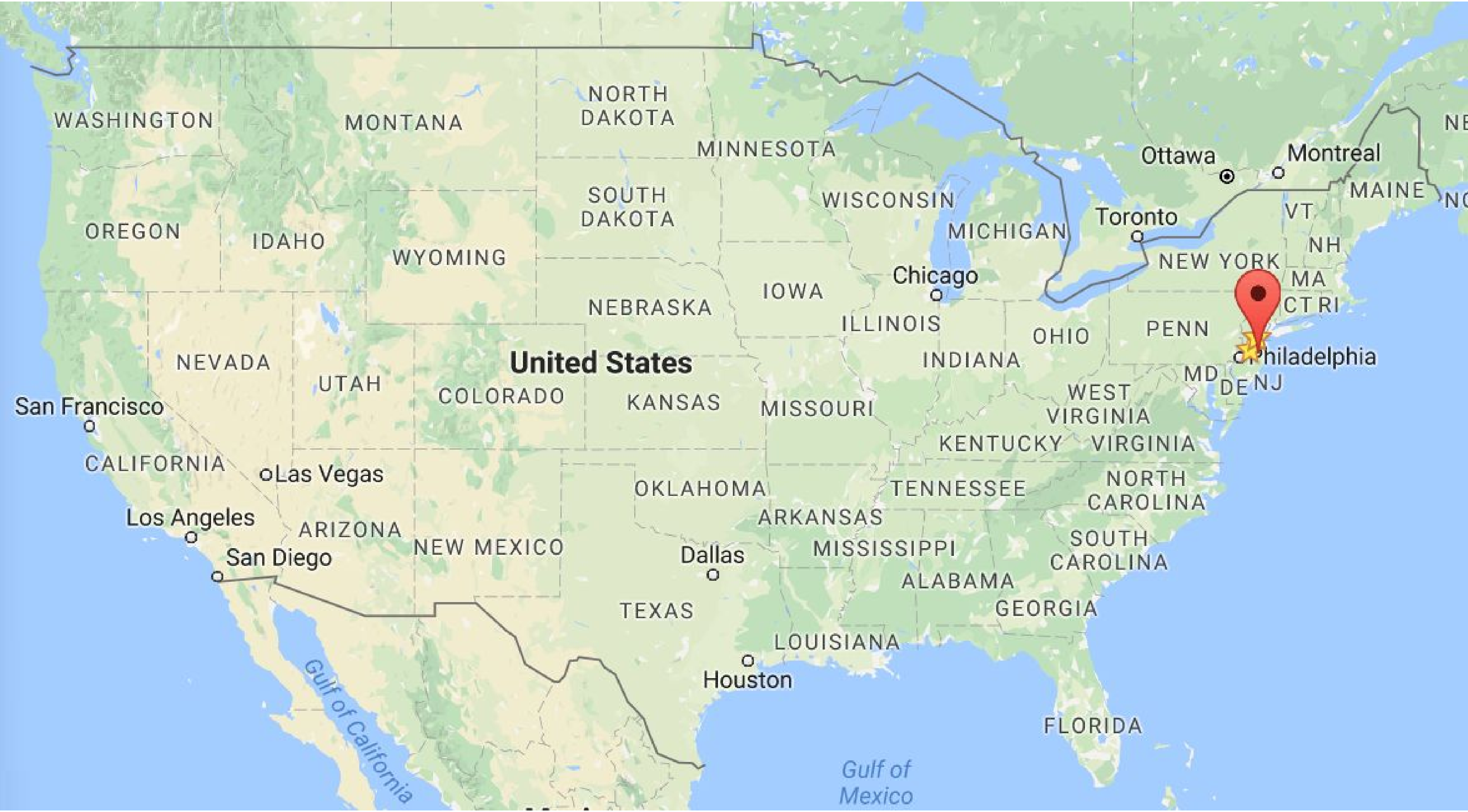
Hobbyist APLing in the 21st Century.

Alex Weiner (New Jersey, USA)


NORTH DAKOTA
WASHINGTON
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MINNESOTA
Ottawa
Montreal
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SOUTH DAKOTA
WISCONSIN
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MICHIGAN
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IOWA
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NEBRASKA
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OHIO
NEVADA
United States
INDIANA
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MD
COLORADO
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DE NJ
San Francisco
MISSOURI
WEST VIRGINIA
KENTUCKY
VIRGINIA
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Las Vegas
OKLAHOMA
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NORTH CAROLINA
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ARIZONA
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Dallas
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San Diego
ALABAMA
GEORGIA
TEXAS
LOUISIANA
Houston
Gulf of California
FLORIDA
Gulf of Mexico

Alex Weiner

Alex Weiner

- Electrical & Computer Engineer

Alex Weiner

- Electrical & Computer Engineer
- APLer

Why APL?

- Lots of things can be modeled as a matrix

Why APL?

- Lots of things can be modeled as a matrix
  - Circuits
  - Images
  - Differential equations

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Why APL?

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  - Circuits
  - Images
  - Differential equations
- Computer Architecture

Why APL?

- Lots of things can be modeled as a matrix
  - Circuits
  - Images
  - Differential equations
- Computer Architecture
  - “A Programming Language” By Iverson

“Hobbyist APLing in the 21st Century”

What does that even mean?

Hobbyist

- Must be fun

Hobbyist

- Must be fun
- Must be low cost

Hobbyist

- Must be fun
- Must be low cost
- Can be non-practical

Hobbyist

- Must be fun
- Must be low cost
- Can be non-practical
- Must not be frustrating

Hobbyist

- Must be fun
- Must be low cost
- Can be non-practical
- Must not be frustrating
- A learning experience

APLing

- Programming in any APL dialect or related language

APLing

- Programming in any APL dialect or related language
- Talking about any APL dialect or related language

21st Century

- A web application

21st Century

- A web application
  - Your program ultimately outputs HTML

Application development in APL

Pick an operating system

Pick an operating system

- Linux
- macOS
- Windows

Pick an APL

Pick an APL

- APL
    - Dyalog APL
    - GNU APL
    - J

Pick an APL

- APL
  - Dyalog APL
  - GNU APL
  - J

- Other
  - J
  - A+,Q,K
  - APL2000, NARS2000
  - ELI
  - S (R is S!)
  - MATLAB, Mathematica
  - Go, C++ (iota)

Determine an application

Determine an application

- A hard problem in computer programming

Determine an application

- A hard problem in computer programming
- Do something cool

Determine an application

- A hard problem in computer programming
- Do something cool
- Something that shows my friends how cool APL is

My Application

My Application

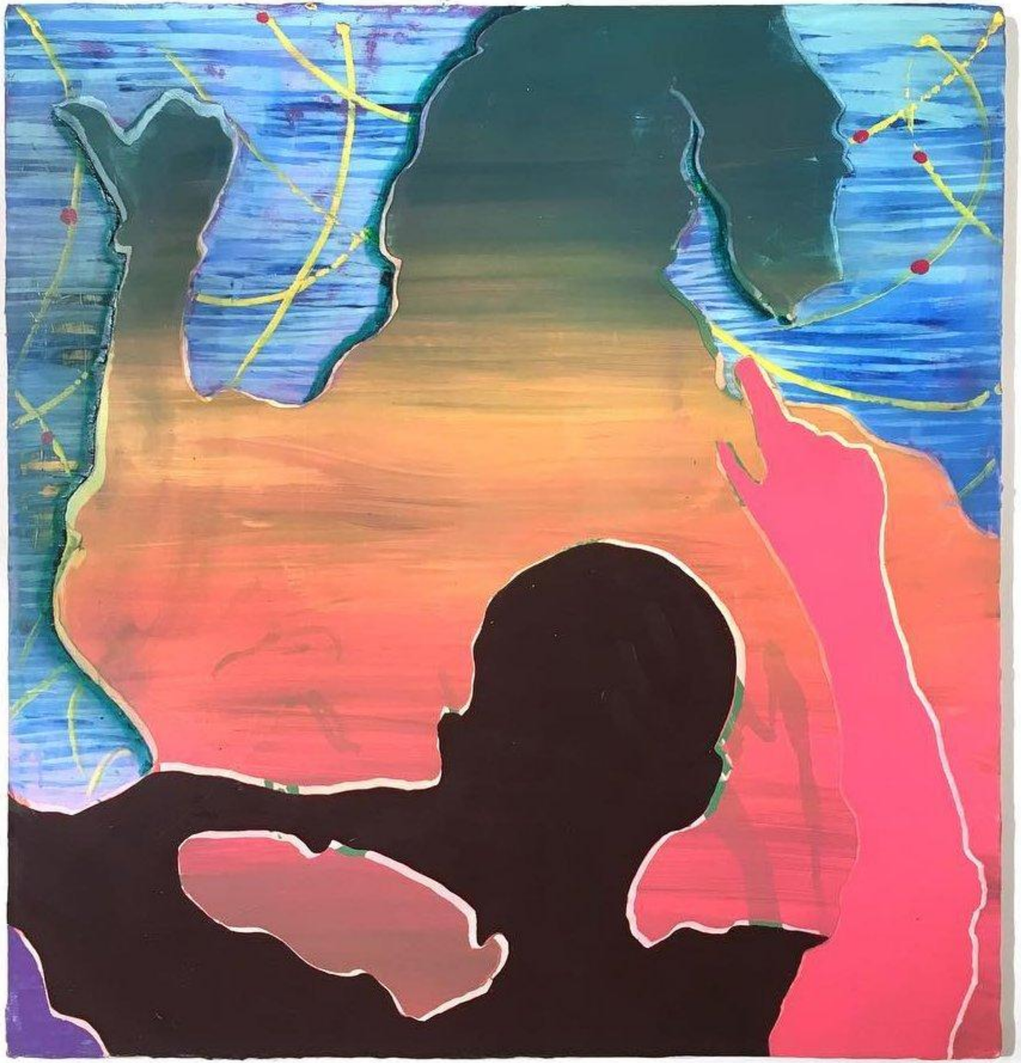
- Called “Flake”

