Deep Diamond Re-ID

Diamonds, not only a girl's best friend

Floris De Feyter, **Dries Hulens**, Bram Claes, Toon Goedemé
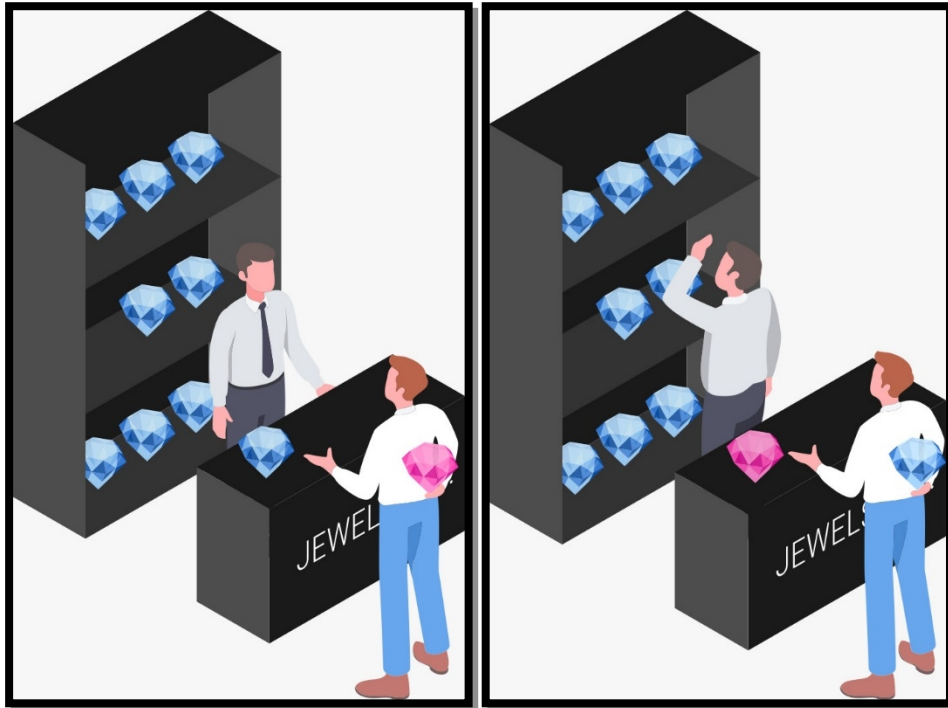
ID: {-12,24,54,1,-87,45,43,67,-56,-36,81,42,56,…, 43}

Problem statement

...diamond switching by customers or employees, and offered advice to discourage the practice. "Switches of diamonds for fake or lesser goods are done by both highly skilled thieves posing as customers and by dishonest employees," the group warned.

Trade 'Blind to Diamond-Swapping Threat'
Aug 15, 2018 10:51 AM   By Joshua Freedman

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Jewelers Security Alliance: 'Beware of Switches'
Dec 9, 2008 2:50 PM   By Jeff Miller

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RAPAPORT... Jewelers Security Alliance (JSA) reminded its retail base to watch out for diamond-switching by customers or employees, and offered advice to discourage the practice. "Switches of diamonds for fake or lesser goods are done by both highly skilled thieves posing as customers and by dishonest employees," the group warned.

Switch artists have developed an "art of disarming an unsuspecting target." They use charm and behaviors designed to impress in order to take advantage of an unguarded moment in the store. The switch is often discovered long after it happens, making it much more difficult to investigate the crime.

Several switches of diamonds for cubic zirconia (CZ) have occurred recently in retail stores, according to the JSA. These include a diamond solitaire ring that was switched in a New York store, diamond earrings and a ring in a Boston boutique and two diamonds at a mall store in Elyria, Ohio.

JSA presented tips to prevent switches: Show only one item at a time, never turn your back on a customer, and wait on only one customer at a time. Be sure to reexamine the jewelry right after a customer has handed it back to the staff. "It could be a CZ, moissanite or an inferior stone. You must either loupe it, or use diamond and moissanite testing equipment," the organization advised.

Additionally, stores should have selling-surface cameras, and staff should be reminded to be aware in case of a distraction, as when a customer drops a diamond, or faints, or does anything else to divert attention.

