

Deep Learning and God?

Using Convolutional Neural Networks and Data Science to Explore Patterns of Religiosity over Centuries



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Today's agenda

- Motivation of the project.
- Mask R-CNN.
- Timeline of the project.
- Performance of the network.
- Statistical results on religiosity and lifespan.
- What could have been done differently?
- What more can be done?
- Conclusion.

Motivation



Why gravestones?

- Previous work used them, manually [2].
- Are symbols indicative of the persons life?
- Assume that religious symbols on gravestones indicate a more religious life.



Research questions

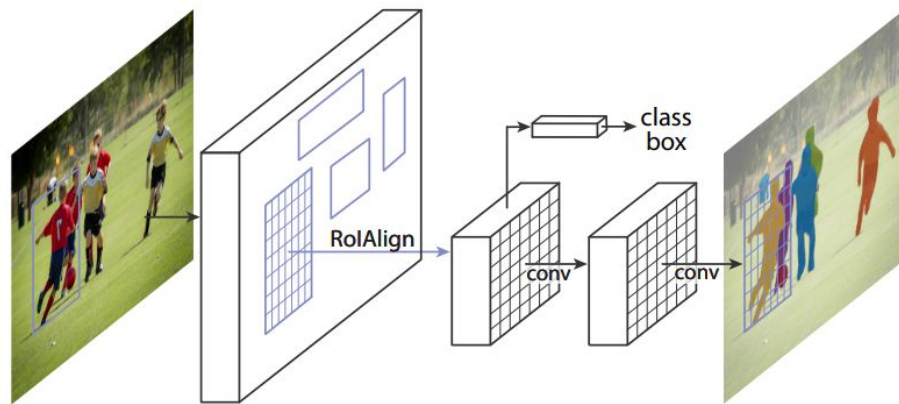
- *How well can religious symbolism on gravestones be classified using a convolutional neural network?*
- *Is symbol detection done by using a convolutional neural network good enough to identify similar correlation between religiosity and lifespan as in [2]?*

Convolutional Neural Network

- Type of neural network generally used for analyzing images.
- Always includes a convolutional layer.
- Can include a nonlinear layer, pooling layer and fully connected layer.
- Weight initialization can be done by using transfer learning.
- Forward and backward propagation compute the activations and weights, and optimization method selects how the weights are changed.

Mask R-CNN

- State of the art CNN, which performs object detection and segmentation.
- Developed by Facebook AI Research [4].
- Available on GitHub [5].
- Built out of two parts, *backbone* and *heads*.
- *Backbone* handles convolutional computations, using a deep convolutional network.
- *Heads* handle object classification, bounding-box regression and mask prediction.



[4]

Timeline of project

- **August/September:**
 - Literature review
 - Webscraping setup
 - CNN programming introductions.



Photo added by [totsie](#)

Jacoby Wayne Kerr

BIRTH	1983 USA
DEATH	10 Oct 2011 (aged 27-28) Dallas, Dallas County, Texas, USA
BURIAL	Woodland Park Cemetery Mineral Wells, Palo Pinto County, Texas, USA
MEMORIAL ID	78311993 · View Source

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SAVE TO

SUGGEST EDITS

Webscraping

- <https://www.findagrave.com/>.
- Proved to be a bottleneck.
- All information within a memorials header was scraped.
- Memorials were scraped randomly.
- Minor data modifications had to be made.

Timeline of project

- **August/September:**
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- **October:**
 - Image segmentation
 - Initial training of CNN.



Segmentation

- Neural network needs to be fed knowledge to train on.
- Images segmented using VGG Image Annotator [6].
- Seven symbols segmented.
 - Crosses
 - Angels
 - Doves
 - Star of David
 - Praying hands
 - Bibles
 - Persons

