

# Convolutional Neural Network for Surgical Tool Detection



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# Motivation

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- Immense Pressure

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- Decision with incomplete data

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- Immense Pressure
- Decision with incomplete data
  - Preventable medical errors

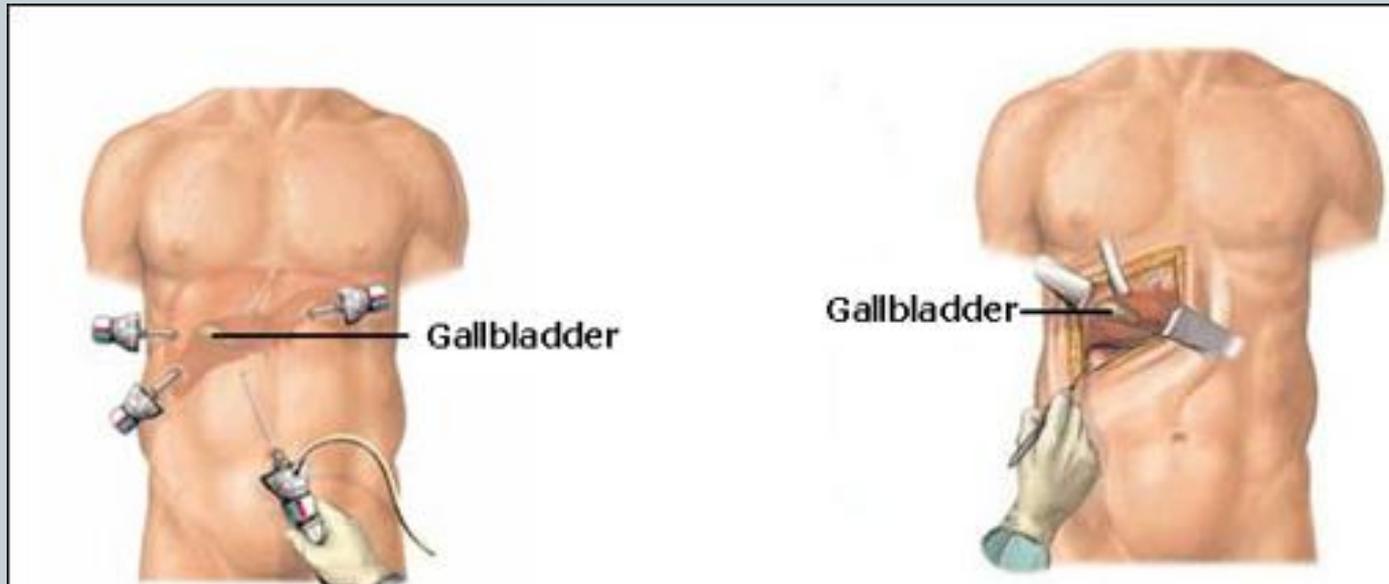
# Motivation

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- Immense Pressure
- Decision with incomplete data
  - Preventable medical errors
- Computer Assisted Intervention (CAI)

# Computer Assisted Intervention

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## Cholecystectomy

[aasthahealthcare.com](http://aasthahealthcare.com)

# Tool Presence Detection

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- **M2CAI16**
  - Detect 7 surgical tools
  - Presence – not localization

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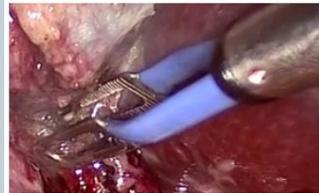
Grasper



