Automated Liver Lesions Classification Using Dictionary Bag Of Visual Words (BoVW) Model

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background

- **Classification of liver lesions is a common challenge in liver imaging**
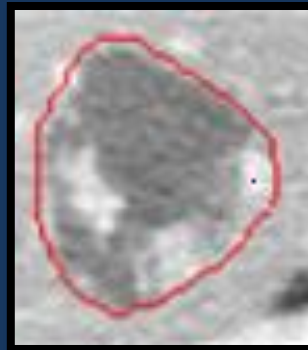- **Differentiation between benign and malignant tumors is a critical task**

Purpose

To Develop and evaluate an algorithm for the automatic classification of liver lesions using the Bag-Of-Visual-Words (BoVW) model

Classification of Hypodense Liver Lesions in portal phase CT
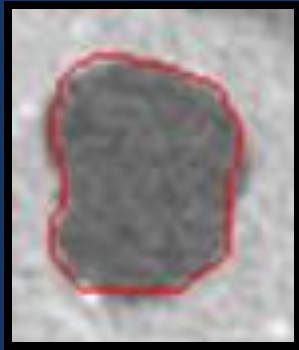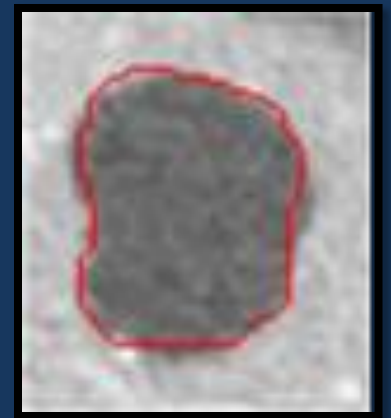

Cysts

Hemangiomas

Metastases

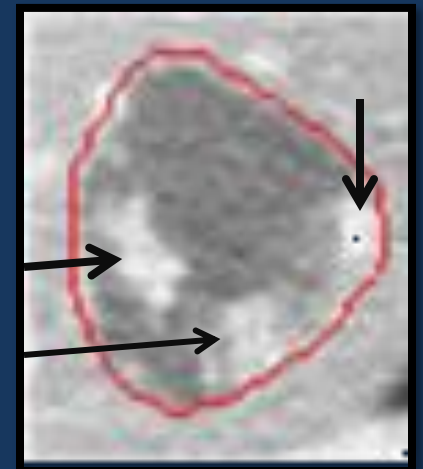# Hypodense Liver Lesions

- **<u>Cysts</u>:**

  Non enhancing, homogenous lesions with sharp borders

Hypodense Liver Lesions

- **<u>Hemangiomas:</u>**

  Discontinuous nodular peripheral enhancement, with fill-in on delayed images

Hypodense Liver Lesions

- **<u>Metastases:</u>**

  Have soft-tissue attenuation, enhance with contrast material, and have less well-defined margins than cysts

Bag Of Visual Words (BoVW) model

- An algorithm for automatic image classification by computer

- Based on referring to features of images as "words in a dictionary"

Sentences about TV

- "Seinfeld is an American television sitcom that originally ran for nine seasons on NBC"

- "It may have started life as a hopeful spin-off from 'Cheers', but right from the very first episodes, 'Frasier' proved that it had enough style and substance of its own to become a TV legend"

- "The majority of *Oz*'s plot arcs are set in "Emerald City", named for a setting from *The Wizard of Oz*"

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- "The majority of *Oz's plot* arcs are set in "Emerald City", named for a **setting** from *The Wizard of Oz"*

Dictionary - TV

Seinfeld *originally* *television* *Seasons*

Spin off **Episodes** **TV** named **OZ's plot**
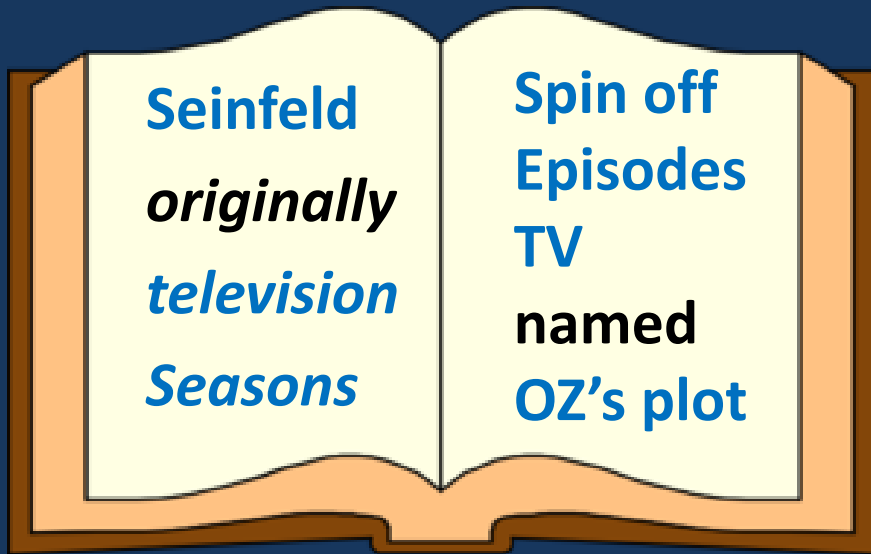
Sentences about Cooking