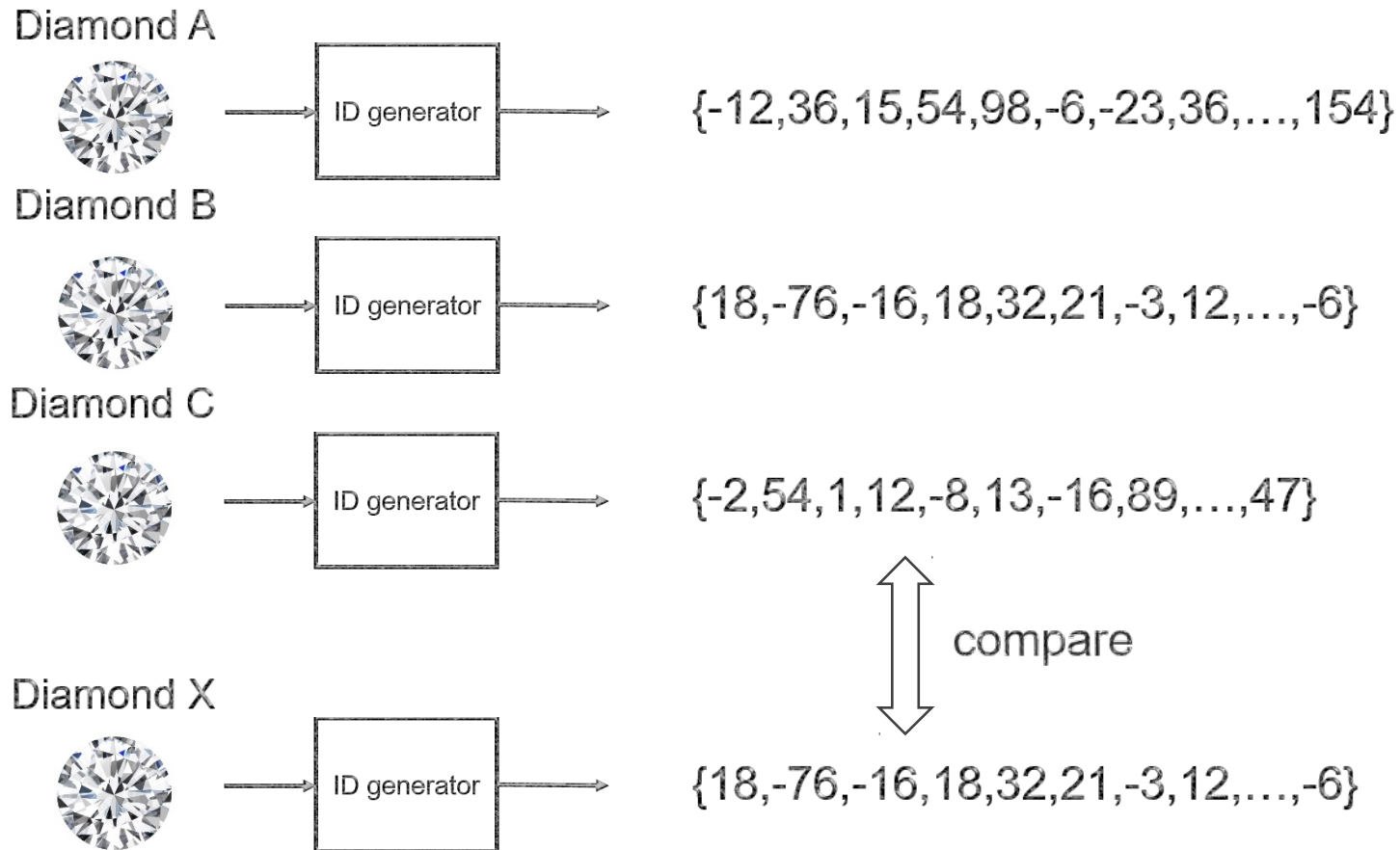JSA offers crime prevention weekly e-mails and alerts.

How does the jewelry store controls the returned diamonds?

- Not !

- If they suspect that diamonds are switched:

-> ASET (Angular Spectrum Evaluation Tool)
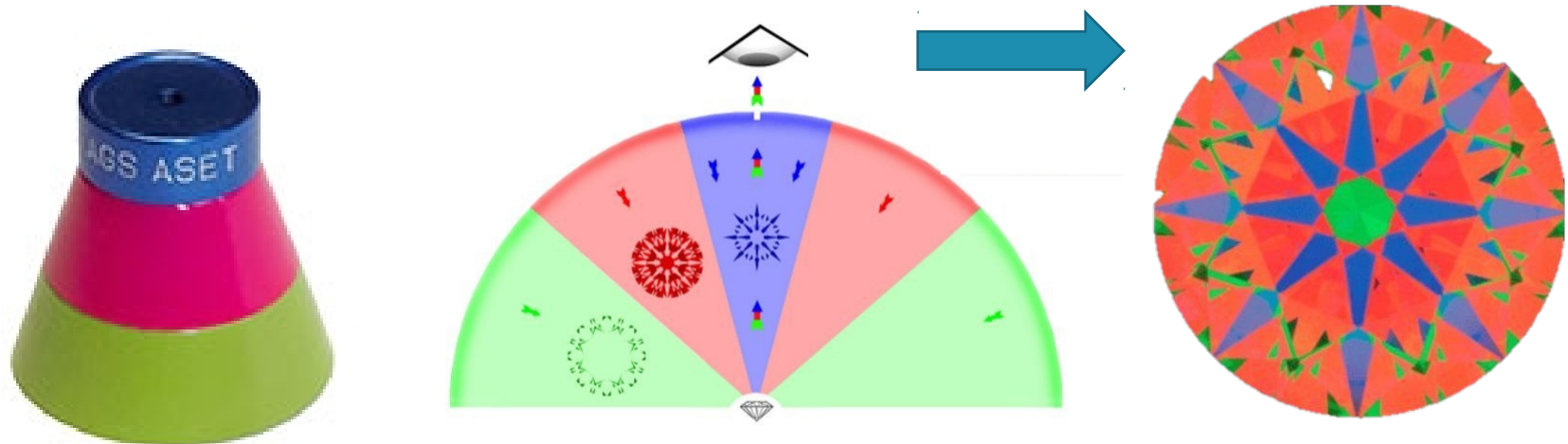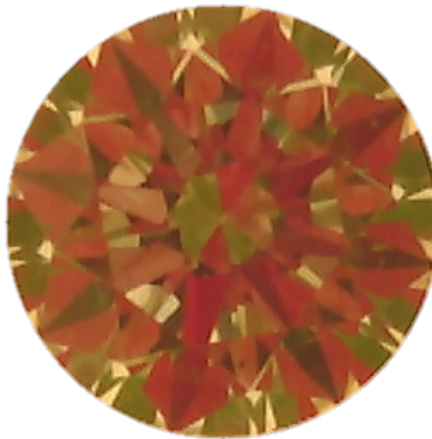
Our solution