Hook



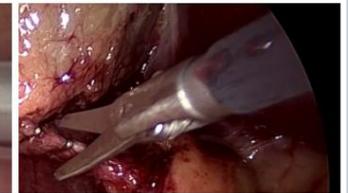
Clipper



Bipolar



Irrigator



Scissors



Specimen bag

# Transfer learning

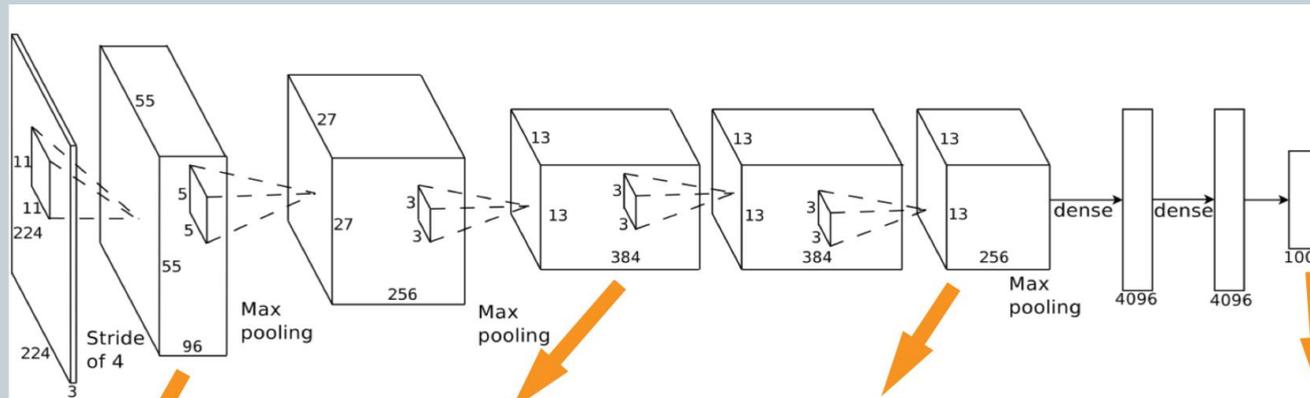
10



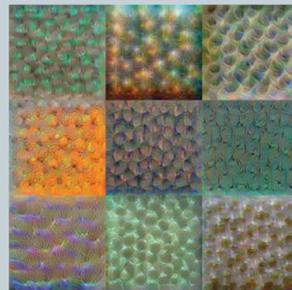
# CNN

11

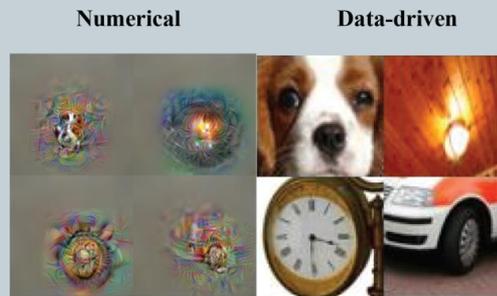
- Key Idea: Model-based Transfer Learning
  - the internal layers of the CNN can act as a generic extractor of mid-level image representation



