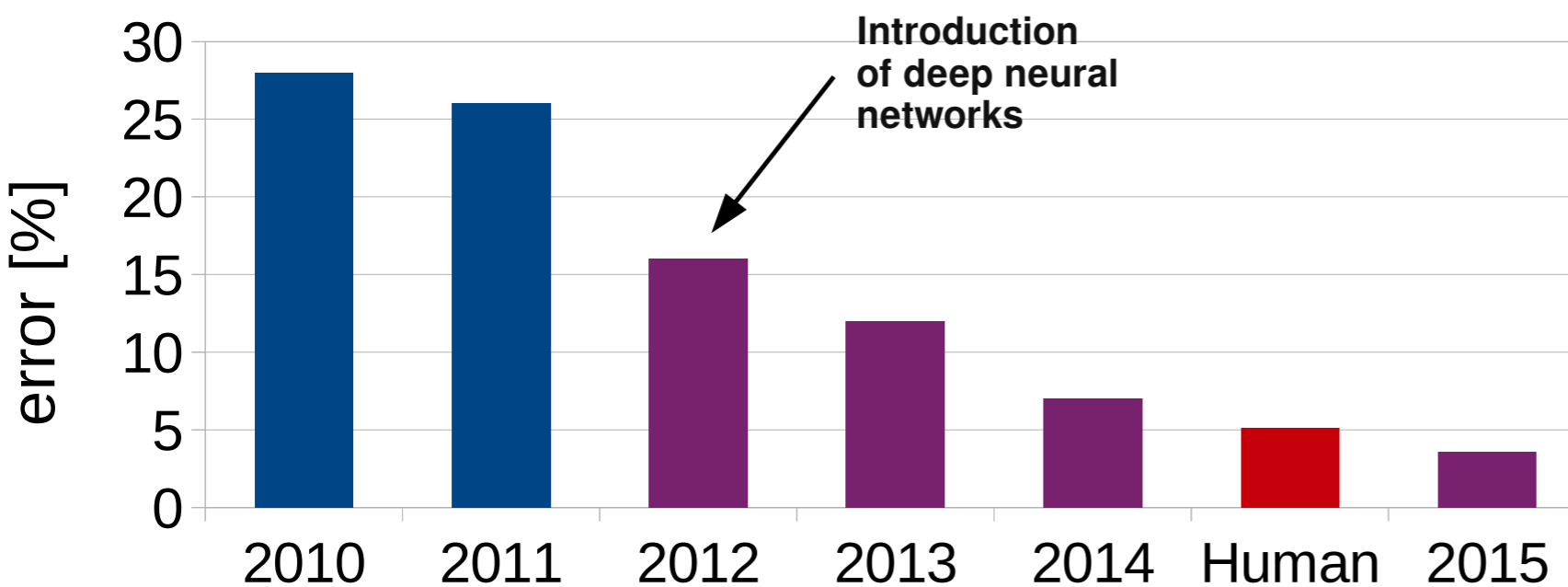


# D-REX

Deep Neural Network Rule Extraction

Deep neural networks getting very popular and perform very well on a wide variety of tasks, sometimes better than humans

Top 5 error on ImageNet



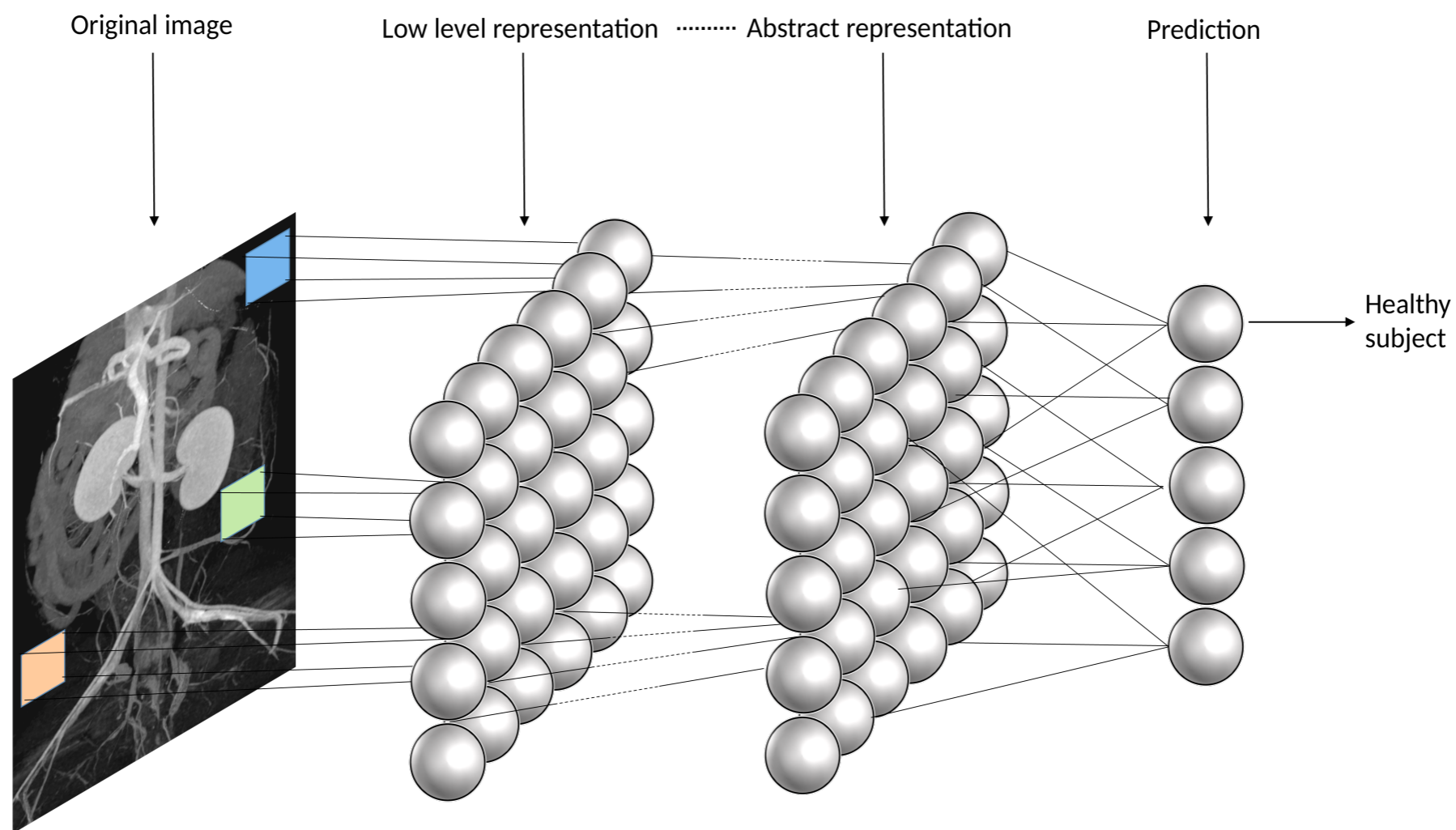
Deep neural networks getting very popular and perform very well on a wide variety of tasks, sometimes better than humans

## “Master of Go Board Is Wallopped by Google Computer Program”

The New York Times, March 9, 2016



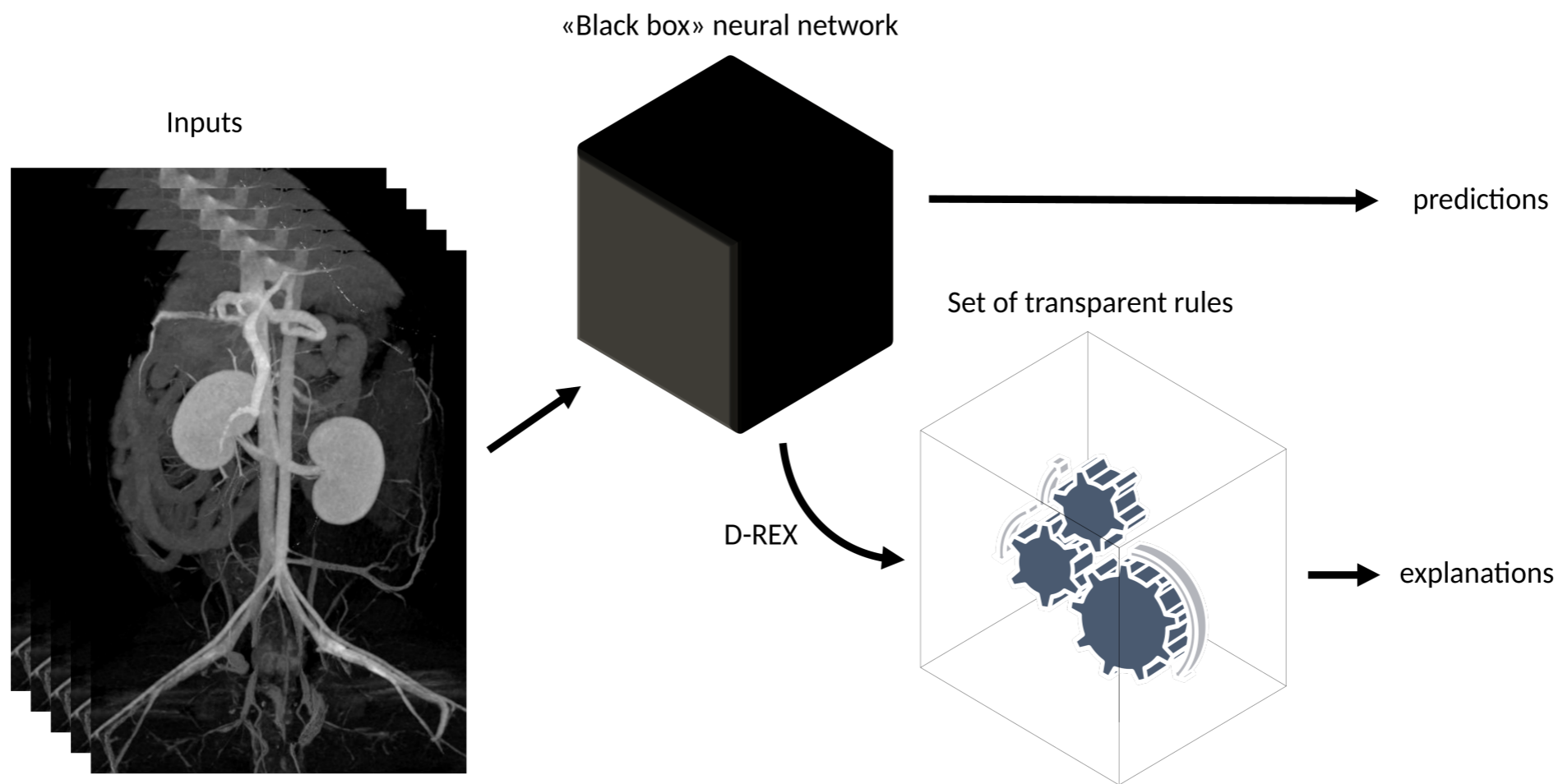
Deep neural networks are neural networks composed of many hidden layers, allowing the modeling of high-level abstraction in data