Diamond re-identification

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Challenges

A

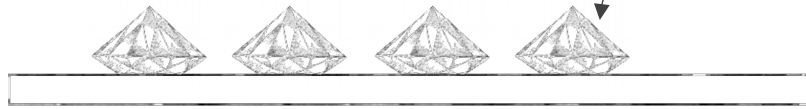Different

B

Equal

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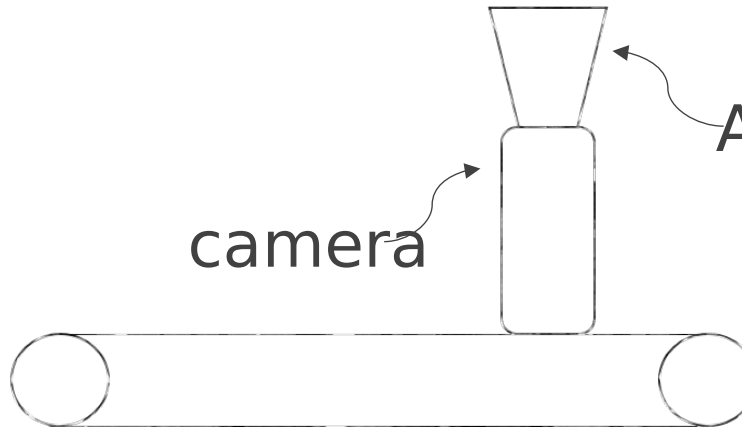
Workflow

1: Take picture with ASET

Setup

uniform light source

Diamond

plexiglass
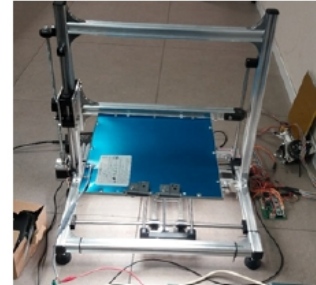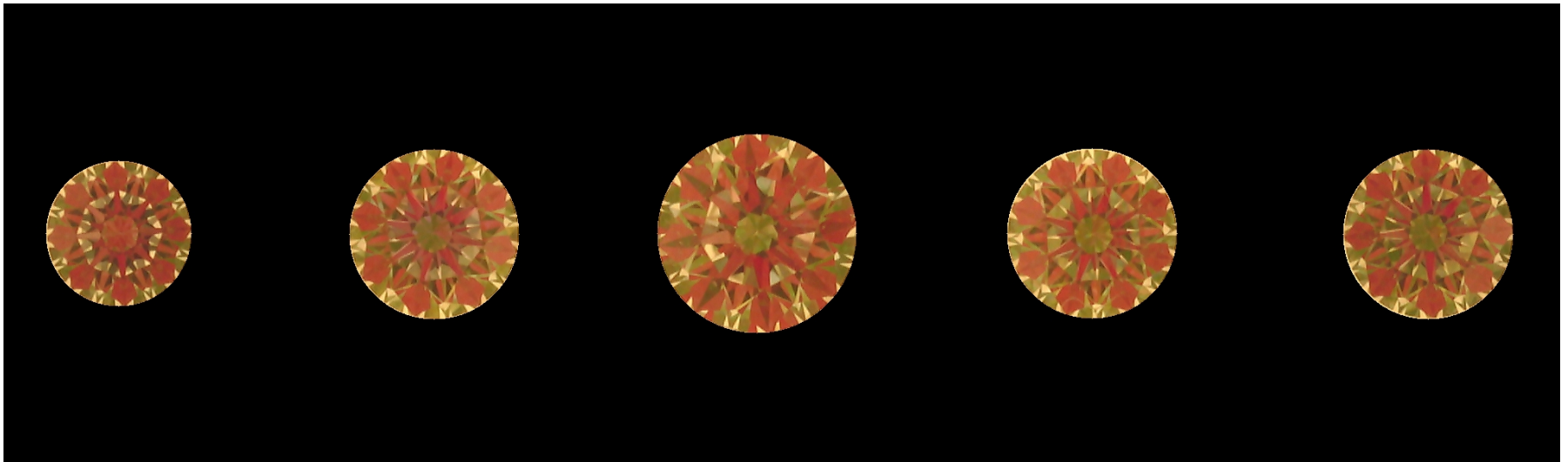
ASET

camera

X-Y table 3D printer

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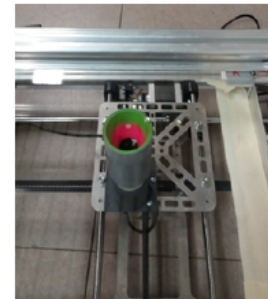
Workflow

