



Chair for Computer Aided Medical Procedures (CAMP)  
Seminar on  
**Deep Learning for Medical Applications**

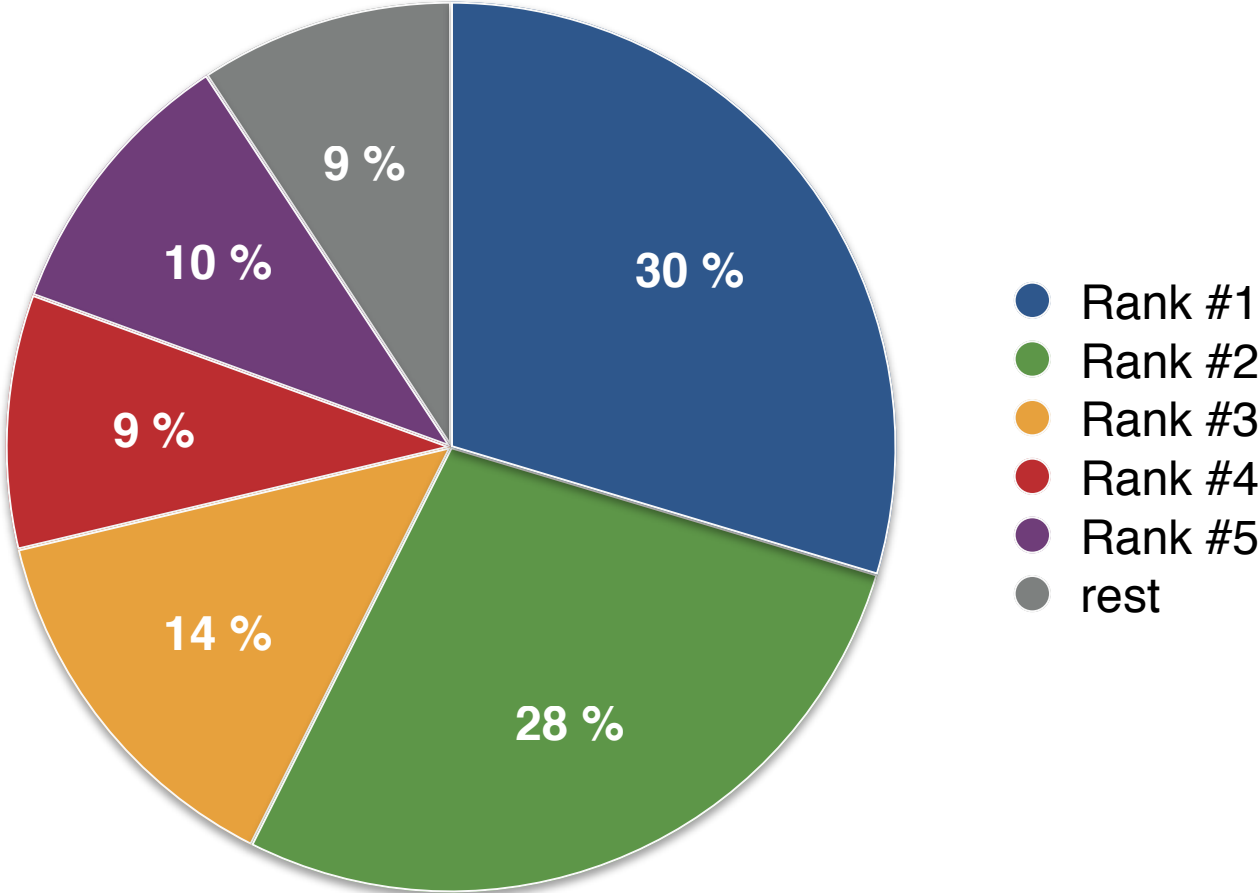
**Shadi Albarqouni**  
**Christoph Baur**



Technische Universität München

# Results of matching system obtained via [matching.in.tum.de](http://matching.in.tum.de)

**108 Applicants**





Chair for Computer Aided Medical Procedures (CAMP)  
Practical course on  
**Machine Learning in Medical Imaging**

