

8DC00 Medical Image Analysis

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Outline for today:

- Course introduction
- Introduction to image registration
 - Causes of misalignment
 - Applications of medical image registration
 - Classification of image registration methods
- Geometrical transforms
 - Recap linear algebra
 - Rigid and affine transformations
 - Non-linear transformations



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Background: BSc in Electrical Engineering (Shandong University, China), MSc in Electrical Engineering (Technical University of Munich, Germany), PhD in Medical Image Analysis (Erasmus MC, Erasmus University Rotterdam)

Research: Deep learning, medical image analysis in neurovascular diseases, image-guided interventions



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Background: BSc in Mathematical Sciences (University College Cork, Ireland), MRes in Medical Imaging, PhD in Biomedical Engineering (King's College London, UK)

Research: Deep learning, quantitative MRI, cardiovascular imaging & modelling

Teaching assistants:

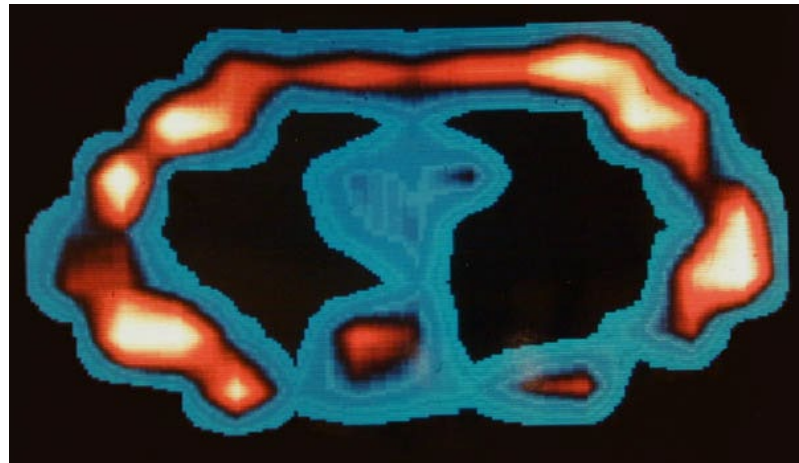
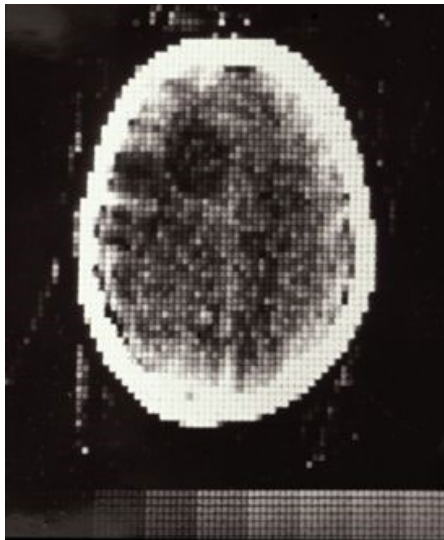
Rebecca Pelsser

