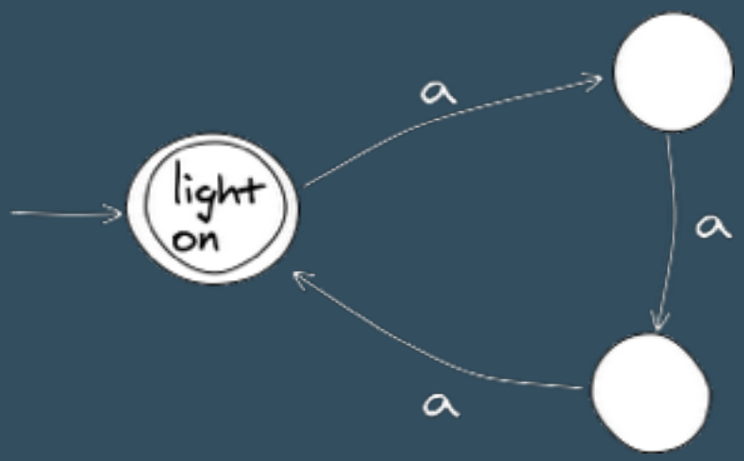
Spring 2015 - Berkeley, CA



CS24

FRESHMAN SEMINAR FOR CS SCHOLARS

WEEK 5 - COMPUTATIONAL MATHEMATICS

UNIVERSITY OF CALIFORNIA - BERKELEY

24 FEBRUARY 2015

CO

UNIVERSITY OF CALIFORNIA - BERKELEY

3 FEBRUARY 2015

—— *FAST!!!! MATLAB AND NUMPY - OPTIMIZATION + PARALLELISM* —

	1024x1024	2048x2048	4096x4096
CUDA C (ms)	43.11	391.05	3407.99
C++ (ms)	6137.10	64369.29	551390.93
C# (ms)	10509.00	300684.00	2527250.00
Java (ms)	9149.90	92562.28	838357.94
MATLAB (ms)	75.01	423.10	3133.90

Java Virtual Machine = Can't use system architecture

http://stackoverflow.com/questions/6058139/why-is-matlab-so-fast-in-matrix-multiplication

Vector
```
v = [1, 2, 3, 4];
```

Range
```
v = 1:10;  => 1, 2, 3, .., 10
```

Range w/ Step
```
v = 1:2:10;  => 1, 3, 5, .., 9
```

Indexing
```
v(1)  => 1
```

Indexing Subset
```
v(1:3)  => 1, 3, 5
```

Transpose
```
v' => [1; 3; 5; 9]
```

Fast matrices
```
eye(3) = 1 0 0
         0 1 0
         0 0 1

ones(3) = 1 1 1
          1 1 1
          1 1 1

zeros(3) = 0 0 0
           0 0 0
           0 0 0
```

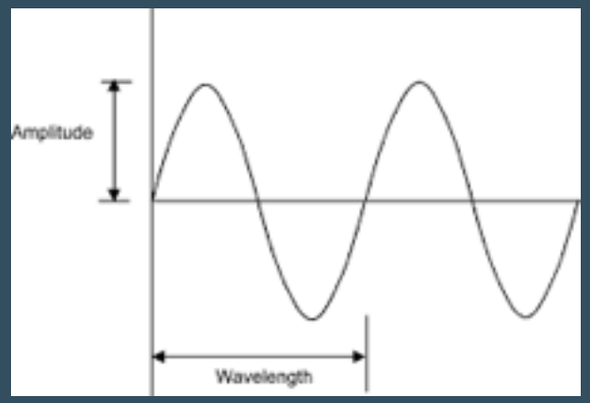
http://www.math.wsu.edu/math/kcooper/M300/text.php

```
// loop method
total = 0;
for i=1:length(v)
    total = total + abs(v(i));
end

// matrix method
total = abs(v) * ones(length(v),1);

// matrix method 2
total = sum(abs(v))
```