1: Take picture with ASET
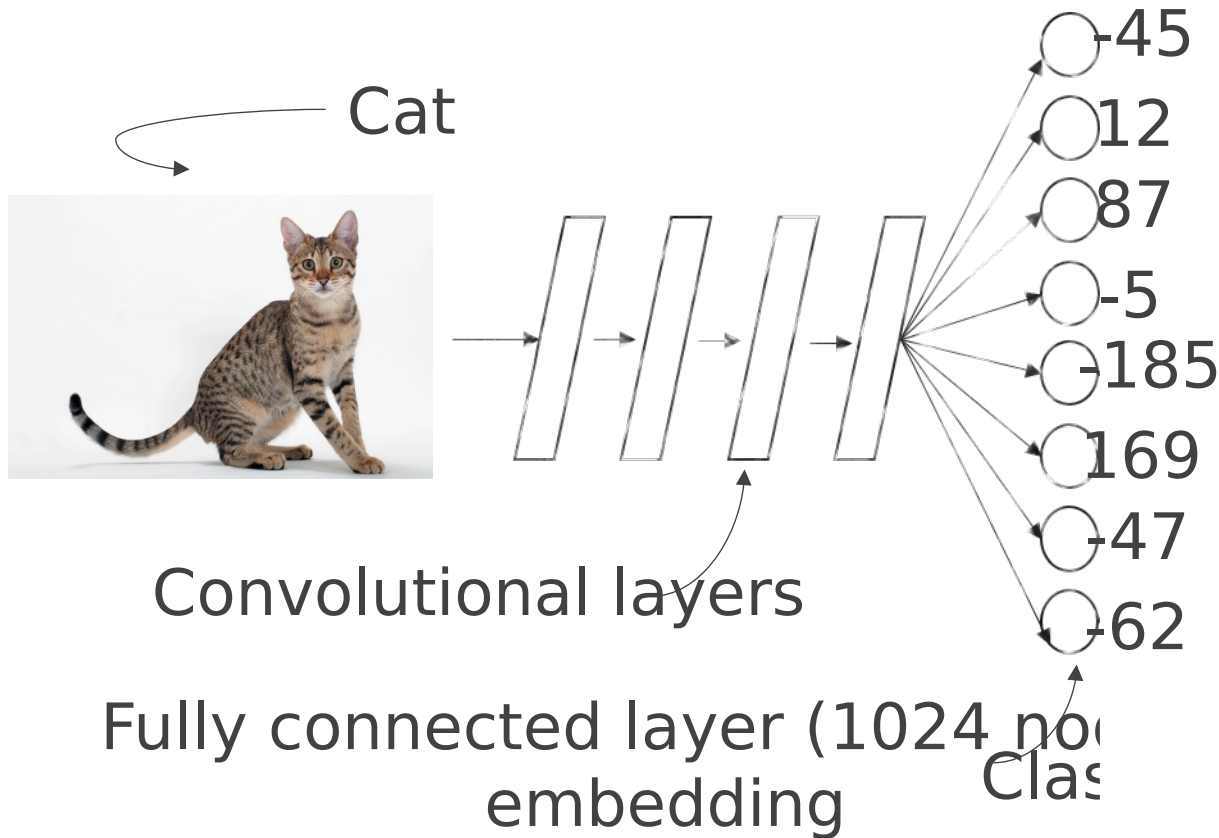

Size: 1-3mm

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Workflow

2: Generate ID (embedding)

