Convolutional kernel

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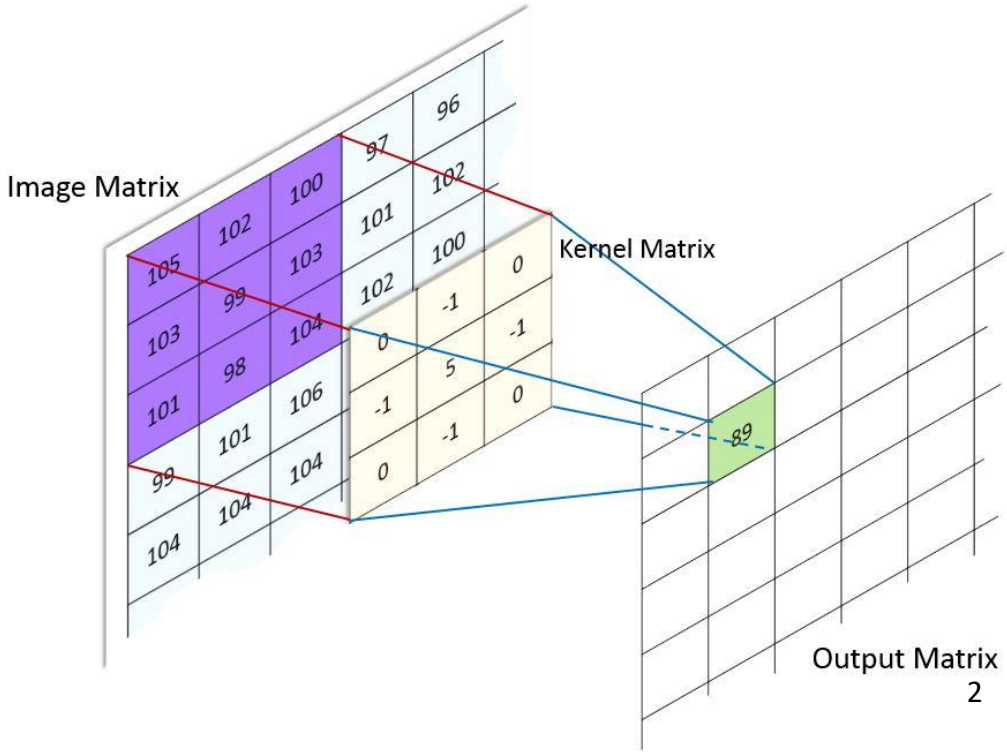
Matrix Convolution

