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DRESDEN LEIPZIG
CENTER FOR SCALABLE DATA ANALYTICS AND ARTIFICIAL INTELLIGENCE

Bio-Image Data Science

Robert Haase

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

SACHSEN
Diese Maßnahme wird gefördert durch die Bundesregierung aufgrund eines Beschlusses des Deutschen Bundestages.
Diese Maßnahme wird mitfinanziert durch Steuermittel auf der Grundlage des von den Abgeordneten des Sächsischen Landtags beschlossenen Haushaltes.

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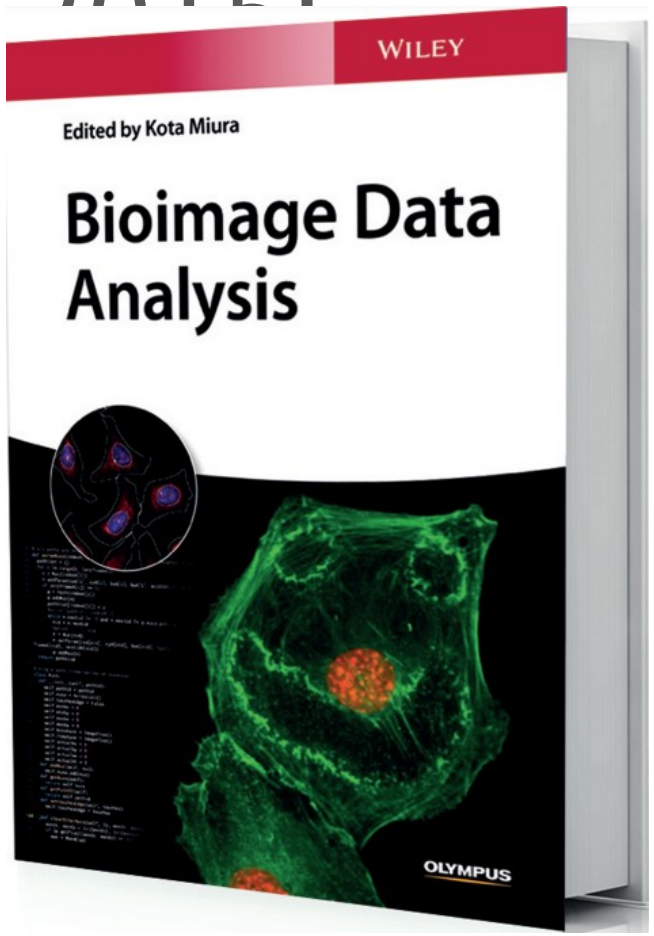
Bioimage Analysis

- Kota Miura & Sebastien Tosi 2015:

In the light of this definition, image analysis, which is also called "computer vision," aims at mimicking the way we see the world and how we identify its visible structures. Image analysis in biology does undeniably also hold this element, but more importantly, its main goal is to *measure* biological structures and phenomena in order to study and understand biological systems in a quantitative way.

To achieve this task, we in fact do not have to be bothered with similarity to the human recognition – we have more emphasis on the objectivity of quantitative measurement, rather than how that computer-based recognition becomes in agreement with human recognition. Therefore, in biology, image analysis is a process of identifying spatial distribution of biological components in images and measuring their characteristics to study their underlying mechanisms in an unbiased way. To underline this difference in the goals of image analysis in the two fields and to distinguish them from each other, we will now on refer to image analysis in biology as *bioimage analysis*.



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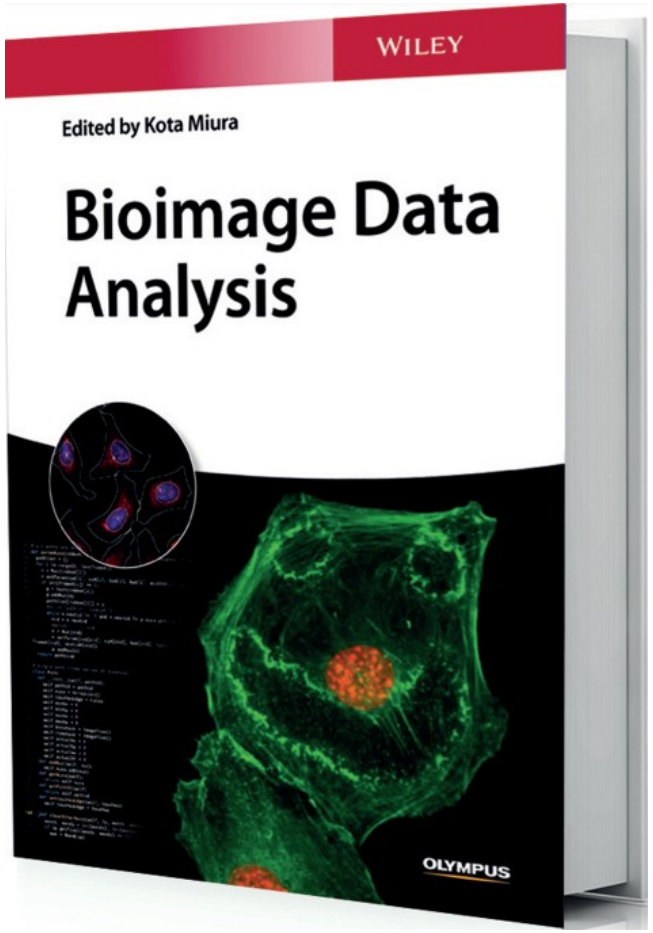

