# Defect Detection in Porcelain Industry based on Deep Learning Techniques

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# Outline

- Motivation and approach
- Deep Learning
- Experimental evaluation
- Conclusions and directions for future work

# Manufacturing process of porcelain

- Preparing the ceramic mass
- Powder atomization
- Shaping the object
- Burning I
- Glazing
- Burning II
- Final sorting

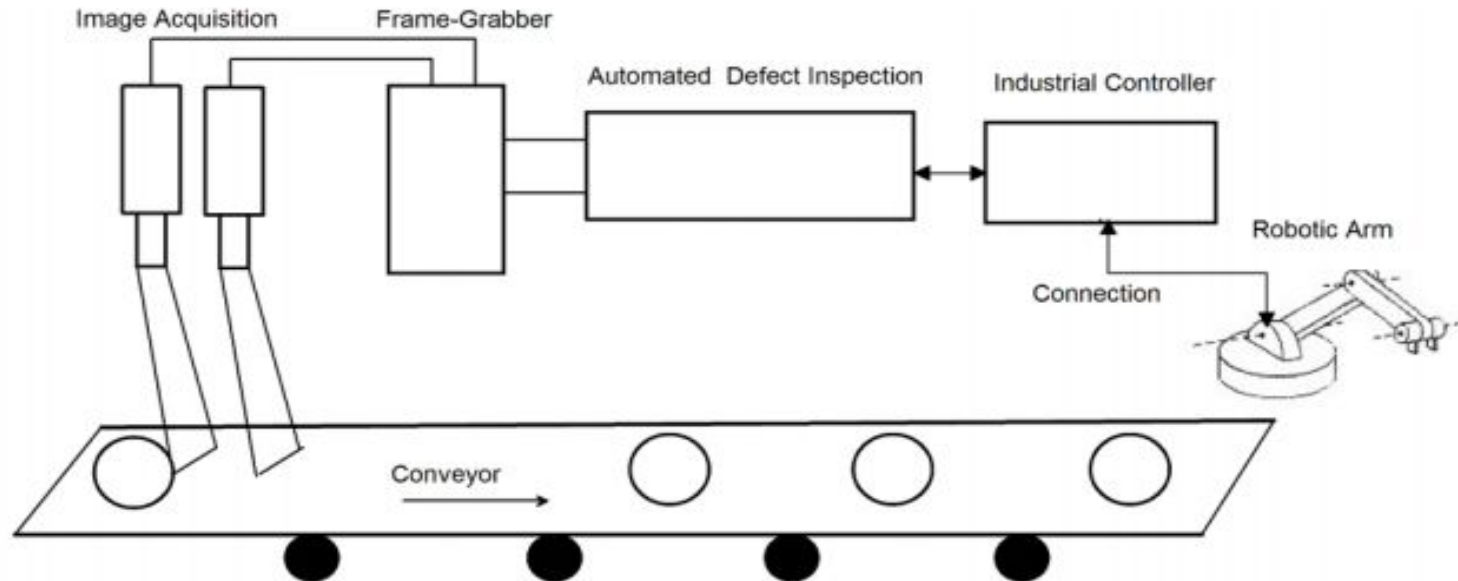# Quality control in the porcelain industry

- Performed manually
- Expensive process, which requires trained personnel
- Prone to human error

The need for automated inspection!

# Project motivation

Automated processes in porcelain industry

**The optimized system will be integrated in the production flow porcelain as follows:**

1. Product reaches the inspection system
2. Sensor detects the product and sends a signal to the artificial vision system
3. The product is illuminated
4. Artificial vision system receives the image from the sensor
5. Software algorithms running on the artificial vision system process and analyze the received image
6. Vision system sends signals to an industrial robot that acts as a diverter if the product is defective