Conv 1: Edge+Blob



Conv 3: Texture



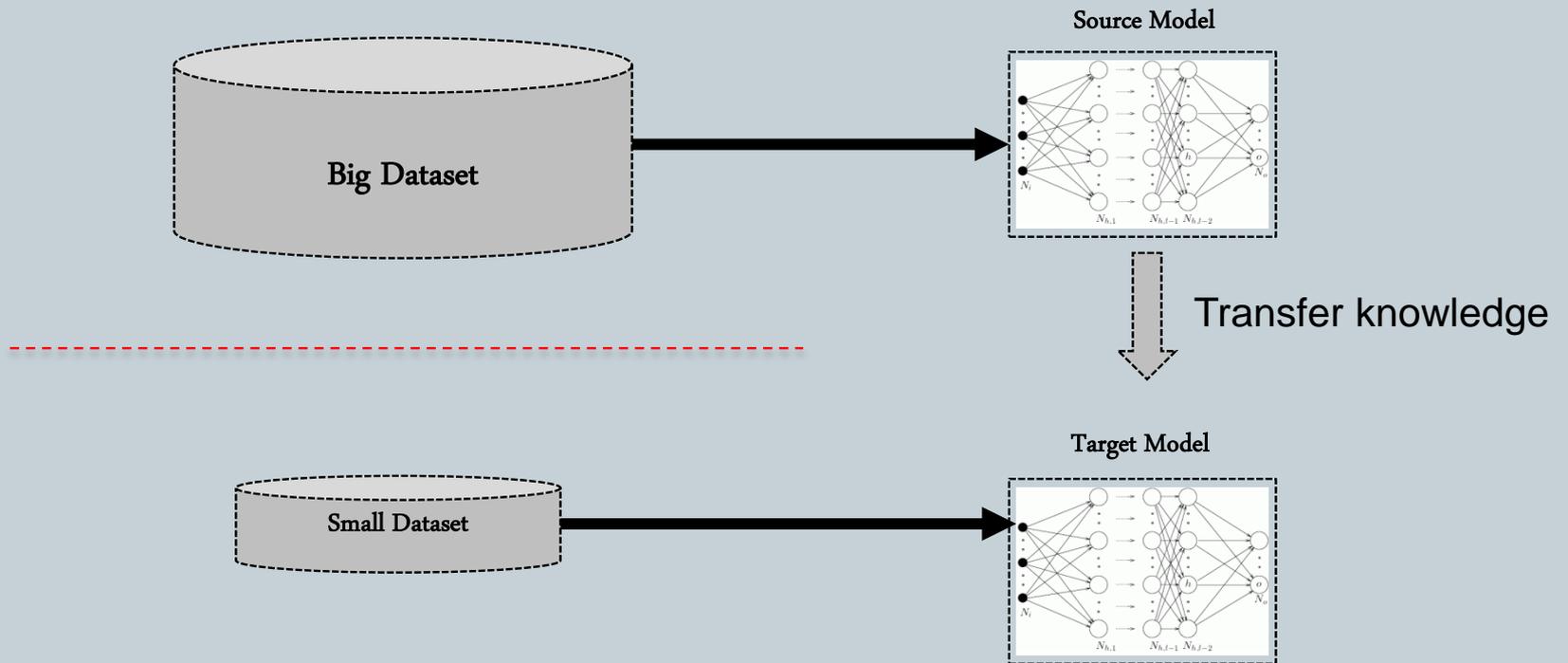
Conv 5: Object Parts



Fc8: Object Classes

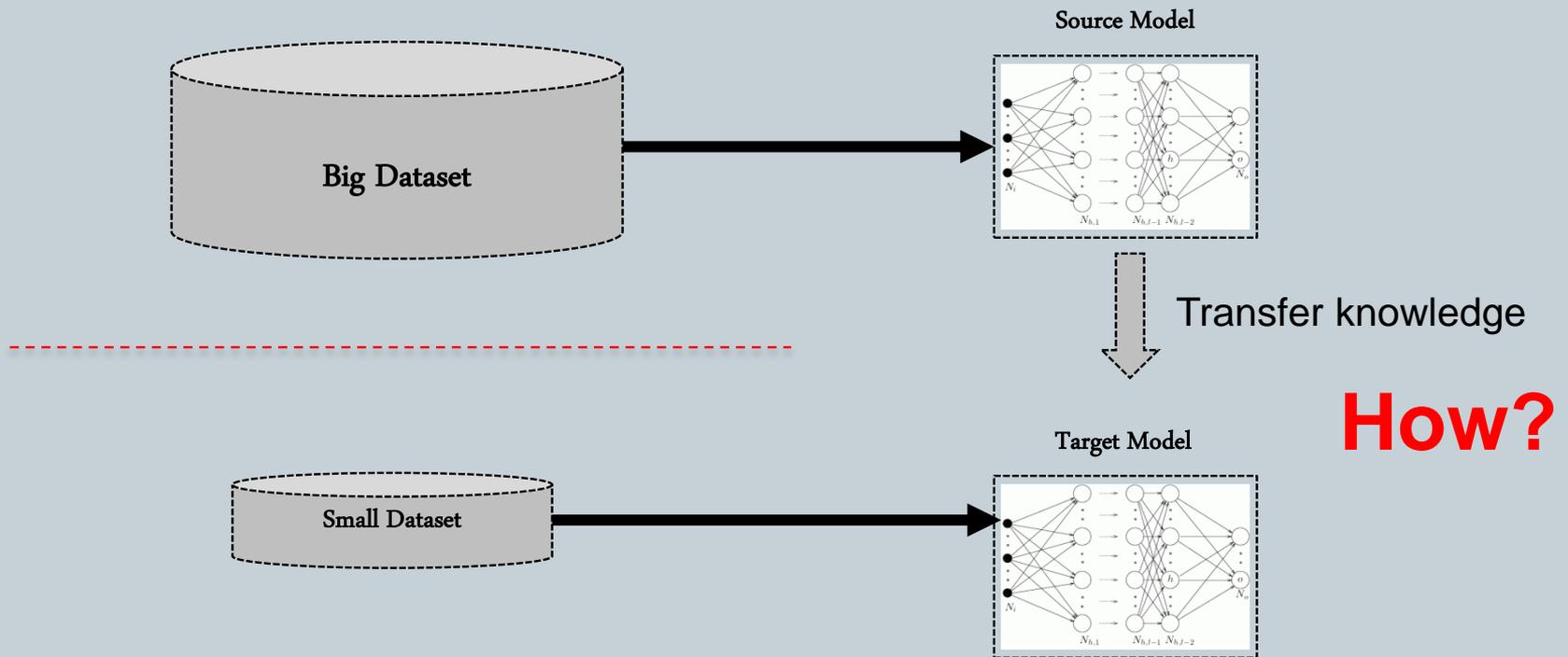