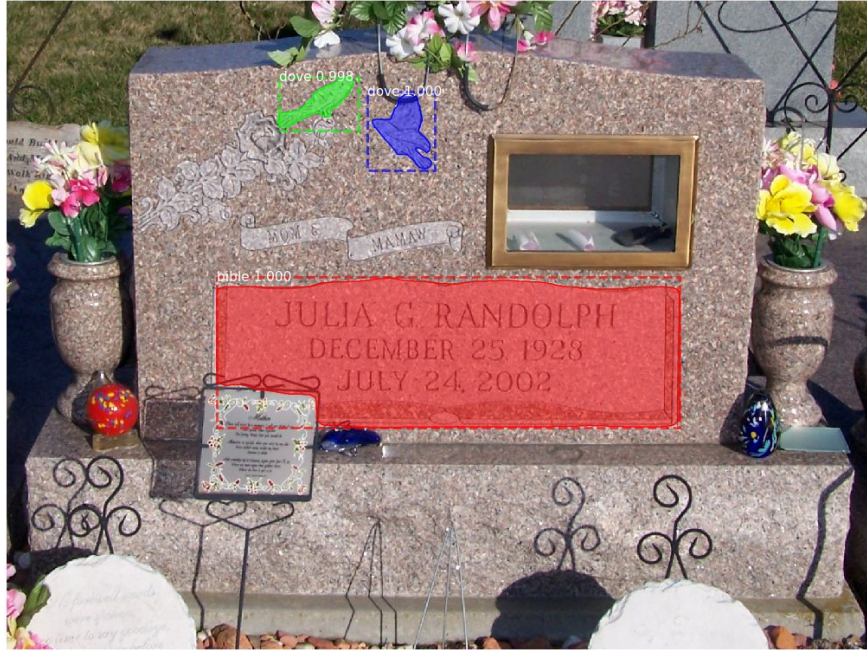
Timeline of project

- **August/September:**
 - Literature review
 - Webscraping setup
 - CNN programming introductions.
- **October:**
 - Image segmentation
 - Initial training of CNN.
- **November:**
 - Random webscraping
 - Image downloading.
 - Training of CNN.
- **December:**
 - Final training of CNN with more segmented data
 - Inference over images
 - Analysis of results.

Training

- Training requires segmented images split into training and validation sets.
- Regularization:
 - L2 regression
 - Augmentations
- Network was trained on 972 segmented images, as well as 268 segmented validation images.
- Training only *heads* returns bad results.

Examples



Overall performance

- mAP is 82.5% when all layers are trained.
- Positive detections for 5/7 classes trained for were above 90% of all detections.
- A lot of false positive doves, and angels also below that threshold.
- A few undetected symbols.

	True:	False:	Undetected:
Angels:	27	4	2
Bibles:	78	4	3
Crosses:	95	7	5
David:	17	1	3
Doves:	21	10	1
Persons:	15	0	0
Praying:	59	6	2

Detection examples

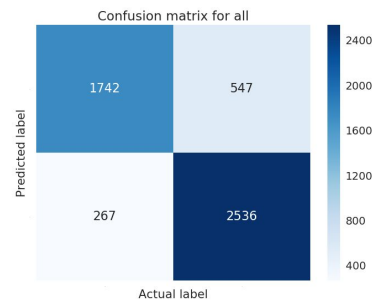
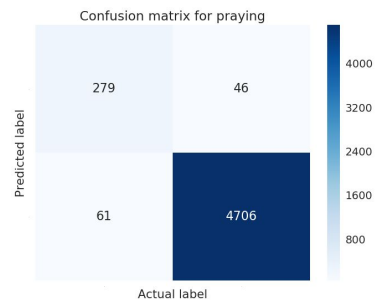
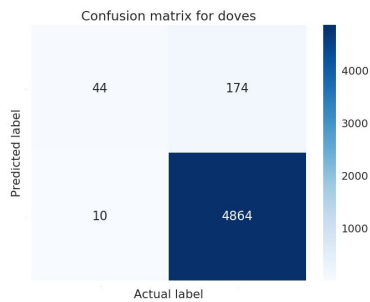
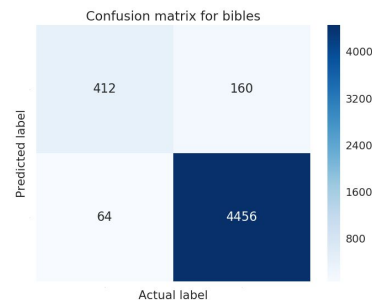
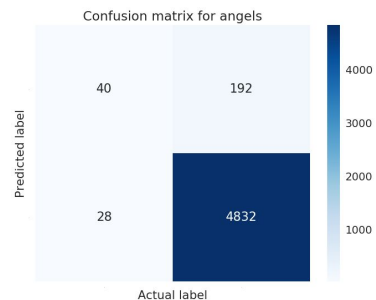
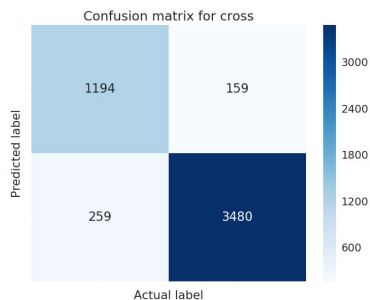
Predictions