**Course Regulations**



Technische Universität München

# Basic Info about the course

- **Type:** Master Seminar (IN2107)
- **Language:** English
- **SWS:** 2
- **ECTS:** 5 Credits
- **Webpage:**
  - <http://campar.in.tum.de/Chair/TeachingWs17DLMA> (files are password-protected)
  - Username/Password: DLMAws17
- **Time:**
  - Mondays, 12-14
- **Location:**
  - CAMP Seminar Room (03.13.010)
- **Requirements:**
  - Good Background in Machine Learning methods.



# Schedule

Date	Topic	Slides	Students
10.07.2017	Preliminary Meeting	<a href="#">slides</a>	Students who join this meeting and show their interest will have high priority!
16.10.2017	Paper Assignment		
23.10.2017	Kick-Off Session	<a href="#">Review</a>	
06.11.2017	Presentation Session 1		Patwari, Hartmann, Rana, Haninger
13.11.2017	Presentation Session 2		Schukraft, Einarsson , Haradhun, Gong
04.12.2017	Presentation Session 3		Muneer Ahmad, Pinheiro Pereira, Arsalan
11.12.2017	Presentation Session 4		Kowatsch, Smits Serena, Tselousov
08.01.2018	Presentation Session 5		Saha, Barthel, De Almeida Lirio Dourado
15.01.2018	Presentation Session 6		Bohare, Sedra, Kasperek



# Papers

No	Title	Conference/Journal	Tutor	Student	Link
1	Automatic Vertebra Labeling in Large-Scale 3D CT using Deep Image-to-Image Network with Message Passing and Sparsity Regularization	IPMI 2017	Anjany		PDF
2	SpineNet: Automatically Pinpointing Classification Evidence in Spinal MRIs	MICCAI 2016	Anjany	Einarsson	PDF
3	Beyond a gaussian denoiser: Residual learning of deep cnn for image denoising.	IEEE TIP 2017	Sai	Rena	PDF
4	Fast convolutional neural network training using selective data sampling: Application to hemorrhage detection in color fundus images.	IEEE TMI 2016	Hassan	Schukraft	HTML
5	Adversarial training and dilated convolutions for brain MRI segmentation.	arXiv 2017	Mehrdad	Hartmann	PDF
6	Spectral Graph Convolutions on Population Graphs for Disease Prediction	arXiv 2017	Ahmad	De Almeida Lirio Dourado	PDF
7	SurvivaNet: Predicting patient survival from diffusion weighted magnetic resonance images using cascaded fully convolutional and 3D convolutional neural networks	MICCAI 2017	Beatrice	Haradhon	PDF
8	MDNet: A Semantically and Visually Interpretable Medical Image Diagnosis Network	CVPR 2017	Shadi	Pinhoiro Pereira	PDF
9	ChestX-ray8: Hospital-scale Chest X-ray Database and Benchmarks on Weakly-Supervised Classification and Localization of Common Thorax Diseases	CVPR 2017	Shadi	Sedra	PDF
10	3D deeply supervised network for automated segmentation of volumetric medical images	MICCAI 2017	Mehrdad	Patawari	HTML
11	Deep Adversarial Networks for Biomedical Image Segmentation Utilizing Unannotated Images	MICCAI 2017	Beatrice	Cong	HTML
12	Deep Learning for Sensorless 3D Freehand Ultrasound Imaging	MICCAI 2017	Mehrdad		HTML
13	DeepCeed: A Deep Interactive Geodesic Framework for Medical Image Segmentation	arXiv 2017	Ahmad	Berthel	PDF
14	CASD: Curriculum Adaptive Sampling for Extreme Data Imbalance	MICCAI 2017	Magda	Muneer Ahmad	HTML
15	Explaining and Harnessing Adversarial Examples	arXiv 2015	Magda	Bohare	PDF
16	Dipole: Diagnosis Prediction in Healthcare via Attention-based Bidirectional Recurrent Neural Networks	ACM 2017	Gerome	Smits Serena	PDF
17	Learning what to look in chest X-rays with a recurrent visual attention model	arXiv 2017	Gerome	Tselousov	PDF
18	Deep MR to CT Synthesis using Unpaired Data	MICCAI 2017	Christoph	Arsalan	PDF
19	Deep Generative Adversarial Neural Networks for Realistic Prostate Lesion MRI Synthesis	arXiv 2017	Christoph		PDF
20	Learning Loss Functions for Semi-supervised Learning via Discriminative Adversarial Networks	arXiv 2017	Shadi (S/3)		PDF
21	Learning from Simulated and Unsupervised Images through Adversarial Training	CVPR 2017	Christoph	Kowatsch	PDF
22	Low Dose CT Image Denoising Using a Generative Adversarial Network with Wasserstein Distance and Perceptual Loss	arXiv 2017	Sai	Haninger	PDF
23	Sharpness-aware Low dose CT denoising using conditional generative adversarial network	arXiv 2017	Sai		PDF
24	Multi-Input Cardiac Image Super-Resolution using Convolutional Neural Networks	MICCAI 2016	Amal		HTML
25	An artificial agent for anatomical landmark detection in medical images	MICCAI 2016	Ahmad	Saha	PDF
26	Fine-tuning Convolutional Neural Networks for Biomedical Image Analysis: Actively and Incrementally	CVPR 2017	Shadi	Kasperk	PDF