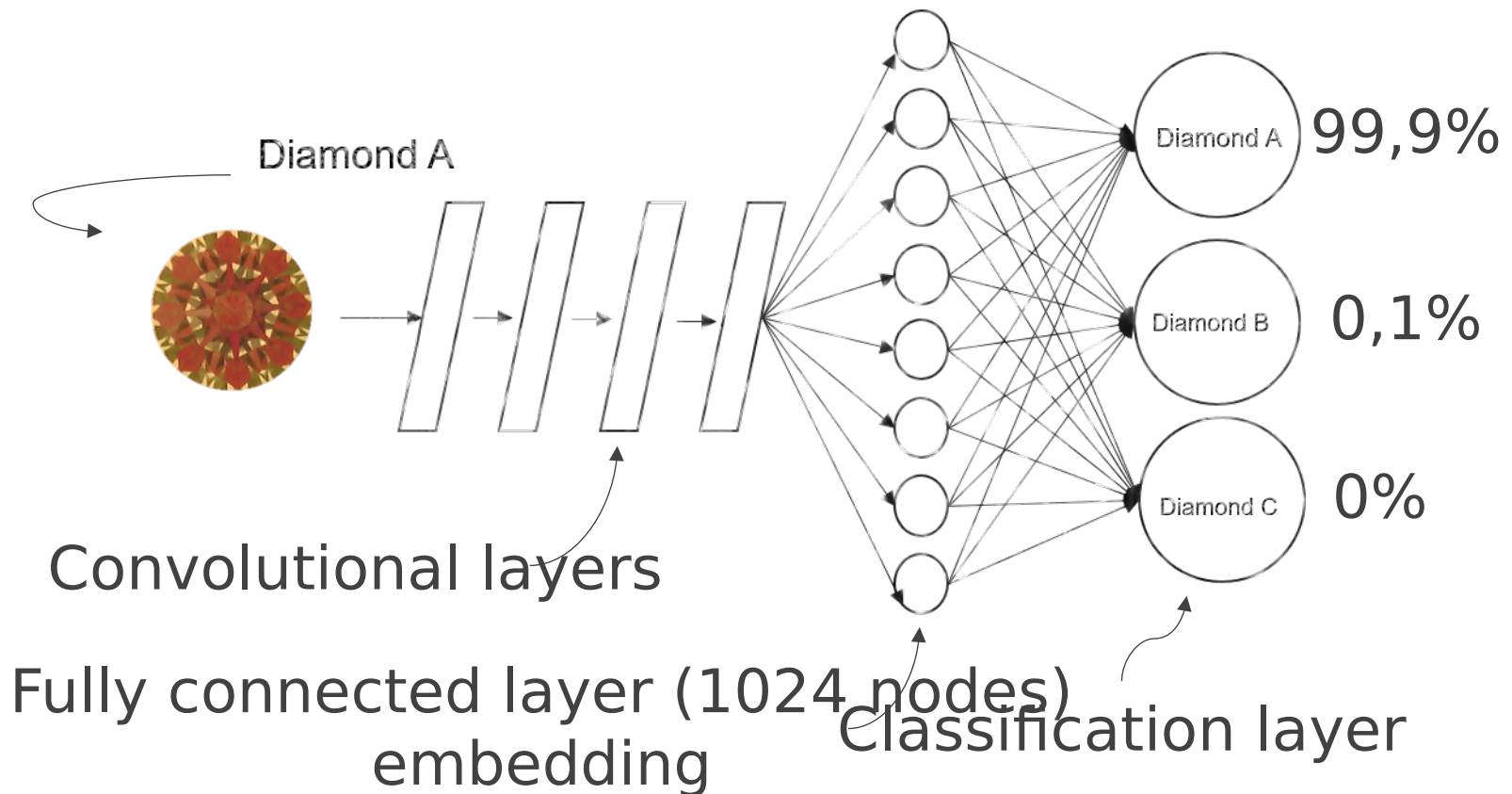- Start from Darknet19 classification network trained on ImageNet

Cat

-45

12

87

-5

-185

169

-47

-62

Convolutional layers

Fully connected layer (1024 nodes)
embedding

Clas

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Workflow

2: Calculate ID with re-identification algorithm

- Transfer learn network with training set of 100 diamonds

Diamond A

Diamond A 99,9%

Diamond B 0,1%

Diamond C 0%

Convolutional layers

Fully connected layer (1024 nodes) embedding

Classification layer

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Workflow

2: Calculate ID with re-identification algorithm

- Drop classification layer

-45
12
87
-5
-185
169
-47
-62

Diamond

Convolutional layers

Fully connected layer (1024 nodes) embedding

ID = Vector[1024]{
-45,
12,
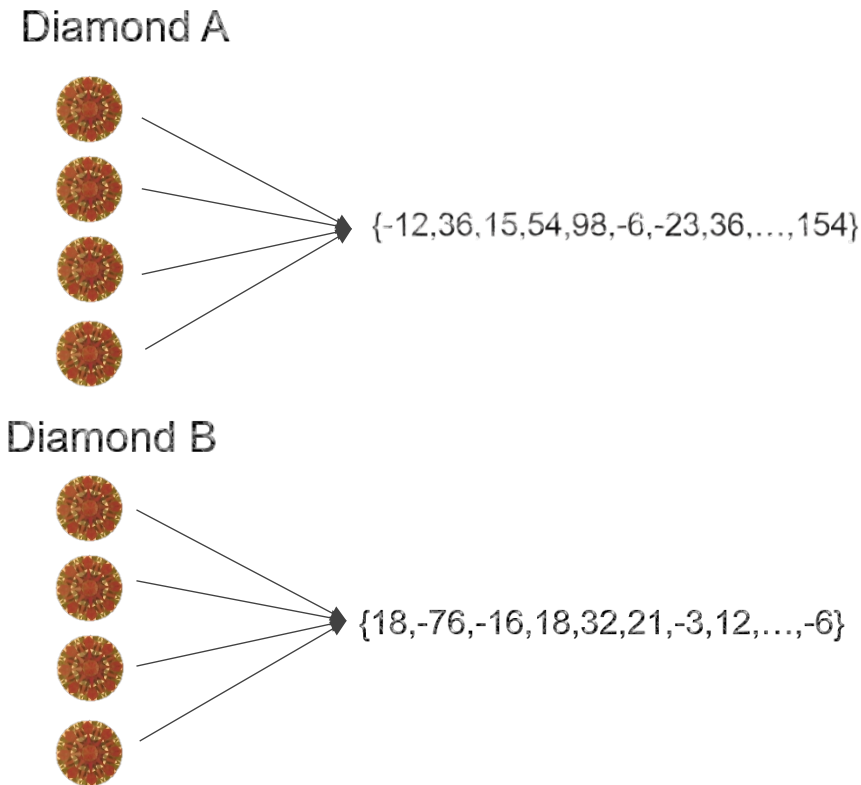87,
-5,
-185,
169,
-47,
-62,
...}

