Human Blastocyst Classification after In Vitro Fertilization Using Deep Learning

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INTRODUCTION

- Visual assessment of embryo quality after IVF by embryologists
- Variability among assessors remains one of the main causes of the low success rate of IVF [1]
- Recent studies also explored the possibilities to automate embryo assessments for IVF [2, 3, 4] from day 5 embryo images
- Can we do it with day 3 embryos which only require simple salt solution for the media?

DATASET

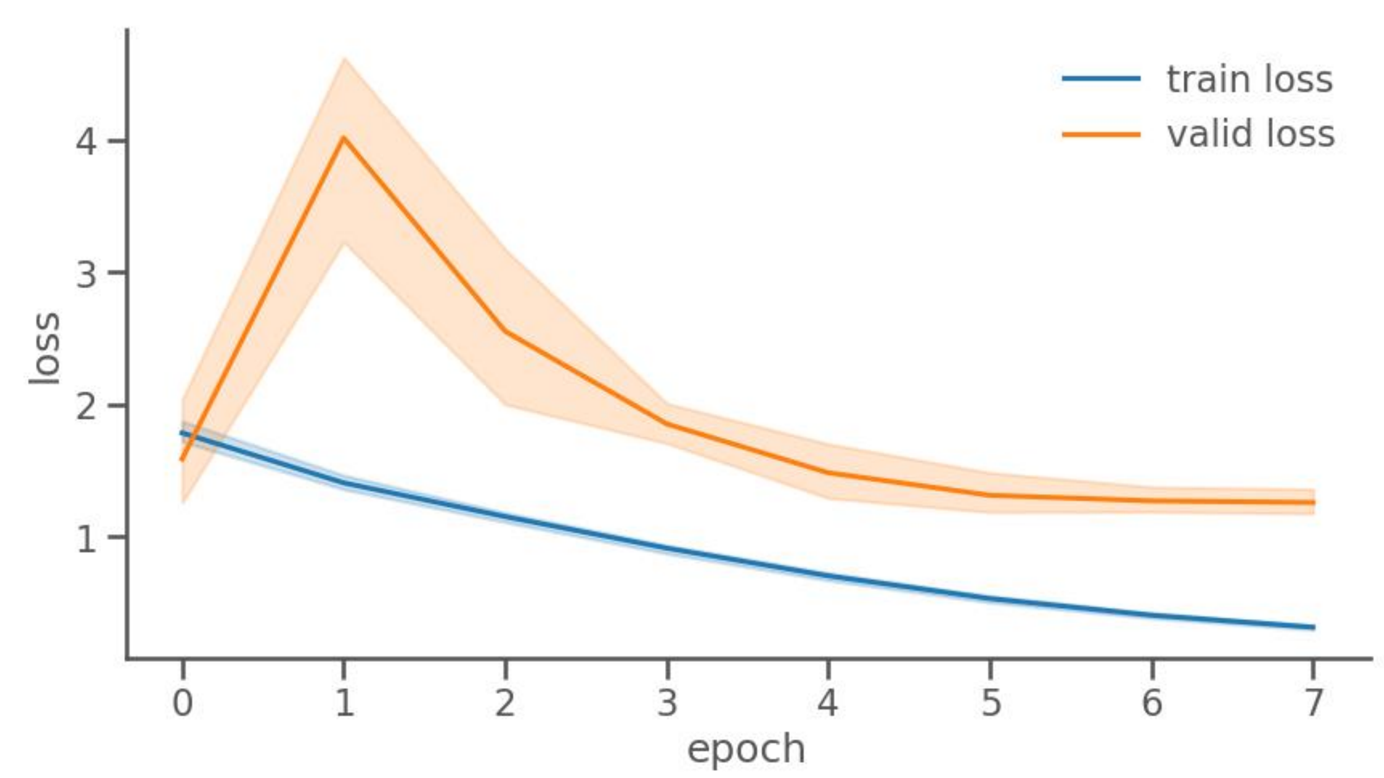
- A total of 1084 images from 1226 embryos of 246 IVF cycles at Yasmin IVF Clinic, Jakarta, Indonesia
- Captured by an inverted microscope at day 3 after fertilization
- A team of 4 embryologists graded them 1-5 by using Veeck criteria [5], but there is only grade 1 to grade 3 embryos in the samples
- This yields 1226 images consisting of: 459 grade 1, 620 grade 2, and 147 grade 3 embryos
- Preprocessed using fast.ai default preprocessor

