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Jena University Language & Information Engineering Lab

Using Artificial Neural Networks to Model Affective Word Meaning

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https://julielab.de

sunshine

calm

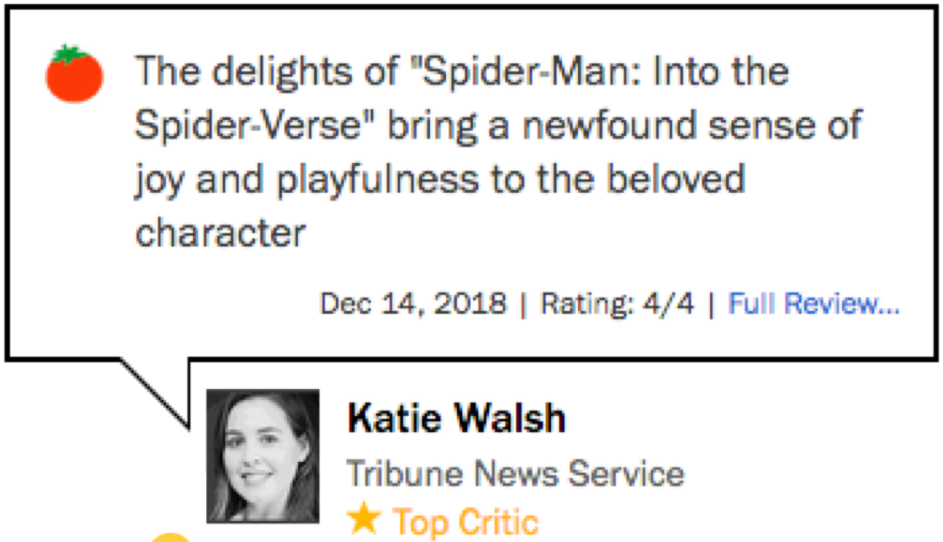
terrorism

What is „Affective Word Meaning“?

- Psycholinguistic quality to evoke emotion in recipients
- Speakers mostly agree on it
  - ➢ *part of connotative lexical semantics*
- Graphematic word (type), mere character sequences
- No context!

Application Domains

- Product and enterprise analytics
- Social sciences
  - voting behavior / approval rate
  - happiness across geographic/socio-economic positions