- "L'Atelier de Joël Robuchon is the name of eight French gourmet restaurants, located in Hong Kong, Las Vegas, London, Paris, Singapore, Taipei and Tokyo"

- "Sushi is a Japanese food consisting of cooked vinegared rice combined with other ingredients, seafood, vegetables and sometimes tropical fruits"

- "Commercial tom yum paste is made by crushing all the herb ingredients and stir frying in oil. Seasoning and other preservative ingredients are then added"

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Dictionaries

TV

Seinfeld
originally
television
Seasons

Spin off
Episodes
TV
named
OZ's plot

Cooking

gourmet
Restaurant
Sushi
Food
from

vinegar
rice
name
Seafood

Classifying a new sentence

- "Pad Thai or phat Thai is a stir fried rice noodles dish commonly served as a street food and at casual local restaurants in Thailand"
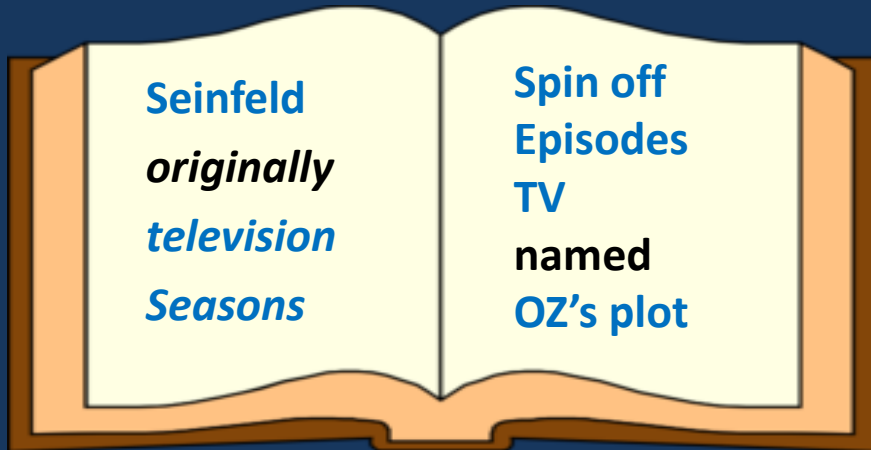
Classifying a new sentence

- "Pad Thai or phat Thai is a stir fried rice noodles dish commonly served as a street food and at casual local restaurants in Thailand"