# Discussed topics:

- **Tools:**
  - Convolutional Neural Networks (CNN)
  - Recurrent Neural Networks (RNN) - (LSTM)
  - Long Short Term Memory (LSTM)
  - Generative Adversarial Networks (GAN)
  - Convolutional AutoEncoders (CAE)
- **Medical Applications:**
  - Lesion Detection
  - Lesion Segmentation
  - Network Exploration
  - Learning Methodology (Supervised, Semi-Supervised or Unsupervised)
  - Image Parsing
  - Multi-Instance Learning
  - Crowdsourcing



# Presentation (50%)

- 20 minutes + 10 minutes Q&A
- slides (Powerpoints, Latex, see website for templates)
- they should cover all relevant aspects of the paper
  - Motivation
  - Methodology
  - Experimental results
  - Take Home Message
  - Discussion
- self-contained (review of state of the art is necessary!)
- **all students are expected to attend all presentations and interact during Q&A** (this will influence your final mark)





## Report (40%)

- should summarize the paper in **your own words** including one/two figures explaining the methodology
- Summary should include:
  - Purpose
  - Methods
  - Experimental results
  - **Discussion**
- language: English
- max 2 pages
- template on course website (latex) --- lrzgit (shared tex)

## Attendance(10%)



# Roadmap



**Presentation + Written report should be submitted in two weeks right after your presentation (Please check our webpage for more details)**





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Practical course on  
**Machine Learning in Medical Imaging**

**DLMA Topics**



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# Papers from 6 different fields