Major drawback: These networks behave like black boxes



Extract knowledge in the form of rules to explain the behavior of the network



# Rule extraction techniques

Localization /  
Feature recognition

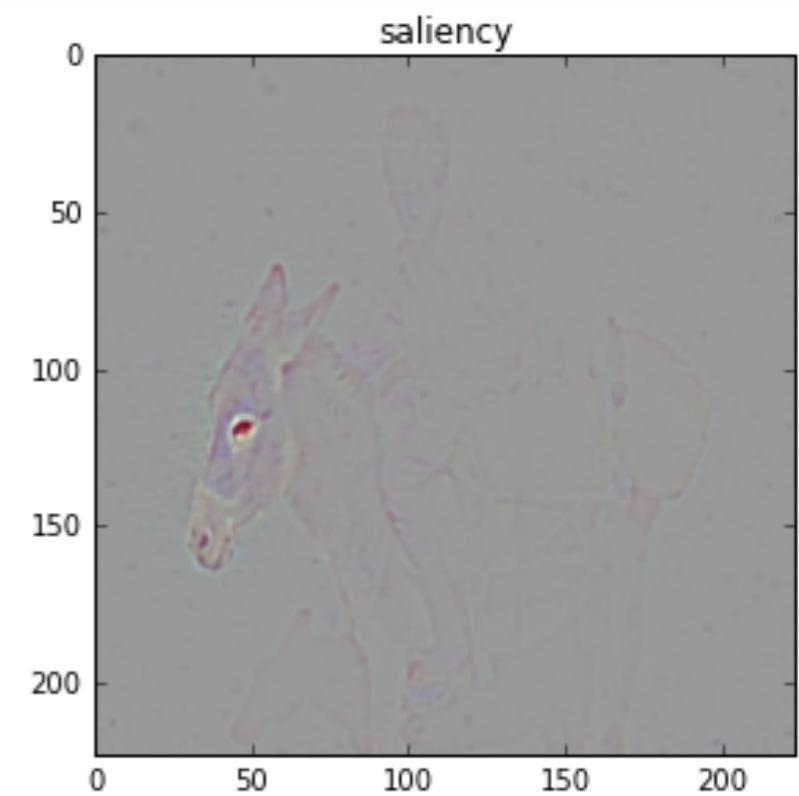
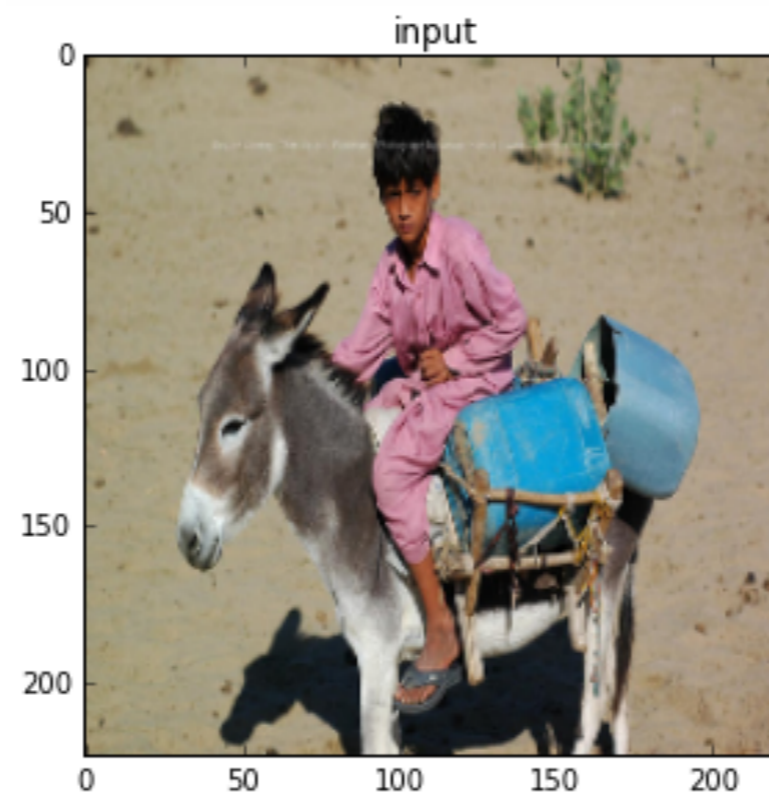
# Rule extraction techniques