Classifying a new sentence

noodles

food

stir fried rice

restaurants

Seinfeld
originally
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TV

Cooking

BoVW - Hypodense Liver Lesions

- Images are divided to small patches ("words"), and a "dictionary" is created.
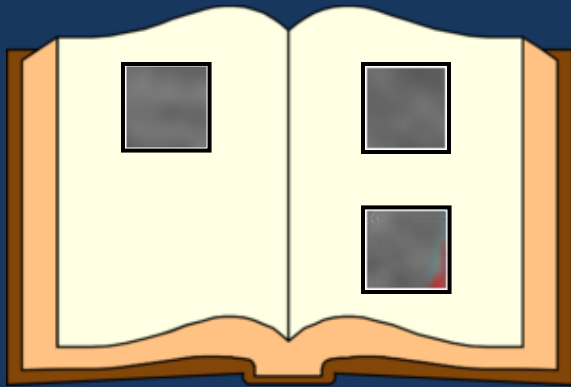
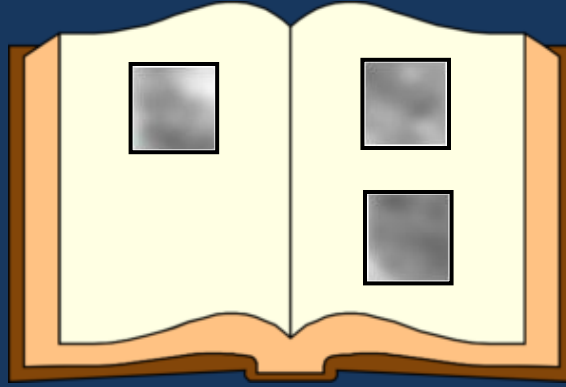- This "dictionary" is used to classify new lesions
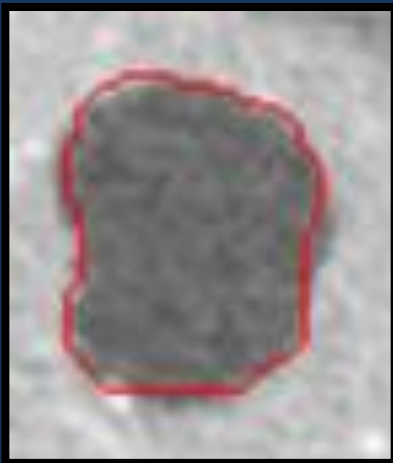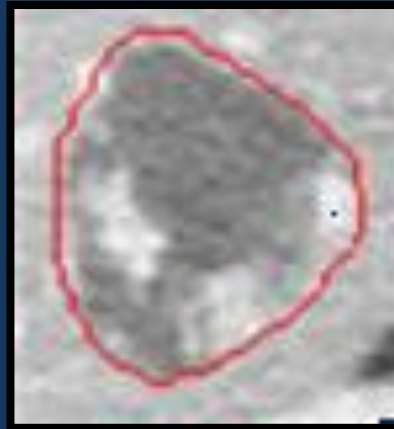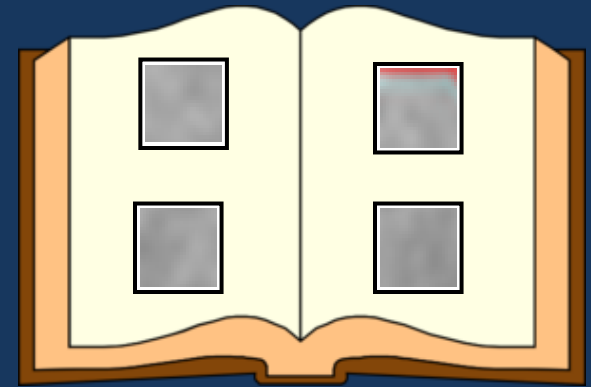
Cyst

Hemangiomas

Metastases

BoVW - Hypodense Liver Lesions

- Images are divided to small patches ("words"), and a "dictionary" is created.

- This "dictionary" is used to classify new lesions
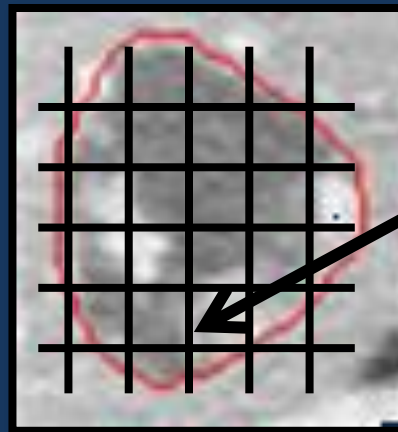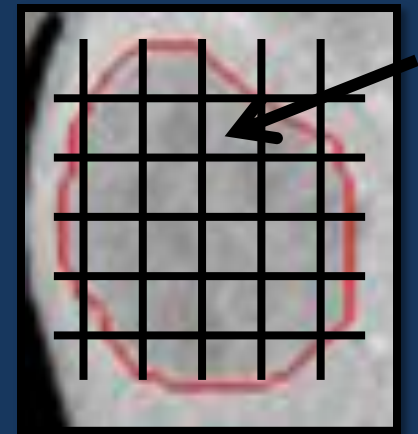
Cyst

Hemangiomas

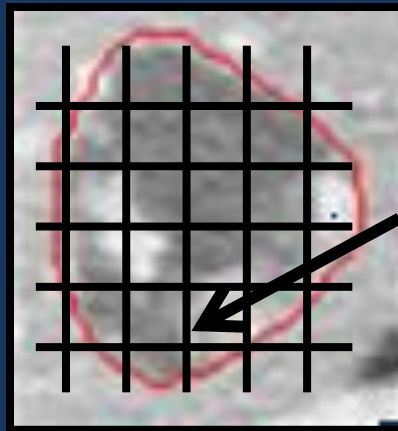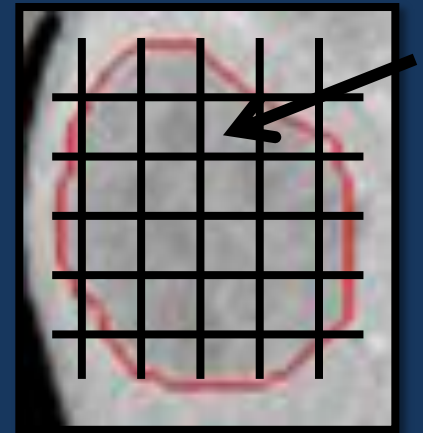**Metastases**