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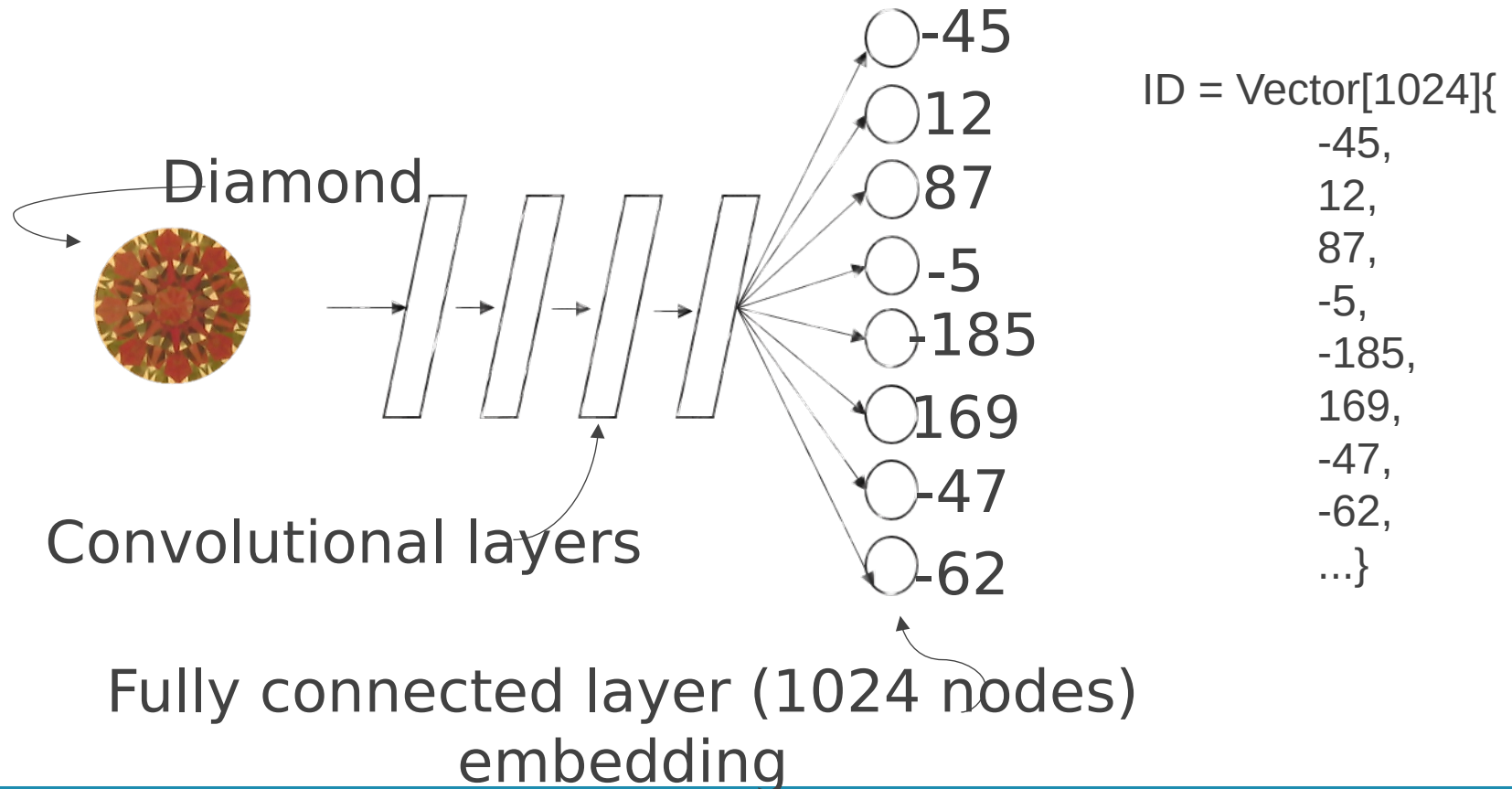
Workflow