# Transfer learning

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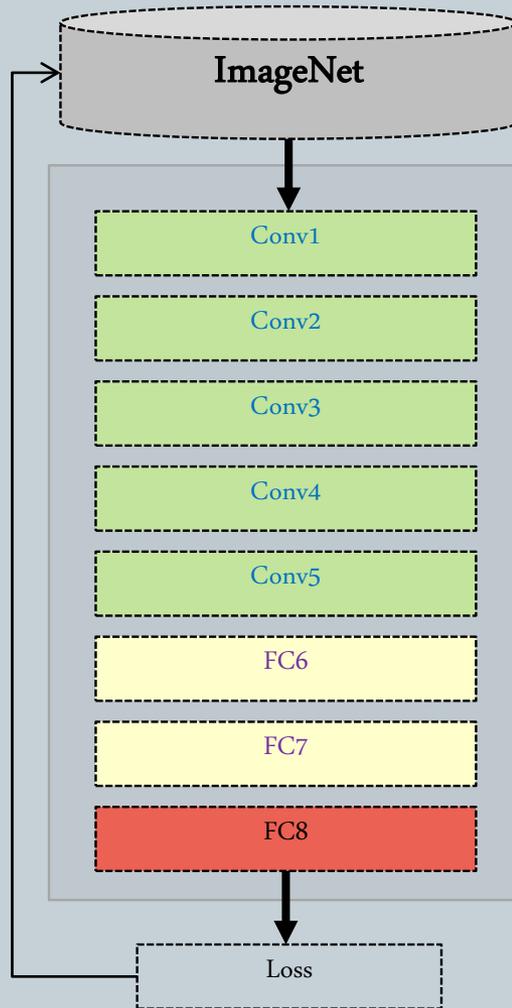
# Transfer learning