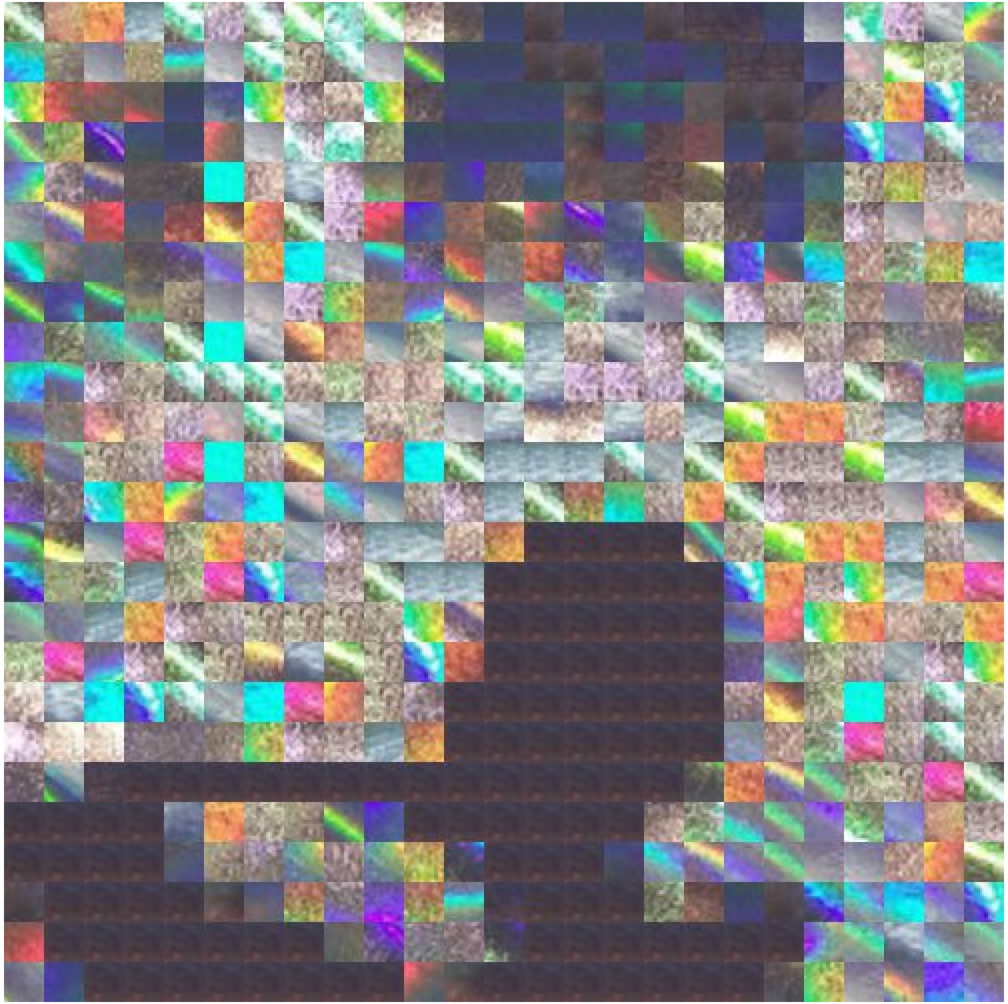
My Application

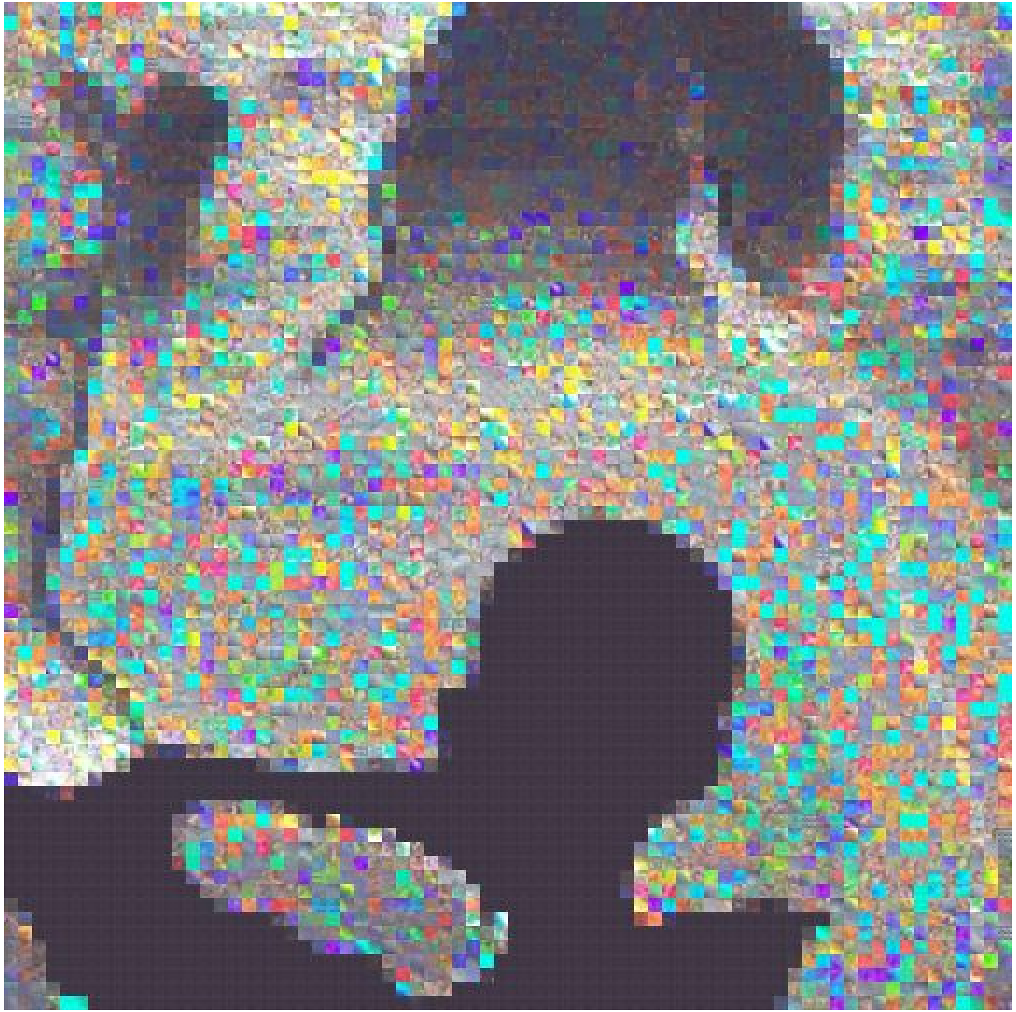
- Called “Flake”
  - Chops
  - Matches

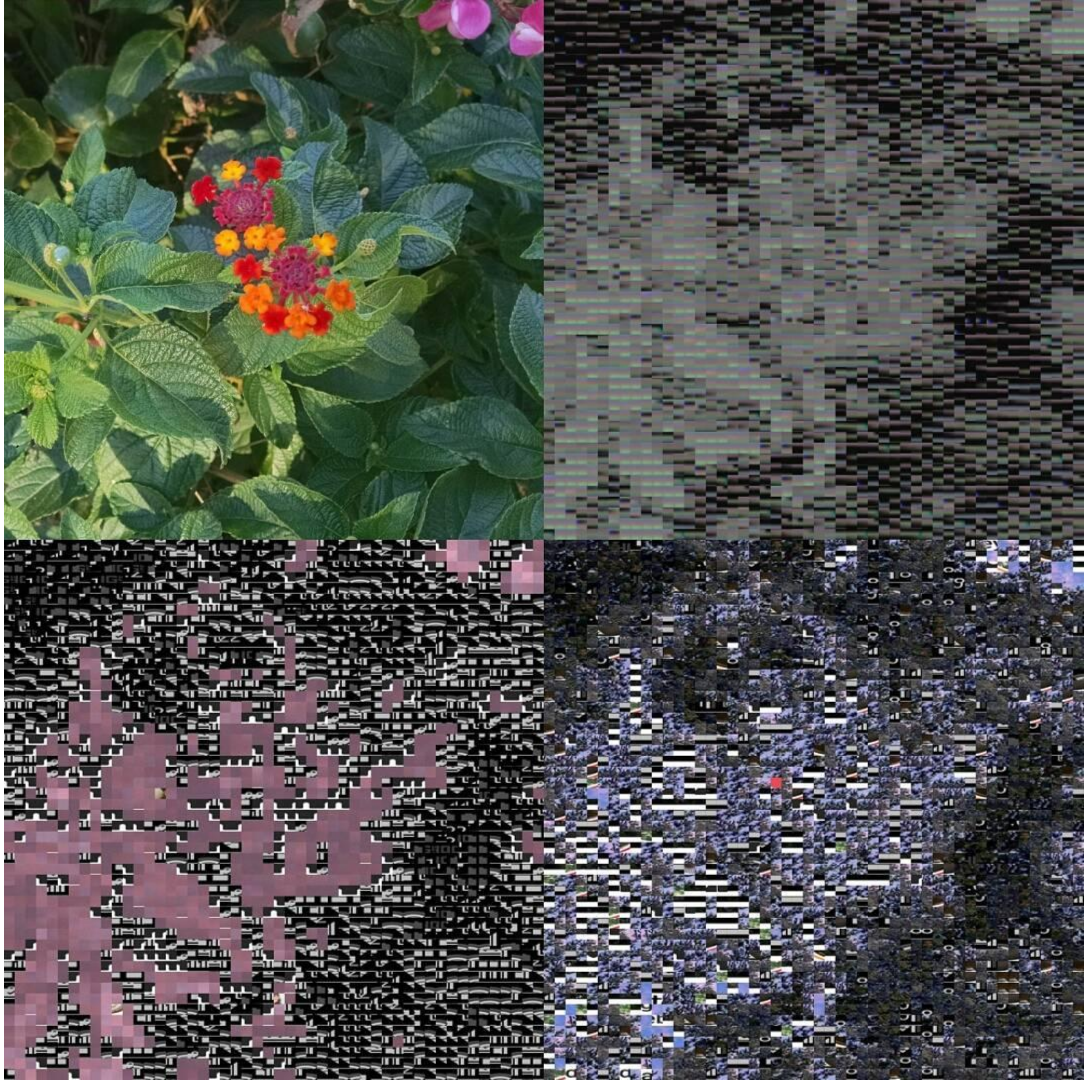
My Application

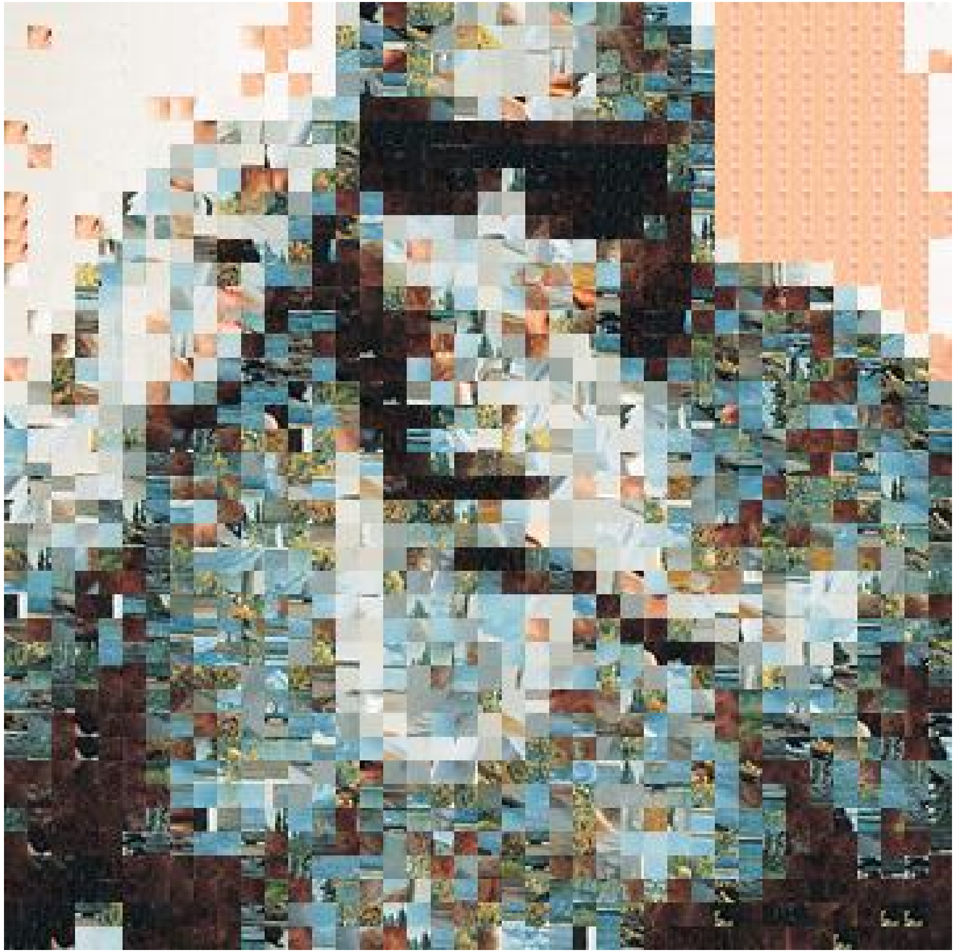
- Called “Flake”
  - Chops
  - Matches
- Examples