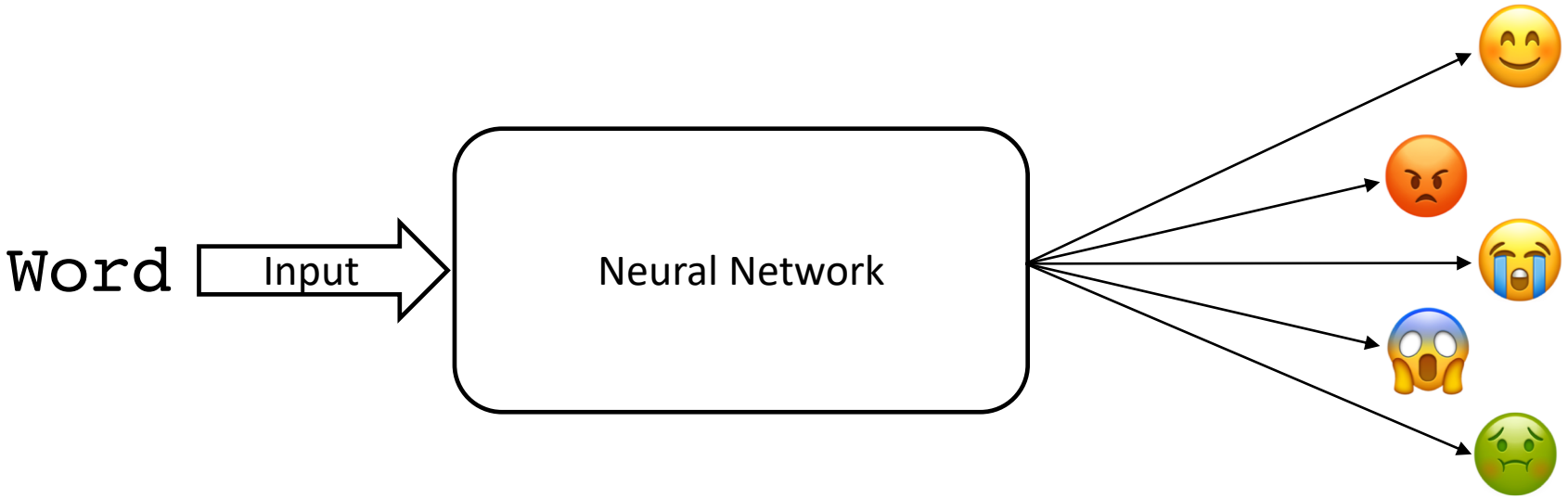
twitter.com

rottentomatoes.com

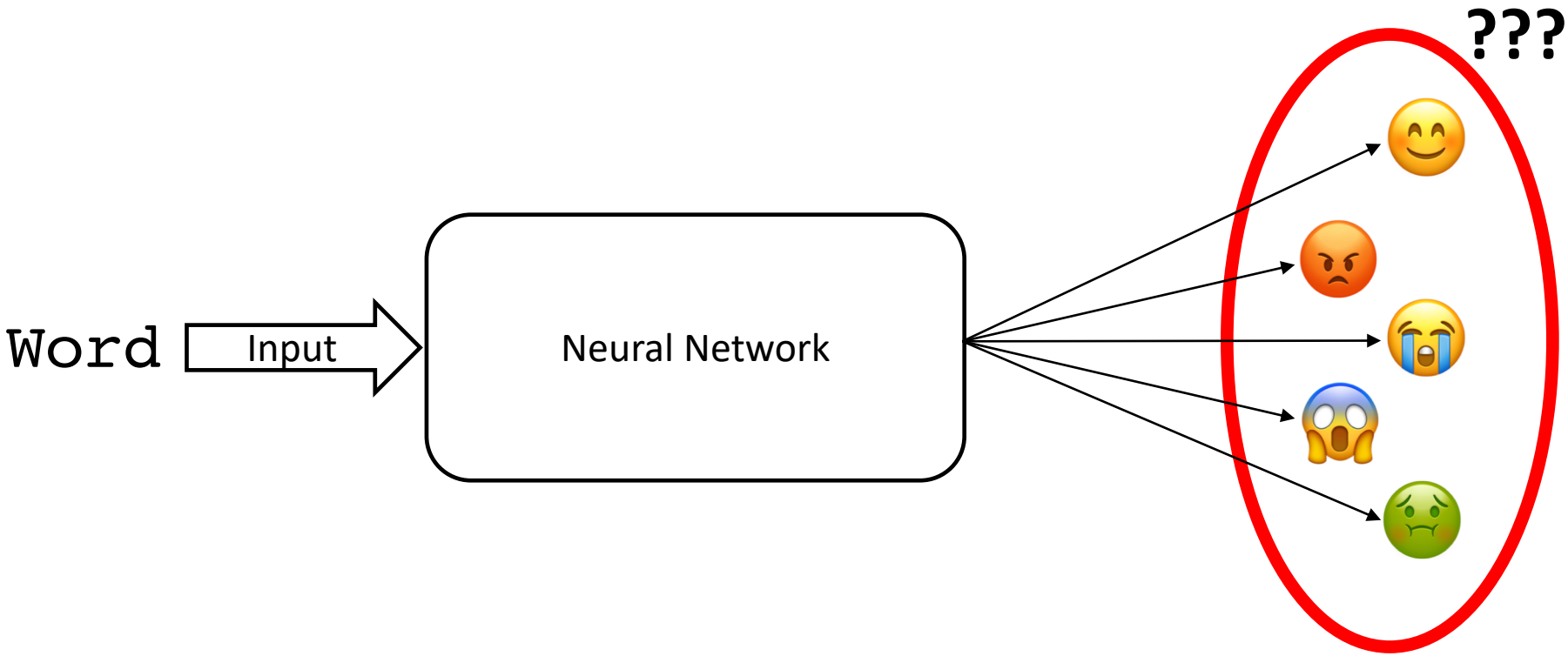
Application Domains

- Product and enterprise analytics
- Social sciences
  - voting behavior
  - happiness across geographic/socio-economic position
- Humanities
  - amelioration/pejoration of words
  - attitudes towards concepts and ideas
  - emotional relationships in character networks