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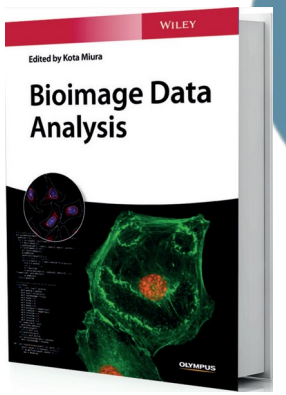

Source: Bioimage Data Analysis, First Edition. Edited by Kota Miura. ♦ 2016 Wiley-VCH Verlag GmbH & Co. KGaA. Published 2016 by Wiley-VCH Verlag GmbH & Co. KGaA

https://analyticalscience.wiley.com/do/10.1002/was.00050003/full/bioimagedataanalysis.pdf

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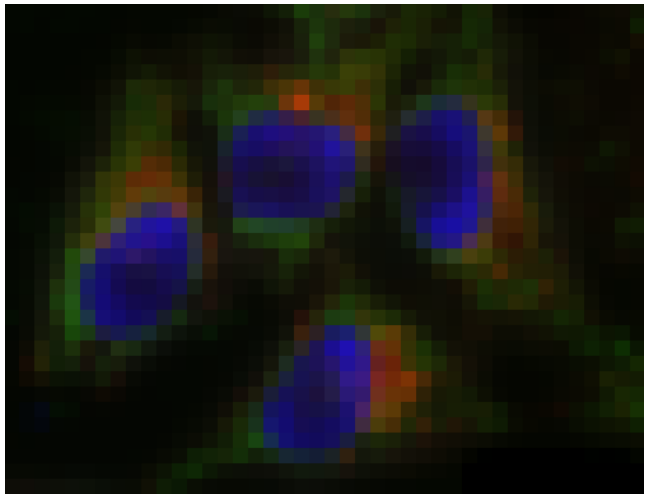
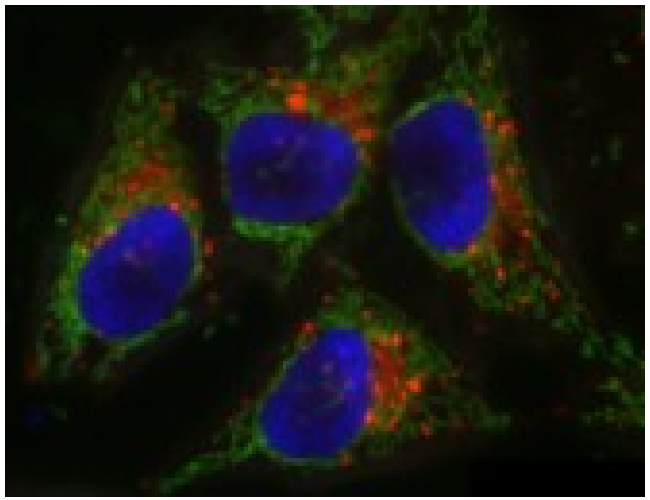
Pixel size versus resolution

- Pixel size is a property of a digital image.
- You configure it during the imaging session at the microscope

Pixel size: 3.3 µm



Pixel size: 0.8 µm



Pixel size: 0.05 µm

- We are not talking about resolution!