13



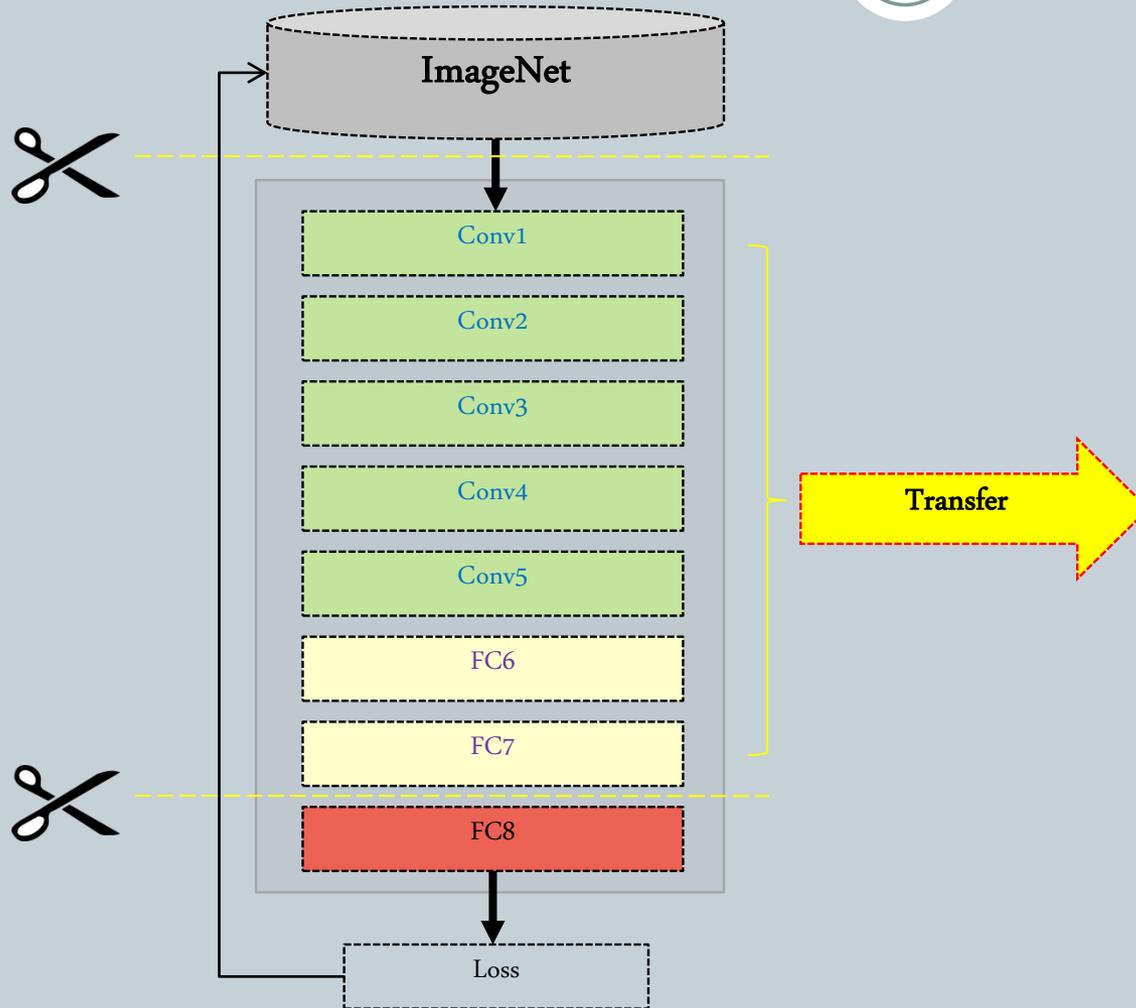
# Transfer learning CNN

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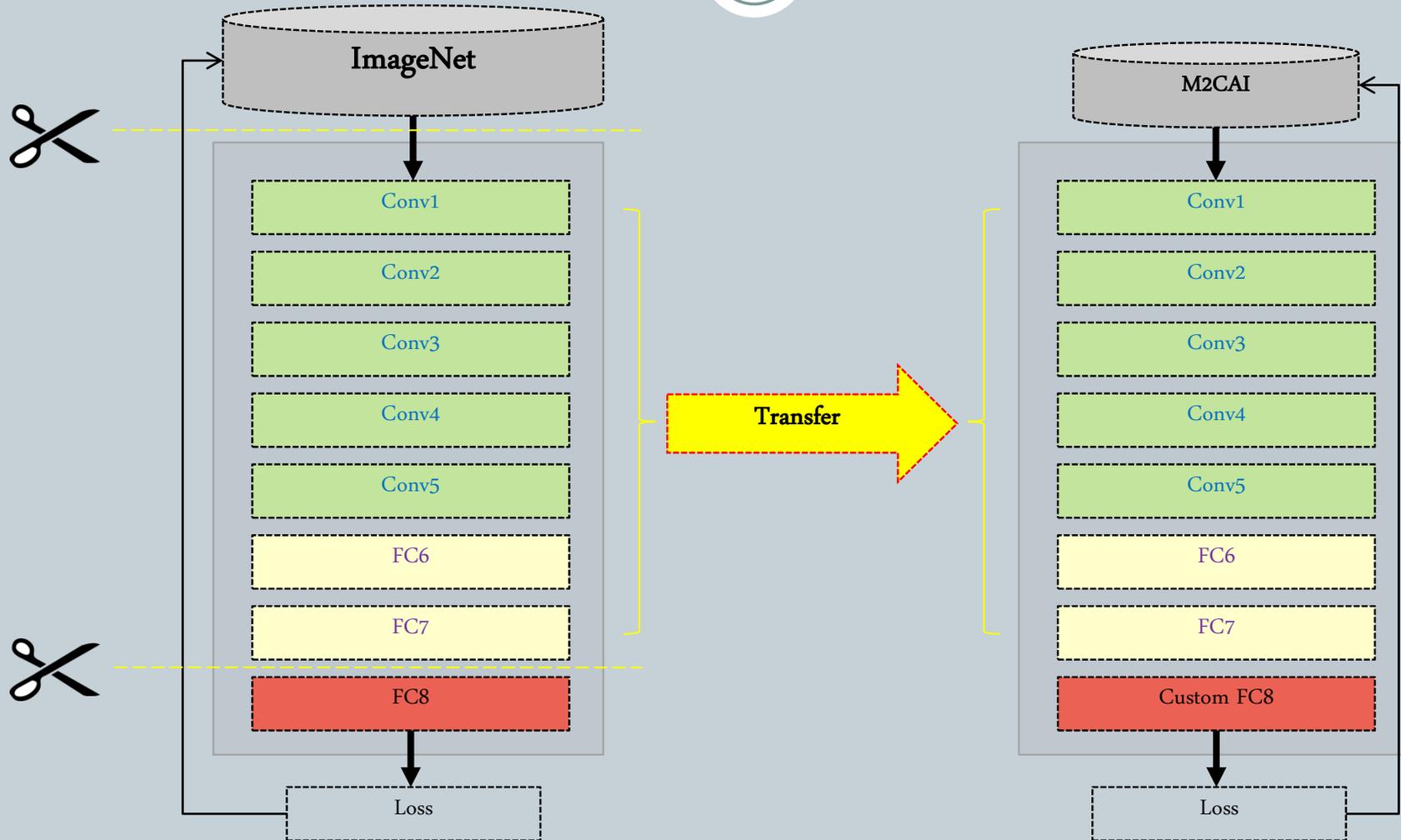
# Transfer learning CNN