Goal of This Work

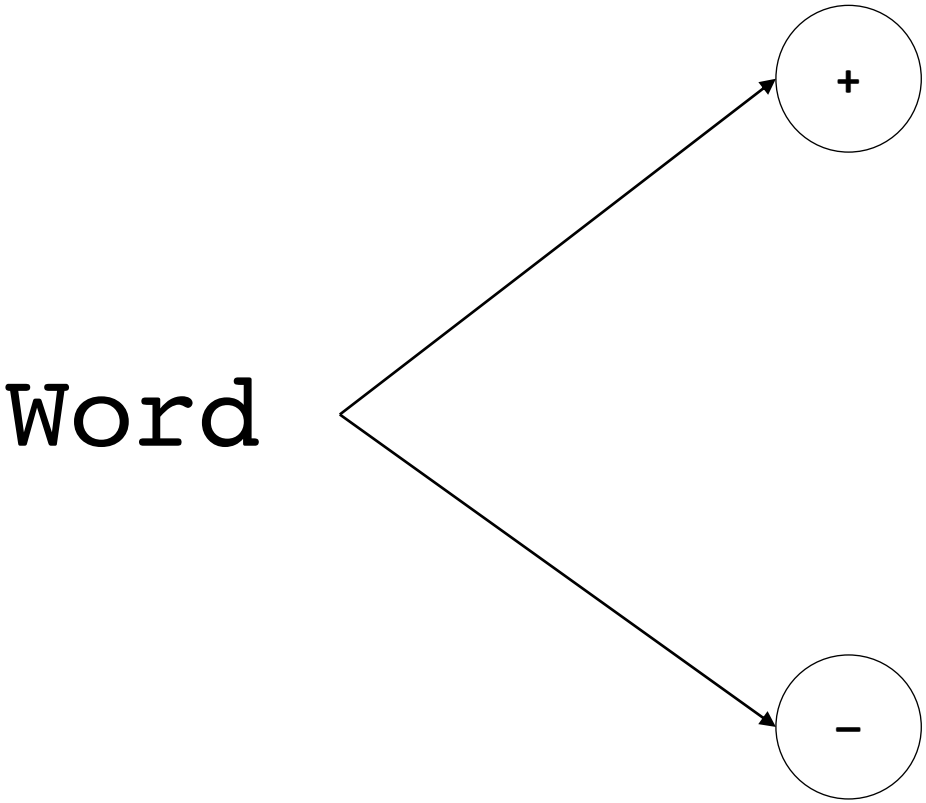


Goal of This Work

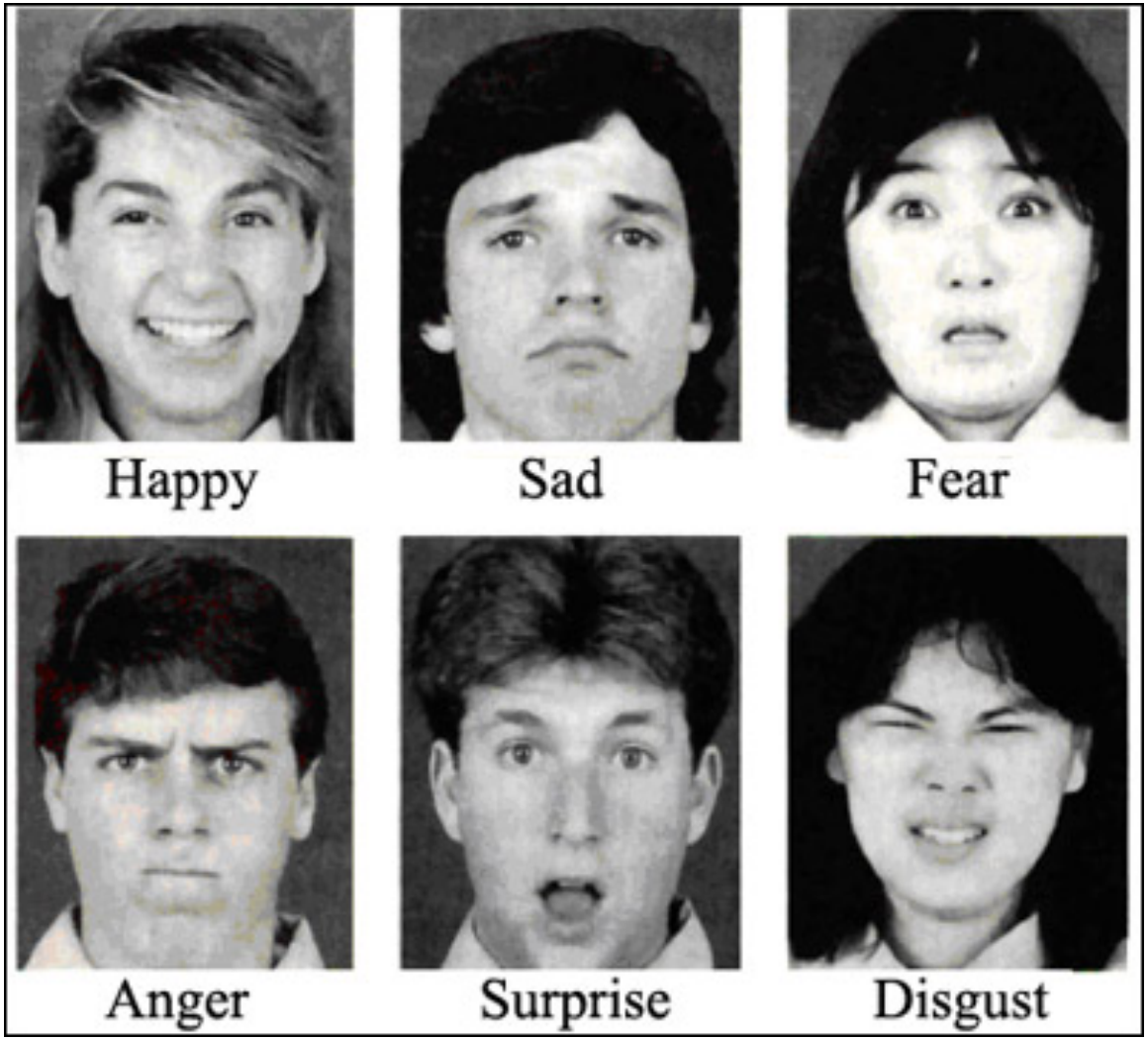


How to Represent Affective Word Meaning?