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Pixel size: 3.3 µm

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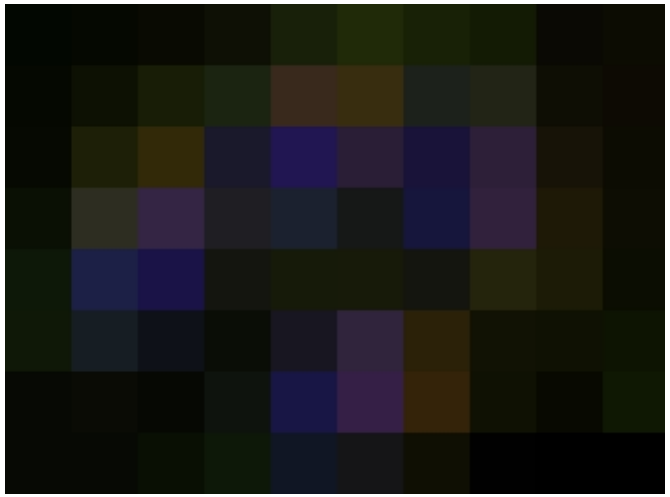
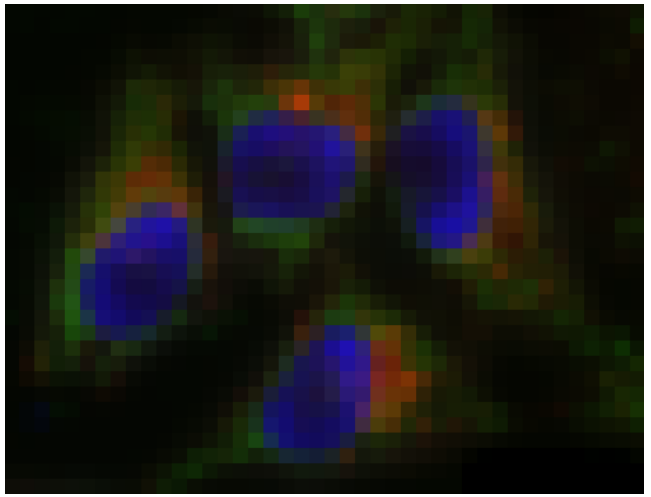
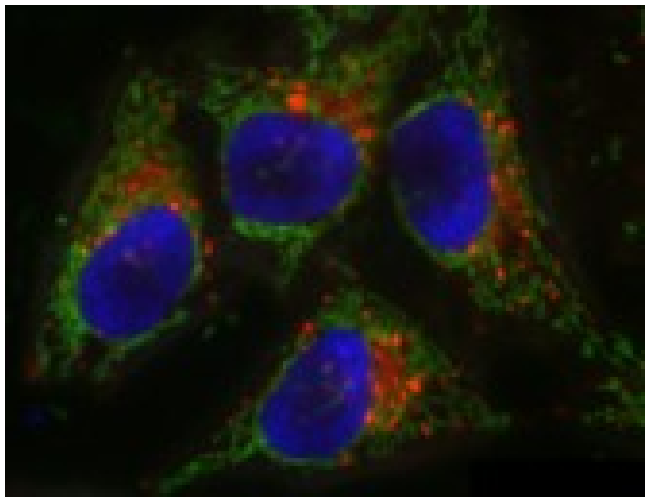