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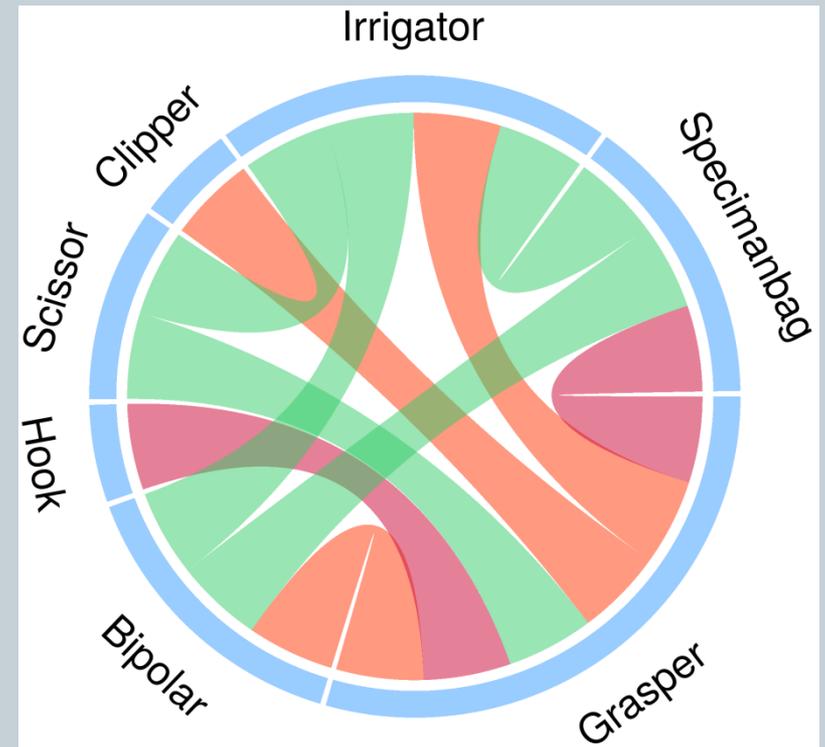
# Transfer learning CNN

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# Tool Co-occurrence and imbalance