Semantic Orientation / Polarity

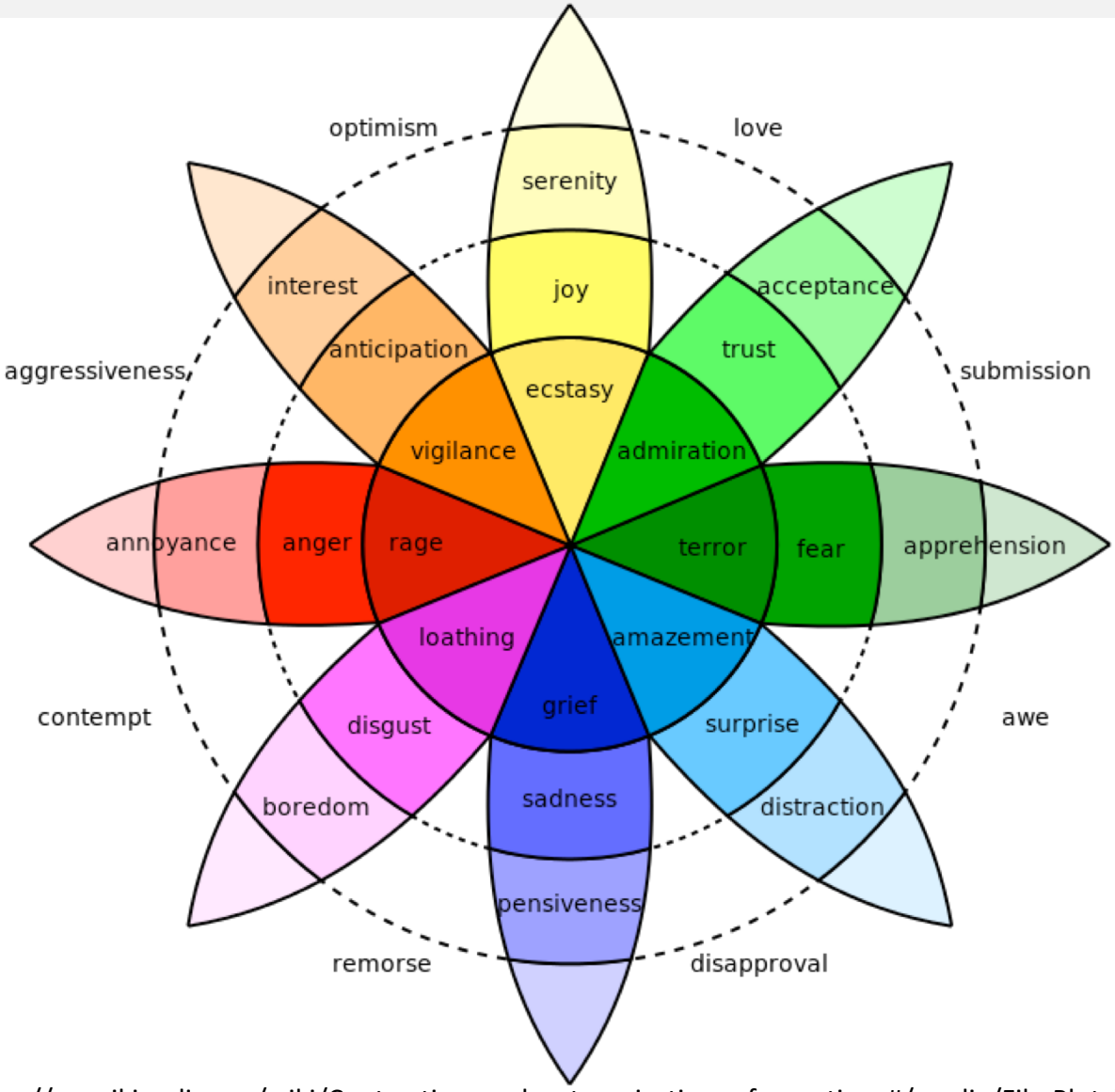


Ekman's Basic Emotions



Source: http://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-00sc-introduction-to-psychology-fall-2011/emotion-motivation/discussion-emotion/