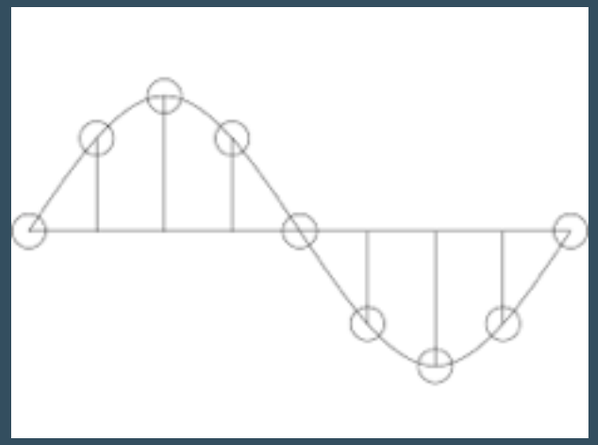
Translating from abstract to discrete

sinwave

Abstract



Discrete



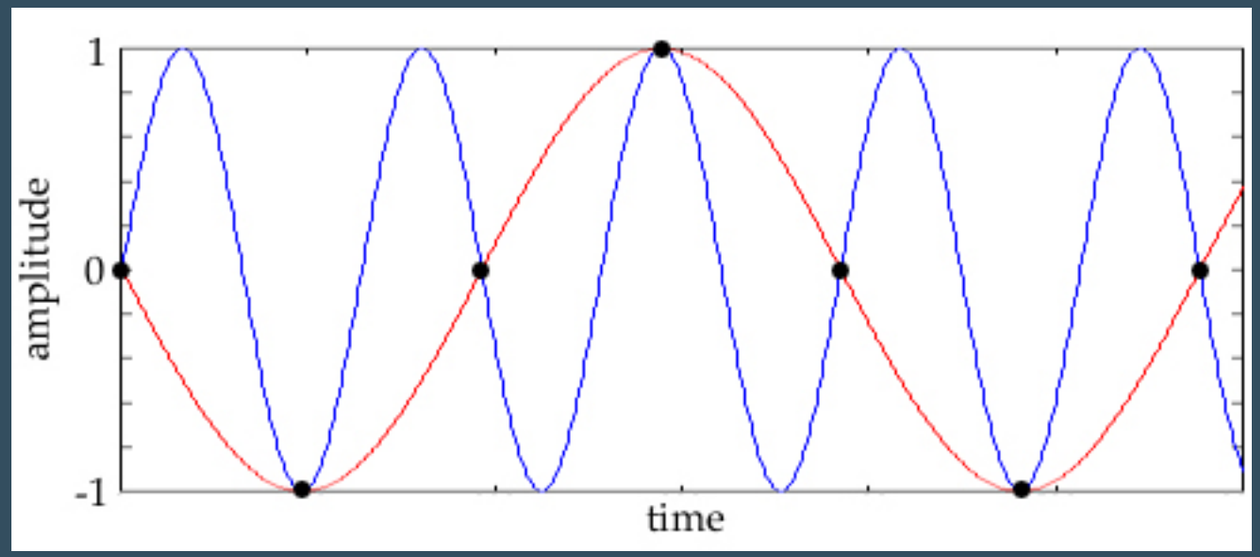
"sampling" = reduction of a continuous signal to a discrete signal

"sample" = ° the point in time/space

"sampling rate" = f_s = 1/T (Hz)

NYQUIST SAMPLING THEOREM

In order to represent a signal well, the sampling rate (or sampling frequency) needs to be at least twice the highest frequency contained in thesignal.



Undersampling :(

Representing an equation in matlab

```
x = 1:0.5:100
y = sin(x)
plot(x,y)
```

```
x = 1:0.5:100
y = sin(x)
z = cos(x)

plot(x,y, z)
```

CONVOLUTION

INTEGRAL FORM

$$(f * g)(t) = \int_{-\infty}^{\infty} f(\tau) g(t - \tau) d\tau$$

DISCRETE FORM

$$g(x) = f(x) * h(x) = \sum_{-\infty}^{\infty} h(x - k) f(k)$$

What does this mean?

$$g(x) = f(x) * h(x) = \sum_{-\infty}^{\infty} h(x-k) f(k)$$

EX1.