Cysts

Hemangiomas

Metastases

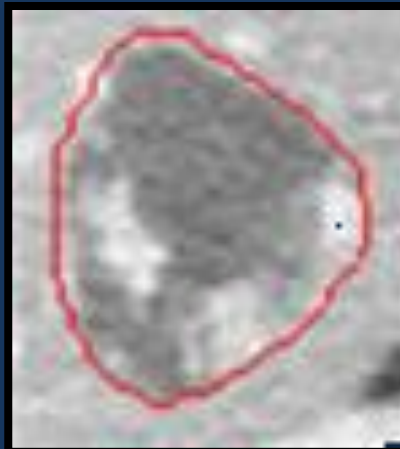**Cyst**

Hemangiomas

Metastases

Methods

- The first step study included portal-phase CT images of 85 liver lesions:
  - 22 cysts
  - 34 metastases
  - 29 hemangiomas

- Performed in our institution in the years 2011-2013

Methods

- Marked the lesions margins

- Provided the diagnosis of each lesion which was established either by biopsy or clinical follow-up

Methods

Methods

- The sensitivity, specificity, NPV and PPV of the algorithm to identify cysts, metastases and hemangiomas were calculated

Results

Algorithm\True	Cysts	Metastases	Hemangiomas	Total
Cysts	20	1	1	22
Metastases	0	30	4	34
Hemangiomas	0	5	24	29

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Results

	Sensitivity	Specificity	PPV	NPV
Cysts	91%	100%	100%	97%
Hemangiomas	88%	88%	83%	92%
Metastases	83%	91%	83%	91%

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Conclusion

- Good preliminary results in characterizing three types of hypodense liver lesions

- This is the first part of a larger study aimed to differentiate several types of liver lesions

Future research

- Analysis of different types of liver lesions:

- HCC

- FNH

- Cholangiocarcinoma

I. Using the BovW algorithm

II. Triphasic Computed tomography studies

Triphasic Computed tomography

- Intravenous contrast administered
- Images taken with scanning delay of;
- 0 seconds (non contrast)
- 25-35 seconds (arterial phase)
- 60-70 seconds (portal venous phase)
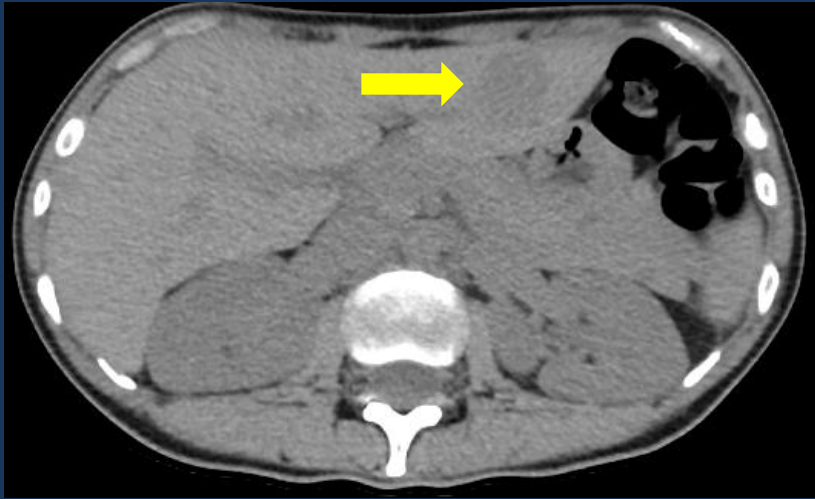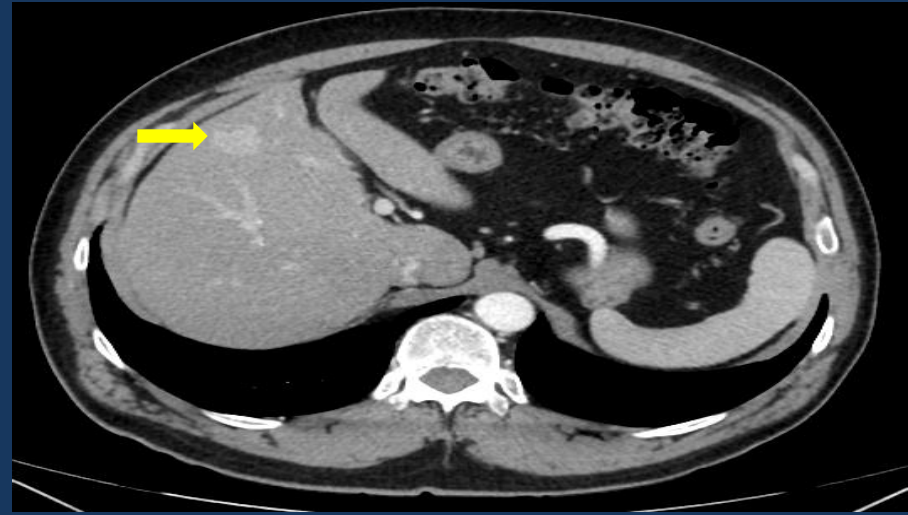- 5-10 minutes (delayed phase)
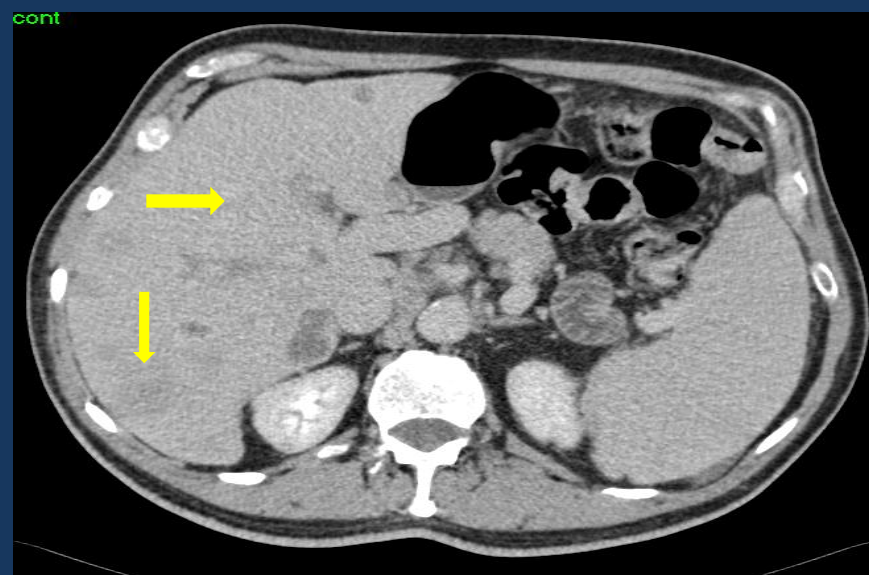
Triphasic Computed tomography