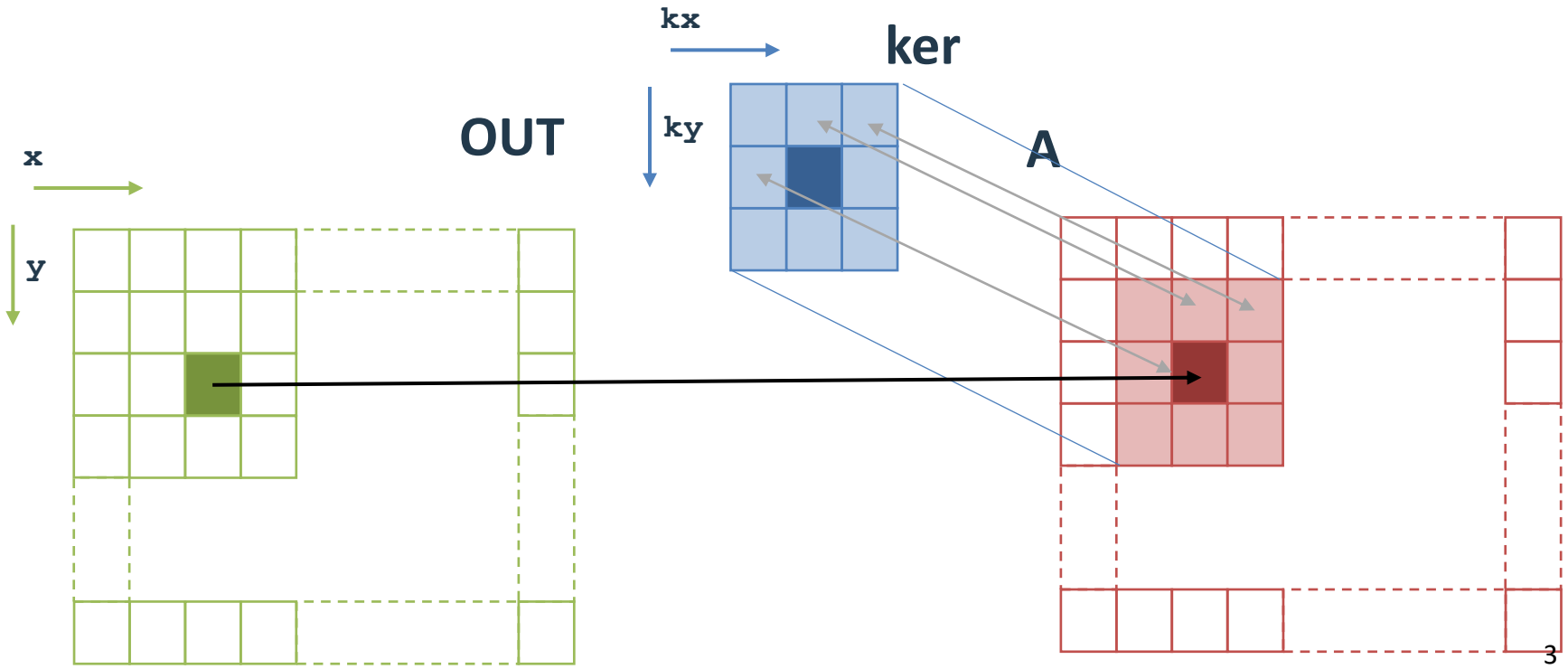
- Local operator (as opposite to «punctual» operator)
  - Gets a subset of input ~~matrix~~ image **A** to produce a pixel
- Kernel of size ***KxK*** is shifted over image.
  - (Typically, smaller, e.g., 3x3, 5x5, 7x7)
  - For every pixel (x, y) of input image **A**
  - Multiply-accumulate **K**x**K** neighborhood



Matrix Convolution

Four nested loops

- **x**, **y** to iterate over input/output matrices/images
- **kx**, **ky** to iterate over kernel **K**
- Mind the borders!!!



Matrix Convolution

Widely used in computer vision

Operation performed, varies with *ker*

- Blur, feature detection, edge detection…
- Convolutional neural networks for Artificial Intelligence