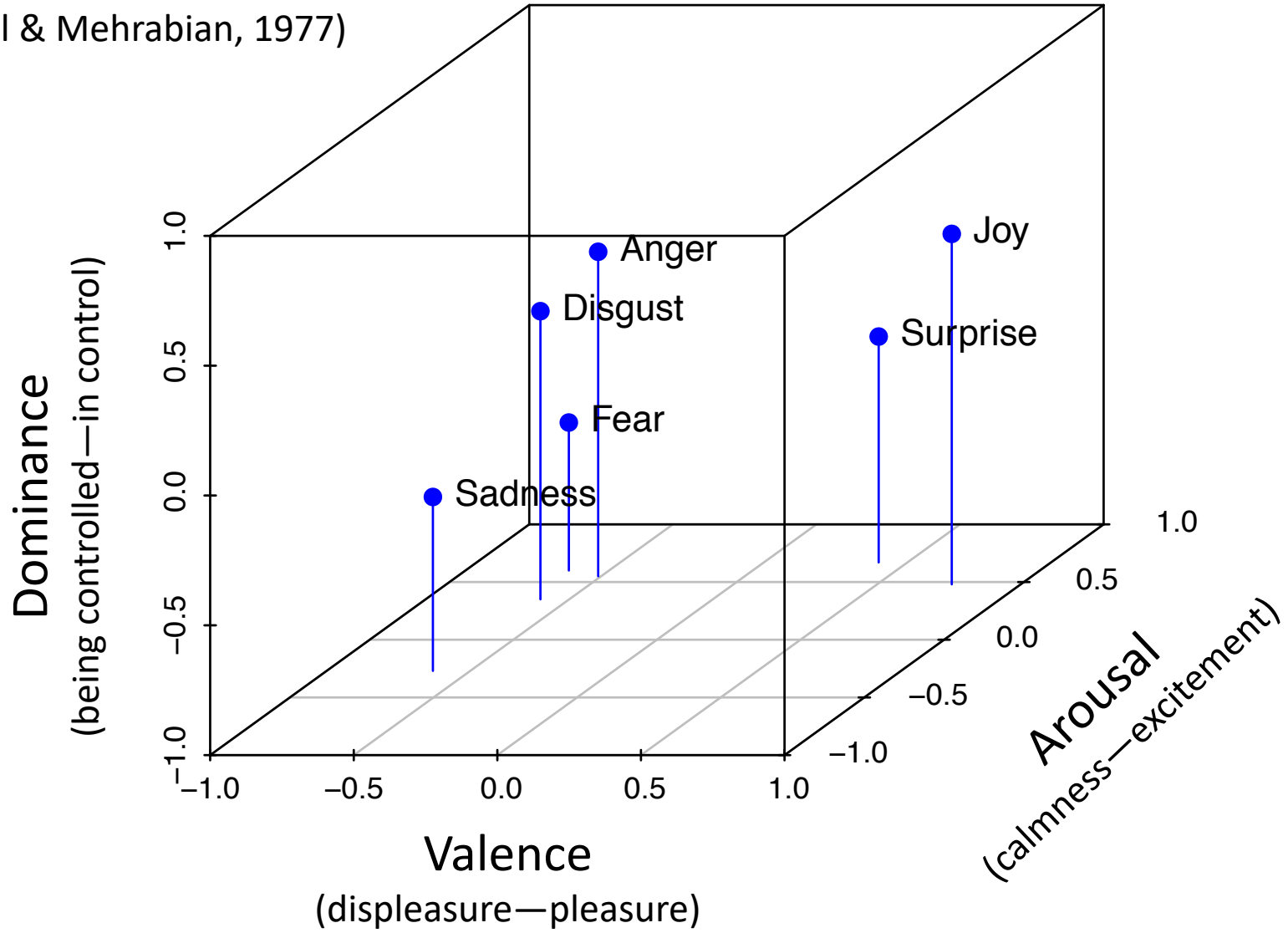
Representing Emotion — Wheel of Emotion



Source: https://en.wikipedia.org/wiki/Contrasting_and_categorization_of_emotions#/media/File:Plutchik-wheel.svg