Localization /  
Feature recognition



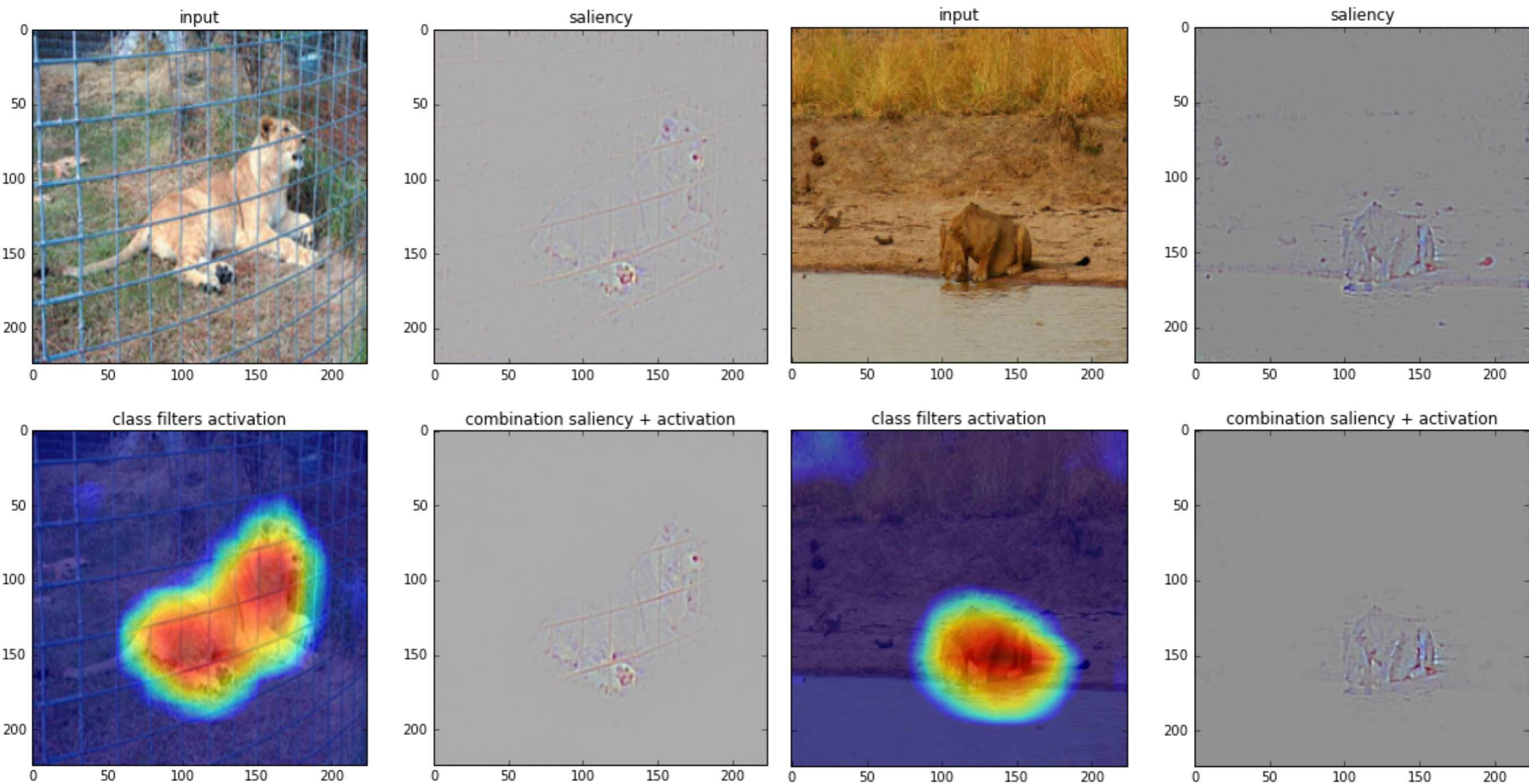
# Rule extraction techniques

Localization /  
Feature recognition



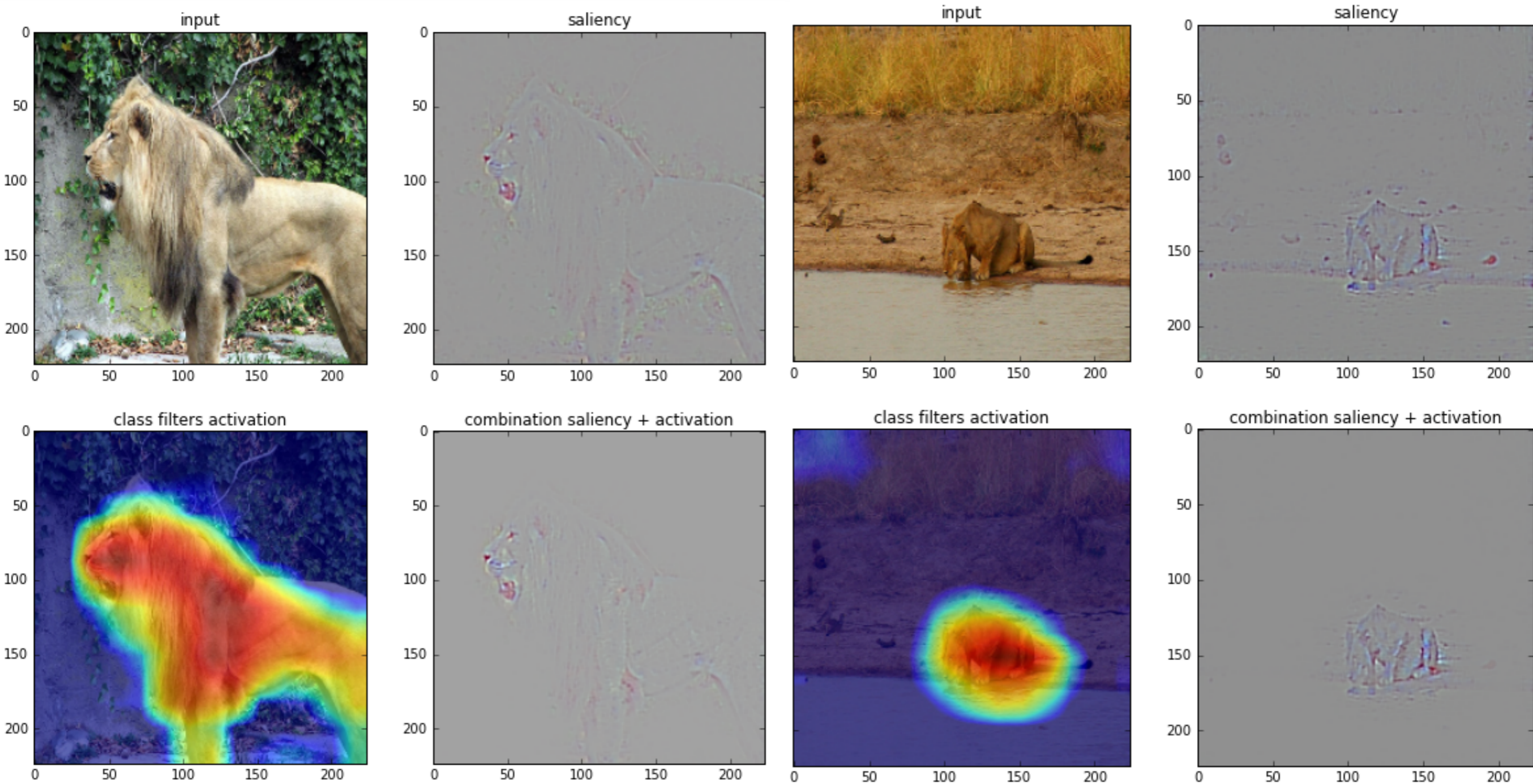
# Rule extraction techniques

## Localization / Feature recognition



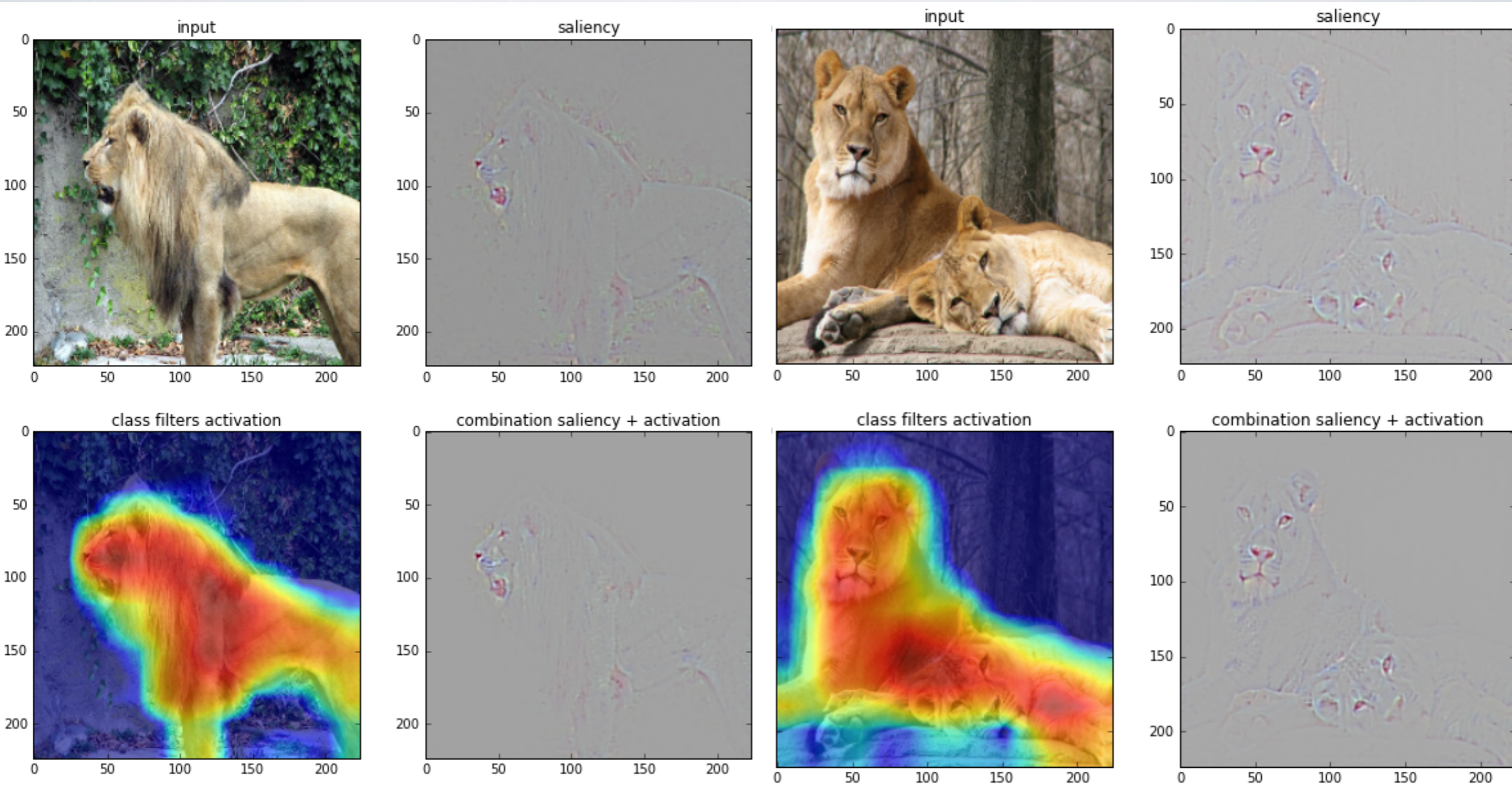
# Rule extraction techniques

## Localization / Feature recognition



# Rule extraction techniques

## Localization / Feature recognition



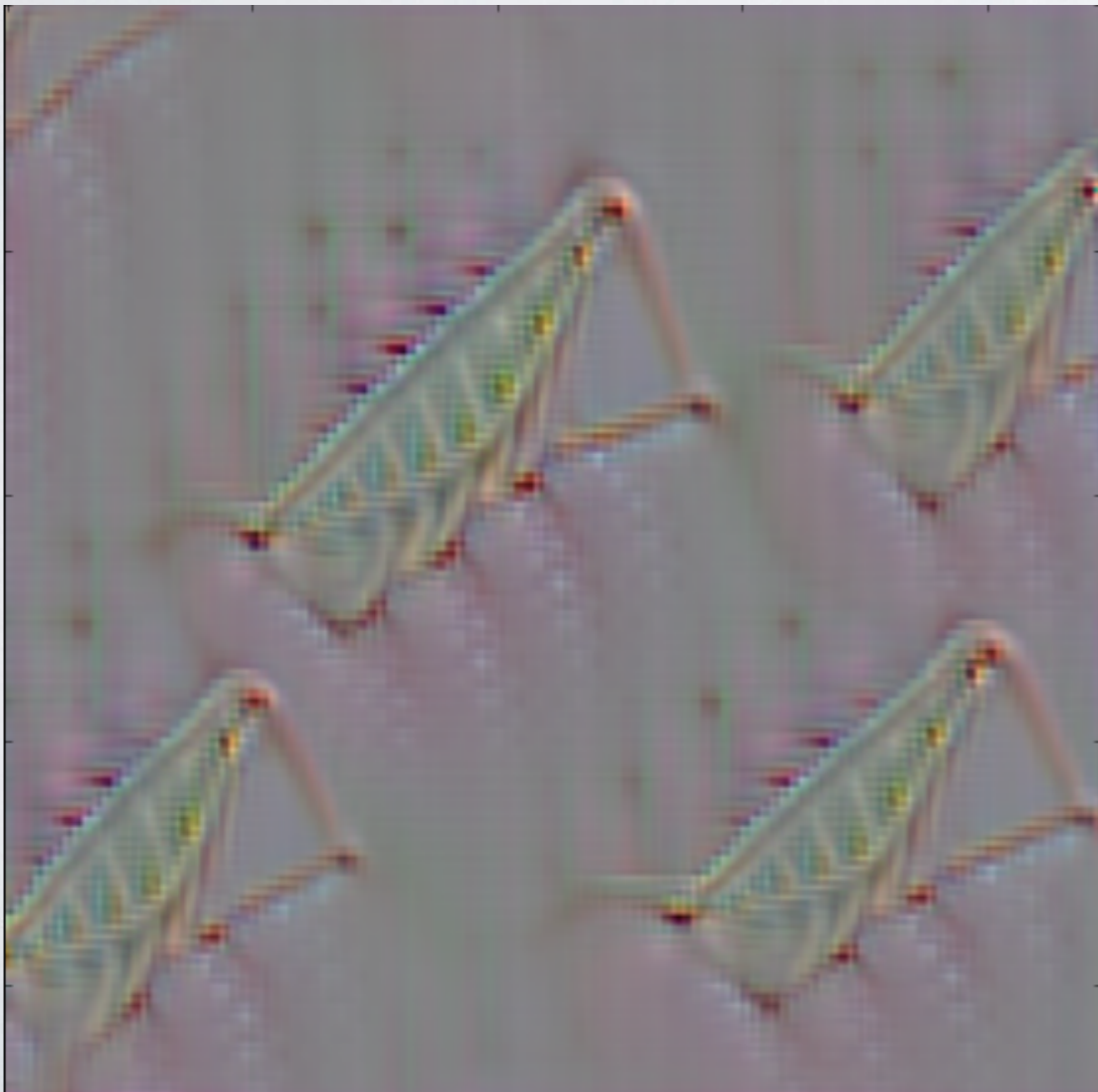