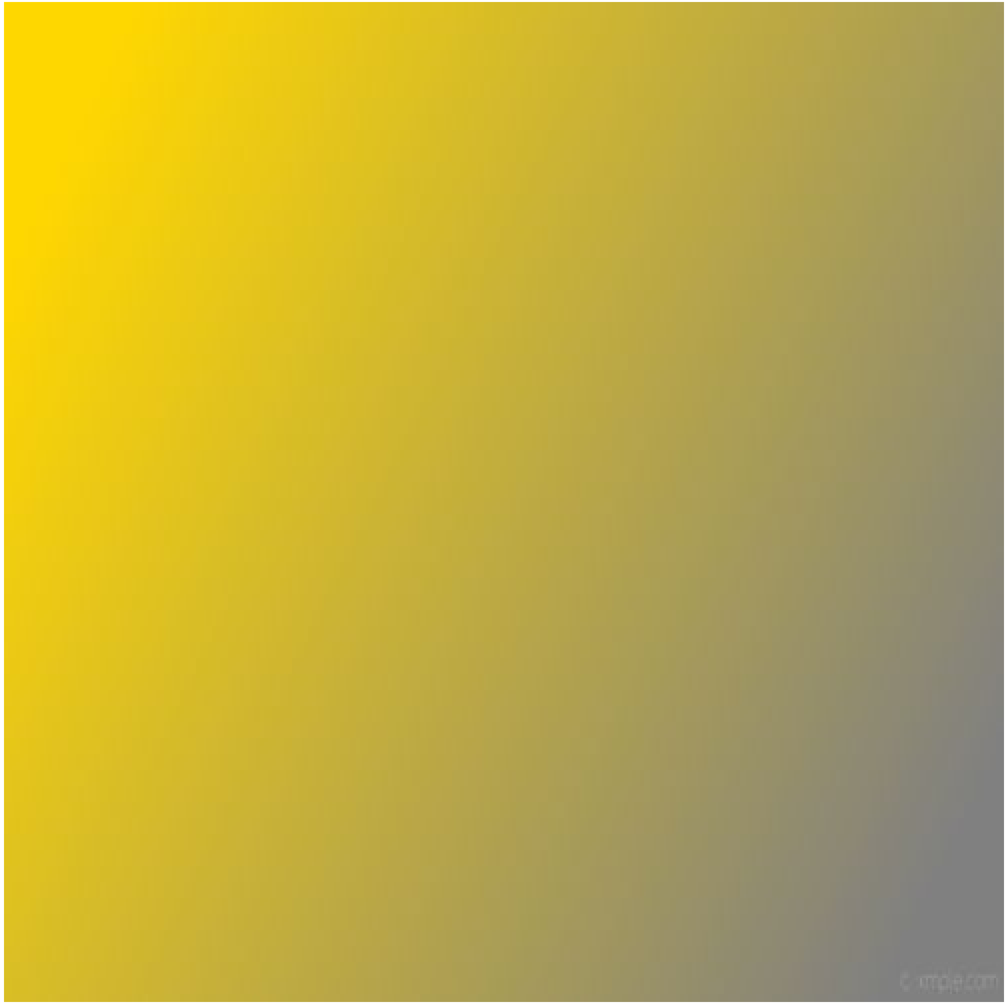


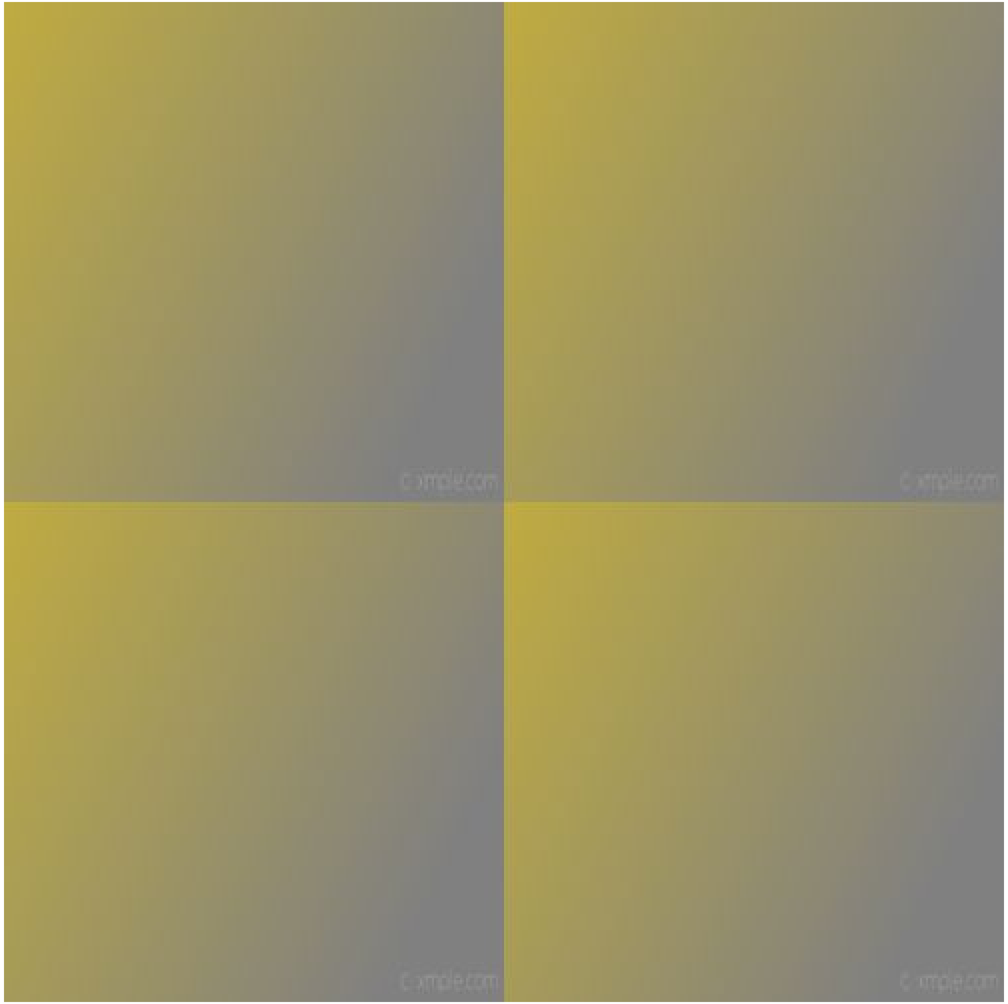


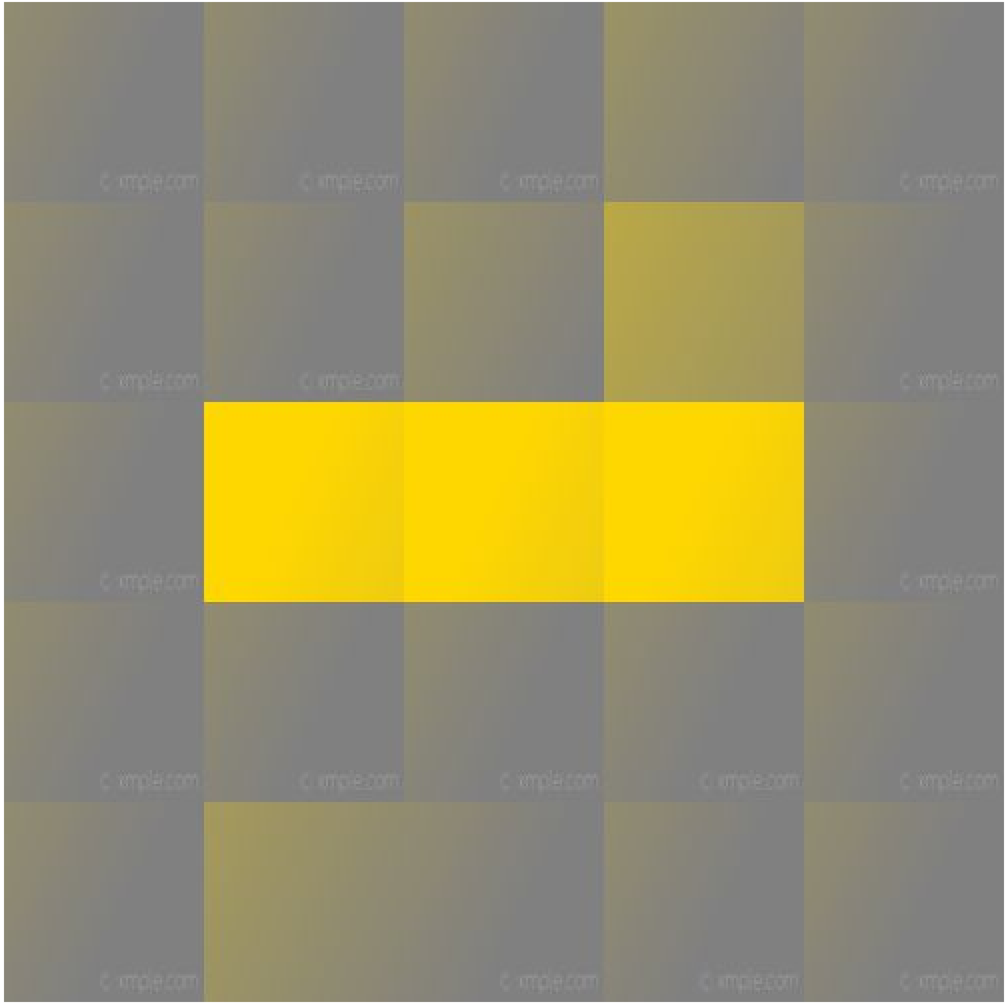




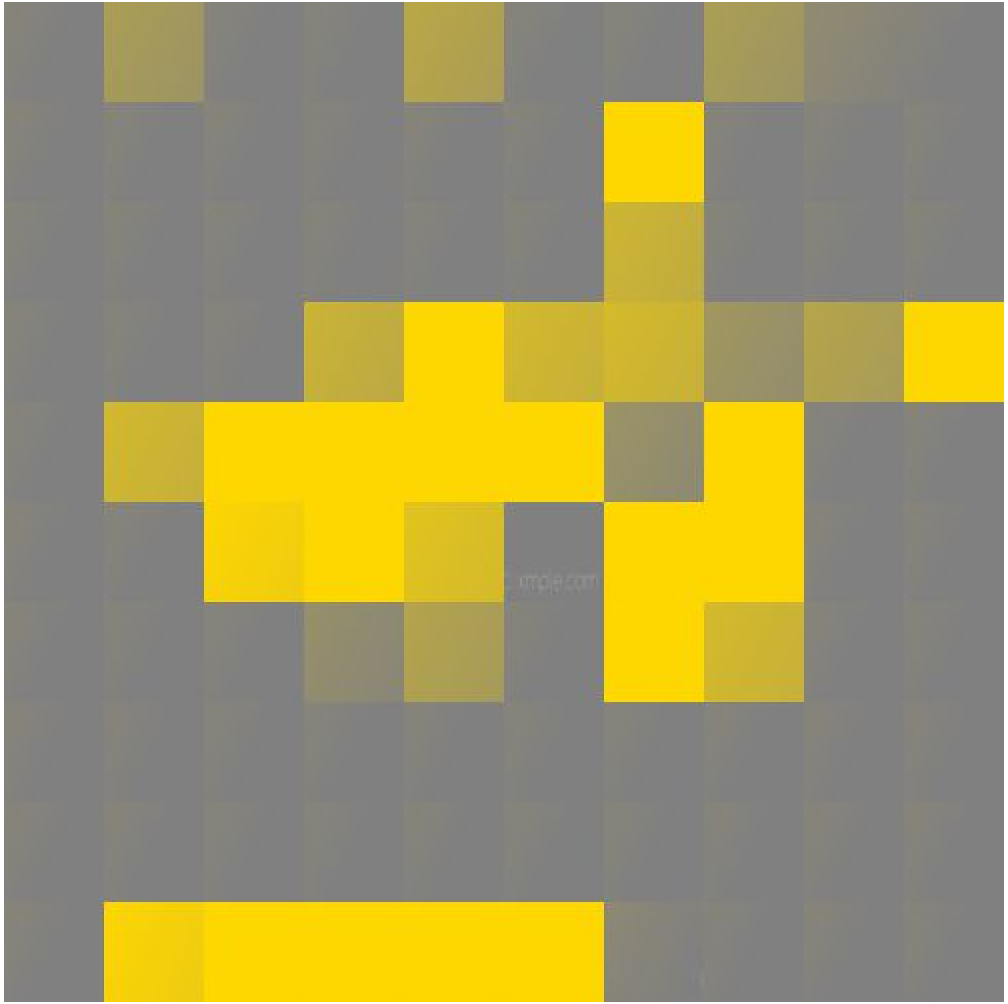


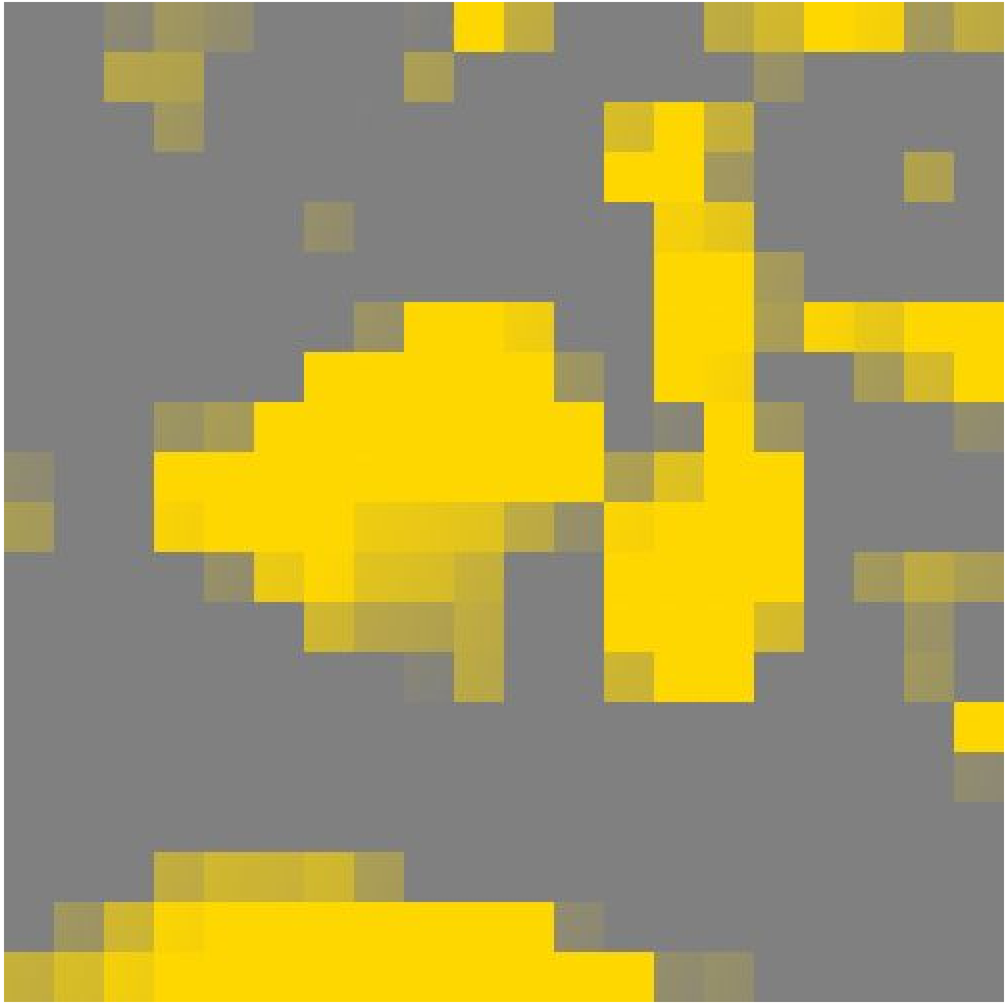


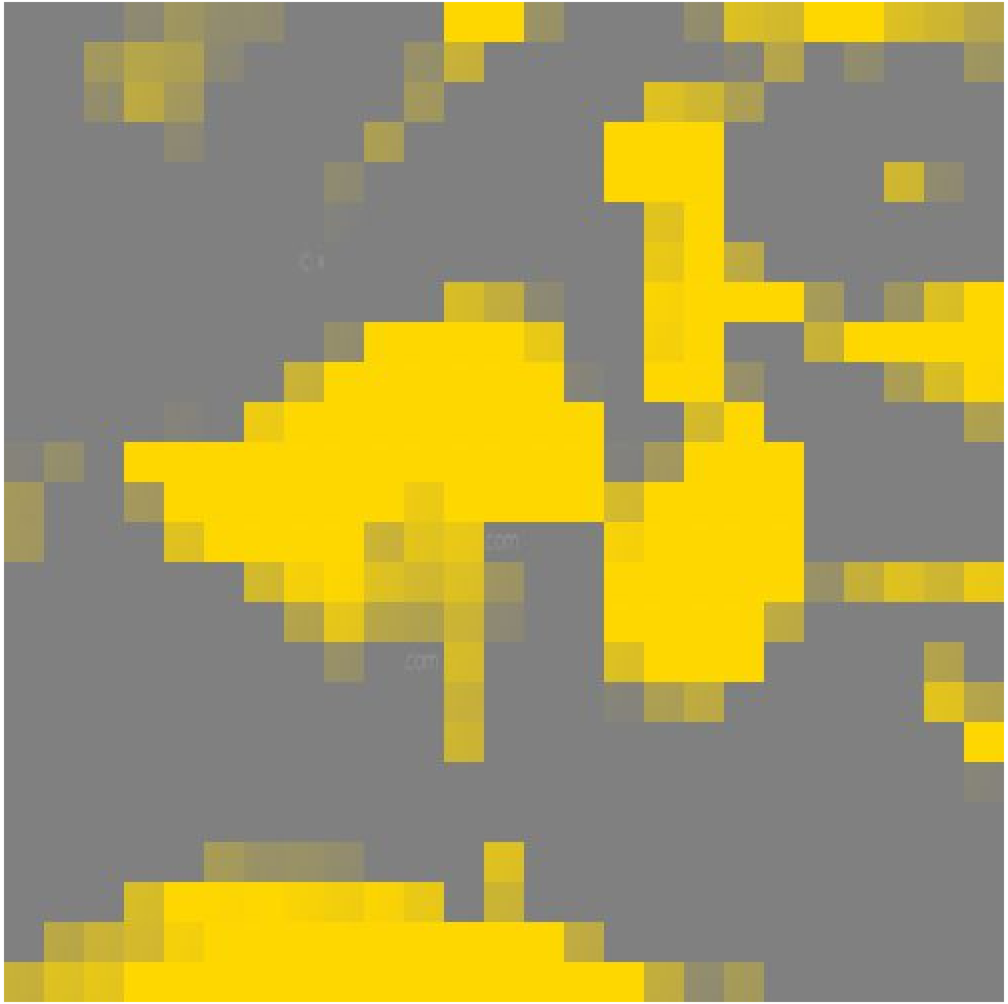