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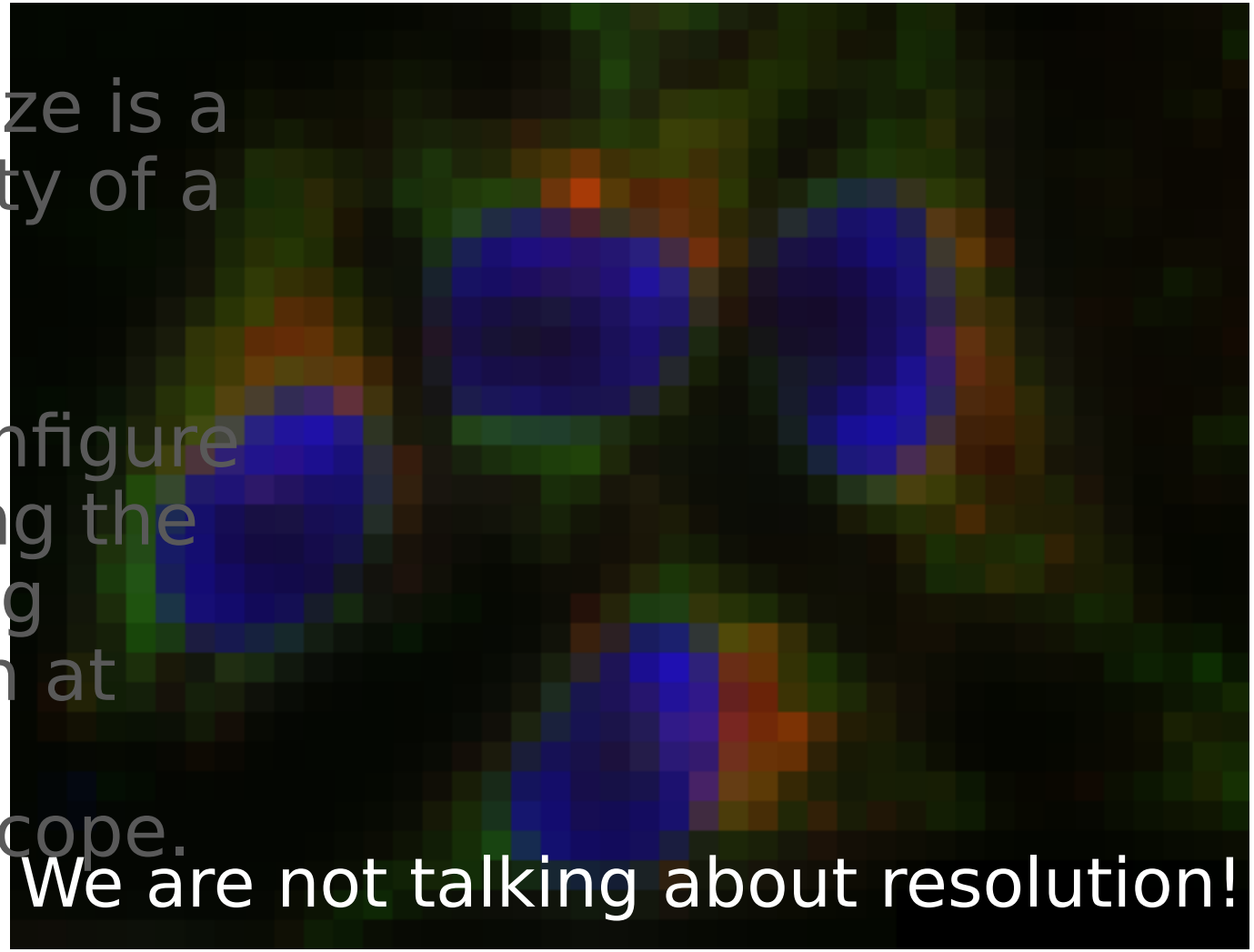
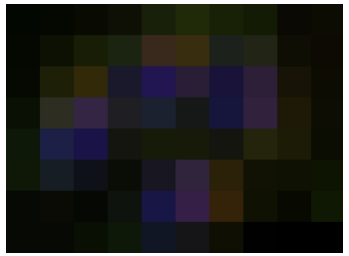
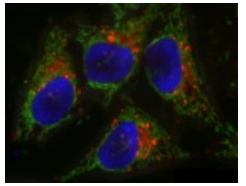