Arrival station manufactured objects

Final box (Parts output)
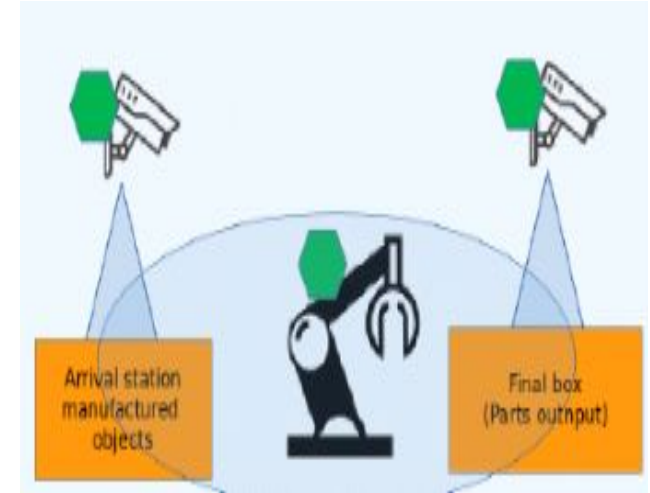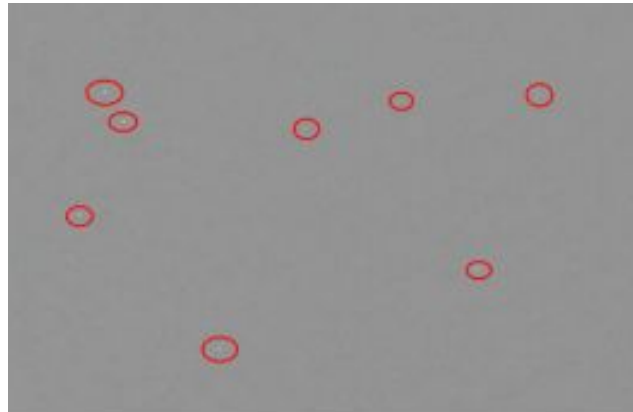
# Types of defects

- 2D defects

- 3D defects

- structure
  defects


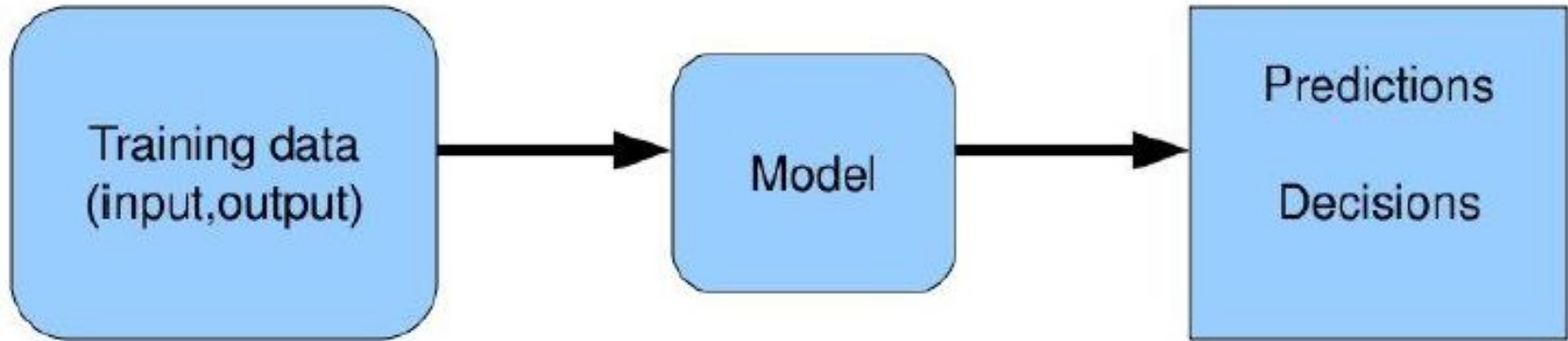
(a) Deterioration after pressing.

(d) Margin deformation.

(b) Bumps.