Cysts
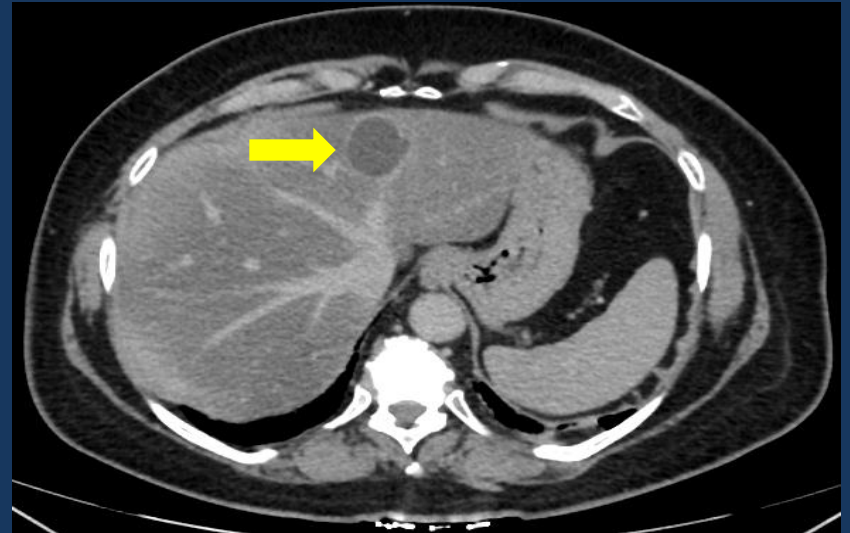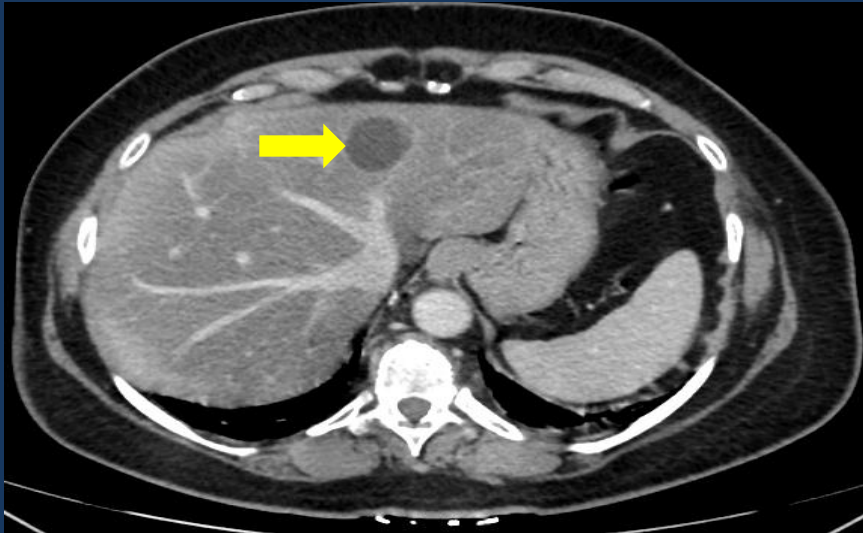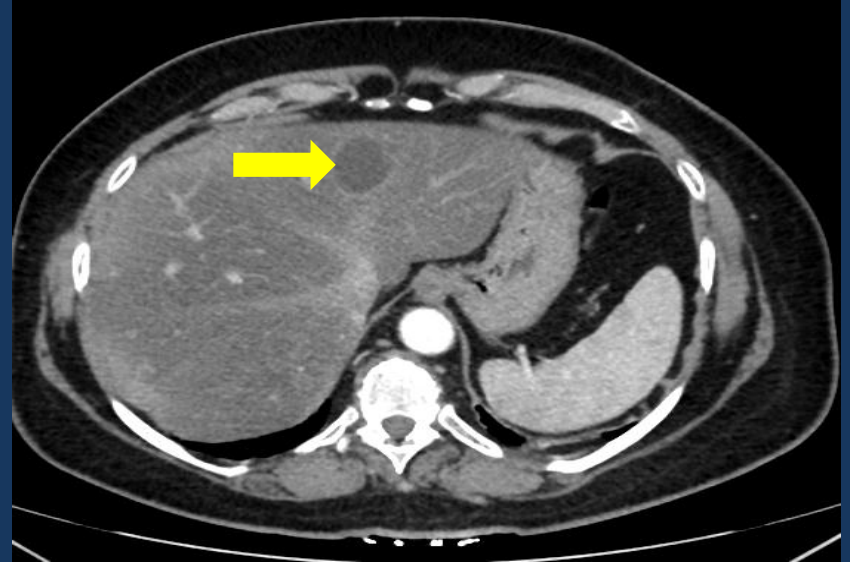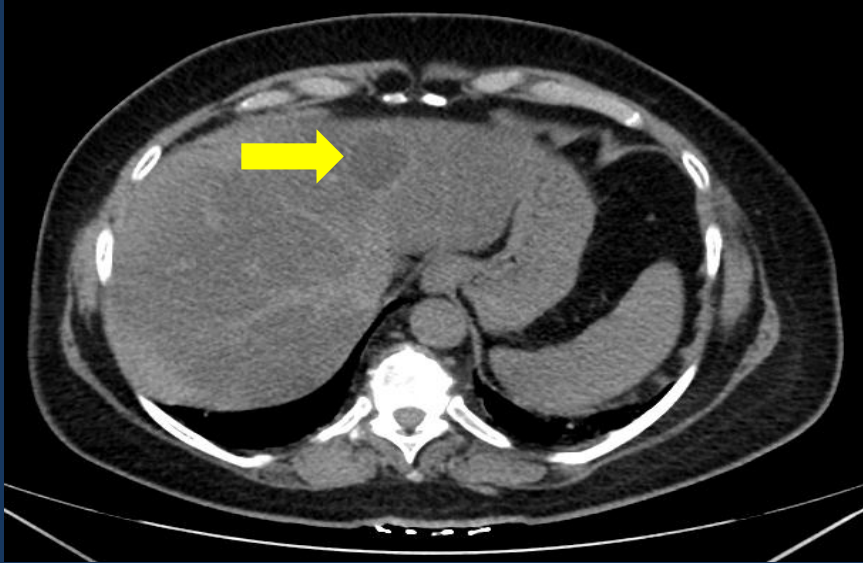
Haemangioma