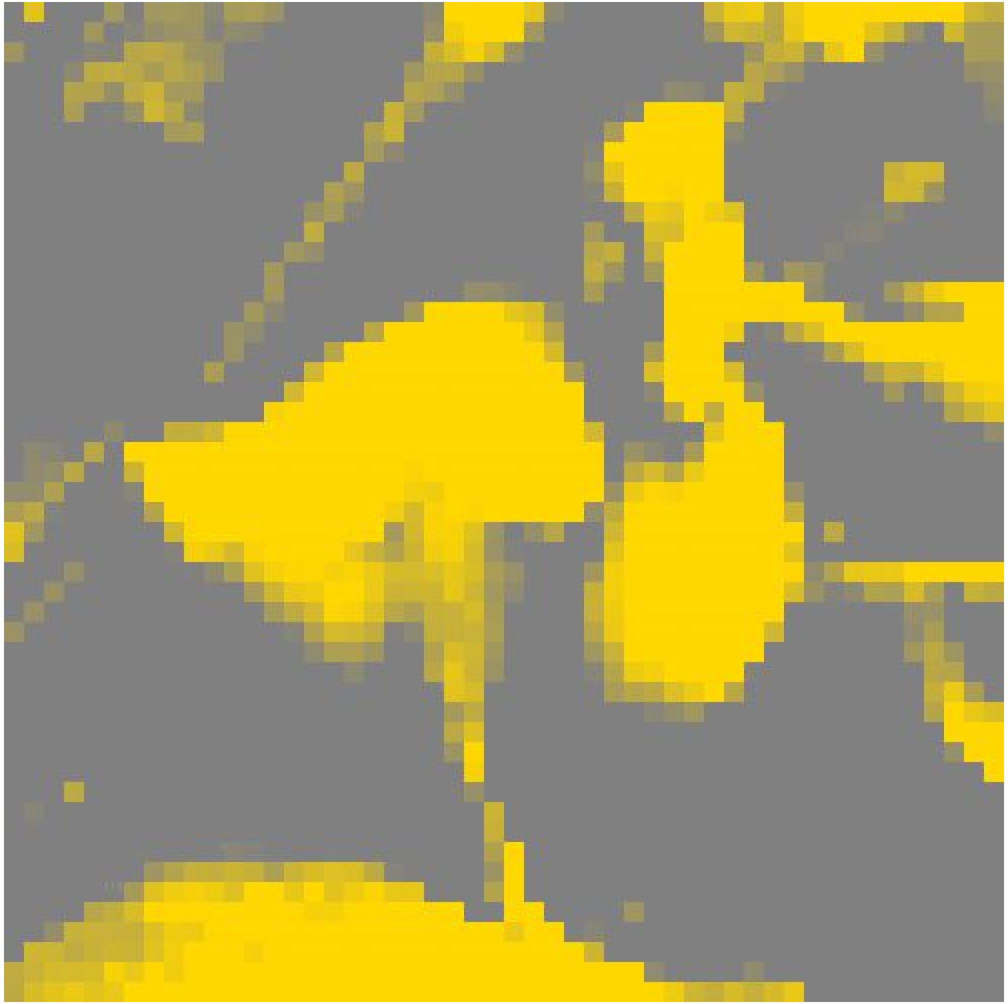


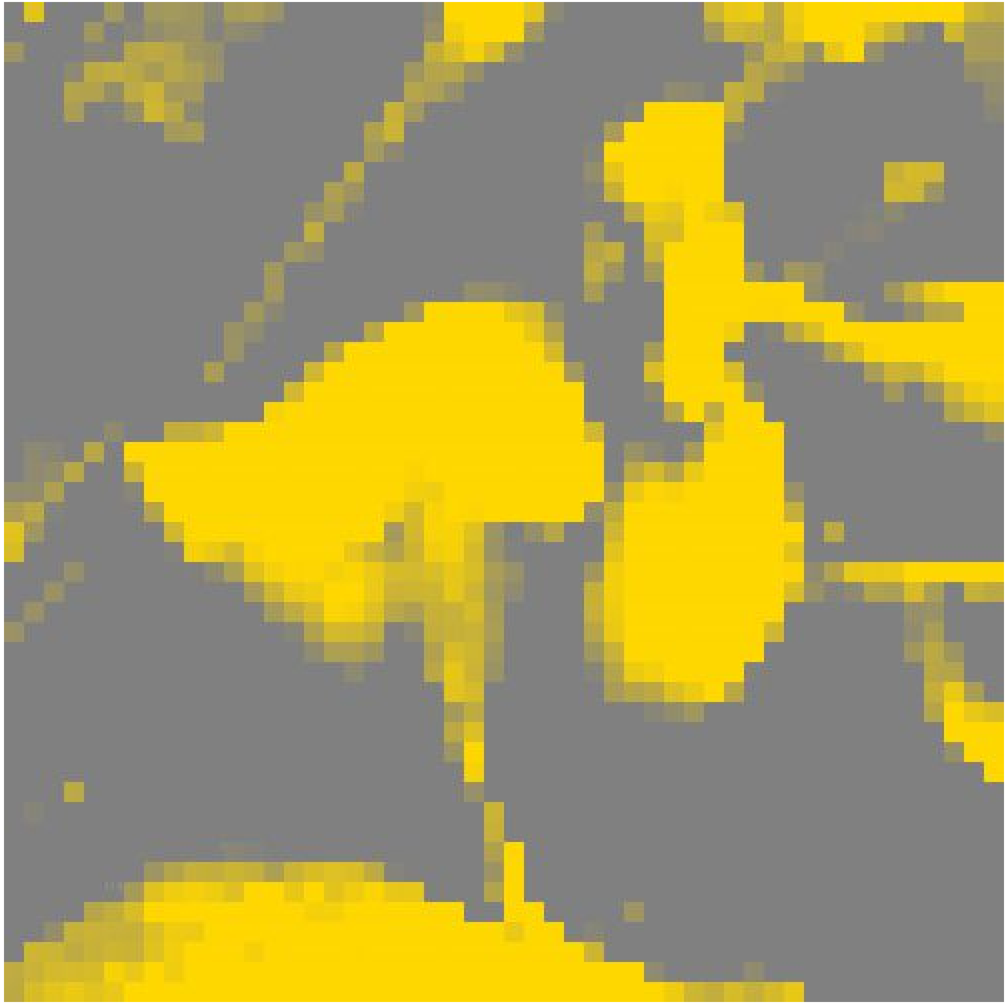
© xmple.com



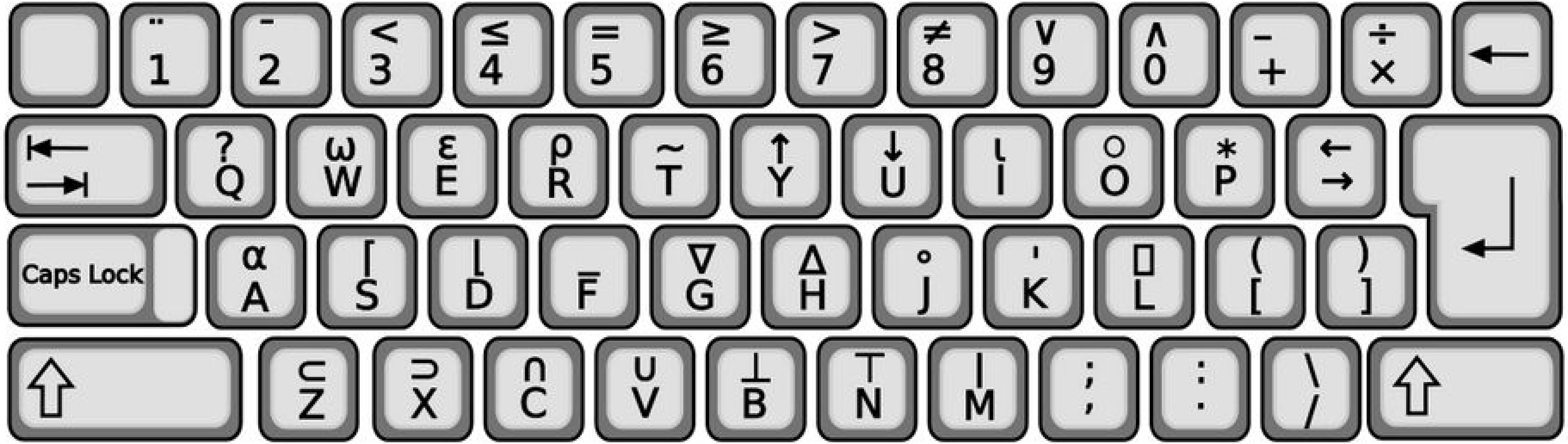








Currently online: YHNMJUIK.COM



Start Developing!

Requirements