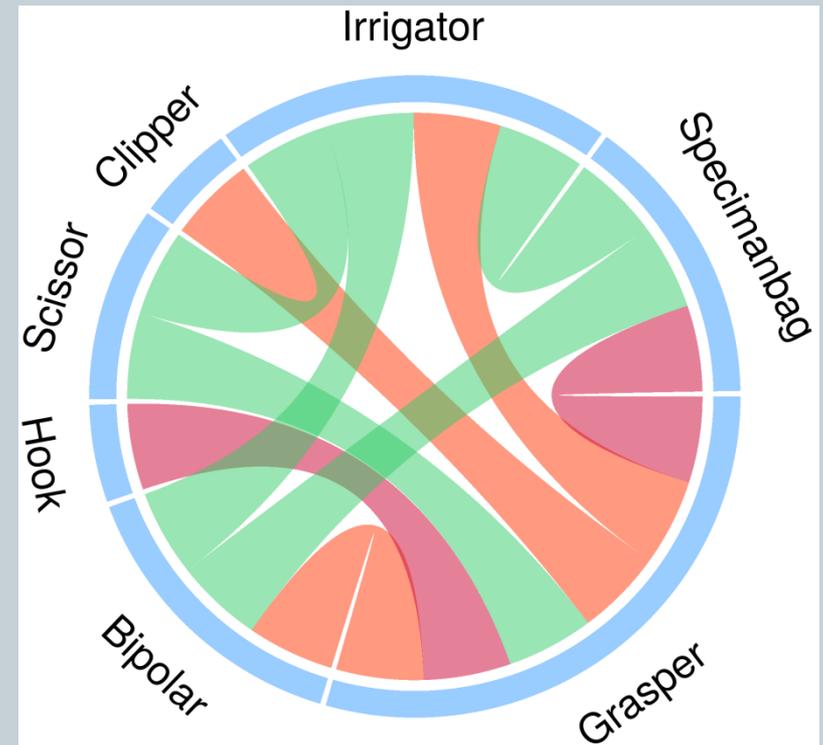
17



# Tool Co-occurrence and imbalance

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Tools	Training	Testing
Grasper	1.28	1.13
Bipolar	22.25	20.76
Hook	1.0	1.0
Scissors	34.37	47.17
Clipper	16.09	23.66
Irrigator	14.82	46.88
Specimen Bag	9.39	15.43

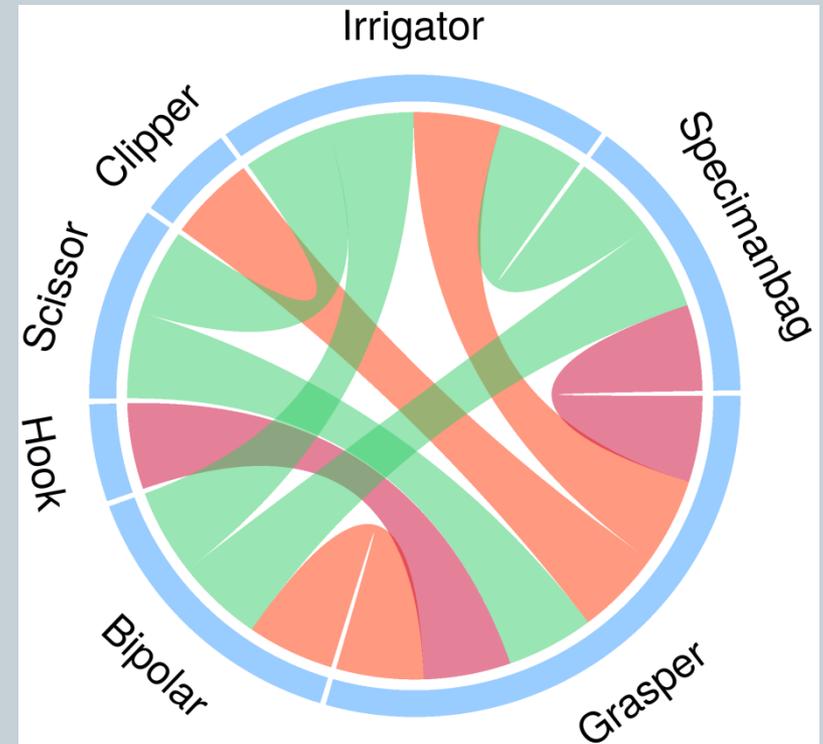


# Tool Co-occurrence and imbalance

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- Stratified sampling to handle imbalance

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# Results

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- M2CAI Tool videos (10 Training, 5 Testing)
  - Transfer learning AlexNet features (ImageNet classification)

	Toolnet <sup>16</sup>	Sahu et al. <sup>12</sup>	Raju et al. <sup>10</sup>	Proposed
MeanAP	0.525	0.539	0.638	0.654