Valence-Arousal-Dominance

(Russell & Mehrabian, 1977)



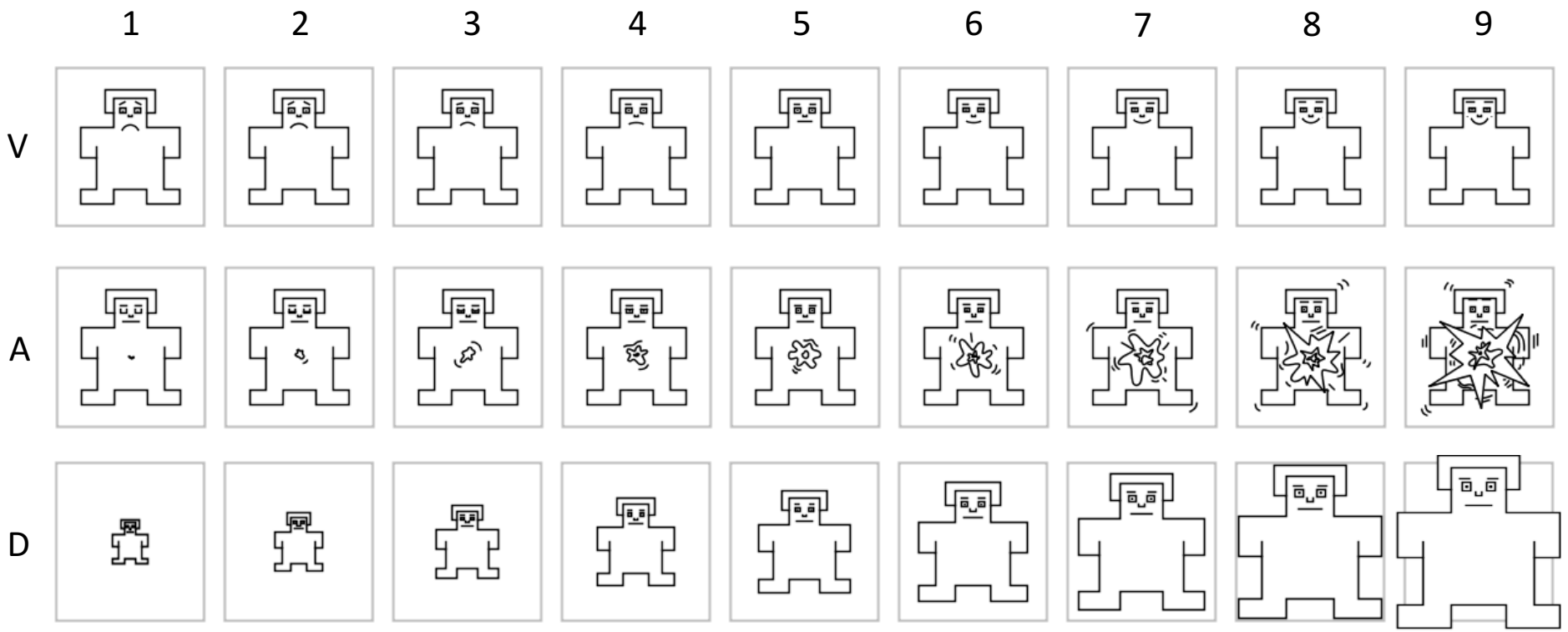
Empirically Measured VAD Ratings

- Psychologists and Psycholinguists need VAD ratings

  (e.g., experiments on word processing and memory)

- Experimental set-up of gathering those
  - questionnaire study
  - >20 raters per word