Mike Albertz

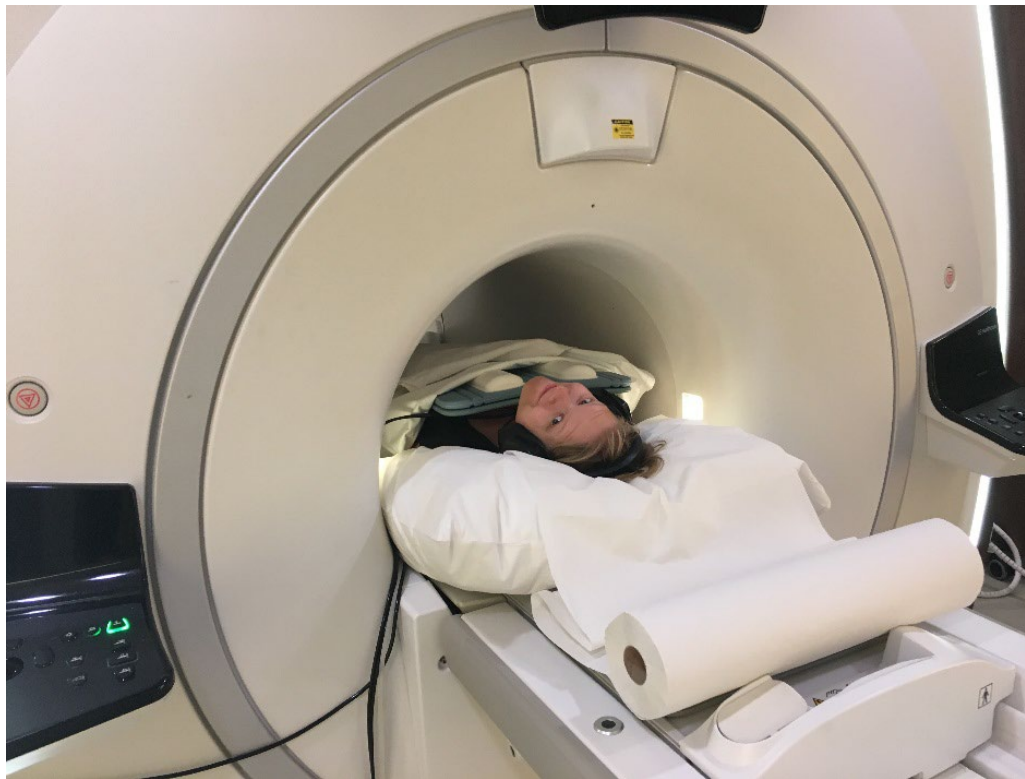
Sarah de Ruiter

Jasper Bongers

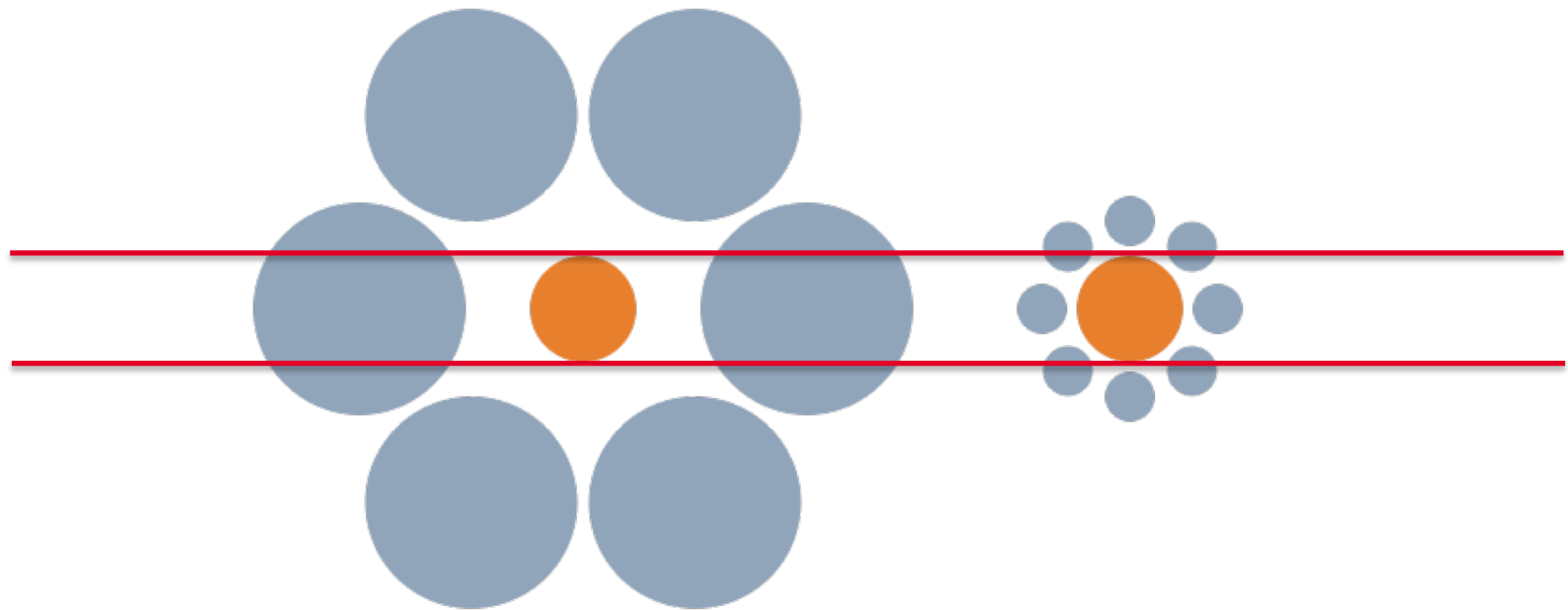