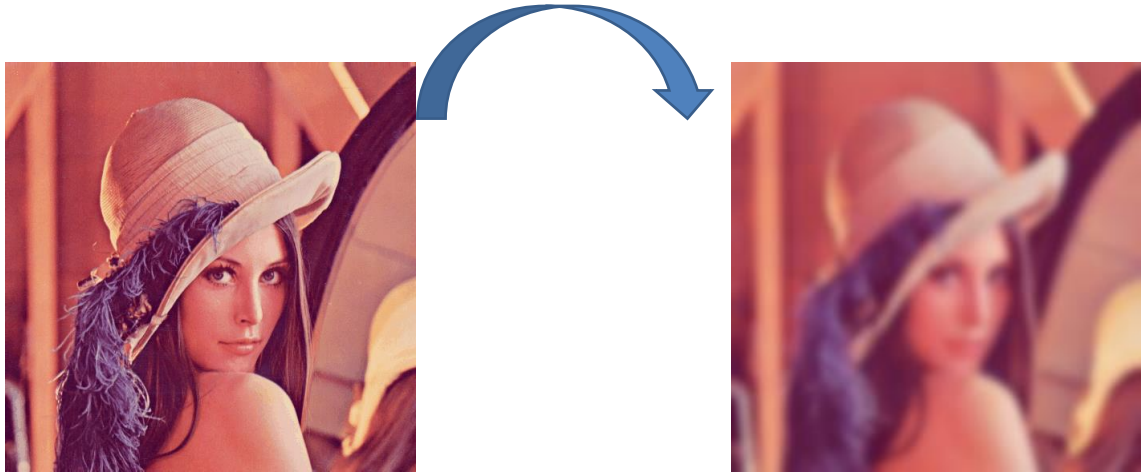


Image blur with gaussian kernel

Kernel shape is controlled by the σ (*Sigma)* value

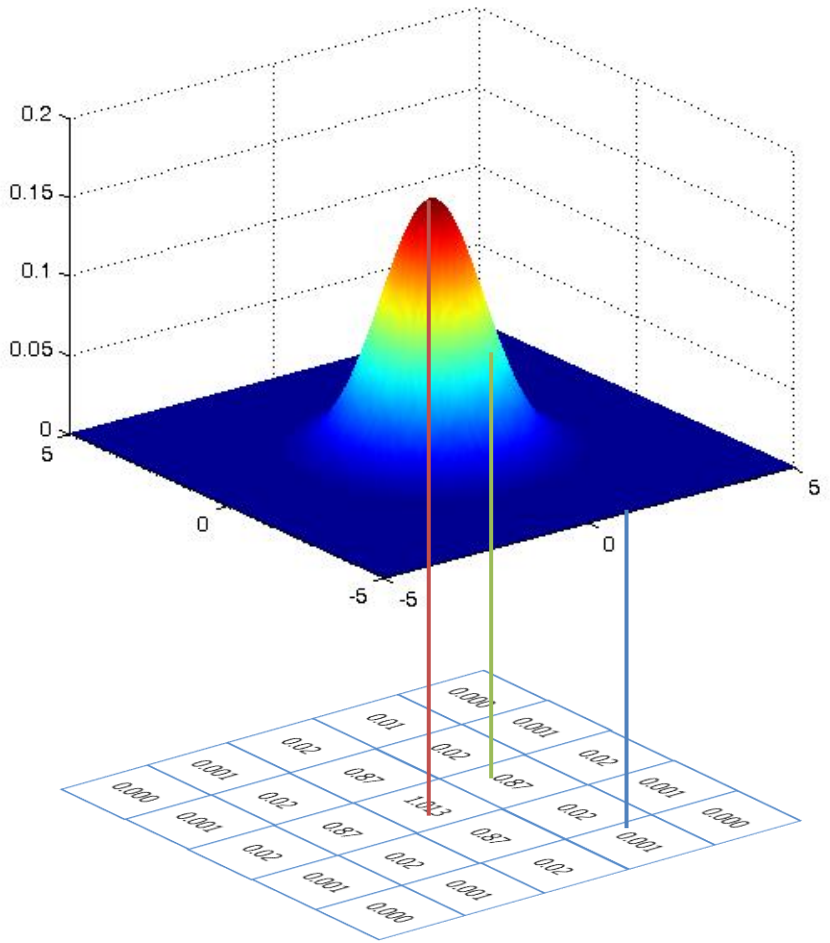
Algorithm knobs

› Kernel dimension

› Value of σ

Kernels contain `float`

› Typically, use normalized kernels (we will see this in a while)



Quiz time!

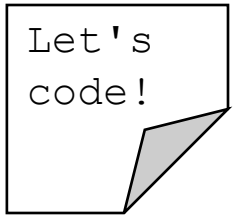
- Q1: what is the invariant kernel of convolution?
- Q2: what do these two kernels do?

0	0	0
0	2	0
0	0	0

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

- Q3: how do size of gaussian influence output?
- Q4: what is the complexity of the 2D-convolution operator?

Exercise



Implement a Gaussian filter, then parallelize it!

Starting from the code in `Lena/` folder

- `imgutils` lib loads and stores a bmp image to/from an array of `uchar`
- Atm, only Grayscale images
- `template.c` as starting point

Who is Lena?

- Image historically used by CV engineers
- Both in Color and B/W, full of contrasts, details, …
- …and she's hot (charged of sexism)

References

- "Calcolo parallelo" website
  - http://hipert.unimore.it/people/paolob/pub/Calcolo_Parallelo/
- My contacts
  - paolo.burgio@unimore.it
  - http://hipert.mat.unimore.it/people/paolob/
- Useful links
  - https://en.wikipedia.org/wiki/Lena_S%C3%B6derberg
  - http://www.google.com