Predictions

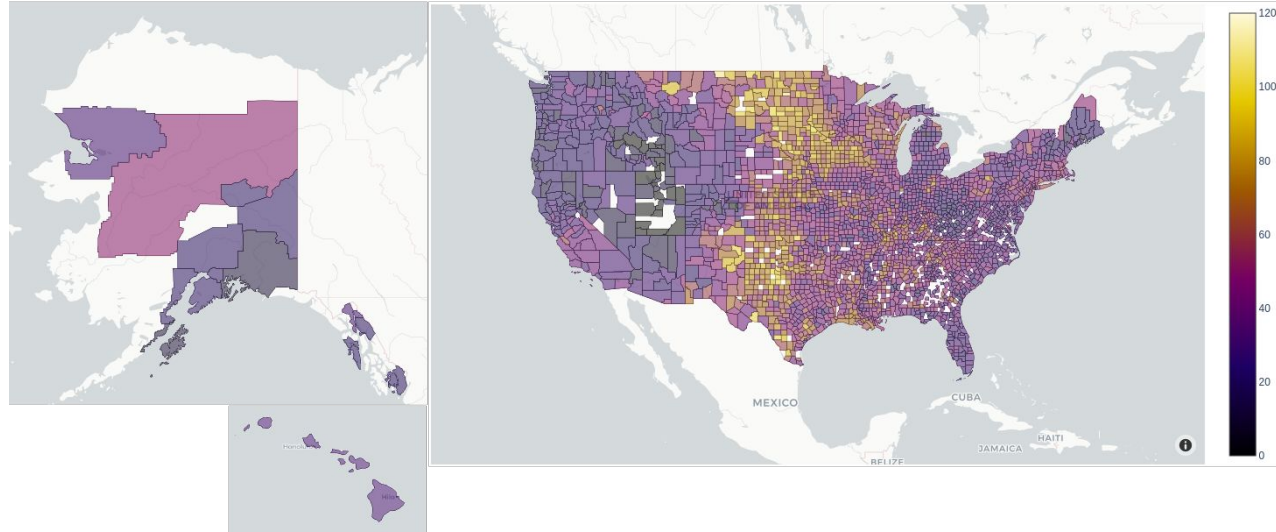


Generalization

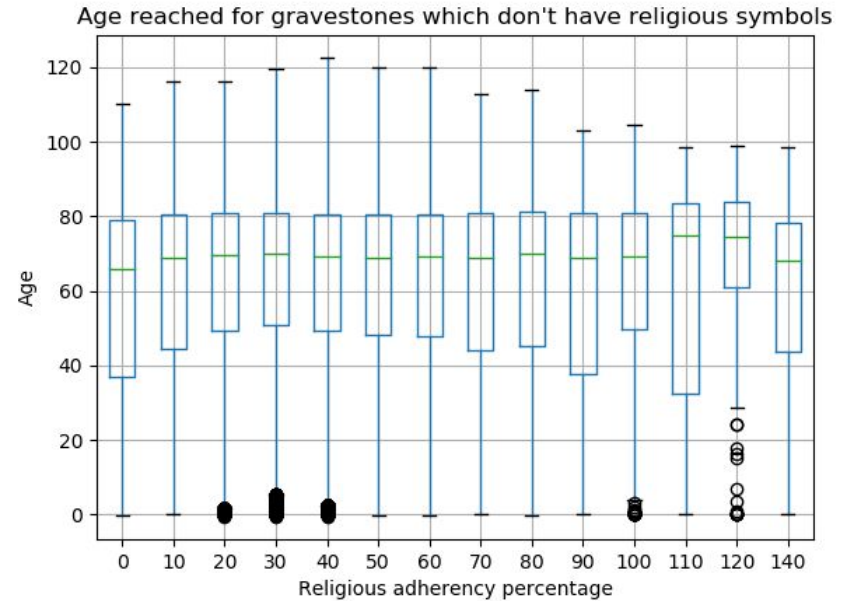
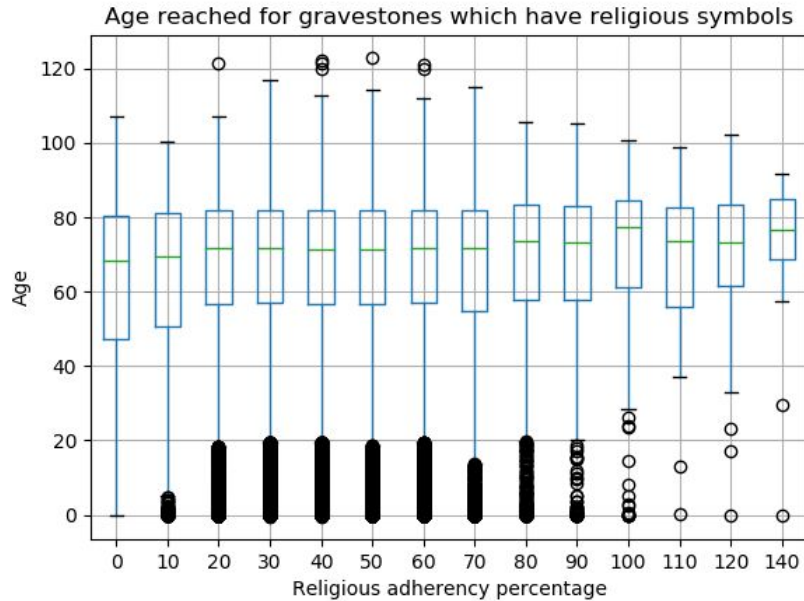


Results from the United States

- Benefits of religion are region specific.
- Over 587 thousand memorials used.
- Memorials from 2918 US counties from every state.
- From 0%-140% religious adherency rate [3].