Requirements

- Image Code

Requirements

- Image Code
  - Into APL
  - Out of APL

Requirements

- Image Code
    - Into APL
    - Out of APL
- Web Code

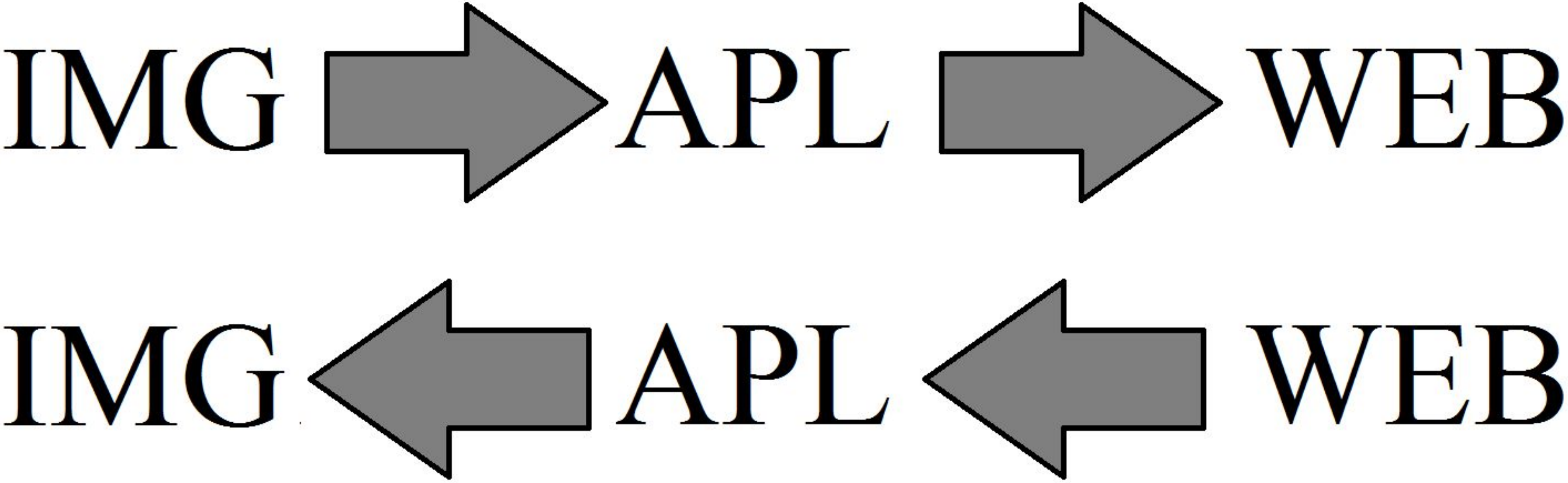
Requirements

- Image Code
  - Into APL
  - Out of APL