Self-Assessment Manikin

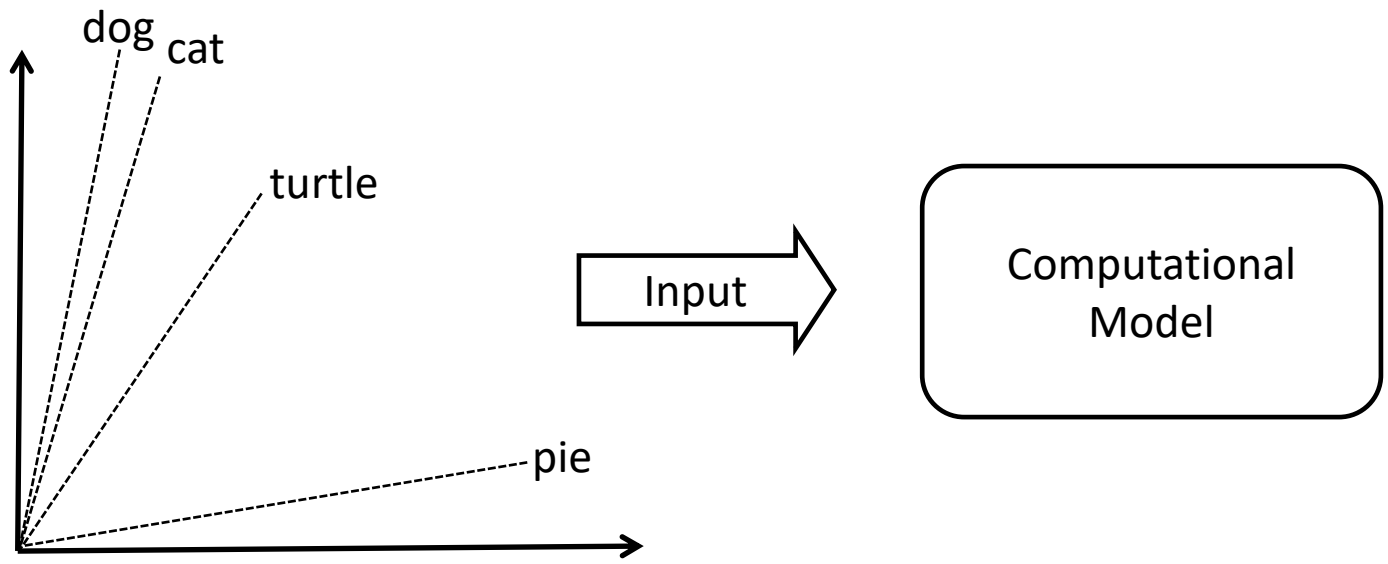


Averaged Individual Ratings: Emotion Lexicons

	Valence	Arousal	Dominance
sunshine	7.6	4.9	5.2
calm	6.3	1.9	5.9
terrorism	1.5	8.4	3.2

How to Model Affective Word Meaning?

Input Representation: Word Embeddings



-0.13102 -0.054447 -0.051866 -0.10289 -0.072061 0.16523 -0.17298 0.21865 0.041183 -0.010858 0.074741 0.35226 0.42662 -0.071747 0.25112 0.12082 -0.33192 -0.4728 -0.0090568 0.0030266 0.032861 0.074323 -0.38017 0.091399 -0.16034 -0.050232 -0.094194 0.16656 0.40901 0.069625 0.059306 0.01991 -0.35846 -0.14549 0.24894 0.50184 -0.0073098 -0.4589 -0.10073 -0.099315 0.30583 -0.40577 0.16586 0.055741 0.26776 -0.13515 0.28127 0.069221 -0.20907 0.092053 0.39419 -0.2412 0.01173 -0.16856 -0.0053851 0.14282 0.17513 0.34775 0.178 0.35883 -0.17684 0.53104 0.04751 -0.30134 -0.53297 -0.22041 0.097703 0.052288 0.10849 0.12409 -0.11369 0.19042 0.19554 -0.14949 -0.29675 -0.14285 0.22217 0.21503 -0.2309 0.4381 0.22739 -0.052386 -0.20003 0.19725 -0.032432 -0.14307 0.021958 0.36876 -0.10084 -0.18536 0.27691 -0.43856 0.087418 -0.33836 0.083161 -0.40672 0.14497 -0.41334 0.0012195 -0.32266 0.067225 0.18359 0.010442 -0.15499 -0.82943 -0.069867 -0.26416 0.42656 0.26765 -0.12262 -0.116 -0.076926 -0.16992 0.055428 -0.20699 -0.090381 0.082171 -0.31509 -0.12135 0.055464 0.9075 0.18585 -0.20836 0.019945 0.17853 -0.31707 0.054172 0.40715 0.32685 -0.20493 0.099457 0.15329 -0.28035 0.36088 0.31671 -0.2216 -0.094332 0.33993 -0.23604 0.44507 -0.025739 0.2082 -0.28423 0.18867 -0.30867 -0.015983 0.13985 0.035387 0.25648 -0.18241 0.50119 -0.31602 -0.19771 -0.3002 0.048059 0.14868 -0.45165 0.11831 0.045376 0.31328 -0.052771 0.08615 -0.18376 0.071614 0.30406 0.26742 -0.22895 0.17671 0.33062 0.17738 0.042157 -0.29211 -0.10786 -0.064557 -0.10006 0.39087 -0.21173 -0.085387 -0.040239 -0.1044 -0.019623 -0.32887 0.15656 0.039189 -0.30531 0.235 -0.025831 0.041146 0.30737 -0.16955 -0.18446 -0.11642 0.038028 0.094888 -0.25135 -0.011466 0.18069 0.44957 -0.28939 -0.46813 0.035372 0.045633 0.1507 -0.098108 -0.31644 -0.19265 -0.3108 0.32345 0.57775 0.042428 0.2334 -0.093899 -0.50785 -0.68498 0.088108 -0.25361 -0.018187 -0.50159 -0.19892 -0.12127 -0.21447 0.22551 0.021314 0.078556 -0.0828 -0.27046 -0.19486 0.13457 0.44123 0.13542 -0.37831 0.36109 -0.04392 0.21795 -0.092712 -0.12707 -0.1428 -0.021229 -0.13407 -0.12783 -0.099737 -0.055585 0.042925 -0.41051 -0.044614 -0.2326 -0.033486 -0.1761 -0.042099 -0.20191 -0.042496 -0.08971 0.062699 -0.39227 0.2632 0.13261 -0.45002 -0.2213 0.31223 0.43488 -0.05547 0.22954 0.70868 -0.37327 0.2844 -0.24495 -0.28255 0.21883 -0.053093 -0.3006 -0.34203 -0.11602 0.36381 0.11346 0.1853 -0.014843 0.21921 0.047219 -0.0054492 0.2878 0.51144 0.17271 -0.026182 0.00051472 0.033597 -0.061401 0.25367 -0.13141 -0.056602 -0.0025169 0.44398 -0.26233 0.21532 0.34318 -0.081855 -0.030759 -0.022955 -0.1757 0.44088 -0.062219