Marijn de Lange

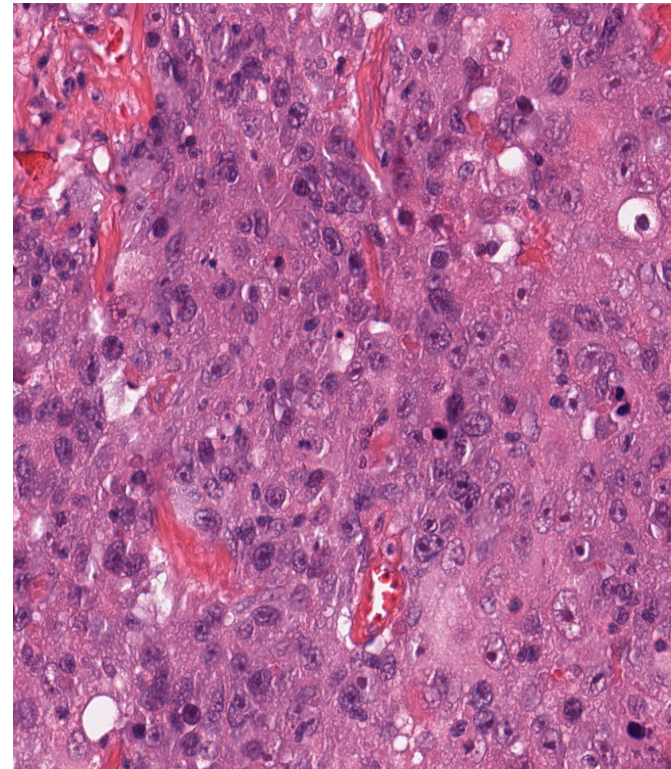
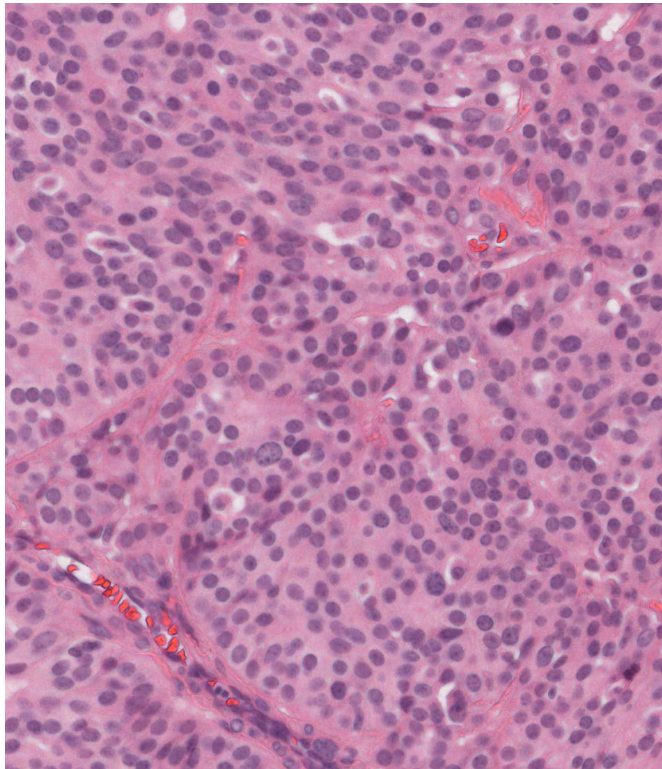