- Web Code
  - Output valid HTML
  - Parse form data as input

Requirements

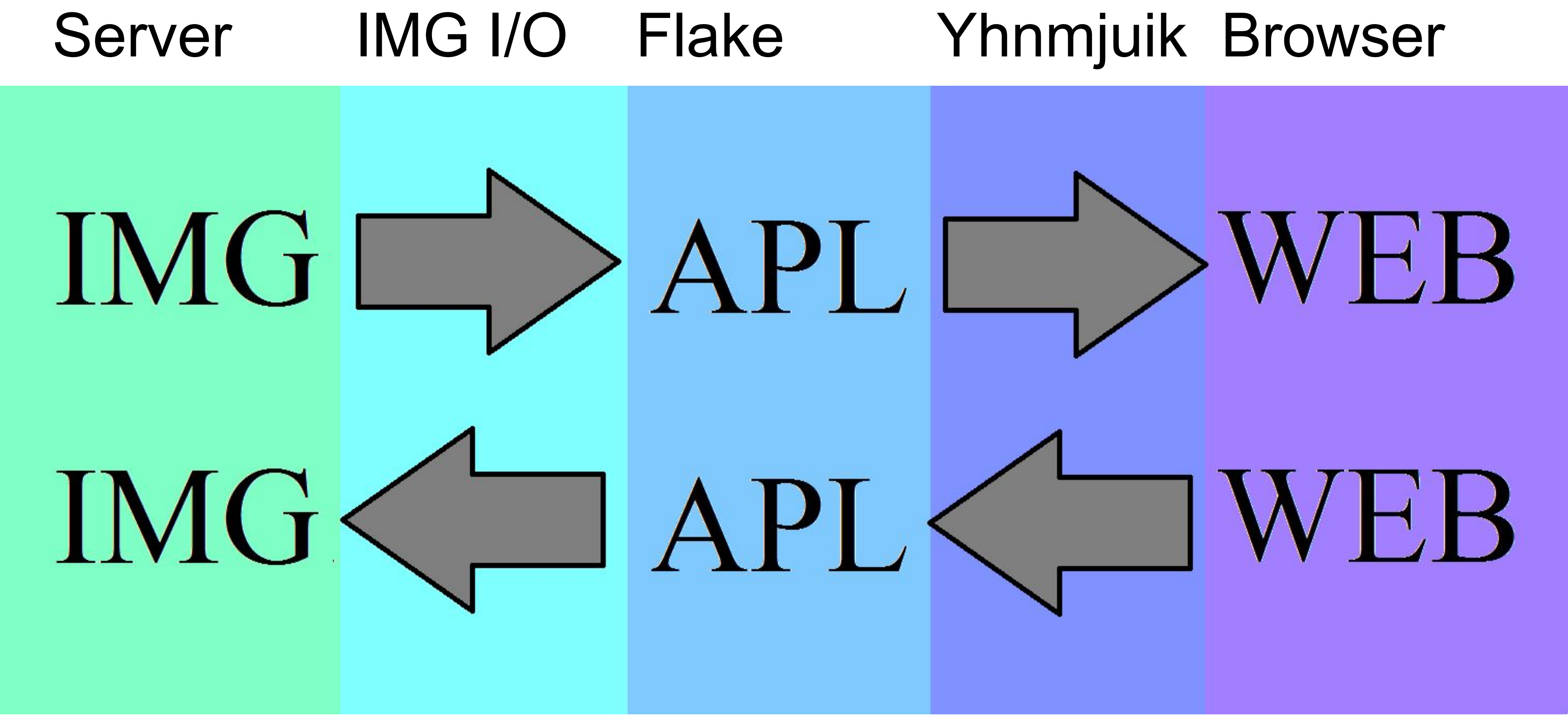
- Image Code
  - Into APL
  - Out of APL
- Web Code
  - Output valid HTML
  - Parse form data as input
- Flake Code