**CNNs & FCNs**  
10 Papers

**GANs**  
5 Papers

**GCNs**  
1 Paper

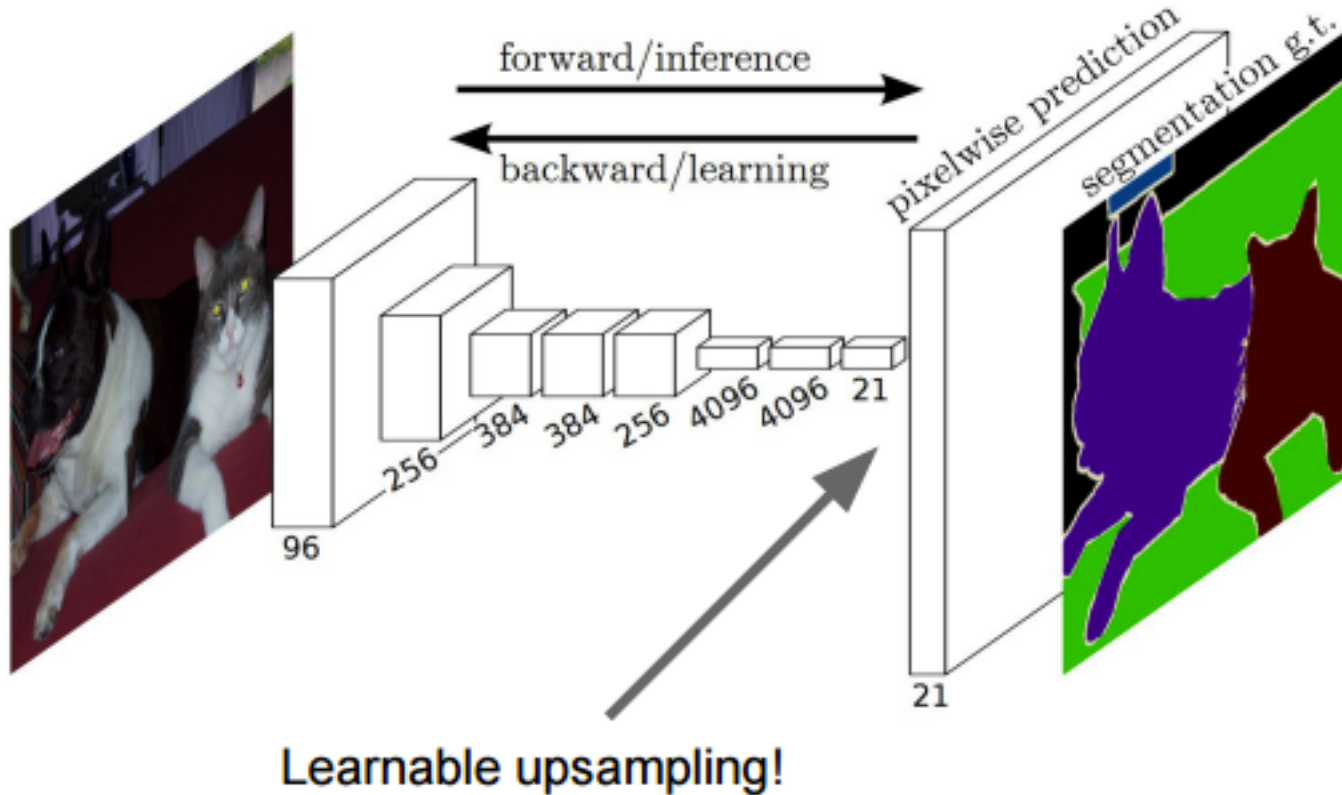
**RNNs & LSTM**  
1 Paper

**Reinforcement  
Learning**  
2 Papers

**Adversarial  
Examples**  
1 Paper



# (Fully) Convolutional Neural Networks



Long, Jonathan, Evan Shelhamer, and Trevor Darrell. "Fully convolutional networks for semantic segmentation." *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2015.



# (Fully) Convolutional Neural Networks

1. Jamaludin, Amir, Timor Kadir, and Andrew Zisserman. "**SpineNet: automatically pinpointing classification evidence in spinal MRIs.**" International Conference on Medical Image Computing and Computer-Assisted Intervention. Springer International Publishing, 2016.
2. Zhang, Kai, et al. "**Beyond a gaussian denoiser: Residual learning of deep cnn for image denoising.**" IEEE Transactions on Image Processing (2017).
3. van Grinsven, Mark JJP, et al. "**Fast convolutional neural network training using selective data sampling: Application to hemorrhage detection in color fundus images.**" IEEE transactions on medical imaging 35.5 (2016): 1273-1284.
4. Christ, Patrick Ferdinand, et al. "**SurvivalNet: Predicting patient survival from diffusion weighted magnetic resonance images using cascaded fully convolutional and 3D convolutional neural networks.**" arXiv preprint arXiv:1702.05941 (2017).
5. Zhang, Zizhao, et al. "**MDNet: a semantically and visually interpretable medical image diagnosis network.**" arXiv preprint arXiv:1707.02485 (2017).