(c) Texture defects.
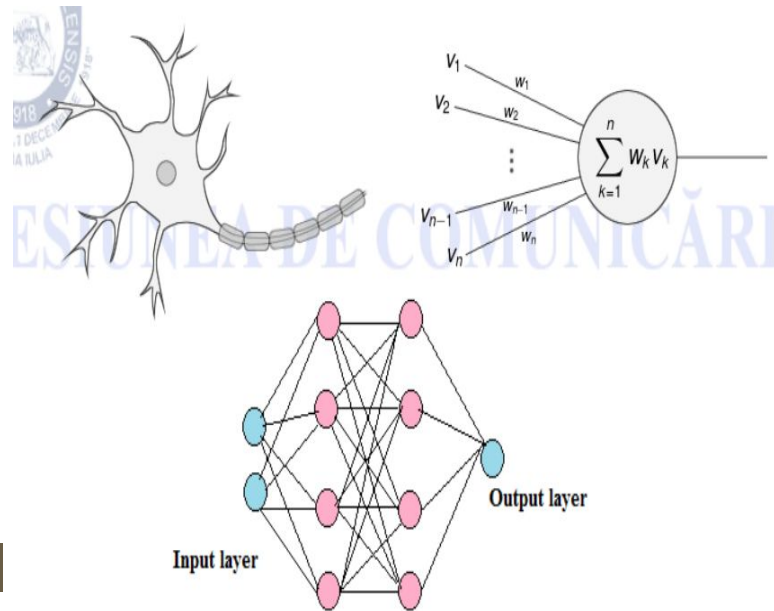
# Approach: Supervised Machine Learning
## Deep Learning - Convolutional Neural Networks



Training data (input,output) → Model → Predictions / Decisions

# Deep Learning: what is it?

Briefly, deep learning is:

1. A framework of machine learning techniques
2. Enables the automatic learning of feature hierarchies
3. Usually based on artificial neural networks

# Deep Learning: how is it different?

- 2013 Kaggle-hosted quest to save the whales
- The challenge was: given a set of 2-second sound clips from buoys in the ocean, classify each sound clip as containing a call from a North Atlantic Right whale or not.
- Winning team emphasized the importance of feature engineering

Deep Learning Approaches

| # | Δrank | Team Name ↑ in the money | Score | Entries |
|---|---|---|---|---|
| 1 | — | SluiceBox ★ | 0.98384 | 70 |
| 2 | — | alfnie ★ | 0.98379 | 27 |
| 3 | ↑1 | RBM | 0.98226 | 32 |
| 4 | ↓1 | Free Willzyx | 0.98210 | 38 |
| 5 | — | Jure Zbontar | 0.98080 | 24 |
| 6 | — | Daniel Nouri | 0.98070 | 16 |
| 7 | ↑1 | Tree growers | 0.97982 | 80 |