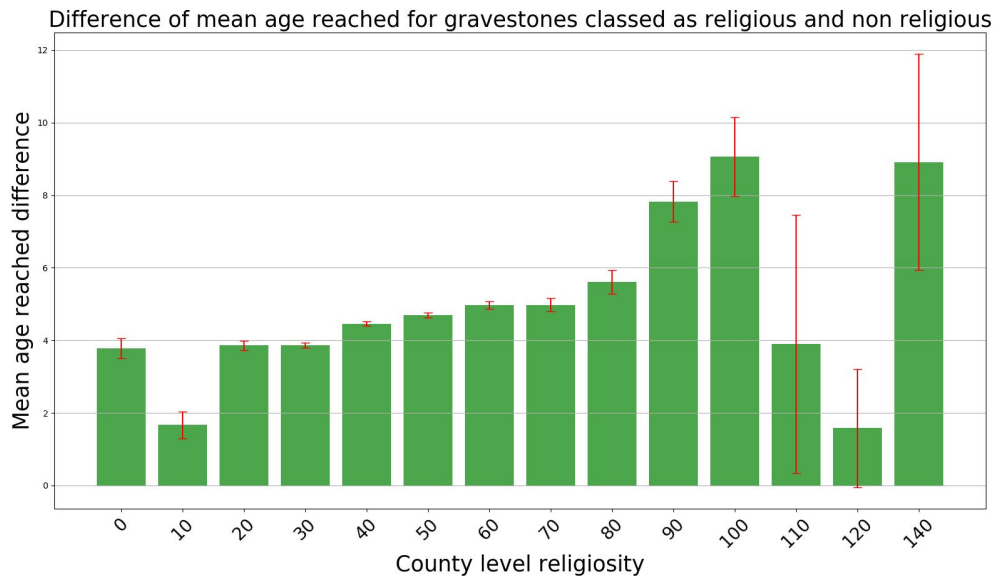


Lifespan distributions



Difference

- Difference of mean age between religious and non-religiously classified memorials.
- Correlation of 0.77 religious gravestones.
- Correlation of 0.36 for non religious gravestones.
- Correlation of 0.51 for difference.
- Whiskers represent standard error of mean.
- 2500 times more samples in 40 group than 110/140 groups.