Requirements



IMG → APL → WEB

IMG ← APL ← WEB



Server IMG I/O Flake Yhnmjuik Browser

IMG APL WEB

IMG APL WEB

↑Those arrows are written in APL, also ↑

Architecture (Version 1)

Architecture (Version 1)

- PHP

Architecture (Version 1)

- PHP
  - Bash

Architecture (Version 1)

- PHP
  - Bash
    - J

Architecture (Version 1)

- PHP
    - Bash
        - J

A TOTAL MESS!

Architecture (Version 2)

Write every part in APL

Start Developing!

Start Developing!
(almost)

Set Up the Keyboard

Set Up the Keyboard

- This is not an APL problem

Set Up the Keyboard

- This is not an APL problem
    - This is an OS problem

Set Up the Keyboard

- This is not an APL problem
  - This is an OS problem
  - Experienced by a large number of APLers

Set Up the Keyboard

- This is not an APL problem
  - This is an OS problem
  - Experienced by a large number of APLers
- Unicode

Set Up the Keyboard

- This is not an APL problem
  - This is an OS problem
  - Experienced by a large number of APLers
- Unicode
  - The APL portion in “Miscellaneous Technical”

Set Up the Keyboard

```
sudo apt-get install subversion

sudo svn co http://svn.savannah.gnu.org/svn/apl/trunk

cd trunk

xmodmap support-files/Dyalog-Keyboard/apl.xmodmap-alexweiner
```

Set Up the Keyboard

- Files about the keyboard
    - trunk/README-3-keyboard
    - trunk/support-files/Dyalog-Keyboard/README

Start Developing

Start Developing!

(really!)