# Convolutional Neural Networks

- Types of layers: convolutional, pooling, fully connected

# CNN structure

```
Output Layer  ←  Hidden Layer (64 neurons)  ←  Dropout Layer (20%)
                                                     ↑
Conv2D Layer (64 filters, 3x3)  →  MaxPooling2D Layer (2x2)  →  Flatten Layer
        ↑
MaxPooling2D Layer (2x2)  ←  Conv2D Layer (32 filters, 3x3)  ←  MaxPooling2D Layer (2x2)
                                                                        ↑
        Visible Layer (1x150x150)  →  Conv2D Layer (32 filters, 3x3)
```
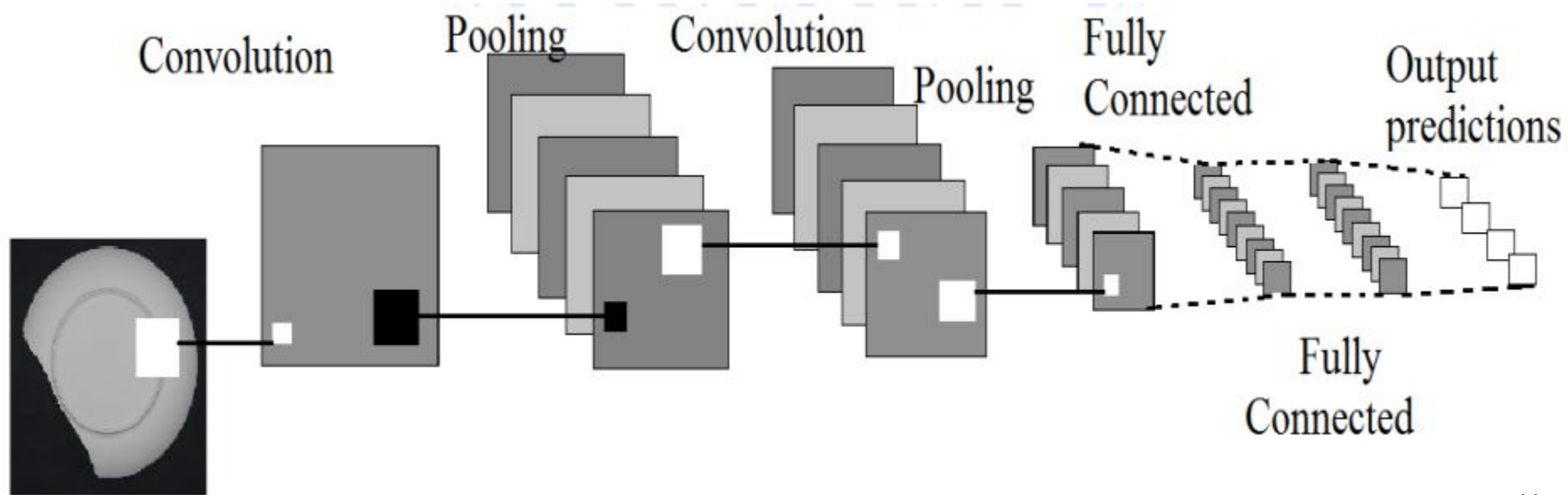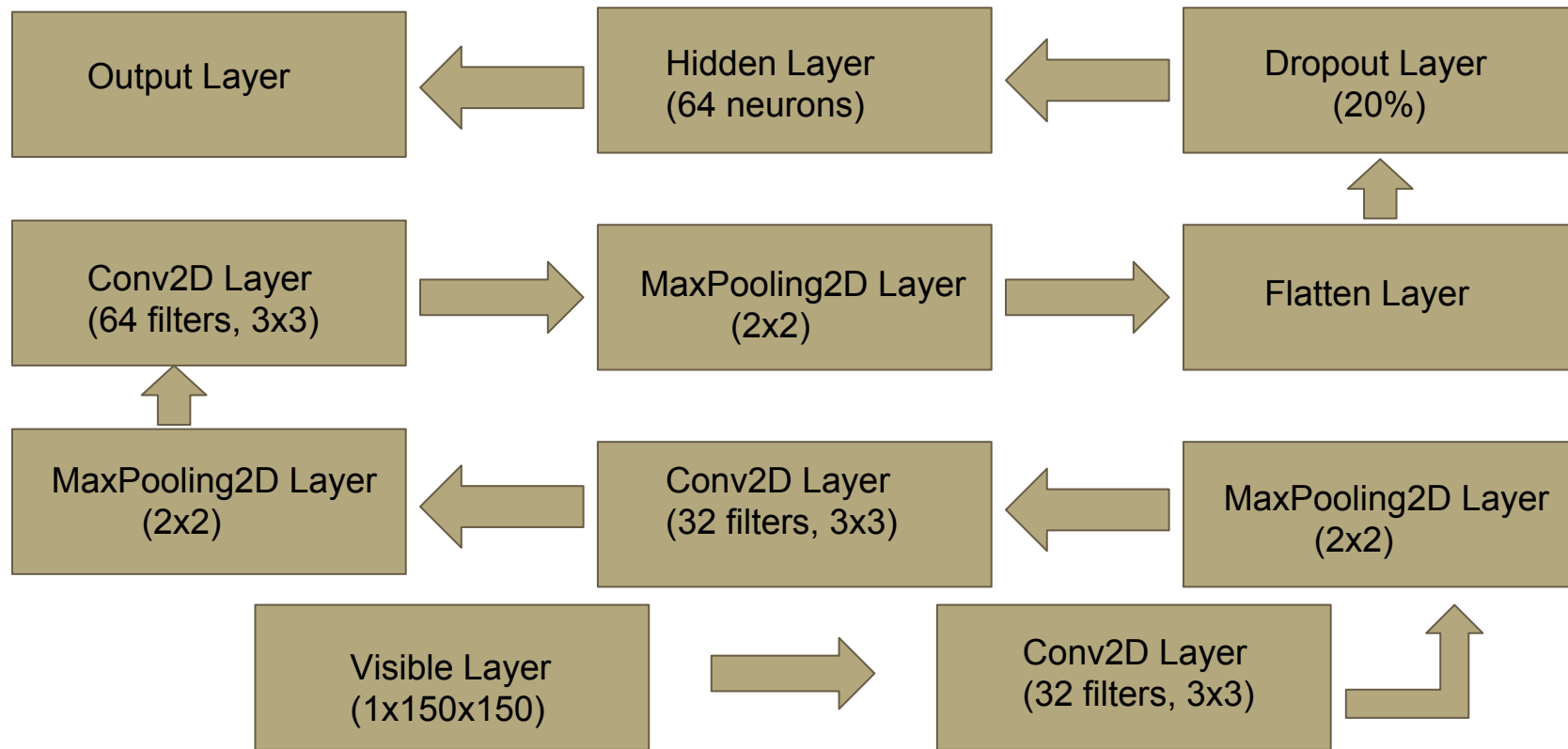