Pixel size: 3.3 µm

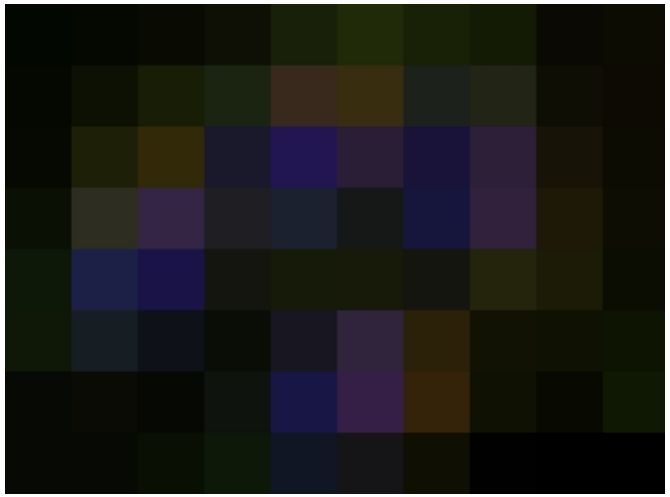


Pixel size: 0.05 µm

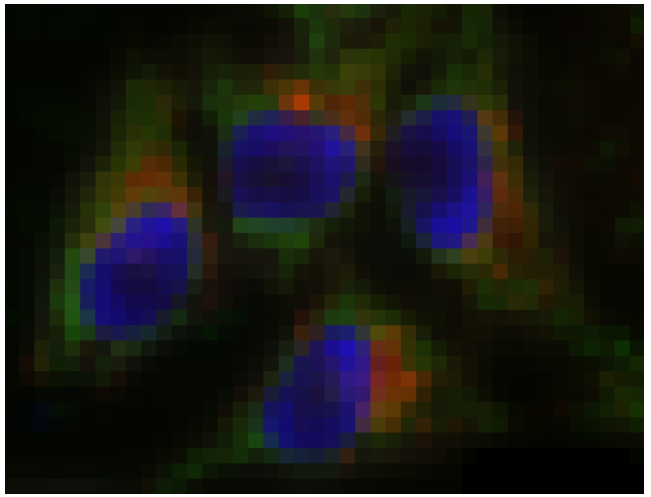
Pixel size: 0.8 µm

Pixelgröße versus Resolution

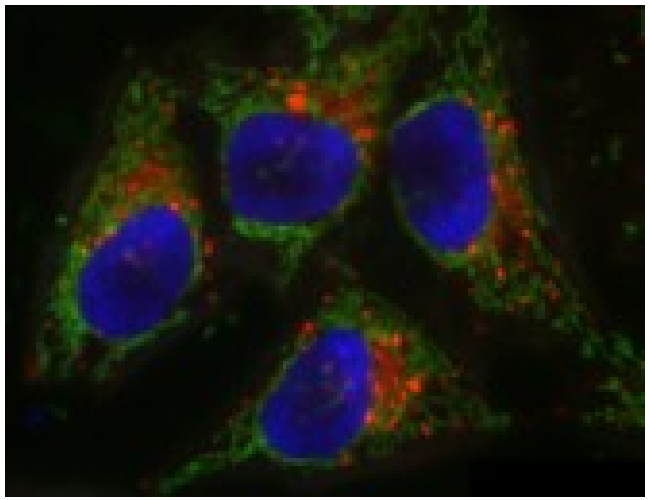
- Die Pixelgröße ist eine Eigenschaft eines digitalen Bildes.
- Sie wird während der Aufnahme am Mikroskop konfiguriert.



Pixelgröße: 3.3 µm



Pixelgröße: 0.8 µm



Pixelgröße: 0.05 µm

- Wir reden nicht über Resolution!

Quiz

- Enabling others to do your experiment is about ...

Repeatability

Reproducibility

Replicability

Reliability

Quiz

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Quiz

- Enabling others to do your experiment is about ...

Bio-image analysis is supposed to be

- **Quantitative**
  - We derive numbers from images which describe physical properties of the observed sample.
- **Objective**
  - The derived measurement does not depend on who did the measurement. The measurement is free of interpretation.
- **Reliable (trustworthy / validated)**
  - We are confident that the measurement is describing what it is supposed to describe.
- **Reproducible**
  - Enabling others to re-do the experiment. For this, documentation is crucial!
- **Replicability**
  - Others *do* execute the same analysis, potentially on other data, and see consistent results.
- **Repeatable**
  - We can do the same experiment twice under the *same conditions* and get the same measurements.

Bio-Bild Analyse

Quantitative Messungen werden von Bildern abgeleitet, um die physikalischen Eigenschaften der beobachteten Probe zu beschreiben, wobei sichergestellt werden muss, dass sie objektiv, frei von Interpretationen und unabhängig davon sind, wer die Messung durchführt. Diese Messungen müssen zuverlässig sein, d. h. sie müssen die Eigenschaft, die sie beschreiben sollen, genau wiedergeben, und sie müssen reproduzierbar sein, d. h. sie müssen eindeutig dokumentiert werden, damit andere das Experiment unter identischen Bedingungen wiederholen und dieselben Ergebnisse erzielen können. Darüber hinaus sollten sie reproduzierbar sein, so dass andere dieselbe Analyse mit unterschiedlichen Daten durchführen und konsistente Ergebnisse erzielen können. Schließlich muss der Prozess wiederholbar sein, damit sichergestellt ist, dass die zweimalige Durchführung des Experiments unter denselben Bedingungen zu identischen Messungen führt. Dasselbe Experiment kann zweimal unter identischen Bedingungen durchgeführt werden, was zu konsistenten Messungen führt.

Bio Image Analysis:

Quantitative measurements are derived from images to describe the physical properties of the observed sample, ensuring they are objective, free from interpretation, and independent of who performs the measurement. These measurements must be reliable, meaning they accurately reflect the property they are intended to describe, and reproducible, requiring clear documentation so others can repeat the experiment under identical conditions and obtain the same results. Furthermore, they should demonstrate replicability, allowing others to conduct the same analysis on different data and achieve consistent findings. Lastly, the process must be repeatable, ensuring that performing the experiment twice under the same conditions yields identical measurements. The same experiment can be performed twice under identical conditions, yielding consistent measurements.

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