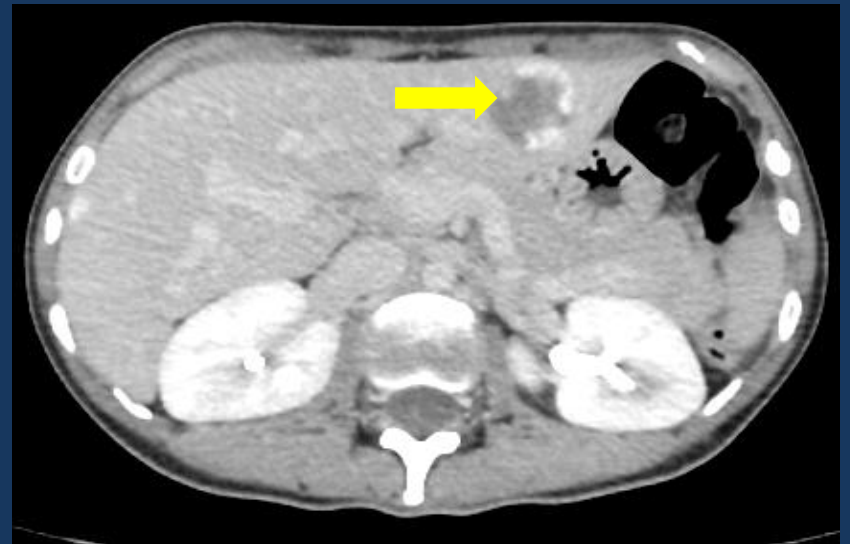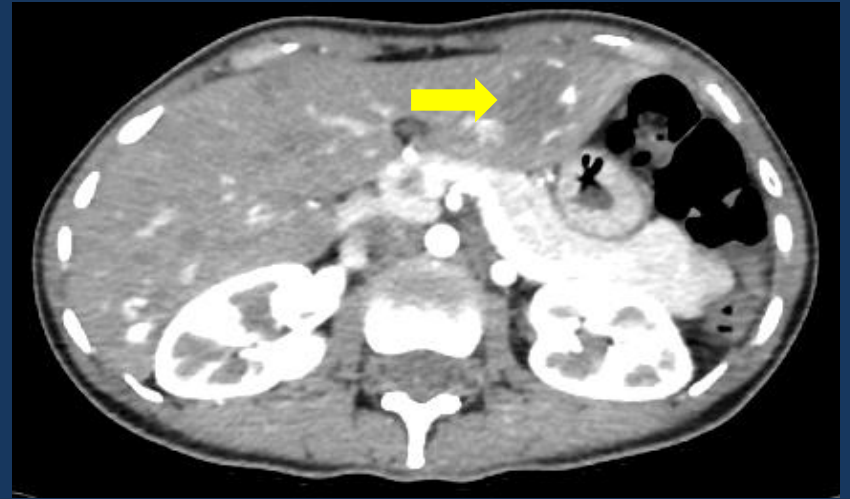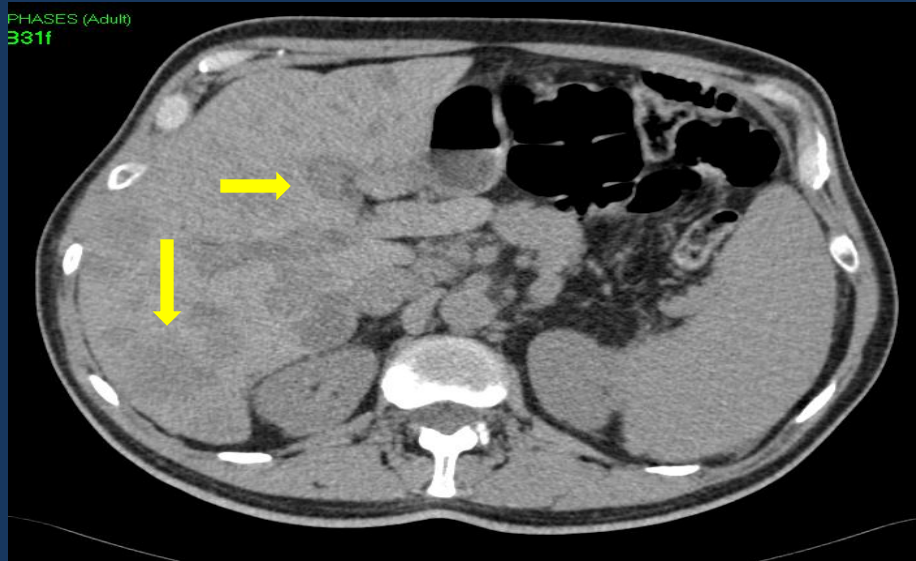
Focal nodular hyperplasia (FNH)
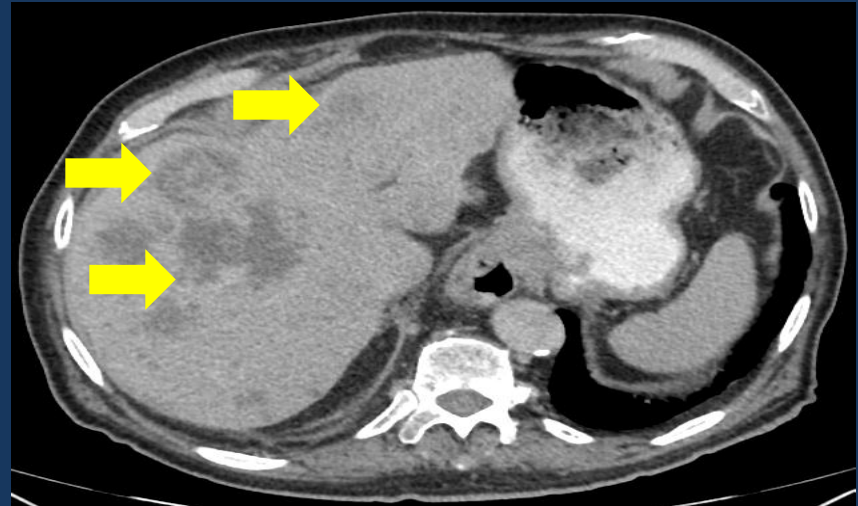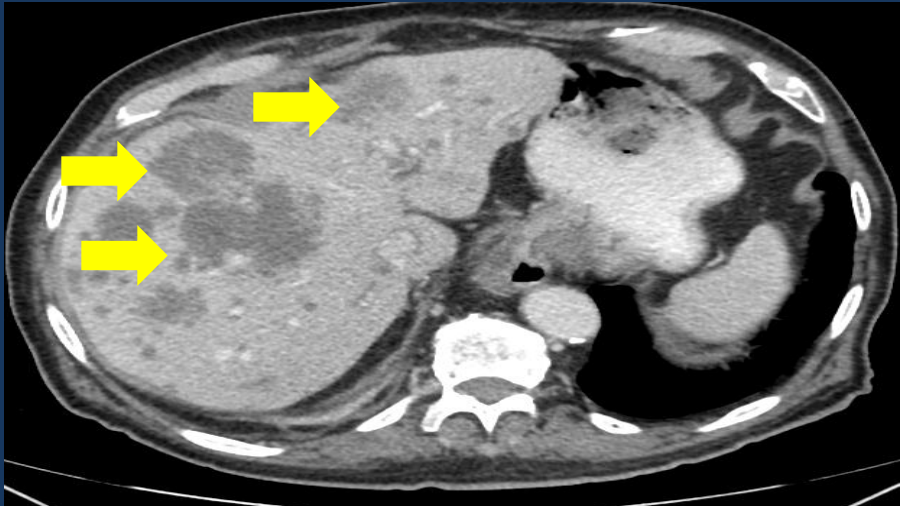