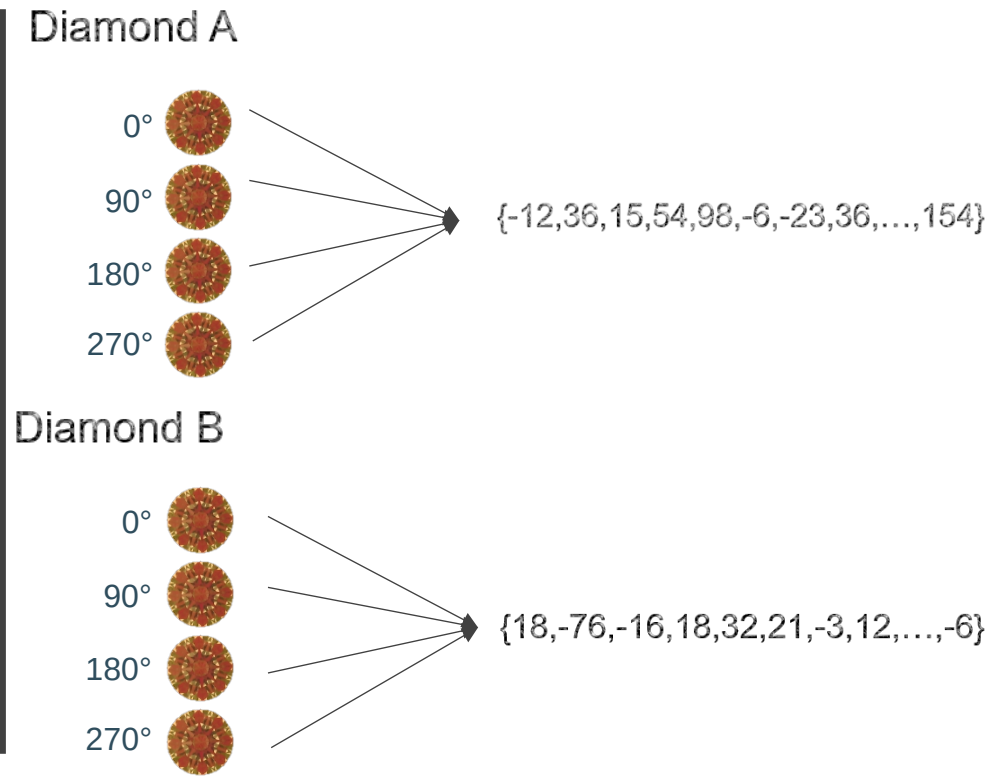## 3. Compare embeddings

Make the embedding more robust by combining multiple embeddings of 1 diamond
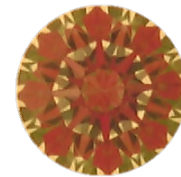
<u>multiple images</u>

<u>rotated images</u>

Diamond A

{-12,36,15,54,98,-6,-23,36,…,154}

Diamond B

{18,-76,-16,18,32,21,-3,12,…,-6}

Diamond A

0°
90°
180°
270°

{-12,36,15,54,98,-6,-23,36,…,154}

Diamond B

0°
90°
180°
270°

{18,-76,-16,18,32,21,-3,12,…,-6}

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Workflow

3. Compare embeddings

- Nearest average (euclidean distance)
- SVM
- K-NN (different values for K)

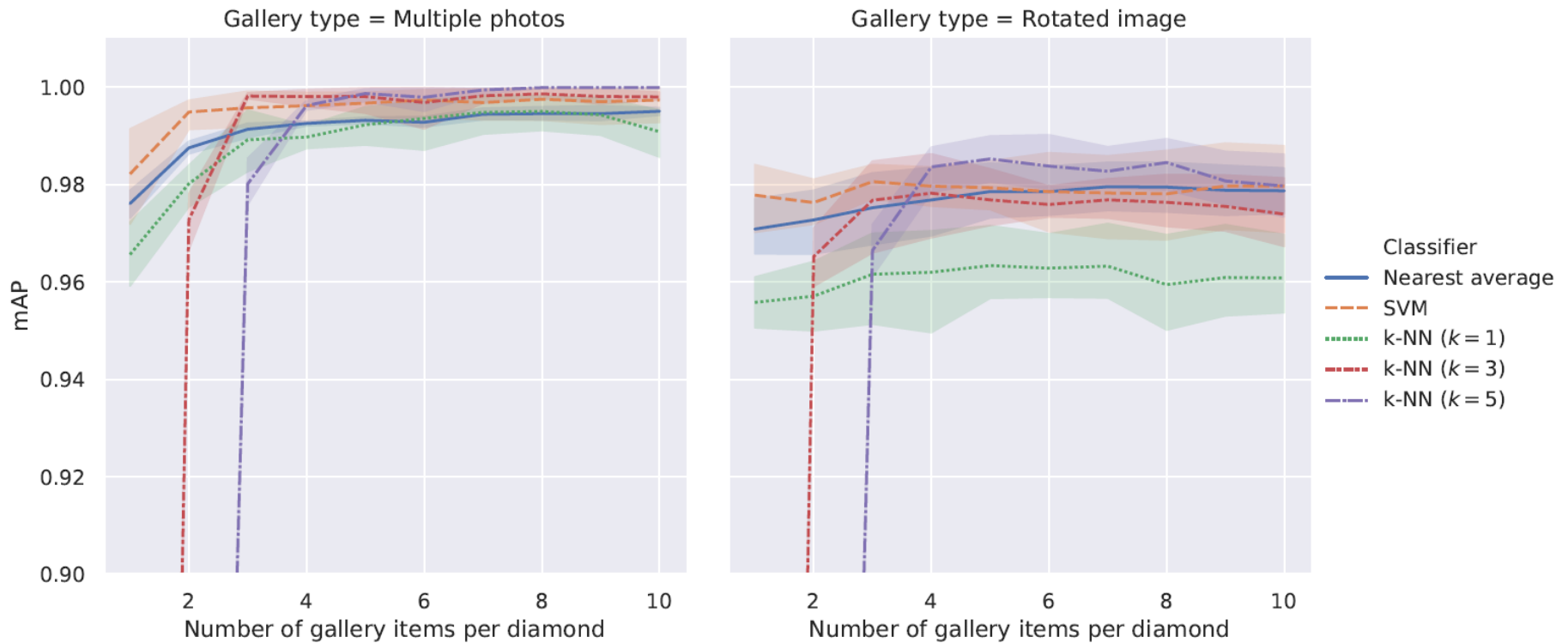{-12,36,15,54,98,-6,-23,36,...,154}   ⟺   {-13,34,16,53,96,-6,-23,34,...,150}