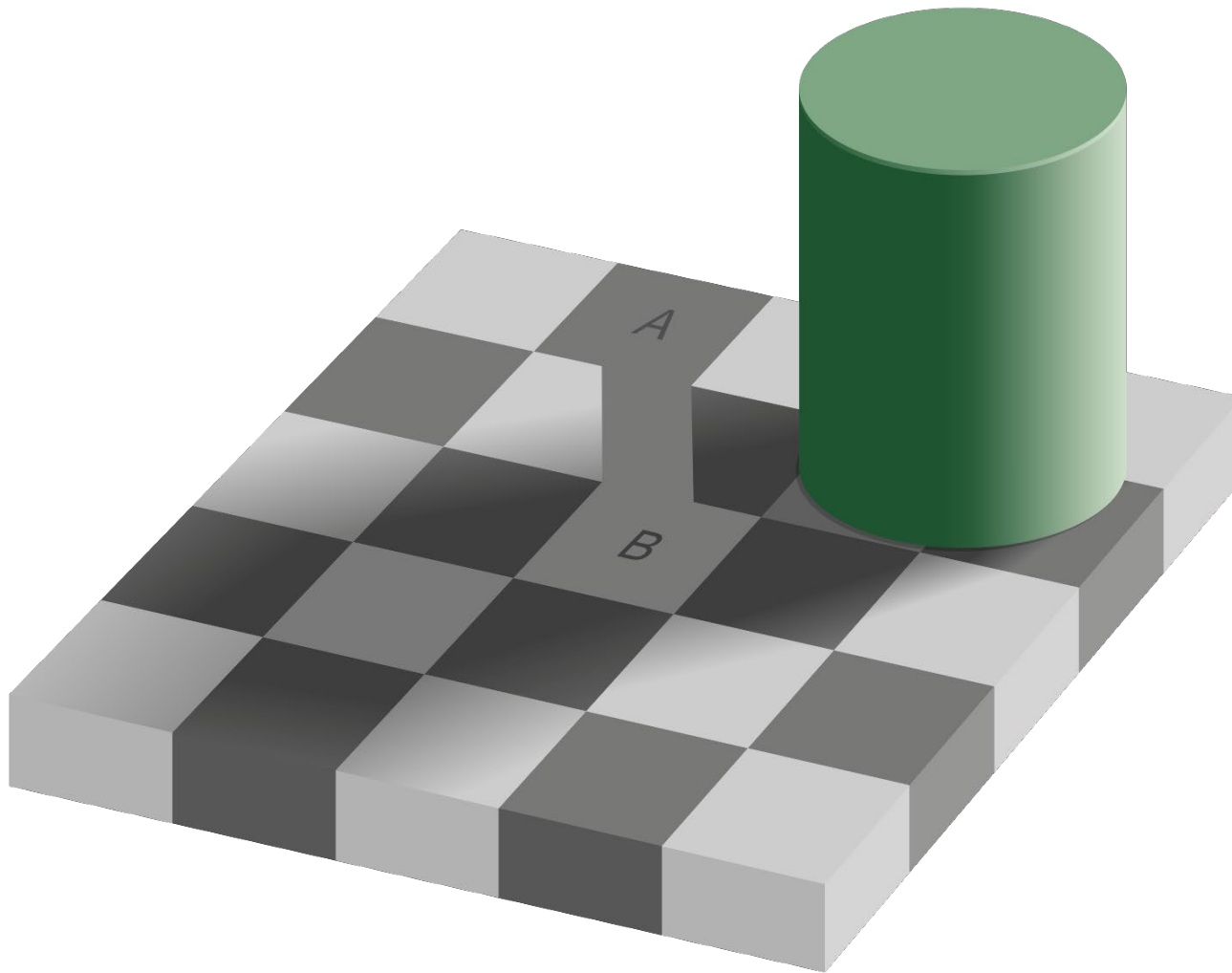
Present day in the Netherlands: 9K CT scans, 5K MR scans per 100K people



Why automatic image analysis?







The goal of medical image analysis is to develop automatic methods that enable **faster, more reliable and quantitative** analysis of medical images.