# Rule extraction techniques

## Feature description

# Rule extraction techniques

## Feature description

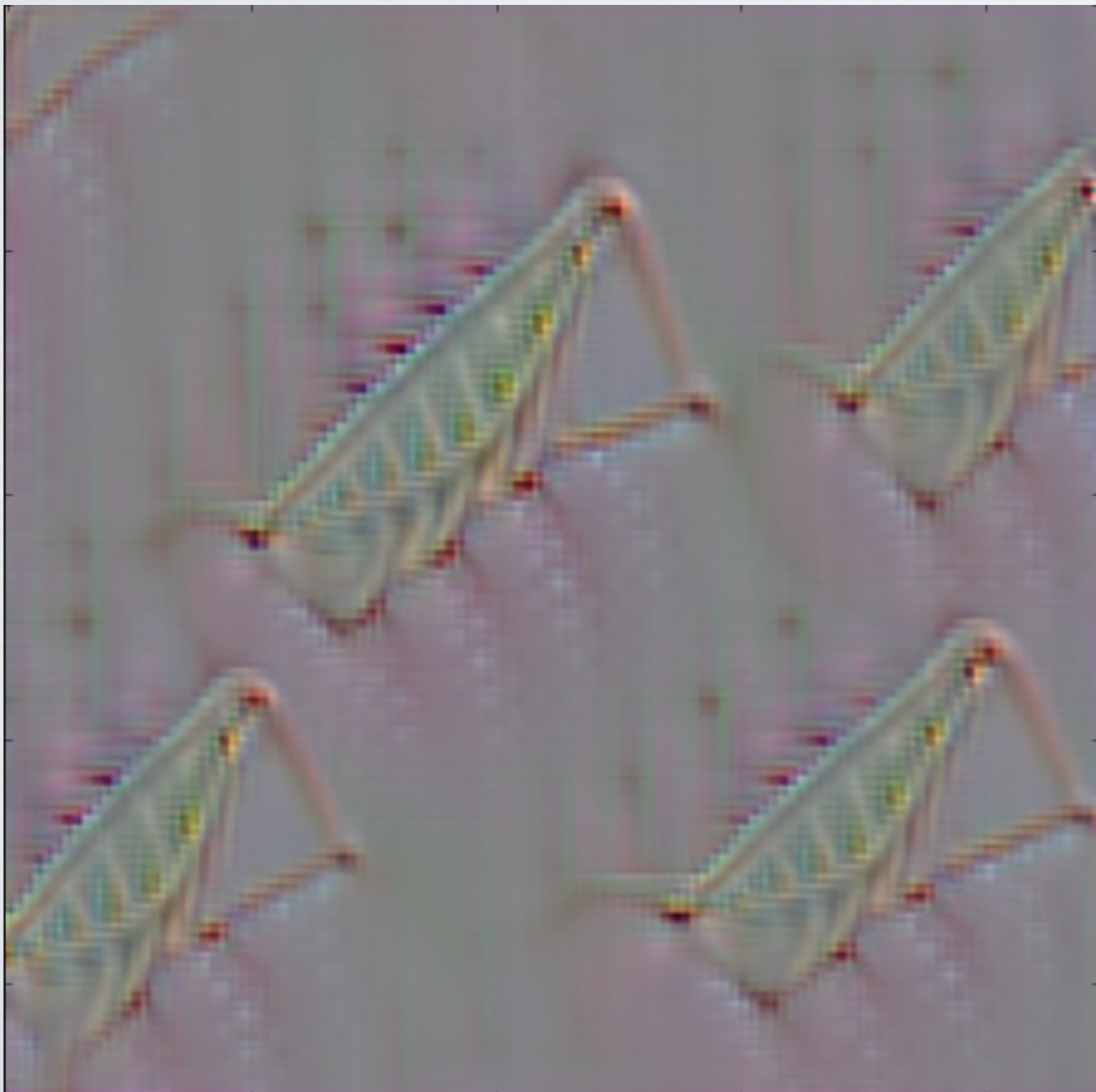
Grasshopper



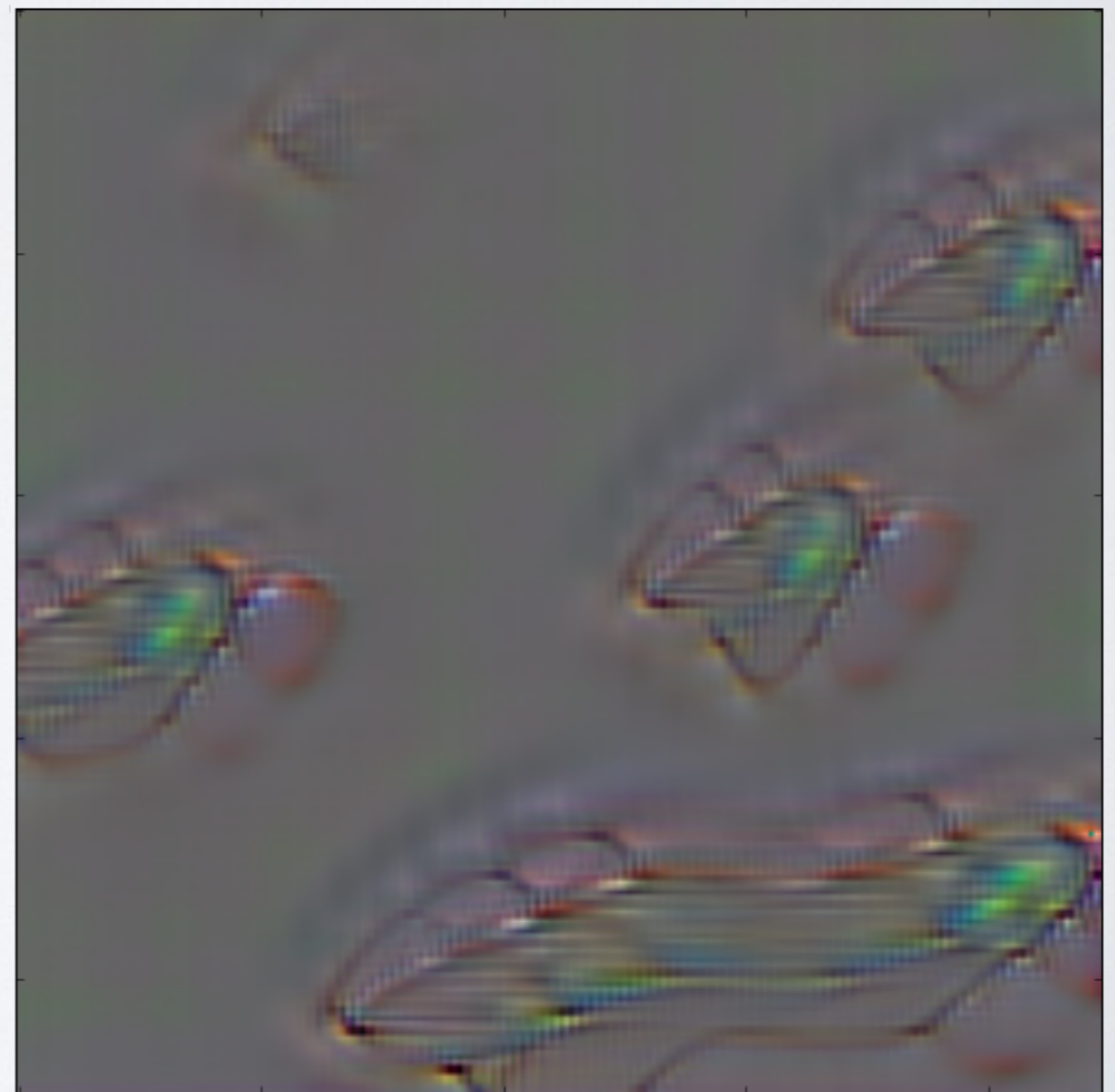
# Rule extraction techniques

## Feature description

Grasshopper



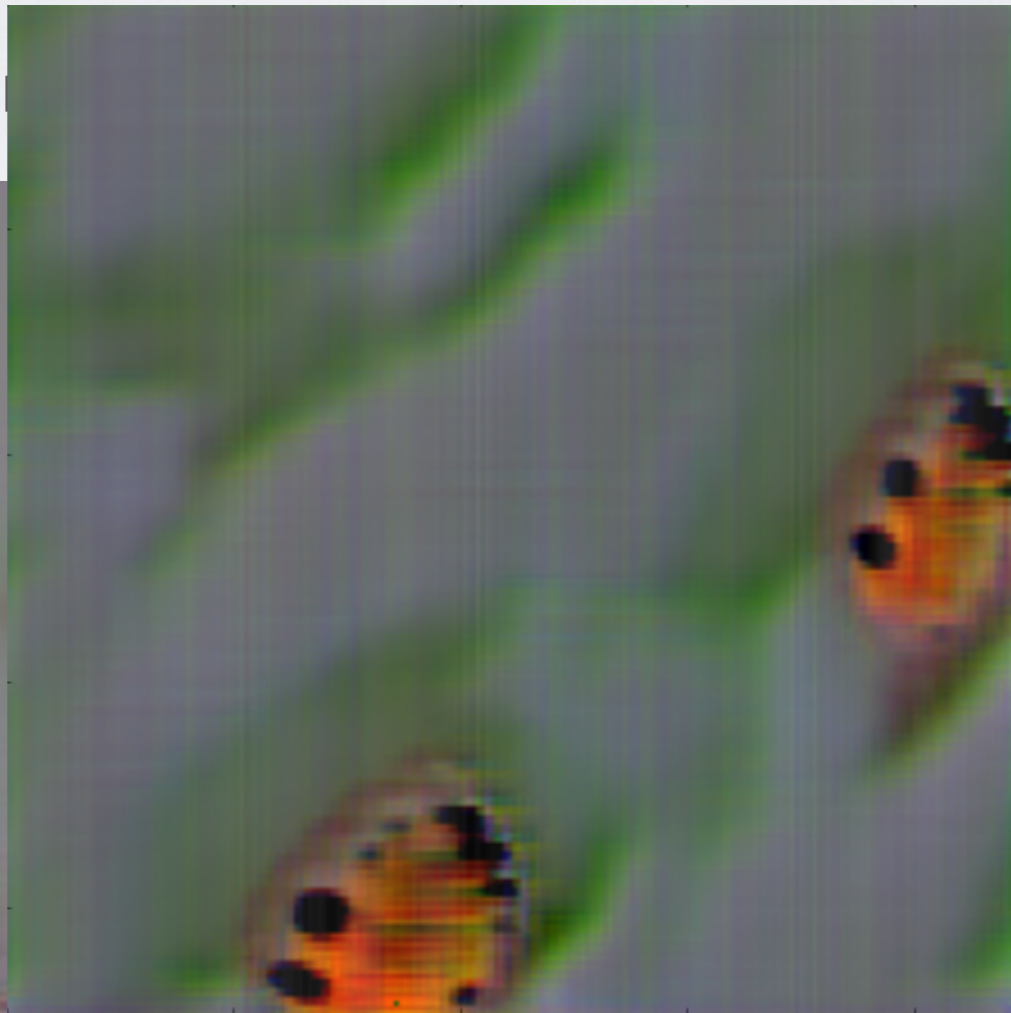
Fly



# Rule extraction techniques

## Feature description

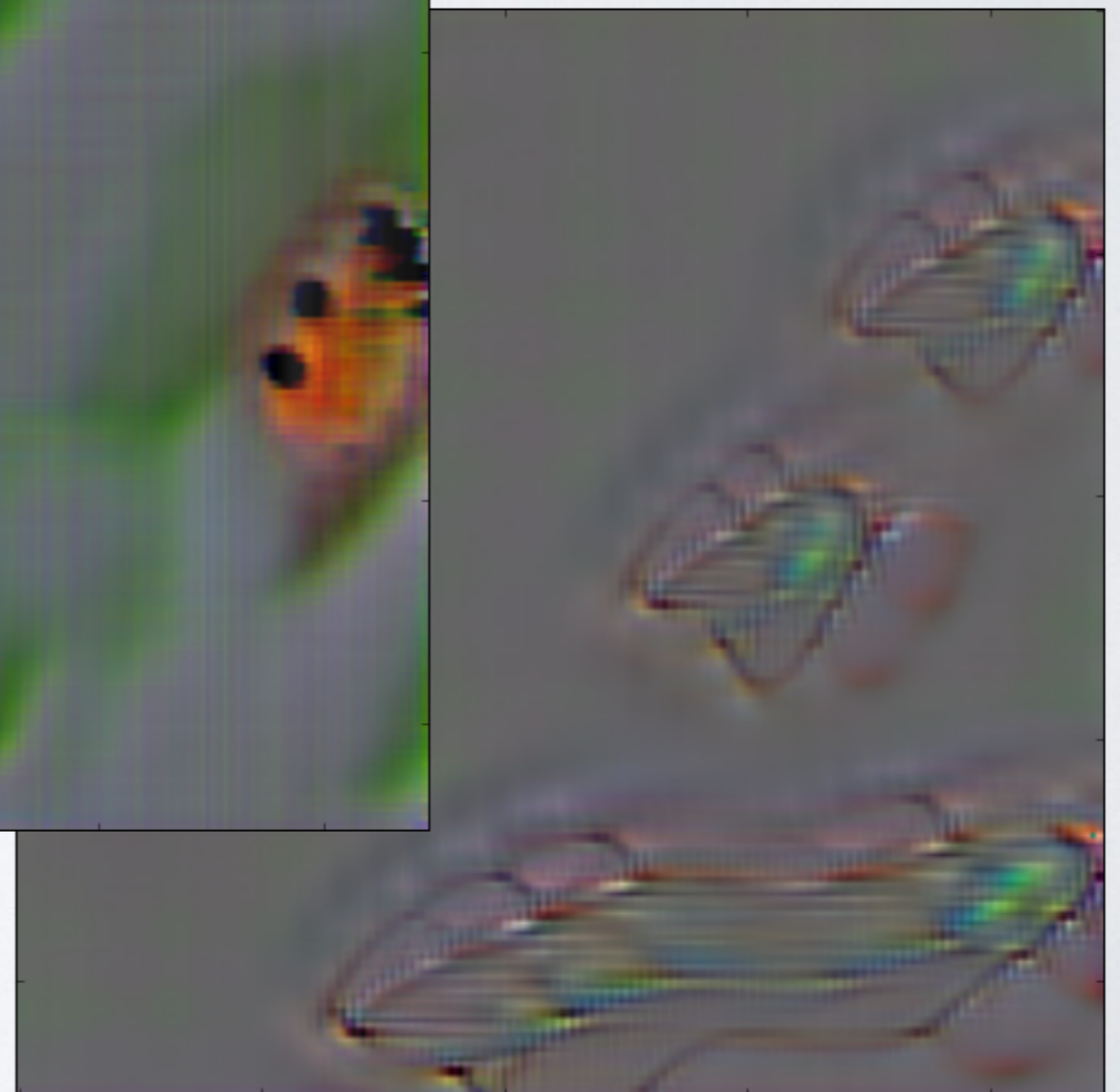
Ladybug



Grasshopper



Fly



# Rule extraction techniques

## Feature description

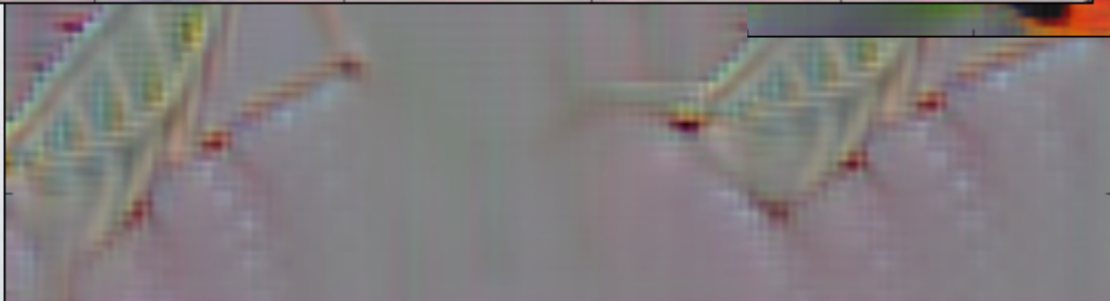