How to write a Bitmap Library

How to write a Bitmap Library

- Look at the spec

How to write a Bitmap Library

- Look at the spec
- Look at some C code

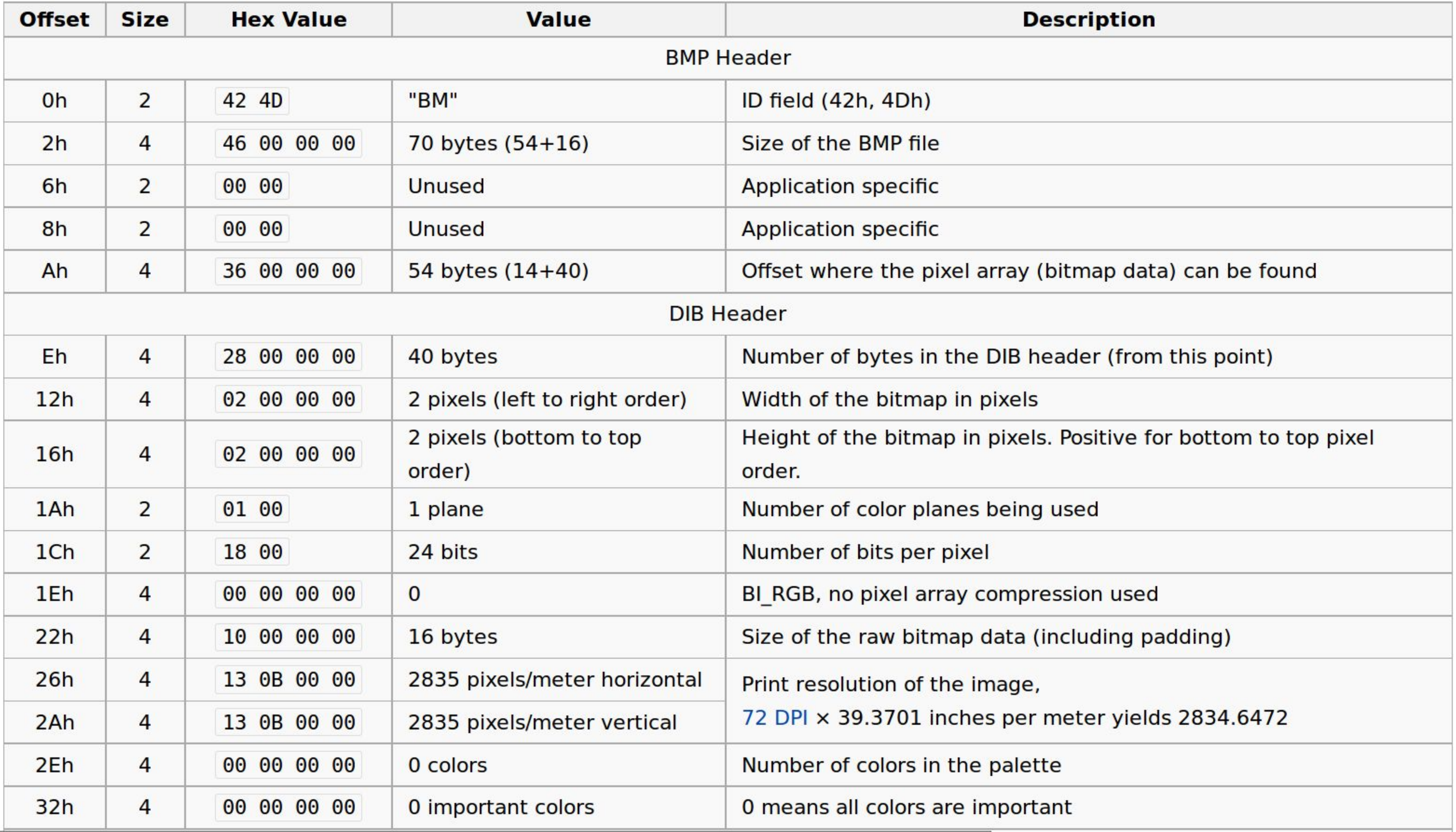
How to write a Bitmap Library

- Look at the spec
- Look at some C code
- The “Aha!” moment

Look at the Specification

Look at the Specification

- Wikipedia

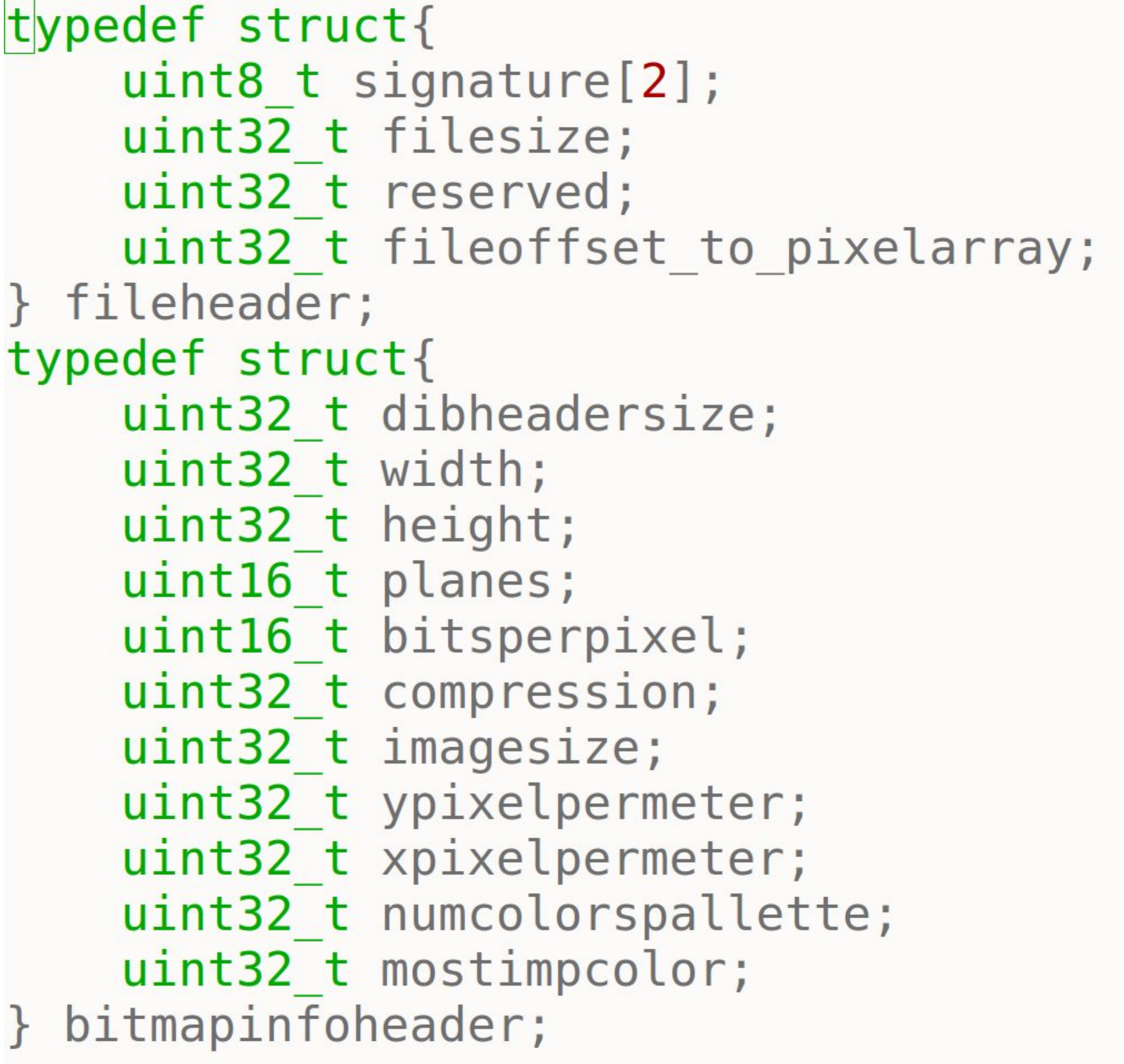


Offset	Size	Hex Value	Value	Description
BMP Header				
0h	2	42 4D	"BM"	ID field (42h, 4Dh)
2h	4	46 00 00 00	70 bytes (54+16)	Size of the BMP file
6h	2	00 00	Unused	Application specific
8h	2	00 00	Unused	Application specific
Ah	4	36 00 00 00	54 bytes (14+40)	Offset where the pixel array (bitmap data) can be found
DIB Header				
Eh	4	28 00 00 00	40 bytes	Number of bytes in the DIB header (from this point)
12h	4	02 00 00 00	2 pixels (left to right order)	Width of the bitmap in pixels
16h	4	02 00 00 00	2 pixels (bottom to top order)	Height of the bitmap in pixels. Positive for bottom to top pixel order.
1Ah	2	01 00	1 plane	Number of color planes being used
1Ch	2	18 00	24 bits	Number of bits per pixel
1Eh	4	00 00 00 00	0	BI_RGB, no pixel array compression used
22h	4	10 00 00 00	16 bytes	Size of the raw bitmap data (including padding)
26h	4	13 0B 00 00	2835 pixels/meter horizontal	Print resolution of the image, 72 DPI × 39.3701 inches per meter yields 2834.6472
2Ah	4	13 0B 00 00	2835 pixels/meter vertical	
2Eh	4	00 00 00 00	0 colors	Number of colors in the palette
32h	4	00 00 00 00	0 important colors	0 means all colors are important

BMP details

APL Representation	Actual Value	Verbal Description
46 0 0 0	70	Size of BMP file
36 0 0 0	54	Offset to pixel array
2 0 0 0	2	Image width
2 0 0 0	2	Image height

Look at C code



```c
typedef struct{
    uint8_t signature[2];
    uint32_t filesize;
    uint32_t reserved;
    uint32_t fileoffset_to_pixelarray;
} fileheader;
typedef struct{
    uint32_t dibheadersize;
    uint32_t width;
    uint32_t height;
    uint16_t planes;
    uint16_t bitsperpixel;
    uint32_t compression;
    uint32_t imagesize;
    uint32_t ypixelpermeter;
    uint32_t xpixelpermeter;
    uint32_t numcolorspallette;
    uint32_t mostimpcolor;
} bitmapinfoheader;
```

The “Aha!” Moment

- 32 bits are four 8-bit bytes

The “Aha!” Moment

```
256⊥¨⌽¨(46 0 0 0) (36 0 0 0) (2 0 0 0) (2 0 0 0)
```

```
46 36 2 2
```

How do you represent an image in APL?

How do you represent an image in APL?

- A 2D Matrix of vectors

How do you represent an image in APL?

- A 2D Matrix of vectors
  - Easier to look at while coding

How do you represent an image in APL?

- A 2D Matrix of vectors
  - Easier to look at while coding
  - Slow

How do you represent an image in APL?

- A 2D Matrix of vectors
  - Easier to look at while coding
  - Slow

```
content←offset↓bmp

partition←bytes_perpixel{ω⊂⍨∈

(α)/¨ια÷⍨ρω}contentbitmap←h w ρ partitioned
```

How do you represent an image in APL?

- A 3D Matrix

How do you represent an image in APL?

- A 3D Matrix
    - Faster code with less operations

How do you represent an image in APL?

- A 3D Matrix
  - Faster code with less operations
  - Extensible

How do you represent an image in APL?

- A 3D Matrix
  - Faster code with less operations
  - Extensible

```
bitmap←⍉width height dimension ⍴ content
```

APL and The Web

Passing web-form data with APL

- What is a web-form

Passing web-form data with APL

- What is a web-form
    - Syntax is HTML

Passing web-form data with APL

- What is a web-form
    - Syntax is HTML
    - HTTP methods:
        - GET
        - POST

Examples of GET and POST

```
<form action="code.apl"  method="get">
  <input type="submit" value="Click">
</form>



<form action="code.apl" enctype="multipart/form-data" method="post">
  <input type="file" name="name">
  <input type="submit" value="Click">
</form>
```

Passing form data with APL

- Language agnostic protocol

Passing form data with APL

- Language agnostic protocol
    - GET
        - “&” is the separator
        - environment variable called “QUERY_STRING”

Passing form data with APL

- Language agnostic protocol
  - POST
    - CRLF is the separator (Unicode 13 10)
    - Passed to stdin

```
Contents←{ω, FIOΔfread 0}⍣{α⊢FIOΔfeof 0}''
```

Demo

Demo

- Parsing a GET

Demo

- Parsing a GET

```
QUERY_STRING←‘var1=value1&var2=value2&var3=value3’

R←'&',QUERY_STRING

(+\R='&')⊂R
```

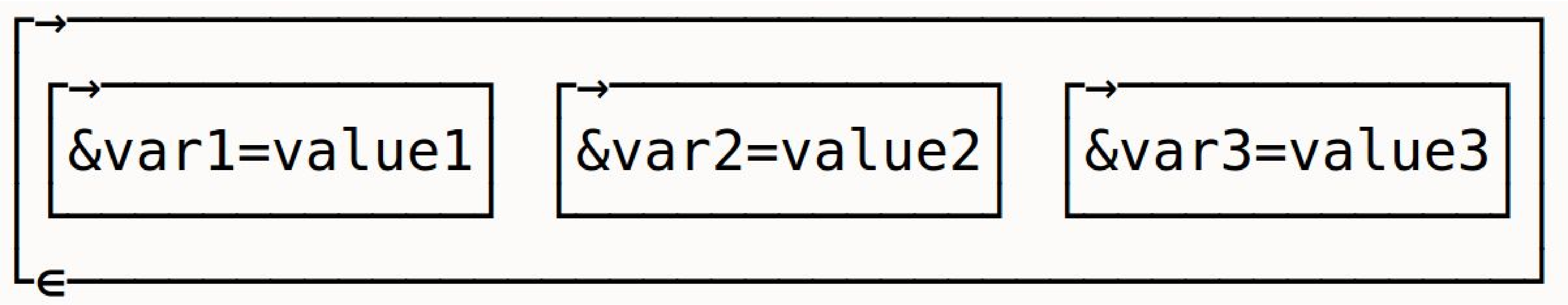
Demo

- Parsing a GET

  QUERY_STRING←‘var1=value1&var2=value2&var3=value3’

  R←'&',QUERY_STRING

  (+\R='&')⊂R



```
┌→─────────────────────────────────────────────────┐
│ ┌→────────────┐  ┌→────────────┐  ┌→────────────┐ │
│ │&var1=value1 │  │&var2=value2 │  │&var3=value3 │ │
│ └─────────────┘  └─────────────┘  └─────────────┘ │
└∊─────────────────────────────────────────────────┘
```

Other Goodies

Indexing

Indexing

- Good algorithms are Index-Origin independent

Indexing

- Good algorithms are Index-Origin independent
- How to convert from ⎕IO←0 to ⎕IO←1

```
ALEX[ 2 3 4 ]           ⍝ ⎕IO←1

ALEX[ 1 2 3 ]           ⍝ ⎕IO←0

ALEX[ ⎕IO + 1 2 3 ]     ⍝ Doesn’t matter
```

Control structures

- None are built in

Control structures

- None are built in
- Branching and line labels are included.

Control structures

```
LDI r16,0b00000001
CPI r16,0b00000001
BRNE somewhere

RJMP continue
somewhere:

continue:
```

```
r16←1
result←r16=1
→(result≠0)/somewhere

→continue
somewhere:

continue:
```

Questions?

Thank You!