Learning goals

After completing the course, the student...

..has insight of the role of medical image analysis tasks in addressing clinical questions.

... has knowledge of how basic engineering and mathematical techniques can be used to design medical image analysis methods.

... can implement and apply medical image analysis methods.

... can analyze the results of medical image analysis methods.

Place of the course in the curriculum:

8DB00 Image Acquisition and Processing (2nd year BSc)

8DC00 Medical Image Analysis (3rd year BSc or MSc)

8P361 Project Imaging (3rd year BSc)

BEP in Medical Image Analysis

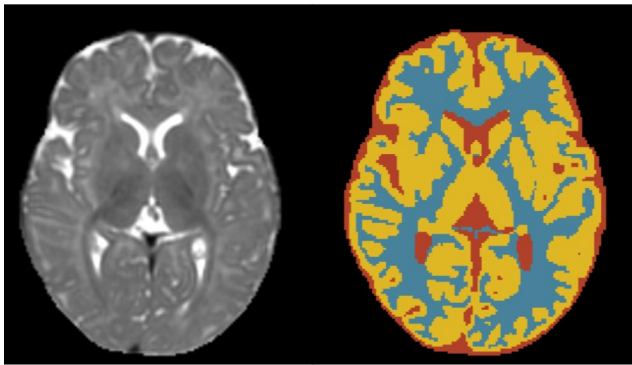
Master:

8DM20 Capita Selecta in Medical Image Analysis (MSc)

8DM40 Machine Learning in Medical Imaging and Computational Biology (MSc)

Overview of different medical image analysis tasks (2D, 3D, 3D+, ...)

Image segmentation

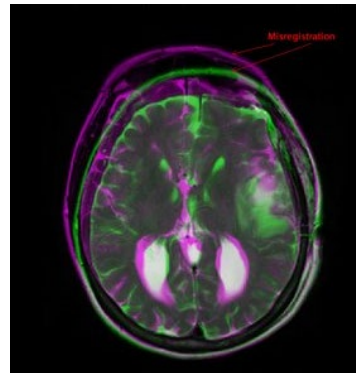


Dividing an image into multiple regions with similar properties (e.g., intensity values).

NB: these regions typically correspond to different anatomical structures.

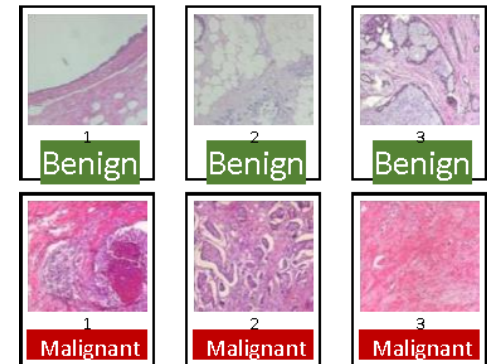
+ validation & active shape models (lecture no. 4!)

Image registration



Finding an optimal transformation that aligns two images.

Computer-aided detection (CAD)



Categorizing/labeling images based on specific rules.

Official definition: “systems that assist doctors in the interpretation of medical images, often based on machine learning”

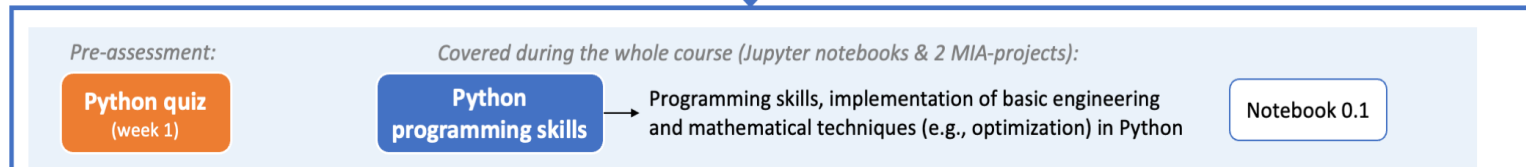
This course

Course organization

Two main topics:

1. Medical image registration (Ruisheng)
2. Computer-aided diagnosis (Cian)

Lectures, exercises & project work



Course schedule

Tuesdays and Fridays: lectures and practicals (guided self-study)

Practicals:

You can work in **groups of up to 4 students** on:

- Exercises
- Project work

You can sign yourself up into a group on Canvas.