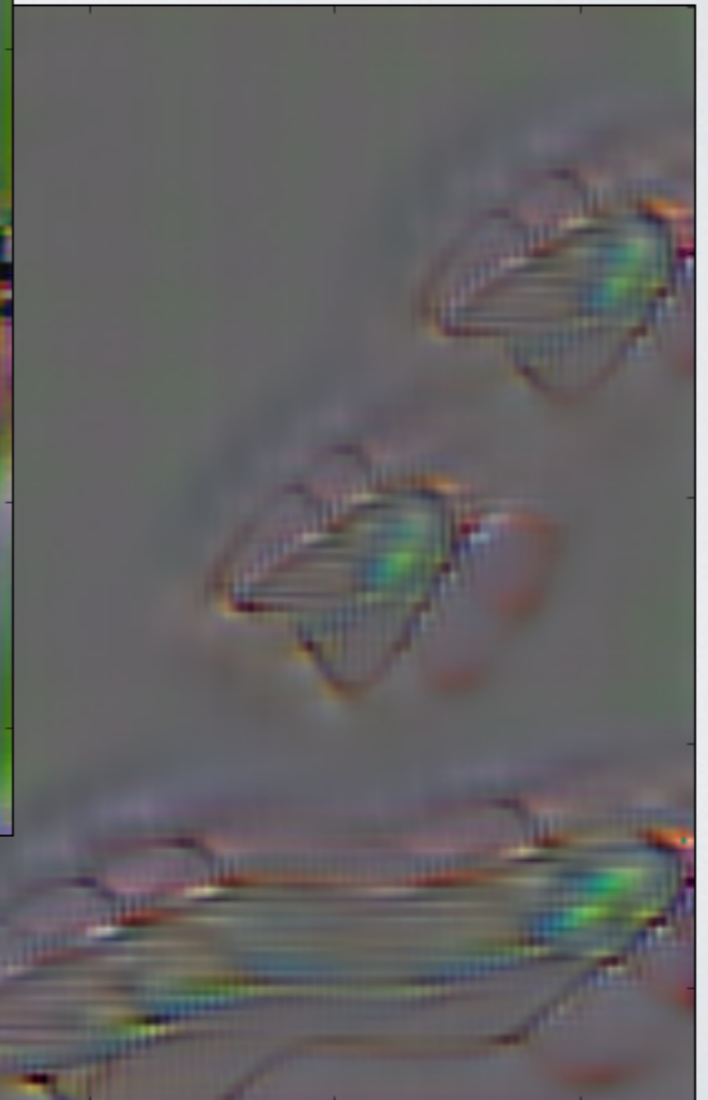
Zebra



Ladybug



Fly



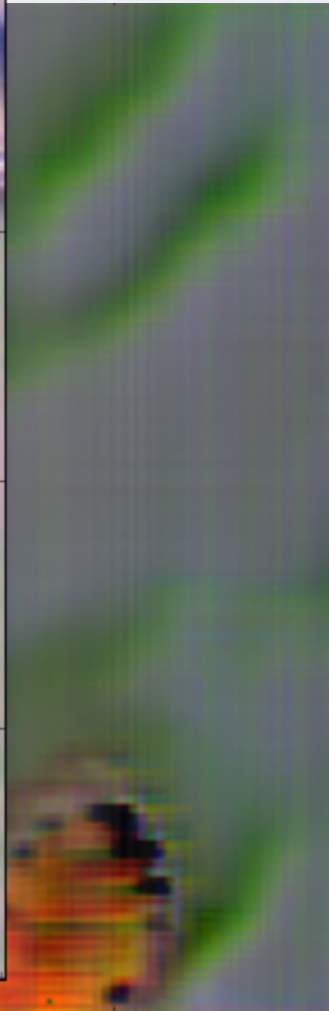
# Rule extraction techniques

## Feature description

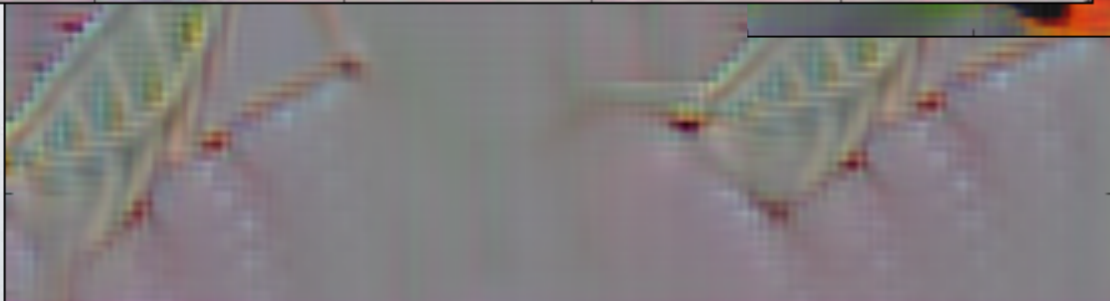
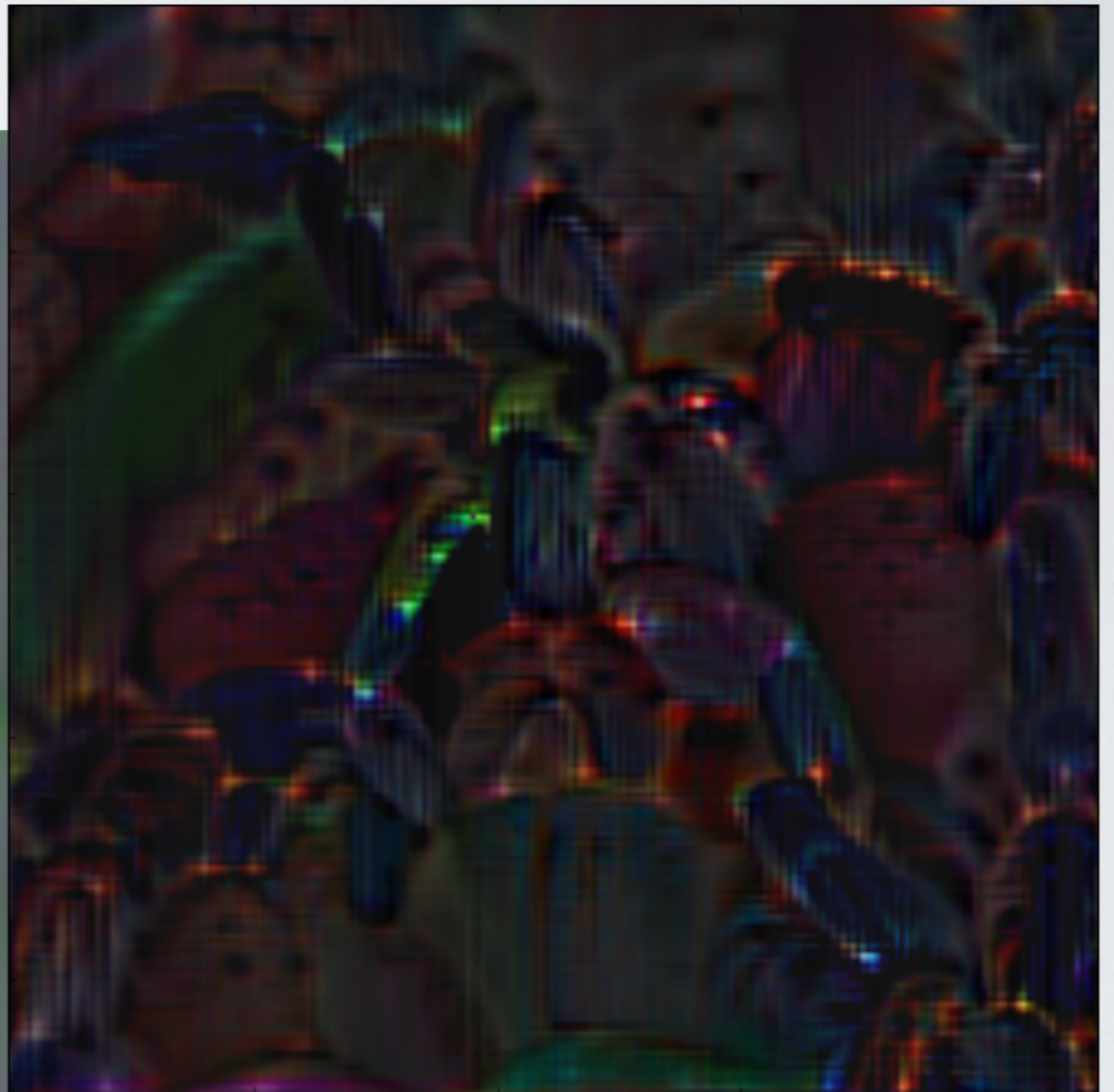
Zebra



Ladybug



Tarantula

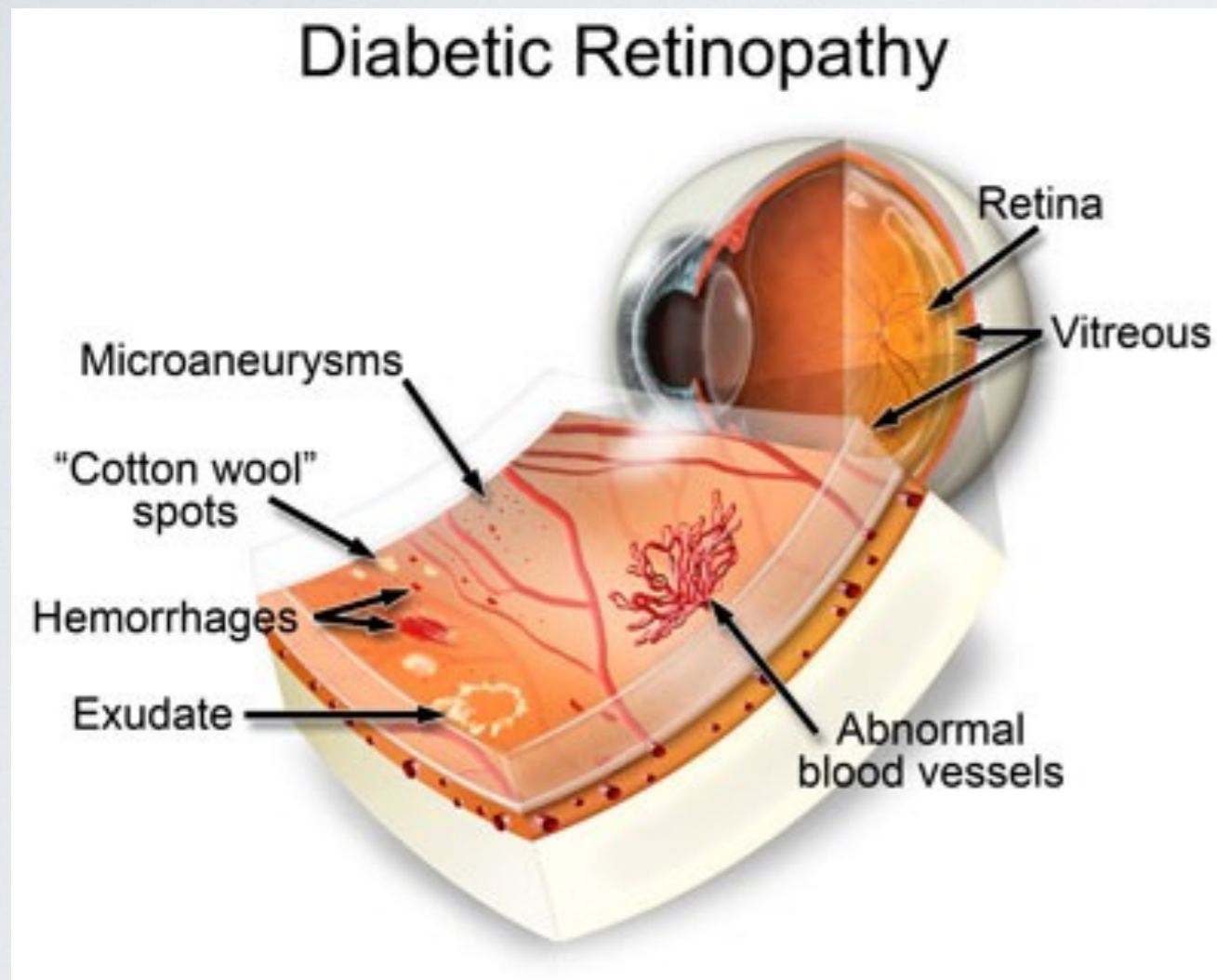


# Applications in the Medical Field

- Novel knowledge acquisition
- Automatic diagnostic/explanation tool
- Big data analysis
- ...