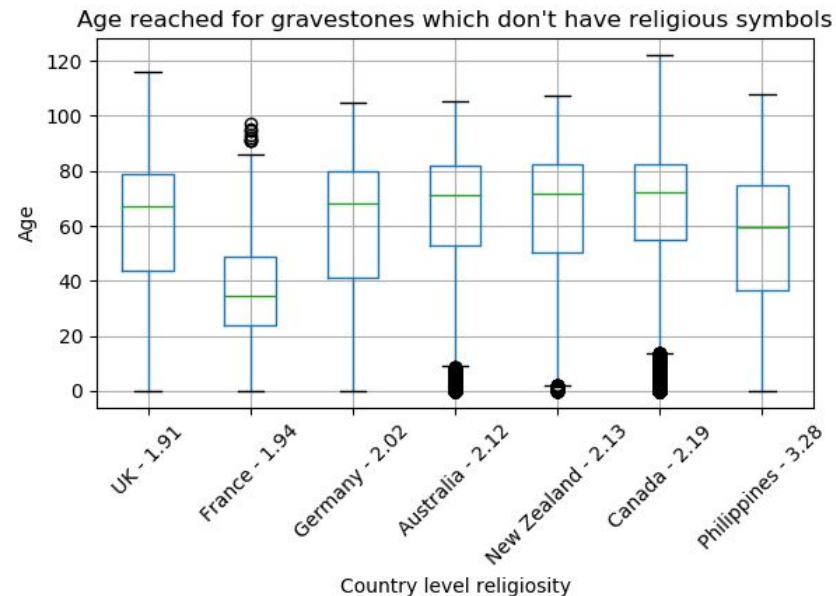
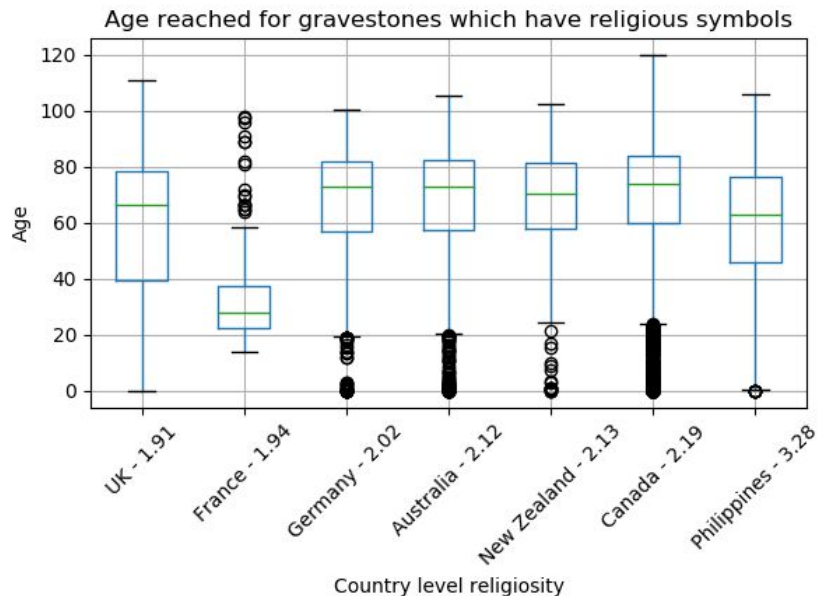


Results from other Countries

- Only countries with more than 500 randomly sampled memorials considered.
- Religiosity value used in [1] used as religiosity ranking.