Focus is on exercises; should be independent.

Report must contain a paragraph describing the contributions of each group member which can be used to to adjust individual grades to reflect a student's (lack of) contribution to the group

Exercises

Goals:

- Help you study the material
- Develop code that can be used for the project work
- Prepare for exam
- Not graded

Projects

- 2 projects (registration, CAD)
- Each project is based on one or more **research questions** that you formulate yourself
- Short report & code
- Graded

Detailed description of the project deliverables and assessment rubric can be found in the project handouts.

Guided project work: questions and extension of the code developed in the exercises that will guide you to a **minimal project solution**.

Assessment

- Projects
 - Medical image registration (15%)
 - Computer-aided diagnosis (15%)
- Written exam (70%), out of which 10% are questions related to the project, i.e. project accounts for 40% of the grade

Communication – digital platforms we will use during this course



- Communication
- Python quiz
- Hand in assignments (project reports & code)
- Handouts lectures



- Course overview
- Python code for exercises and projects
- Handouts lectures

Communication

Main communication channel is Canvas: post your questions in the Discussion section.

Emailing is **discouraged** (e.g. only for individual circumstances and not related to content). If you do email, use the tag [8DC00] in the subject line.

How to effectively ask questions?

- **Start the question by explaining the context**
 - State the goal of the task you are working
- **Formulate a specific question**
 - “I don’t know how to solve Exercise 2” is not a specific question.
 - Be clear and honest about what you want to get out.
 - “Is this enough for the project work?” is not allowed.

- **Demonstrate that you have attempted to answer the questions or solve the problem**
 - Formulate a provisional answer (does not matter if it is correct or not)
- **Python:**
 - Read the documentation
 - Error messages are informative!
 - Before asking for help, make sure that your problem is reproducible

- **How to get started with the exercises and project work?**
 - Github page: <https://github.com/tueimage/8dc00-mia>
 - Follow software installation instructions:
 - Anaconda / packages
 - Python
 - Jupyter

If you prefer a GUI: Anaconda Navigator

The screenshot displays the Anaconda Navigator interface. On the left is a sidebar with navigation options: Home, Environments, Learning, and Community. The main area shows a grid of application tiles. Red arrows point from text labels to specific tiles: 'Start a prompt (terminal)' points to the 'CMD.exe Prompt' tile, 'Spyder' points to the 'Spyder' tile, and 'Jupyter Notebook' points to the 'Jupyter Notebook' tile. Each tile includes an icon, the application name, version, a brief description, and a button to either 'Launch' or 'Install' the application. The top of the window has a menu bar with 'File' and 'Help', and a 'Sign in to Anaconda Cloud' button. The bottom of the sidebar contains links to 'Documentation' and 'Developer Blog', along with social media icons for Twitter, YouTube, and GitHub.

Start a prompt (terminal)

Spyder

Jupyter Notebook

Applications on media Channels Refresh

CMD.exe Prompt 0.1.1
Run a cmd.exe terminal with your current environment from Navigator activated
Launch

Jupyter Notebook 6.0.3
Web-based, interactive computing notebook environment. Edit and share human-readable docs while describing the data analysis.
Launch

Powershell Prompt 0.0.1
Run a Powershell terminal with your current environment from Navigator activated
Launch

Qt Console 4.7.5
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.
Launch

Spyder 4.1.3
Scientific Python Development Environment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features
Launch

Glueviz 0.15.2
Multidimensional data visualization across files. Explore relationships within and among related datasets.
Install

JupyterLab 2.1.5
An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.
Install

Orange 3 3.23.1
Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.
Install

RStudio 1.1.456
A set of integrated tools designed to help you be more productive with R. Includes R essentials and notebooks.
Install

Documentation Developer Blog

Twitter YouTube GitHub

Example of setting up a Python environment:

<https://www.youtube.com/watch?v=AxSwTvnwCUU&t=45s>