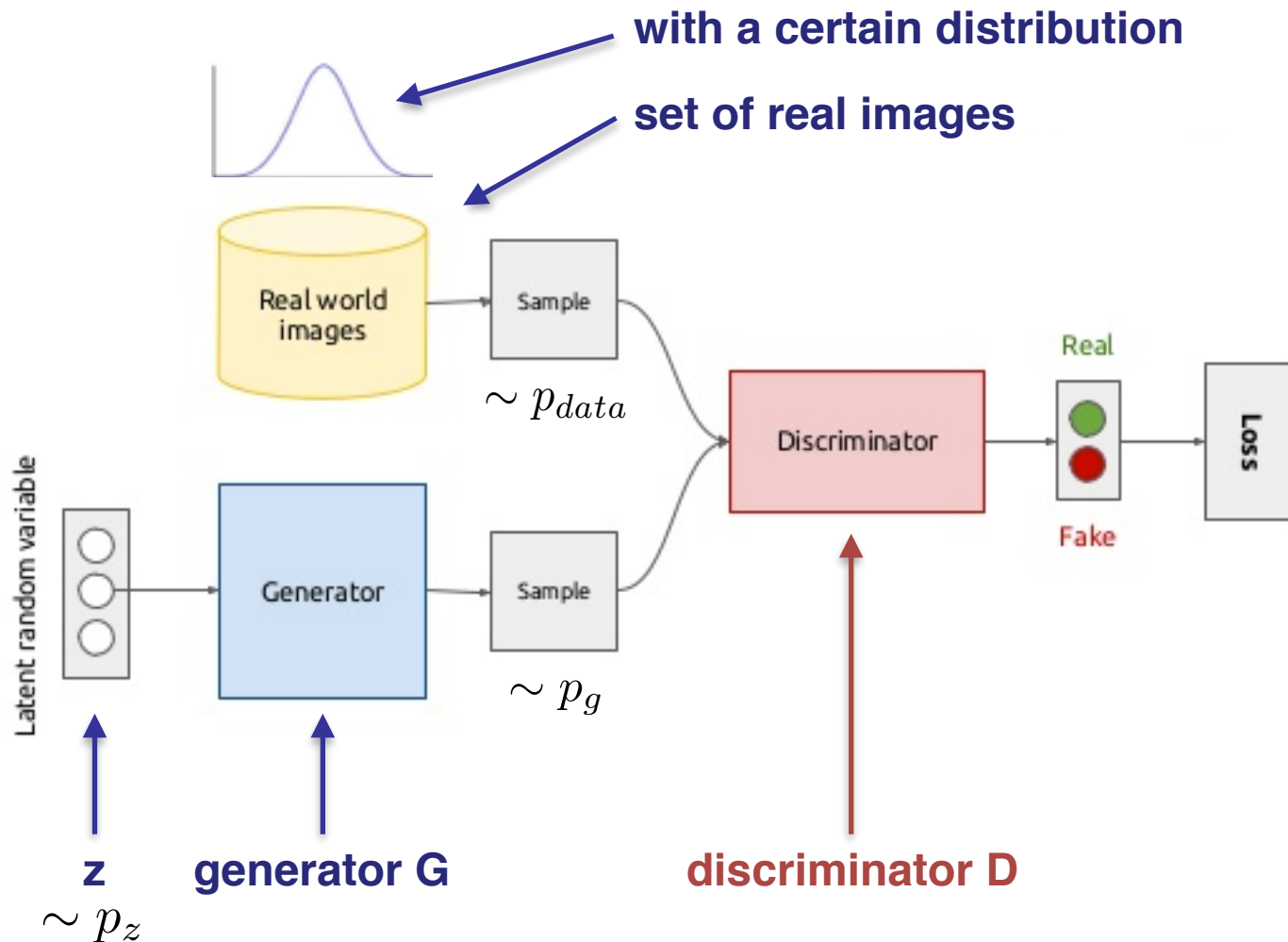


# (Fully) Convolutional Neural Networks

6. Wang, Xiaosong, et al. "**ChestX-ray8: Hospital-scale Chest X-ray Database and Benchmarks on Weakly-Supervised Classification and Localization of Common Thorax Diseases.**" arXiv preprint arXiv:1705.02315 (2017).
7. Dou, Qi, et al. "**3D deeply supervised network for automated segmentation of volumetric medical images.**" Medical Image Analysis (2017).
8. Wang, Guotai, et al. "**Deepigeos: A deep interactive geodesic framework for medical image segmentation.**" arXiv preprint arXiv:1707.00652 (2017).
9. Jesson, Andrew, et al. "**CASED: Curriculum Adaptive Sampling for Extreme Data Imbalance.**" International Conference on Medical Image Computing and Computer-Assisted Intervention. Springer, Cham, 2017.
10. Zhou, Zongwei, et al. "**Fine-tuning Convolutional Neural Networks for Biomedical Image Analysis: Actively and Incrementally.**" Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2017.



# Generative Adversarial Networks



5

Goodfellow, Ian, et al. "Generative adversarial nets." *Advances in neural information processing systems*. 2014.





# Generative Adversarial Networks

1. Yang, Qingsong, et al. "**Low Dose CT Image Denoising Using a Generative Adversarial Network with Wasserstein Distance and Perceptual Loss.**" *arXiv preprint arXiv:1708.00961* (2017).