SIGNAL $f(x)$

9	4	5	1	…

KERNEL $h(x)$

1	2	1

1	2	1

	5	10	5	

		4	8	4

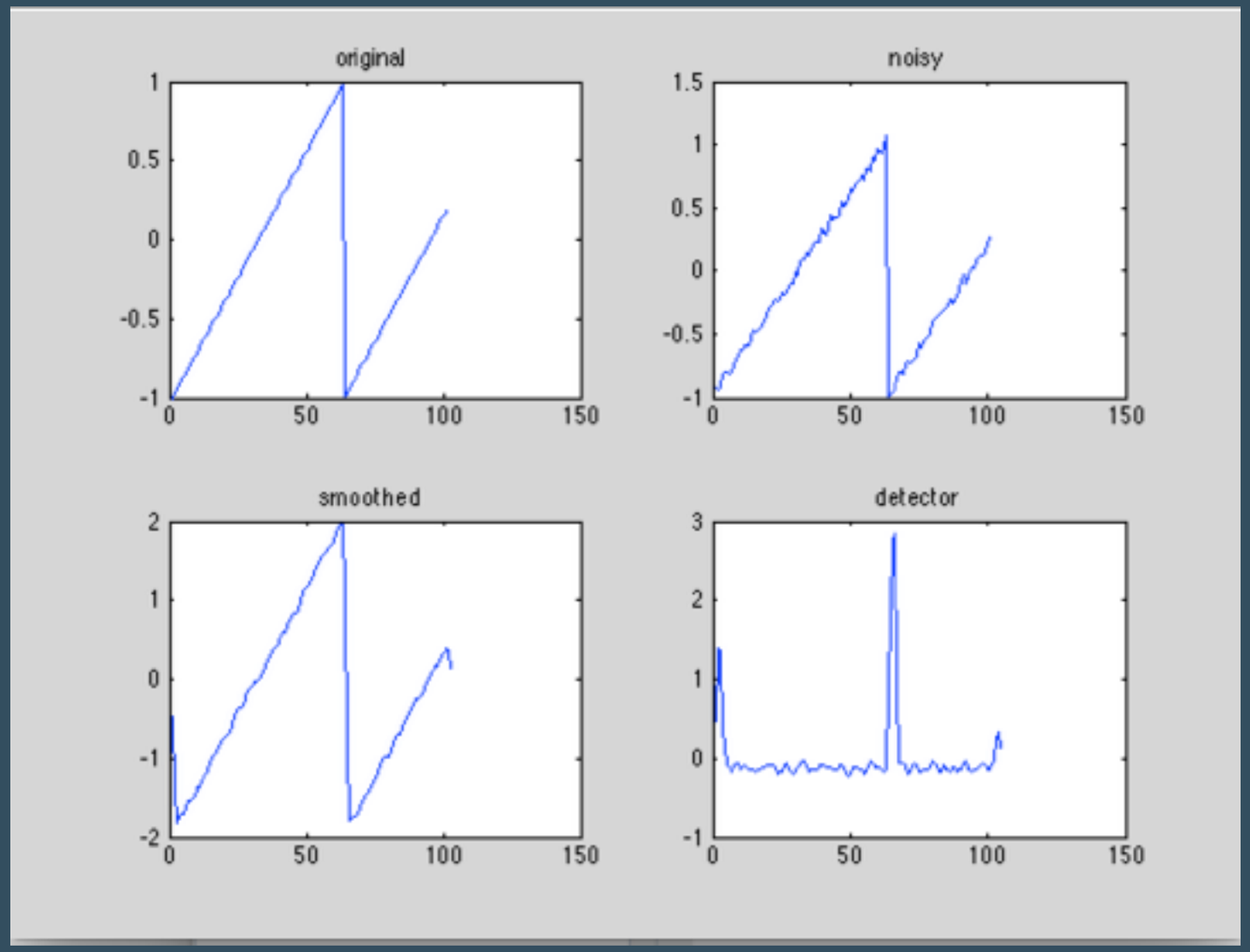
9	18	9		

	9	4	5	1	…

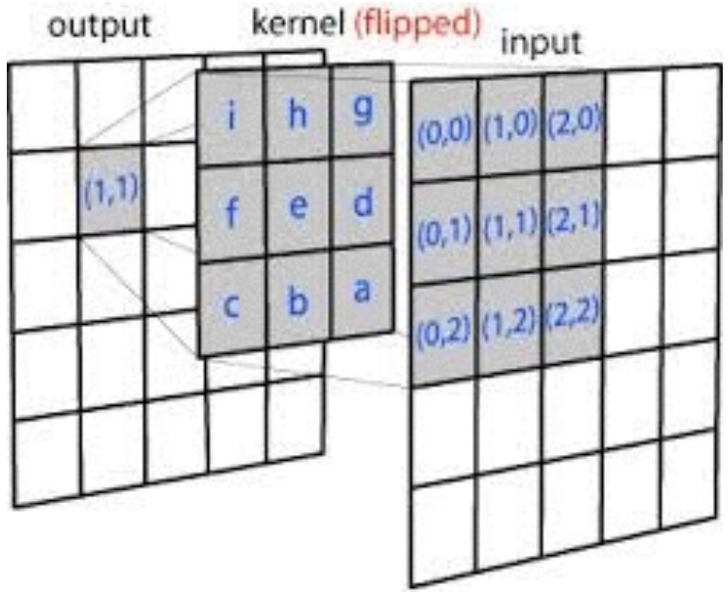
1	2	1		

9	22	22	15	7	1