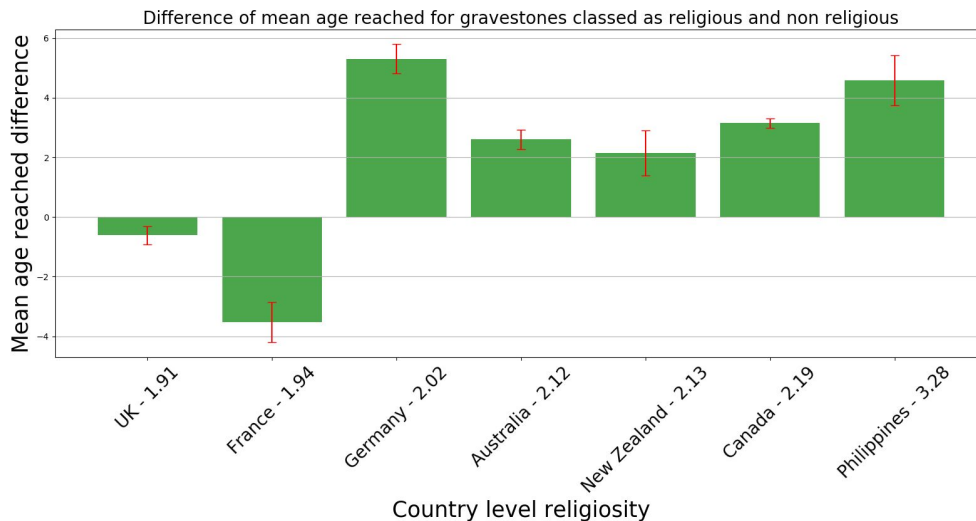
Country	Samples	Religiosity
Australia	6012	2.12
Canada	23346	2.19
France	792	1.94
Germany	2389	2.02
New Zealand	1246	2.13
Philippines	892	3.28
United Kingdom	7795	1.91

Lifespan distributions



Difference

- Difference of mean age between religious and non-religiously classified memorials.
- Correlation of 0.13 for religious and 0.00 for non religious.
- Correlation of 0.49 for difference.



Possible improvements

- Augmentations decreased training error, when regularization methods are supposed to do the opposite.
- Difficulties getting an accurate generalization error due to misalignment in classified pictures.
- Possibly gravestones are too different between countries, so measuring correlation on religiosity is better done within a country.
- Implementing and training a Mask R-CNN correctly on a GPU took a long time, and wasn't accomplished until mid November.
- Optimization of hyperparameters through methods such as Bayesian optimization would be good, wasn't done due to time training took.
- Exclude data from wartimes, such as apparent in France.

Future work

- The scraped data includes a lot more information about each person. Birthplaces, deathplaces and such could be used to investigate common relocation patterns.
- Religious adherency rates have been charted in the United States for a long time. This project only used current religiosity rates.
- Correlation of symbol appearances by age. Angels were commonly featured on infant memorials.

Conclusion

- Religious symbols were classified with an accuracy of 82.5%.
- 84% accuracy was reported when classifying between religious and non-religious gravestones.
- Automatically detecting symbols find similar results as seen in [2].

References

- [1] J. Gebauer, F. Schönbrodt, P. Rentfrow, C. Sedikides, W. Bleidorn, and J. Potter, “The Religiosity as a Social Value Hypothesis: A multi-method replication and extension across 65 countries and three levels of spatial aggregation,” *Journal of Personality and Social Psychology*, volume 113, number 3, pages 18–39, 2017.
- [2] T. Ebert, J. Gebauer, J. Talman, and J. Rentfrow, “What the dead may tell us about the living: Religiosity and longevity based on gravestone inscriptions,”
- [3] U.s. religion census | religious statistics demographics, <http://www.usreligioncensus.org/index.php>, Accessed: 2019-12-28.
- [4] K. He, G. Gkioxari, P. Dollár, and R. B. Girshick, “Mask R-CNN,” *CoRR*, 2017. [Online]. Available: <http://arxiv.org/abs/1703.06870>.
- [5] W. Abdulla, Mask r-cnn for object detection and instance segmentation on keras and tensorflow, https://github.com/matterport/Mask_RCNN, 2017.
- [6] A. Dutta and A. Zisserman, “The VIA annotation software for images, audio and video,” in *Proceedings of the 27th ACM International Conference on Multi-media, series MM '19, Nice, France: ACM, 2019*, isbn: 978-1-4503-6889-6/19/10. doi: 10.1145/3343031.3350535. [Online]. Available: <https://doi.org/10.1145/3343031.3350535>.