2. Moeskops, Pim, et al. "**Adversarial training and dilated convolutions for brain MRI segmentation.**" *Deep Learning in Medical Image Analysis and Multimodal Learning for Clinical Decision Support*. Springer, Cham, 2017. 56-64.
3. Zhang, Yizhe, et al. "**Deep Adversarial Networks for Biomedical Image Segmentation Utilizing Unannotated Images.**" *International Conference on Medical Image Computing and Computer-Assisted Intervention*. Springer, Cham, 2017.
4. Wolterink, Jelmer M., et al. "**Deep MR to CT Synthesis Using Unpaired Data.**" *International Workshop on Simulation and Synthesis in Medical Imaging*. Springer, Cham, 2017.
5. Shrivastava, Ashish, et al. "**Learning from simulated and unsupervised images through adversarial training.**" *arXiv preprint arXiv:1612.07828* (2016).



# Reinforcement Learning

1. Ghesu, Florin C., et al. "**An artificial agent for anatomical landmark detection in medical images.**" *International Conference on Medical Image Computing and Computer-Assisted Intervention*. Springer International Publishing, 2016.
2. Ypsilantis, Petros-Pavlos, and Giovanni Montana. "**Learning what to look in chest X-rays with a recurrent visual attention model.**" arXiv preprint arXiv:1701.06452 (2017).