Code available at https://bit.ly/embryo-uai-ui

METHODS

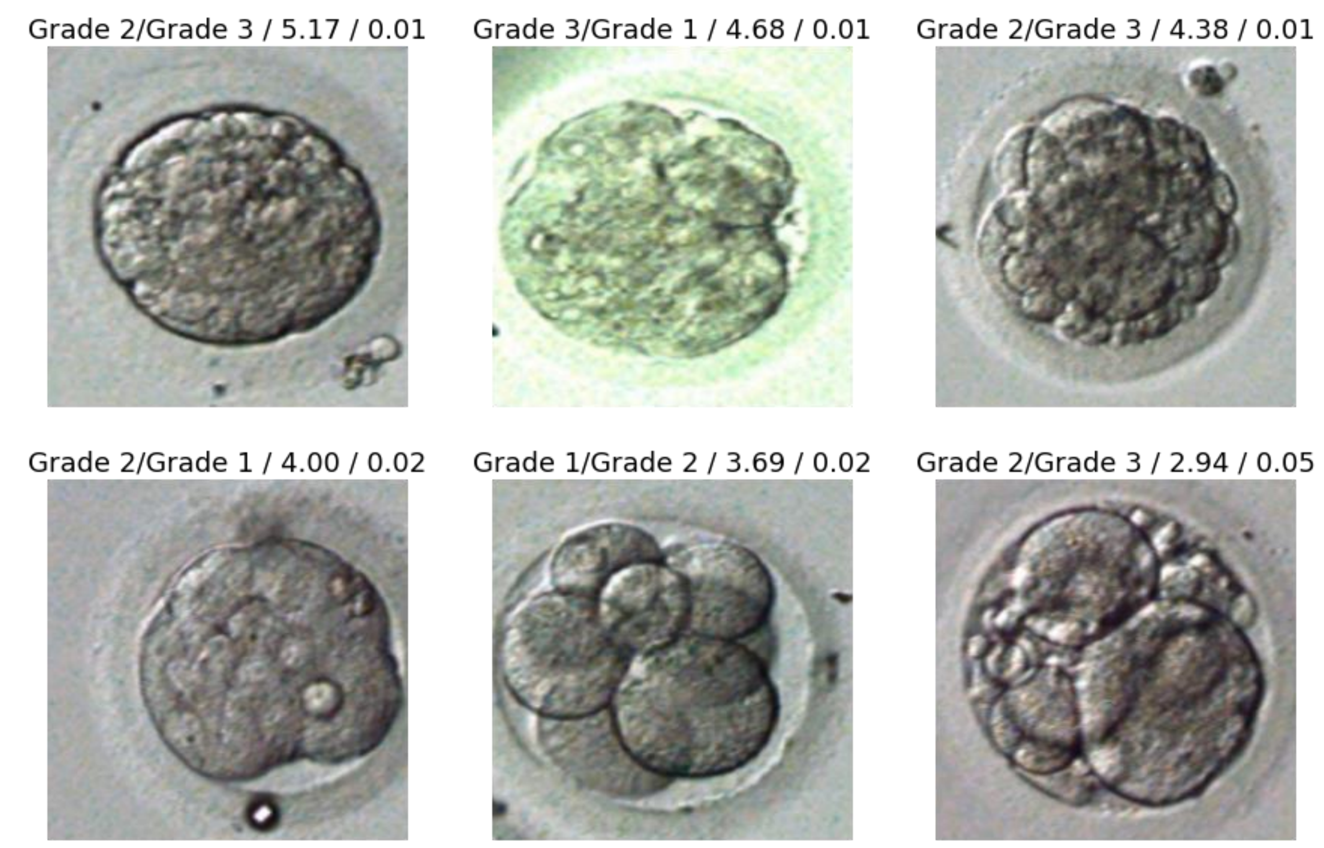
- fast.ai library, cyclical learning rate
- Fine-tuning pre-trained convolutional neural networks: ResNets, DenseNets, Xception, MobileNetV2
- Repeated 5 times to get the average results due to randomization

RESULTS



model	accuracy	loss
ResNet18	$89.38\% \pm 0.75\%$	0.3312 ± 0.0330
ResNet34	$89.97\% \pm 1.27\%$	0.3495 ± 0.0343
ResNet50	$\mathbf{91.79\% \pm 0.48\%}$	$\mathbf{0.3114 \pm 0.0253}$
ResNet101	$91.07\% \pm 1.00\%$	0.3749 ± 0.0623
DenseNet121	$89.97\% \pm 0.27\%$	0.3567 ± 0.0365
DenseNet169	$91.14\% \pm 0.54\%$	0.3472 ± 0.0366
Xception	$88.86\% \pm 0.96\%$	0.3209 ± 0.0206
MobileNetV2	$91.14\% \pm 0.84\%$	0.3442 ± 0.0258

RESULTS, CONT.



CONCLUSIONS

- Best accuracy of 91.79% by ResNet50
- More complex models failed to achieve better accuracy
- MobileNetV2 with fewer parameters achieved 91.14% accuracy, similar to the best model
- Problems in different shades of colour and digital obstructions from the image processing software

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