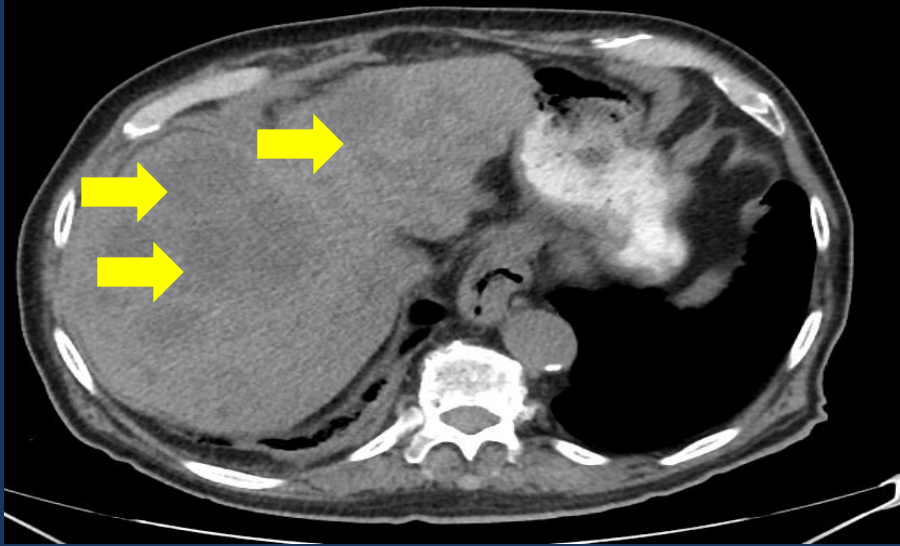
Hepatocellular carcinoma

Metastasis- Neuroendocrine

Metastasis- Colorectal

Working assumption

- Initial research concentrated on common, well defined lesions.

- The classification of ambiguous lesions is more complicated.

- The added data from the different stages of triphasic examinations will improve the classification accuracy of the algorithm

Thank You