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Results

768 pictures of 64 never seen diamonds

100% mAP K-NN (k=5) 8 reference pictures
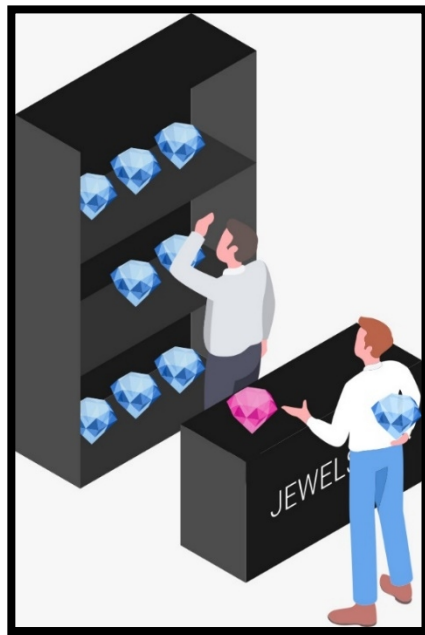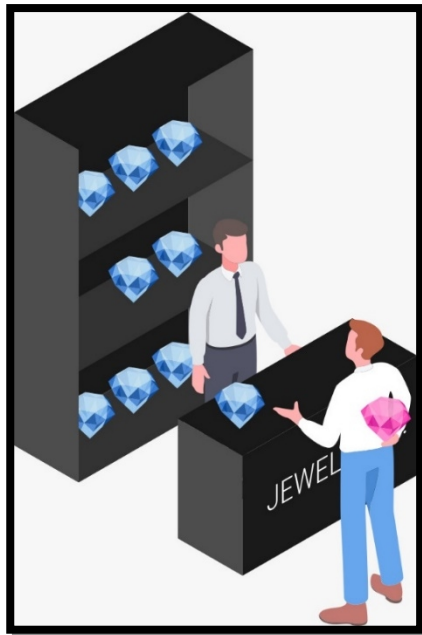
98,4% mAP Euclidean distance 1 reference picture

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Results

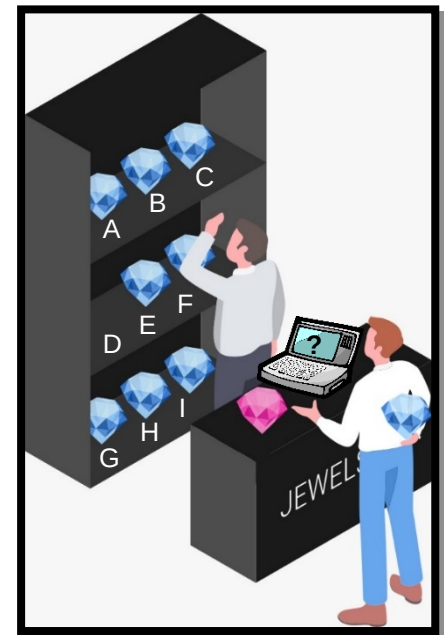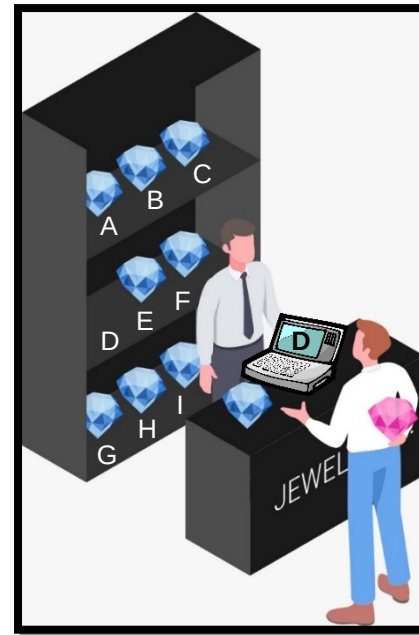Network configurations (nearest average as compare technique)

Network	Input res.	Vector dim.	Accuracy
Darknet V2	600 x 600	1024	98.4%
	256 x 256	1024	96.9%
Darknet V3		1024	97.8%
	600 x 600		97.5%
		128	95.6%
Resnet	600 x 600	256	97.0%

Summarize

In the past

Now

100% mAP K-NN (k=5) 8 reference pictures

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Questions ?

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