SIGNAL PROCESSING

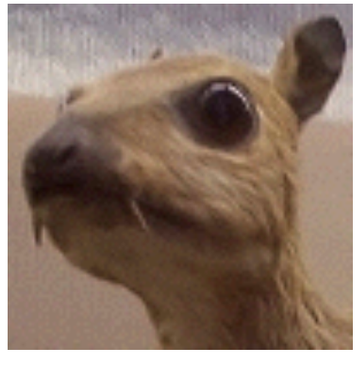


2-D Case - Image Processing



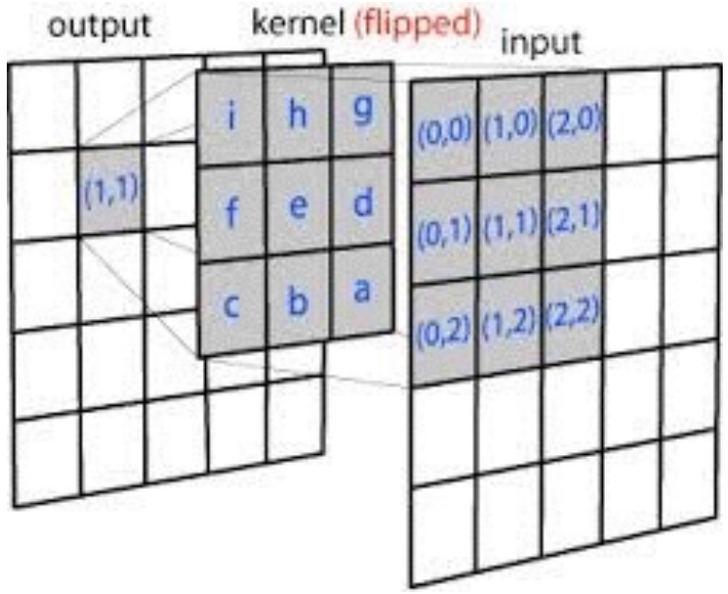
$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$