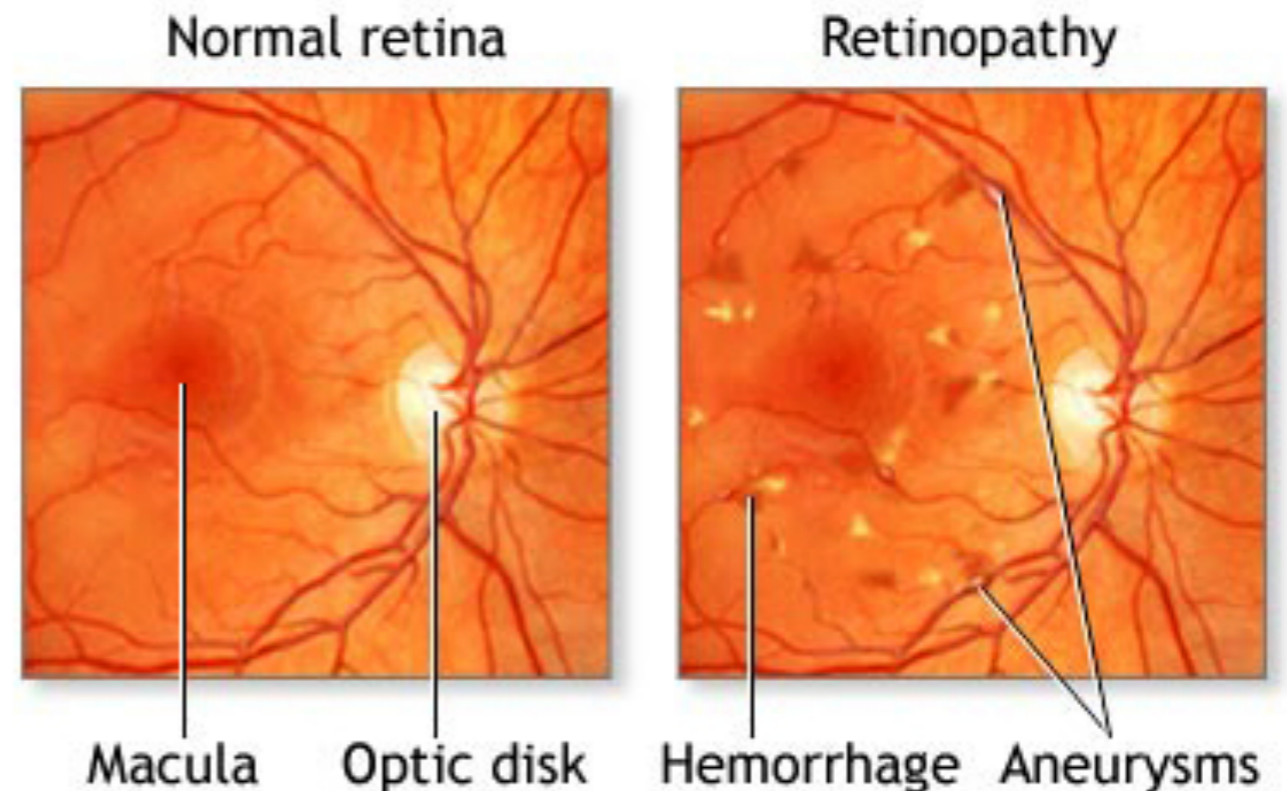
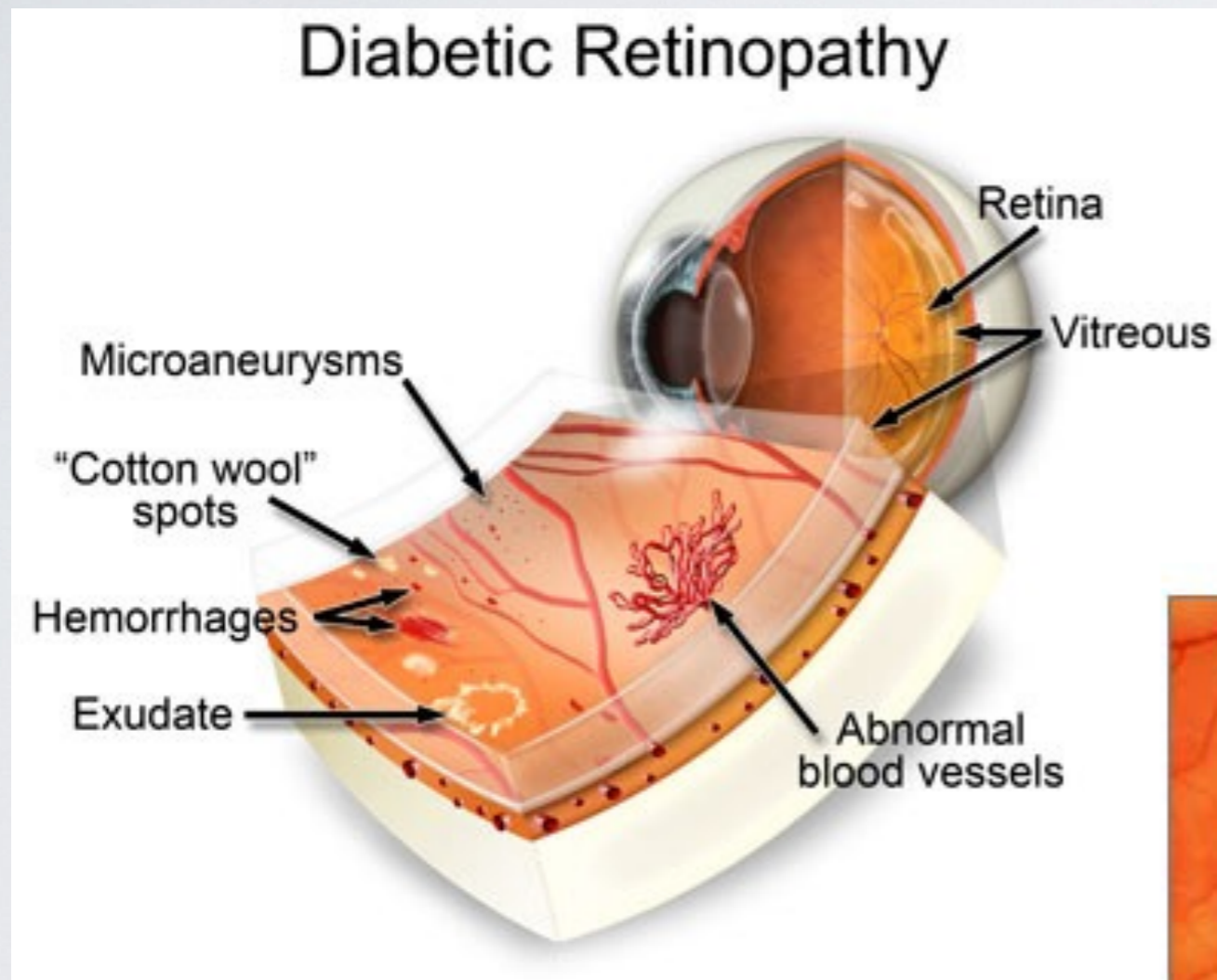
# Applications in the Medical Field