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# Results

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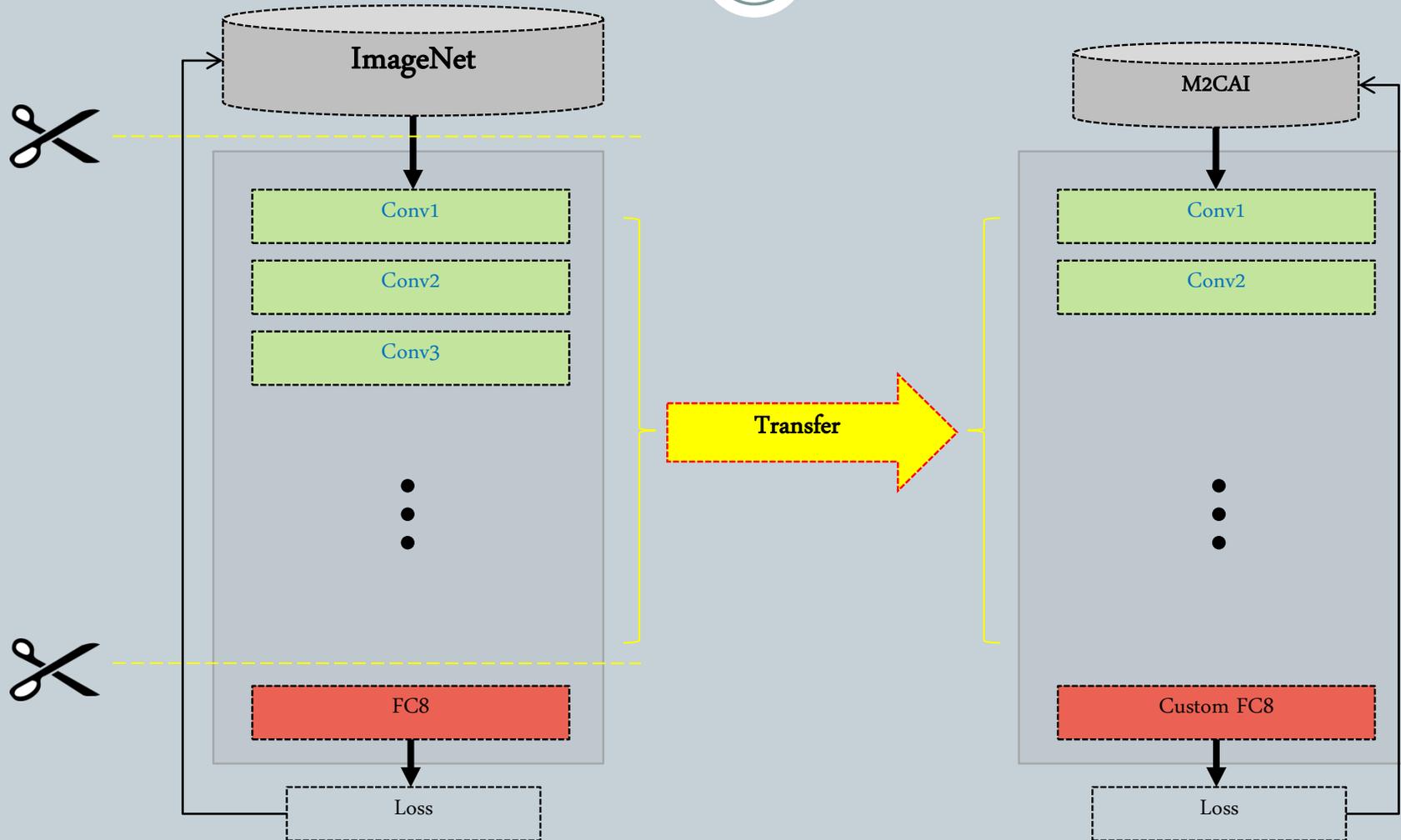
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- Cholec80 Tool videos (40 Training, 40 Testing)
  - Transfer learning AlexNet
  - Transfer learning ResNet-50

# Transfer learning

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# Results

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- Cholec80 Tool videos (40 Training, 40 Testing)

Tools	EndoNet <sup>18</sup>	ZIBNet <sup>17</sup> -AlexNet <sup>11</sup>	ZIBNet <sup>17</sup> -ResNet <sup>6</sup>
Grasper	84.8	86.6	90.5
Bipolar	86.9	94.8	95.6
Hook	95.6	98.8	99.3
<b>Scissors</b>	58.6	68.8	86.8
Clipper	80.1	85.0	96.5
Irrigator	74.4	77.2	89.7
Specimen Bag	86.8	88.3	96.1
<b>MeanAP</b>	81.0	85.7	<b>93.5</b>

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**Thank you for your attention!**

# Contact



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