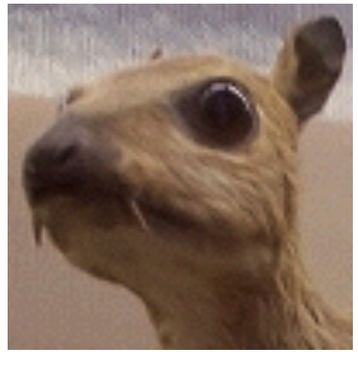
$$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

PAINTBRUSH IS A KERNEL

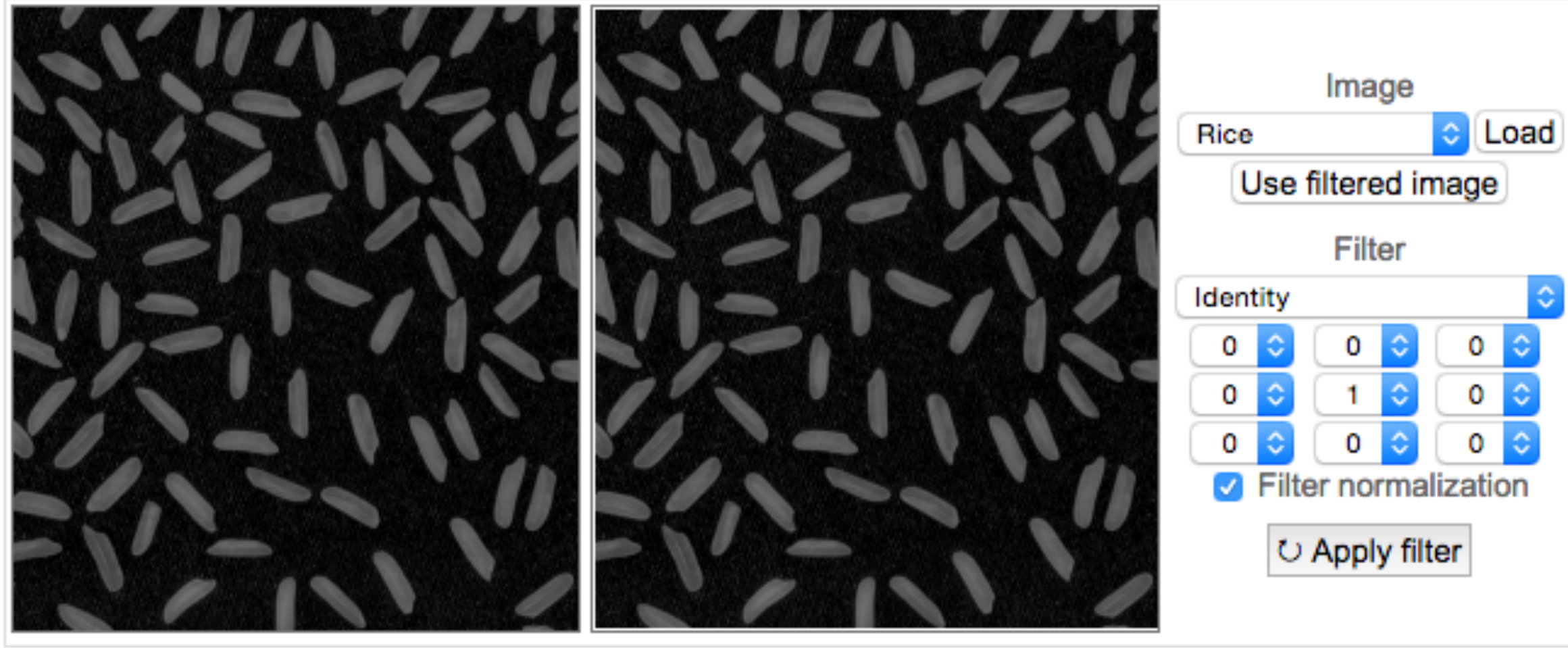


$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$



$$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$



http://matlabtricks.com/post-5/3x3-convolution-kernels-with-online-demo

GPS SCENARIO

What if Napoleon had a GPS tracker?

Let's generate a retreat detector!