# Experimental results
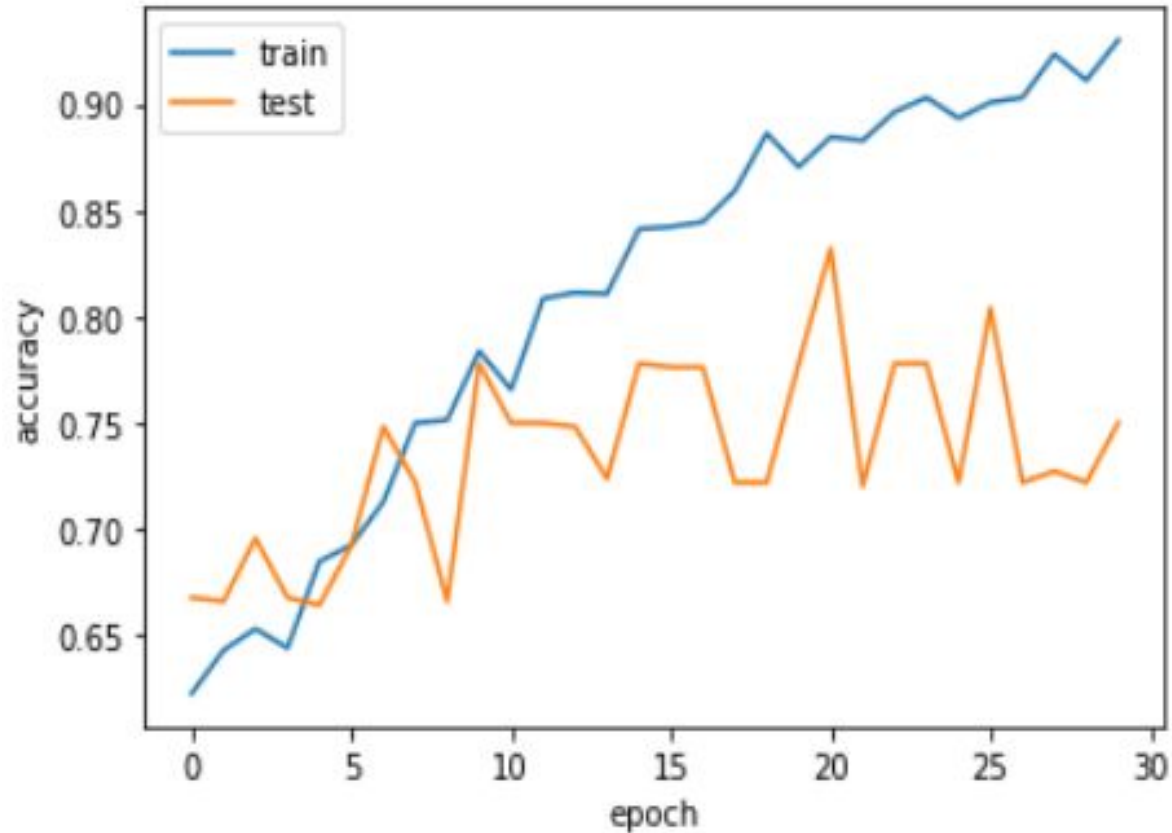
# Conclusion and future work

- Integrates robots, artificial vision and machine learning
- Defect detection at different phases of the production process
- Positive economic impact, shorten production time

- Fine-tune the parameters
- Examine the combination of different CNNs
- Change CNN's structure

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# Thank you for your attention!

- Questions?
- Contact: adriana.birlutiu@uab.ro
- References
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