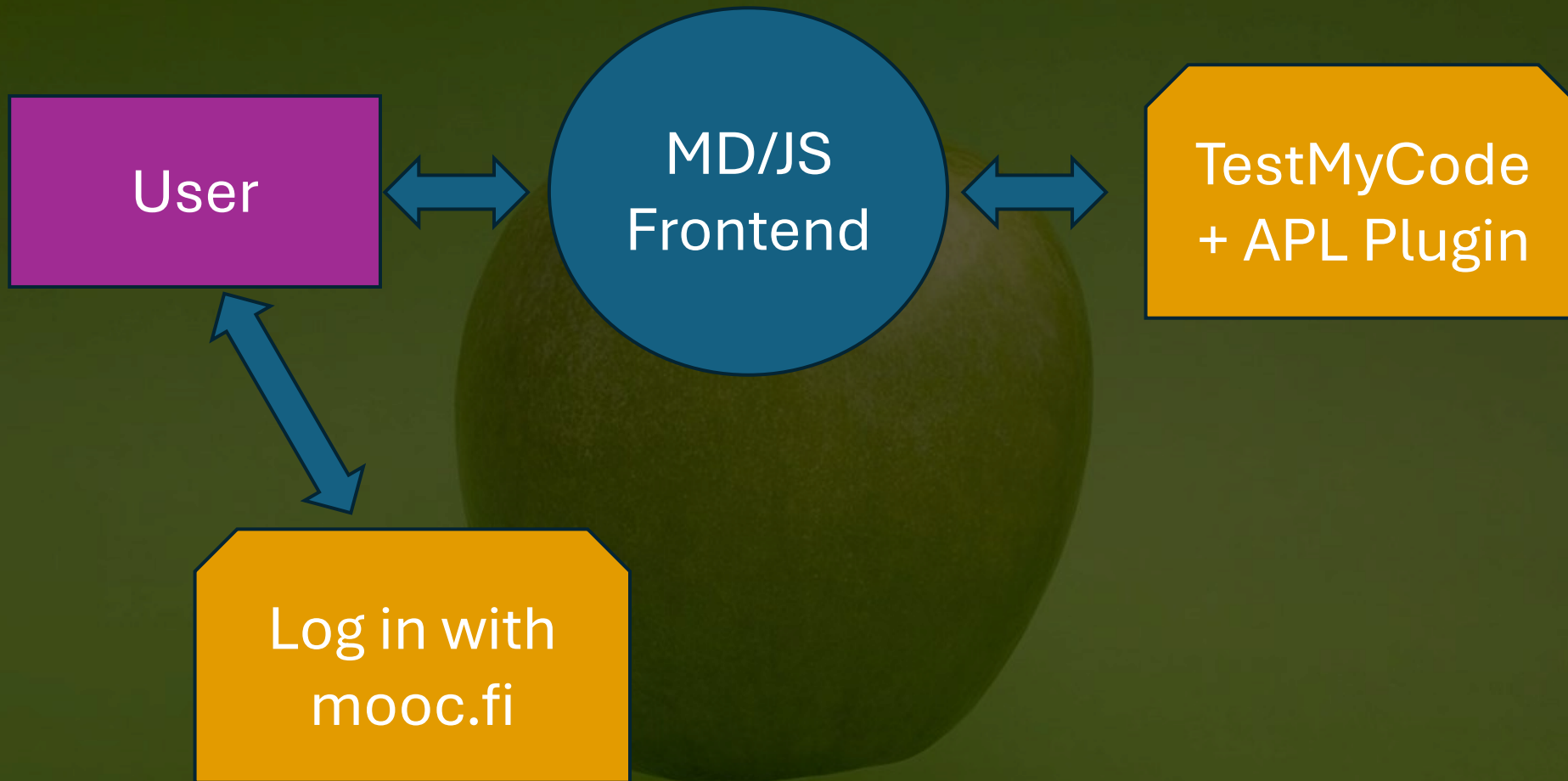

```

    A We have to assume not all characters are available. Those should be:
    Always,␣A,␣D,'abcdefghijklmnopqrstuvwxy_.,:;!"/=-+'#$%&^&tilde;(){}[]$@`|¶&'
    Always,␣'ÁÀÃÇÈÉÊËÌÍÎÏÐÓÔÕÖÙÚÛÜÝÞàáâãäåæçèéêëìíîïðñúûüöóòø'
    Always,␣'≤≥/λ<>#vλ÷×?ερ~ιιιο*[]"[]∇ΔΔ~ο<οnυιTI|ω~θvλ∇λ∇φθθ∇∇i∇,≡#εο...A[]* '
    u_θθ=␣DR''
    Always,␣'ι-ι',␣UCS u/8838 9016 9018 9056 9060 9080 A c_ []= []ο []: ο" ι_
    Always,␣UCS 9061/~uλ18≤1 θ>'.'␣∇FI 1># ␣WG'APLVersion' A ο"
    λ/t.ωεAlways:QU ω A no special chars?
    A If only a few chars transform the whole string into ␣AV
    UCS_{1φ'}(␣ucs ',∇cmpv ␣UCS ω)
    A More than a few; create a mixture of ␣UCS and 'quotes'
    minsize_3 A how much special chars to include between sections; that number is subjective
    cv._minsize>ερ~c_ucs<~c_1,1iucs≠~1φucs_~t A consider small groups of ASCII as UCS
    A λ/sc_εc:ucs ω A are the pieces small enough to be all in ␣UCS?
    (lp rp)~'()'/'~'(1iα)λ1<+/c_1,1iucs≠~1φucs_εc
    rp,~lp,ε{α,',',ω}/(c/ucs){α:UCS ω ο QU ω}~c<ω
  }obj
  lp,obj,rp
}ω
␣CT_␣DCT_θ
ω≡iexpr:expr
␣SIGNALc('EN' 16)('Message' 'Generated expression did not match argument')A NONCE
}

∇ py_ExportPy;bin;nl
A Serialise and compress this namespace and embed in python string
A The string contains APL expressions executed in dyalog.run to define T and Test in ␣SE
bin_→φ2(219I)1(220I)␣THIS
nl_␣UCS 1θ
py_-'# This is generated by Test.ExportPy in grader/grader.apln',nl
py_-'test_namespace = ""T_θ',nl
py_,-ε('T,-'ο,ο∇"((#bin)ρ150:1)cbin),~nl
py_-'""',nl
py_-'import_test_ns = "Test_θ(220I)~2(219I)T"',nl
py_-'setup_framework = "␣CS ␣SE\n" + test_namespace + "\n" + import_test_ns + "\n␣CS #\n"',nl
py_-'# Set up test framework in ␣SE. User code is fixed in #. Hope nothing goes wrong with namespace references when running the user''s solution...',nl
∇
:EndNamespace

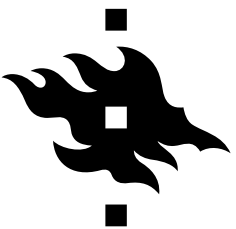
```





Roadmap

- TMC integration (it's written in Rust lol)
- Completing chapters 5-7
- Piloting with a small group of students / oldies
- Release on mooc.fi





We are all
novice APL'ers



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We need your help



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Thank you!



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