LUTHUANIA

MOSCOW

BELARUS

dist = sqrt(a^2 + b^2)

sqrt((0 − 100)^2 + (100 − 90)^2)

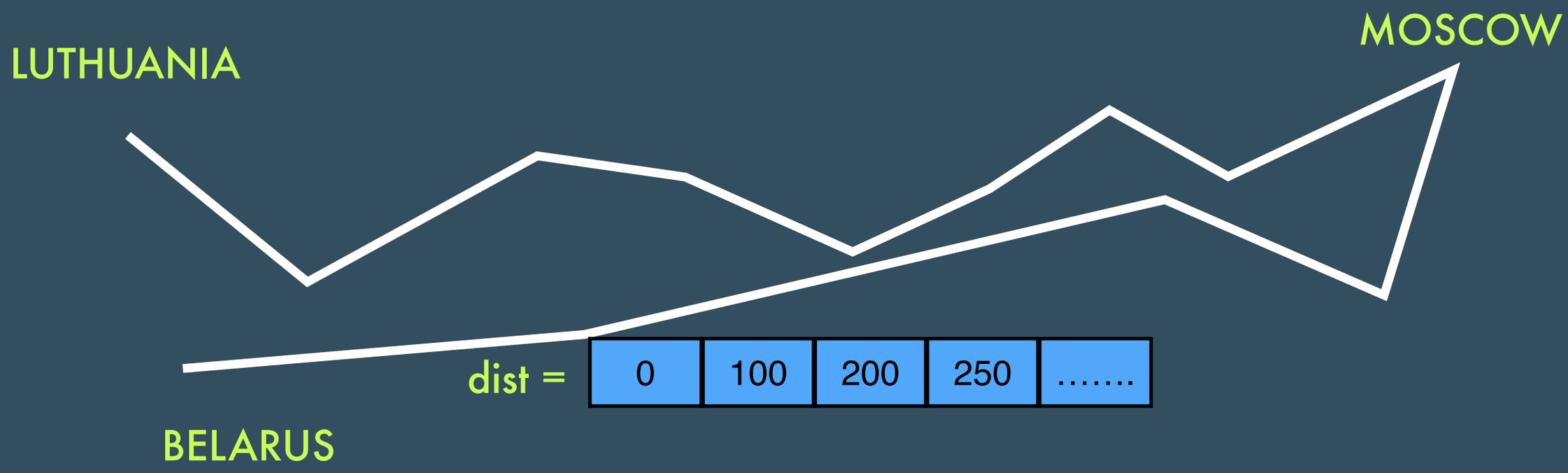
0	100	150	200	.....
100	90	100	95	

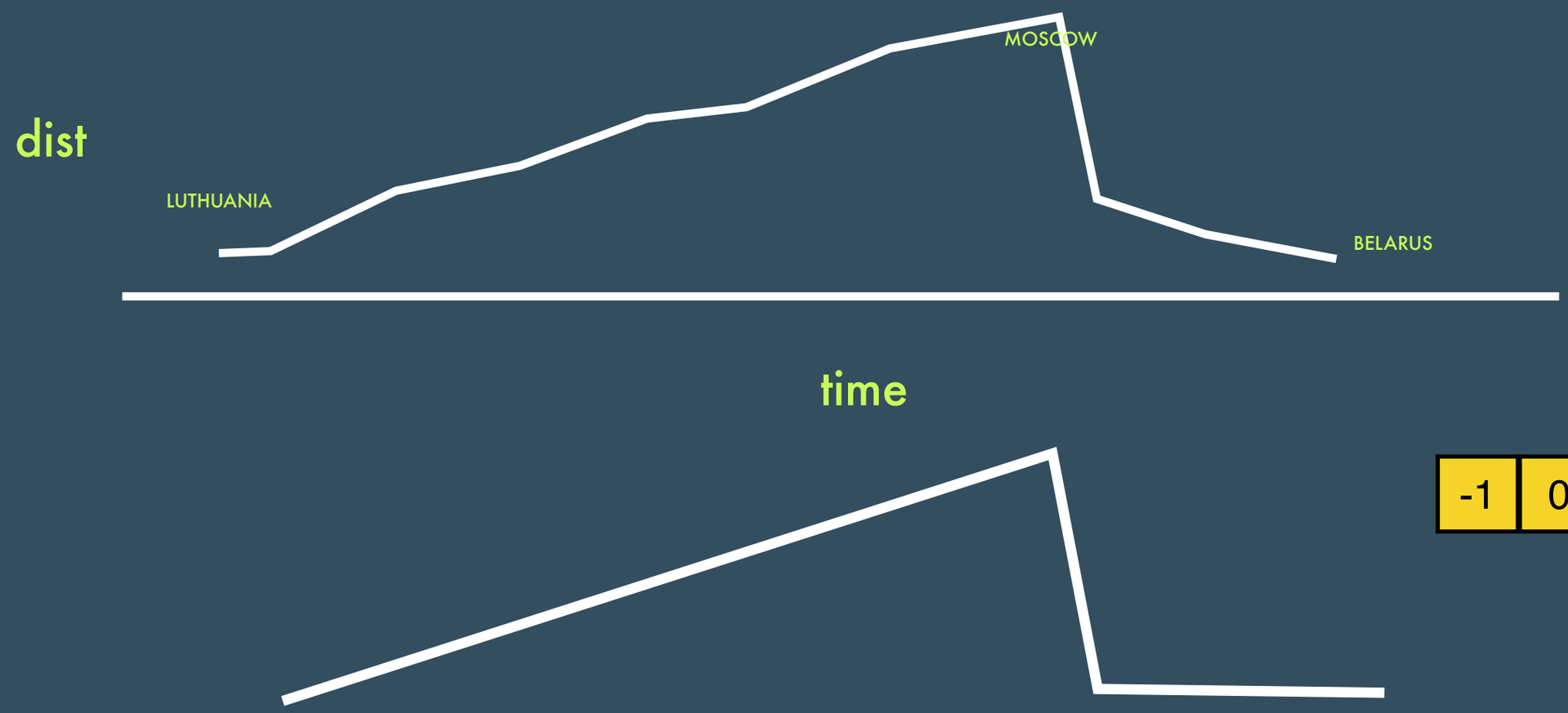
+

0
100

dist =

0	100	200	250	.....


LUTHUANIA
MOSCOW
dist =
0
100
200
250
.....
BELARUS

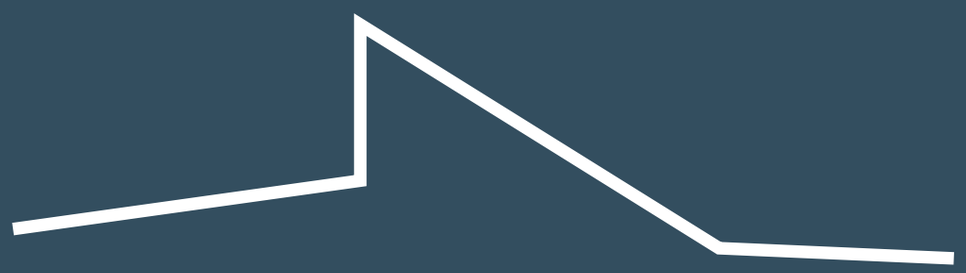

dist
LUTHUANIA
MOSCOW
BELARUS
time
-1
0
1

RUNNING/WALKING/STATIONARY

STREET LIGHT DETECTOR

dist

TELEPORTATION DETECTOR



PLANE/CAR/WALK

time

TODOS

COOKBOOK #4
QA #4

SIMPLER Q/A SUBMIT
PARTNER LINK NO LONGER NEEDED.
MAKE SURE TO ADD YOUR NAME TO THE FILES.

QUESTIONS ?

Week 6

HUMAN COMPUTER INTERACTION

RECIPES AND QUESTIONS (A4) DUE

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