## Automated diabetic retinopathy diagnosis



# Applications in the Medical Field

## Automated diabetic retinopathy diagnosis

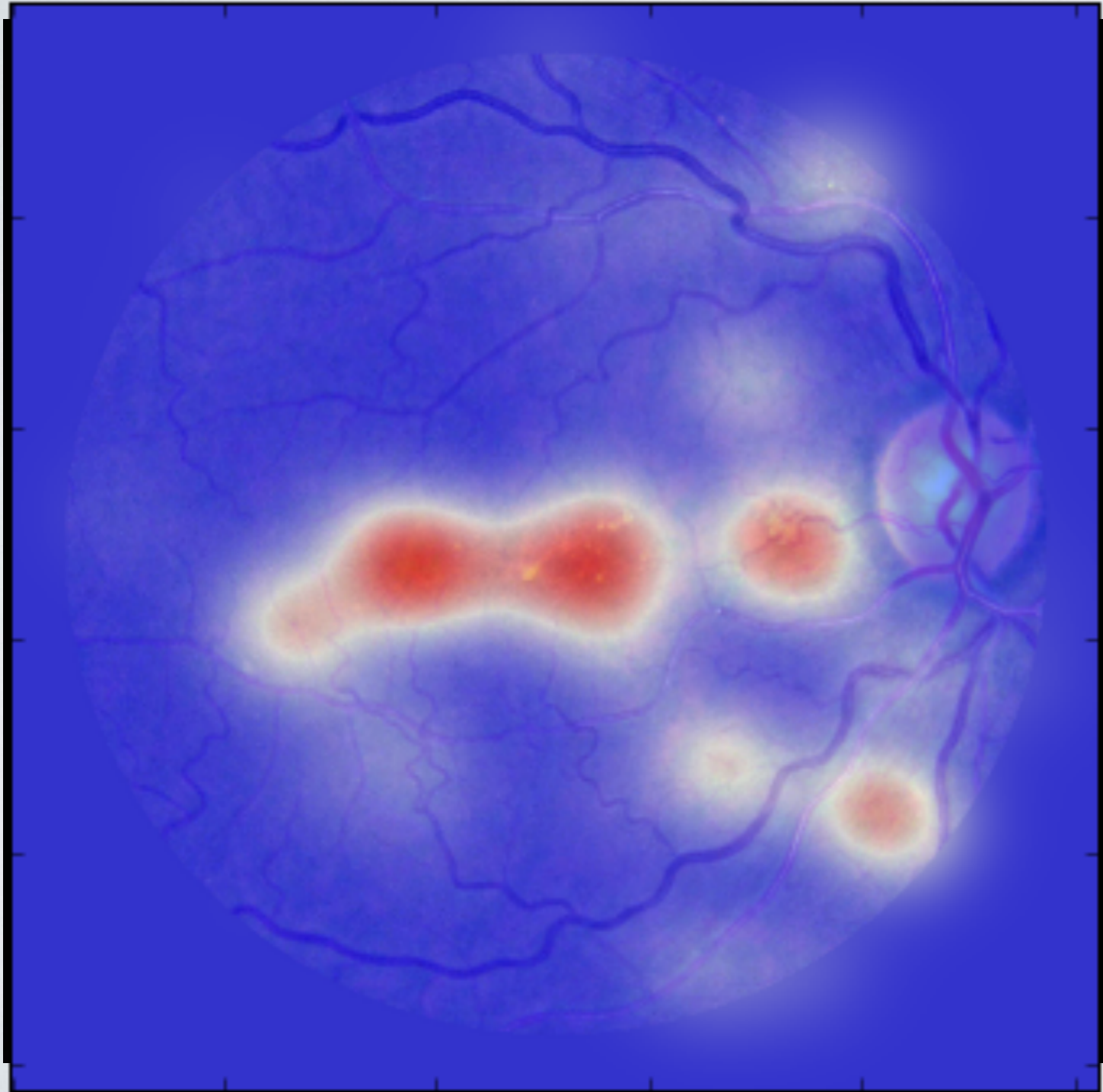


# Applications in the Medical Field



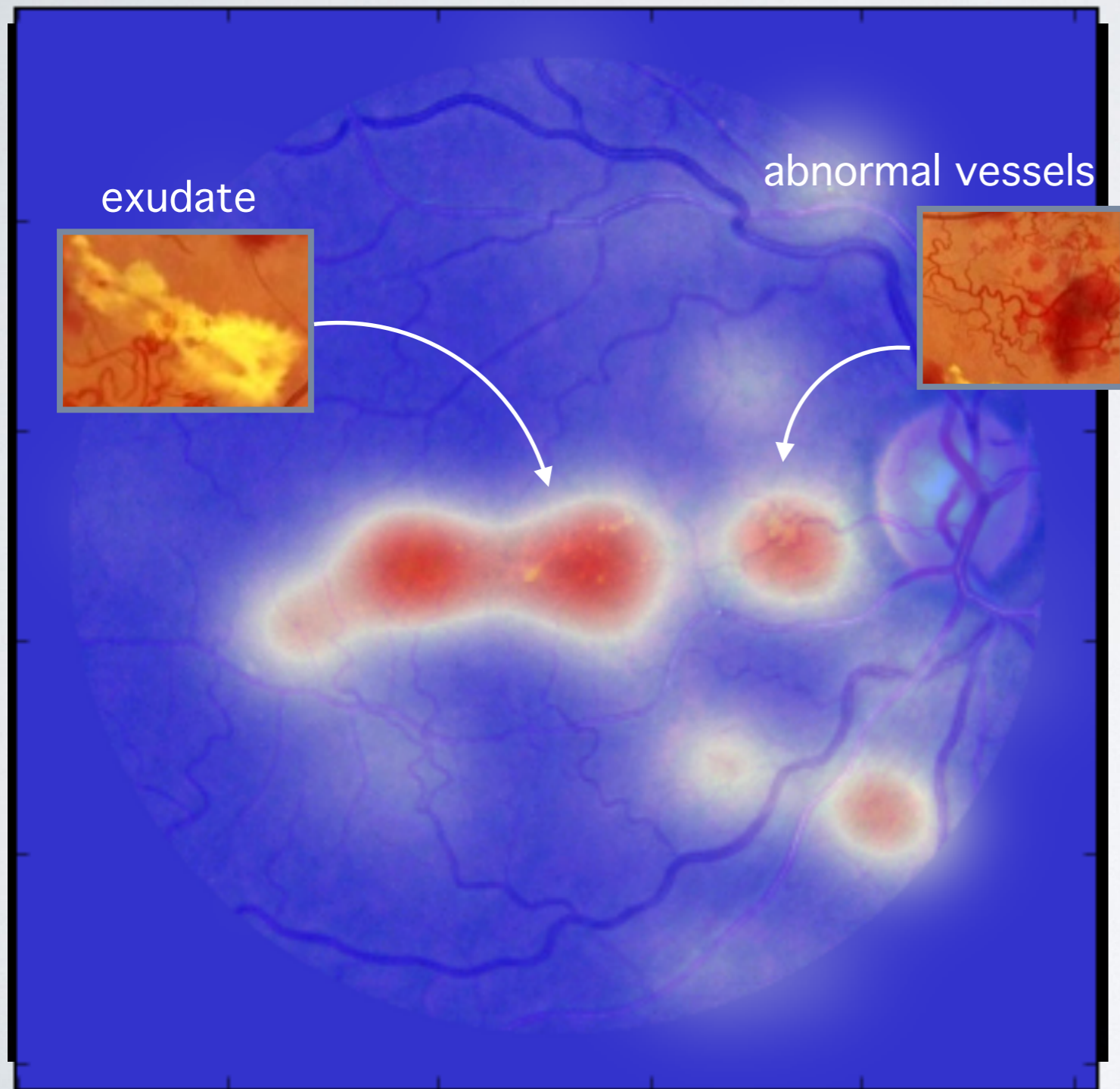
Classified as a class 2/4  
diabetic retinopathy

# Applications in the Medical Field



Classified as a class 2/4  
diabetic retinopathy

# Applications in the Medical Field



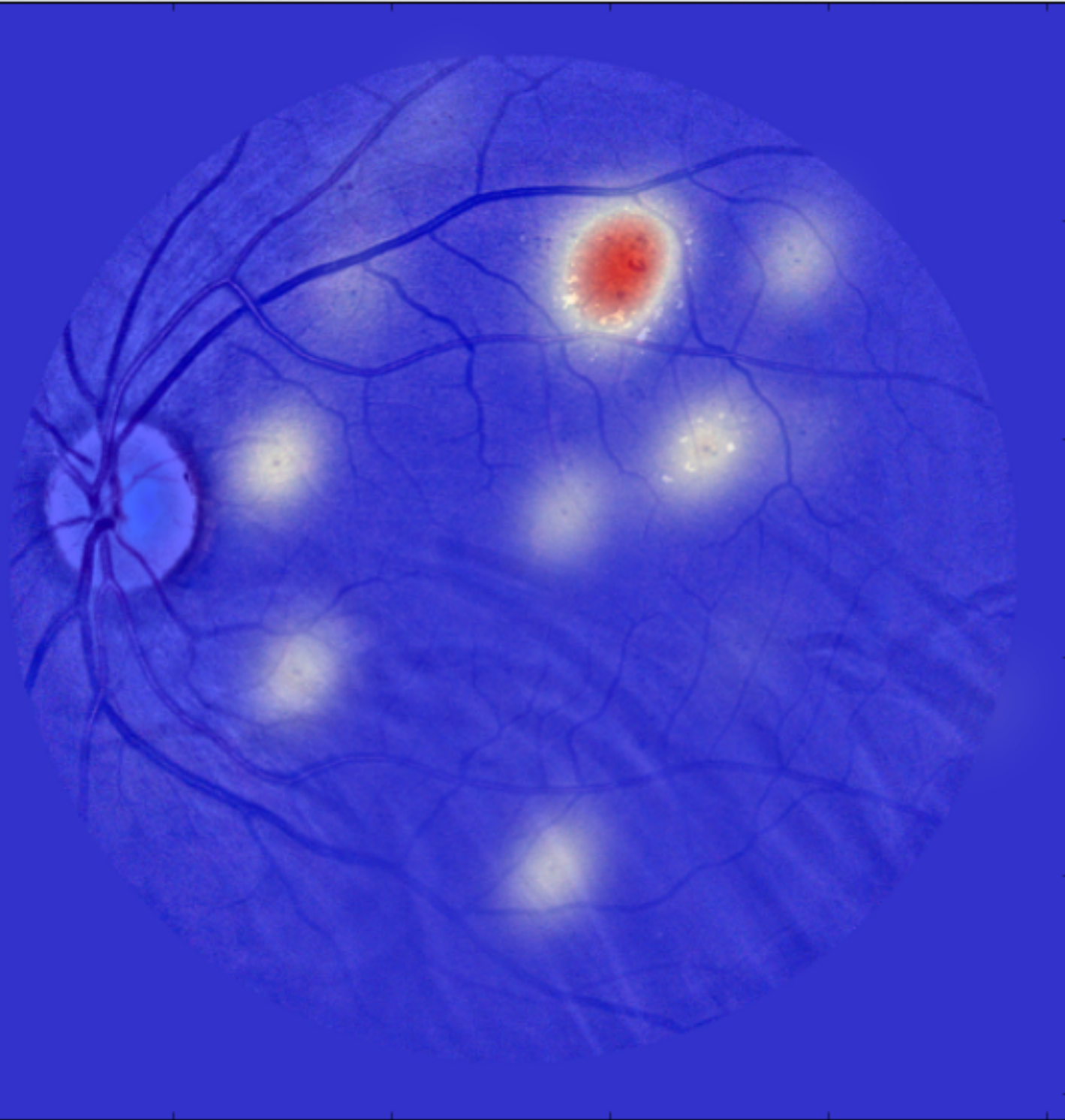
Classified as a class 2/4  
diabetic retinopathy

# Applications in the Medical Field



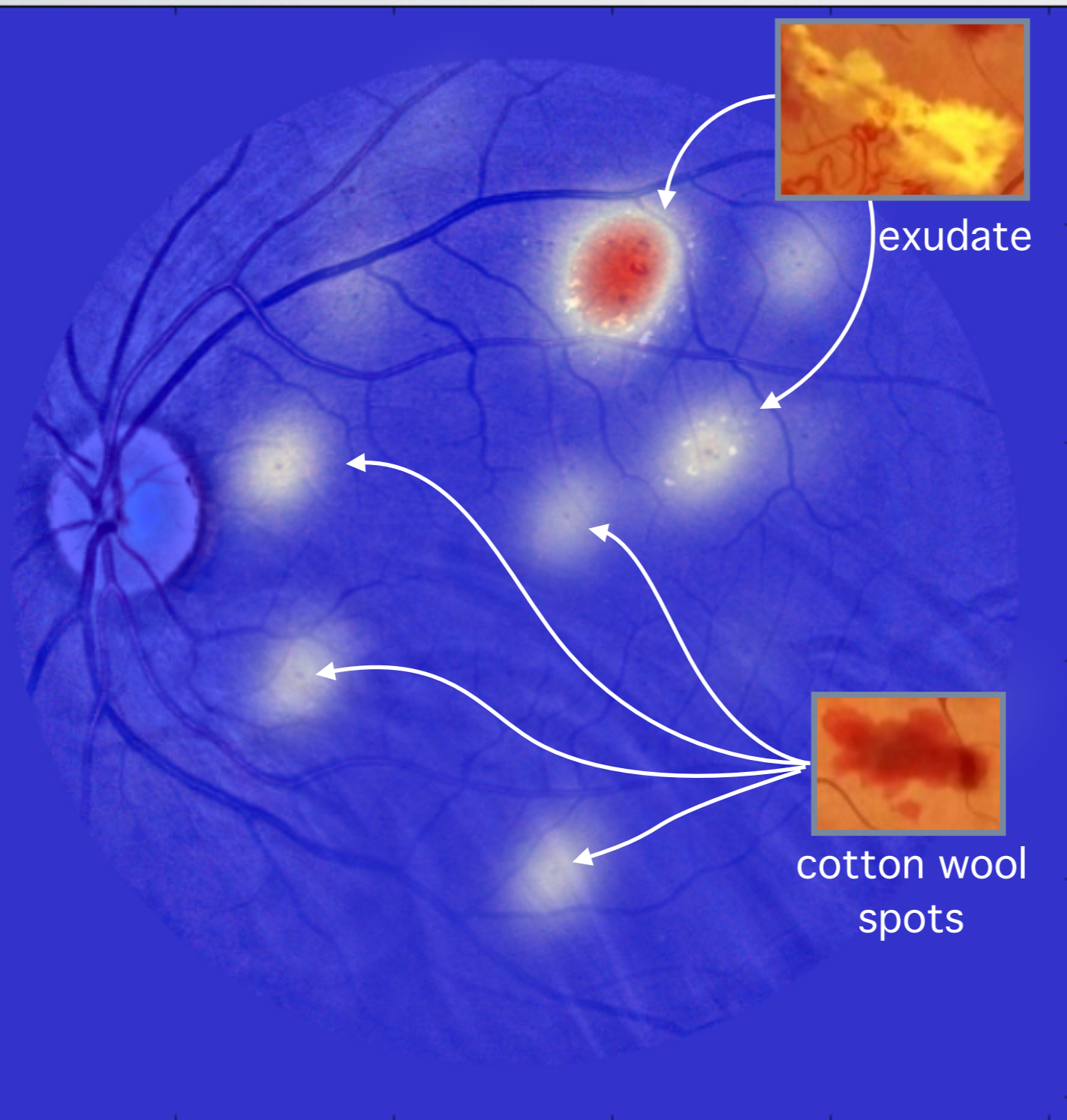
Classified as a class 3/4  
diabetic retinopathy