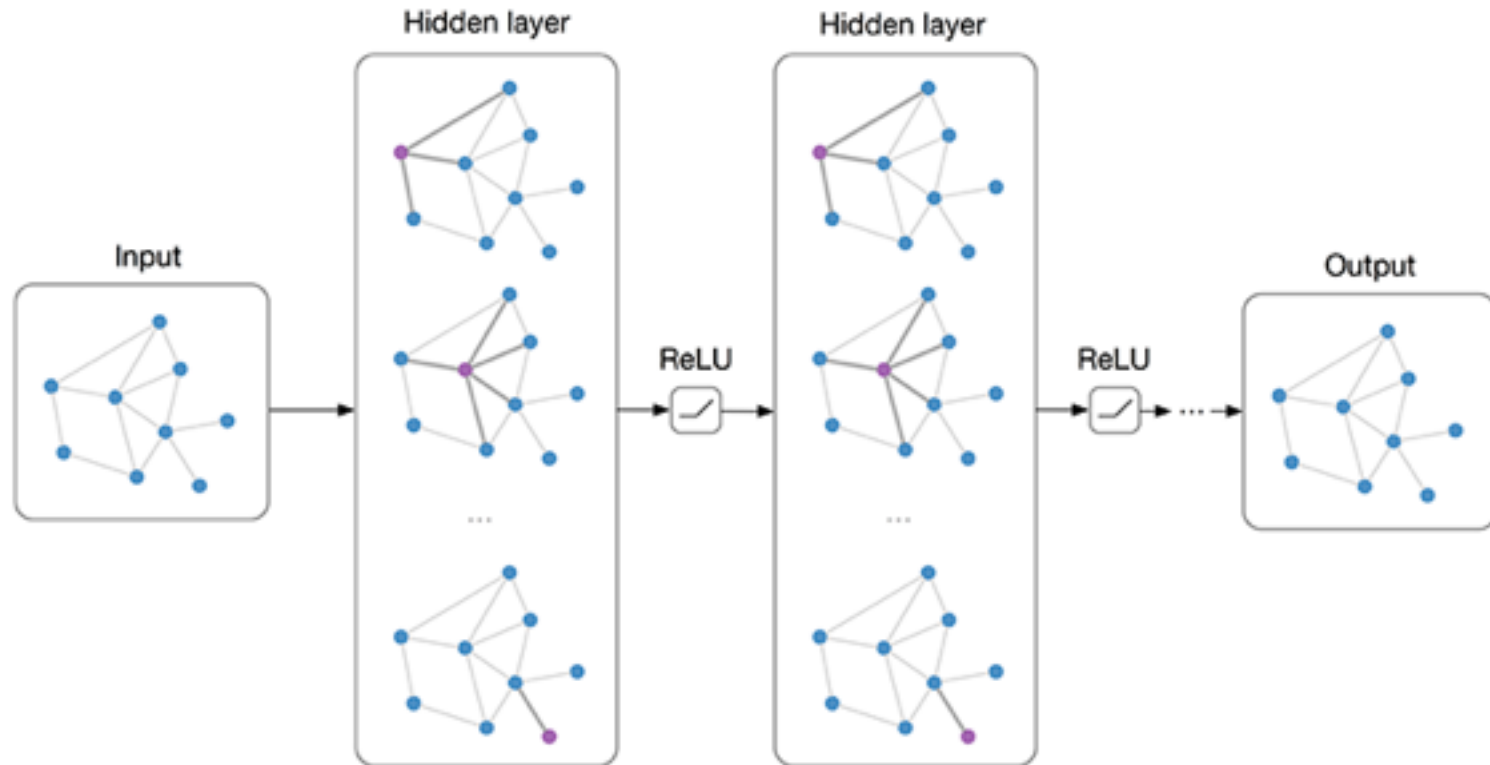
# Recurrent Neural Networks

1. Ma, Fenglong, et al. "**Dipole: Diagnosis Prediction in Healthcare via Attention-based Bidirectional Recurrent Neural Networks.**" Proceedings of the 23rd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining. ACM, 2017.



# Graph Convolutional Neural Networks

1. Parisot, Sarah, et al. "**Spectral Graph Convolutions on Population Graphs for Disease Prediction.**" arXiv preprint arXiv:1703.03020(2017).



*Kipf, Thomas N., and Max Welling. "Semi-supervised classification with graph convolutional networks." arXiv preprint arXiv:1609.02907 (2016).*



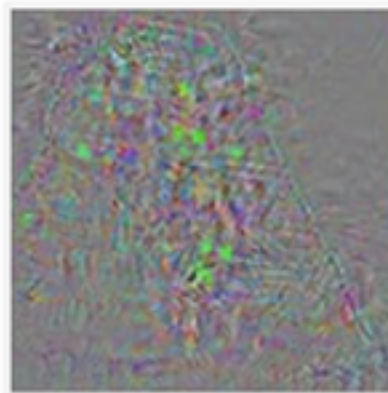
# Adversarial Examples

1. Goodfellow, Ian J., Jonathon Shlens, and Christian Szegedy. "**Explaining and harnessing adversarial examples.**" arXiv preprint arXiv:1412.6572 (2014).



**Original image**

Temple (97%)



**Perturbations**



**Adversarial example**

Ostrich (98%)