# Applications in the Medical Field

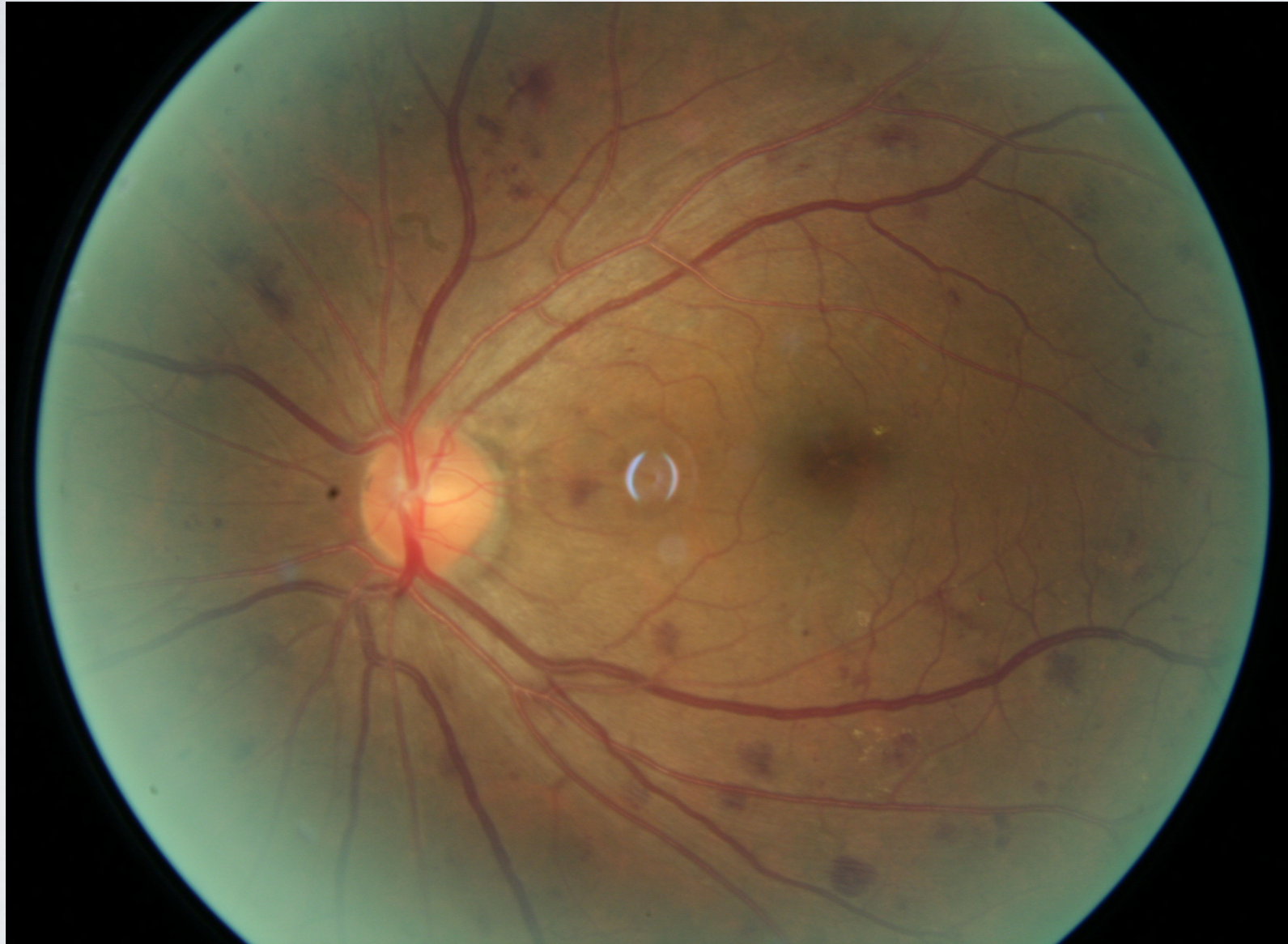


Classified as a class 3/4  
diabetic retinopathy

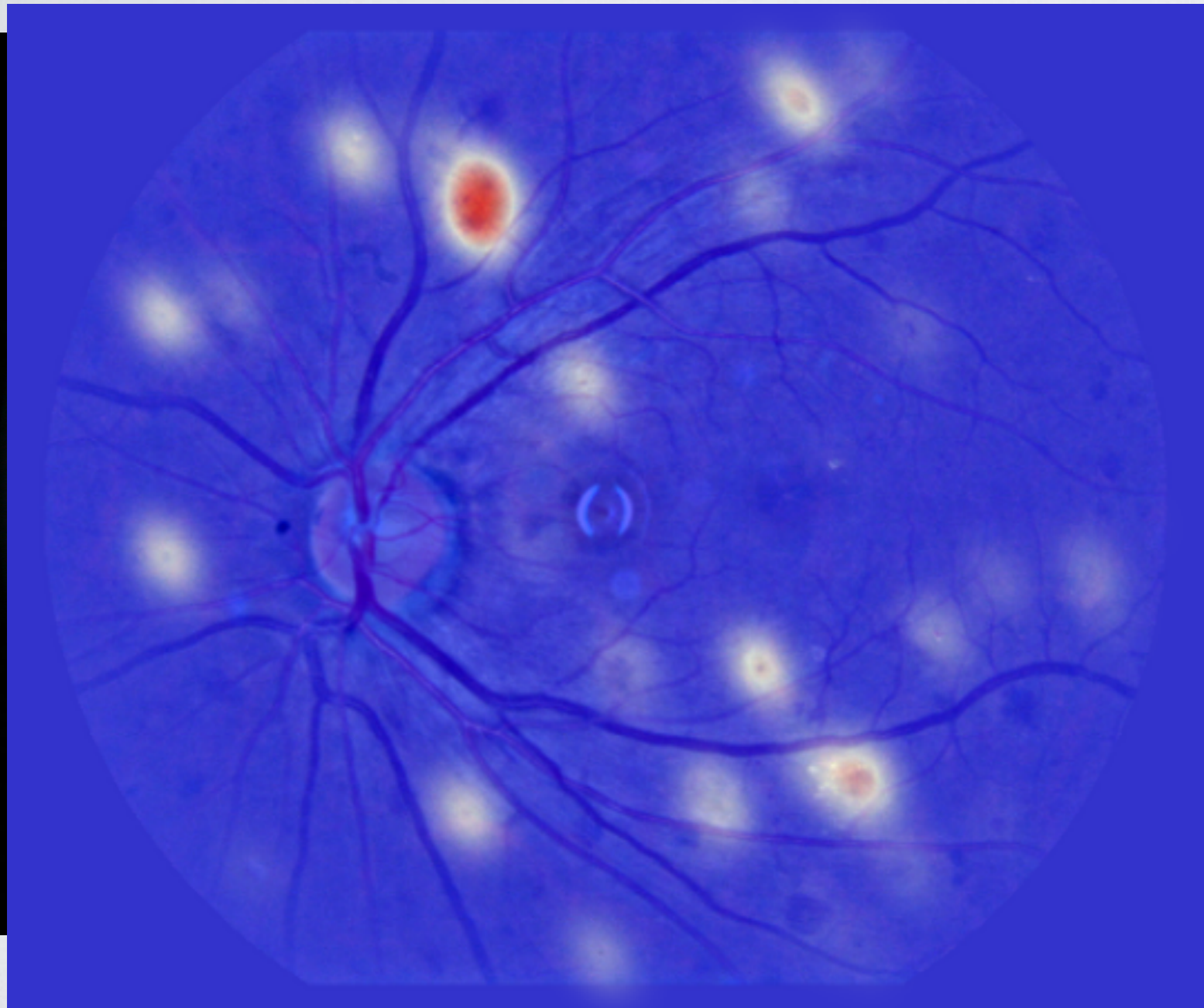
# Applications in the Medical Field



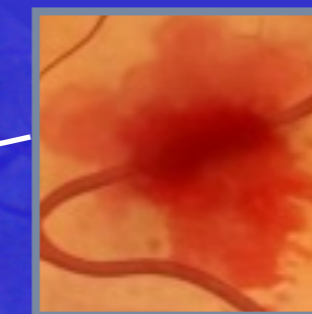
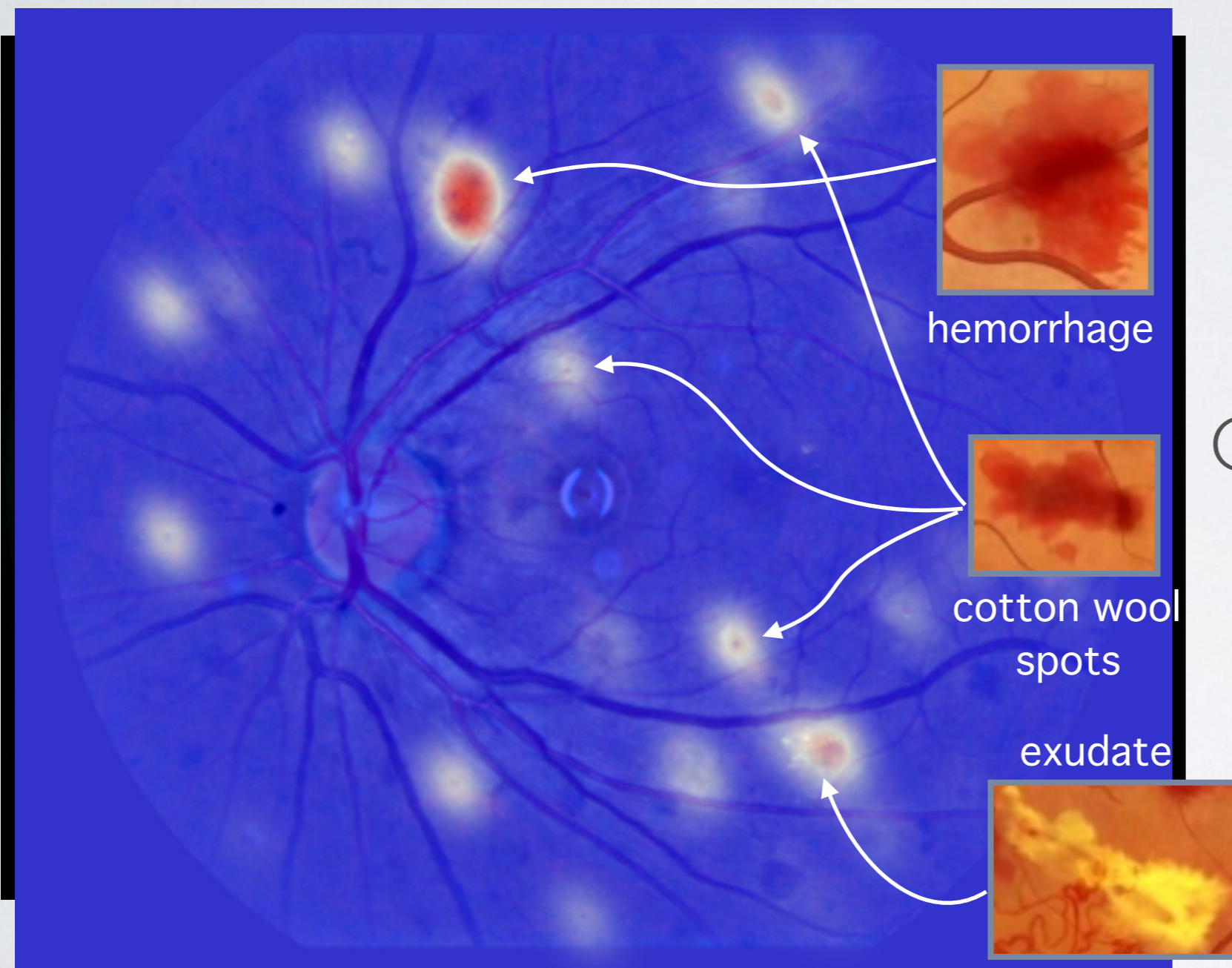
Classified as a class 3/4  
diabetic retinopathy



Classified as a class 4/4  
diabetic retinopathy



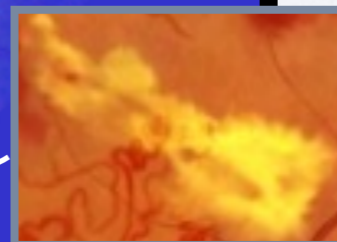
Classified as a class 4/4  
diabetic retinopathy



hemorrhage



cotton wool  
spots



exudate

Classified as a class 4/4  
diabetic retinopathy

# Computational Intelligence for Computational Biology

## HEIG-VD

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