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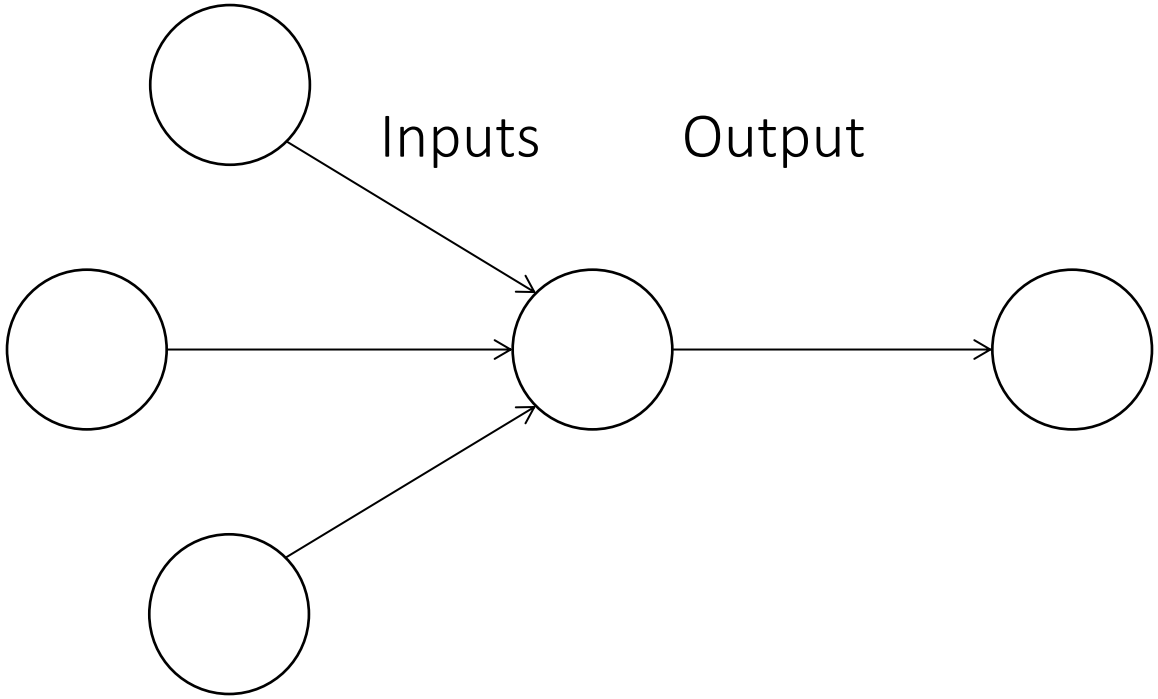
(*sunshine*)

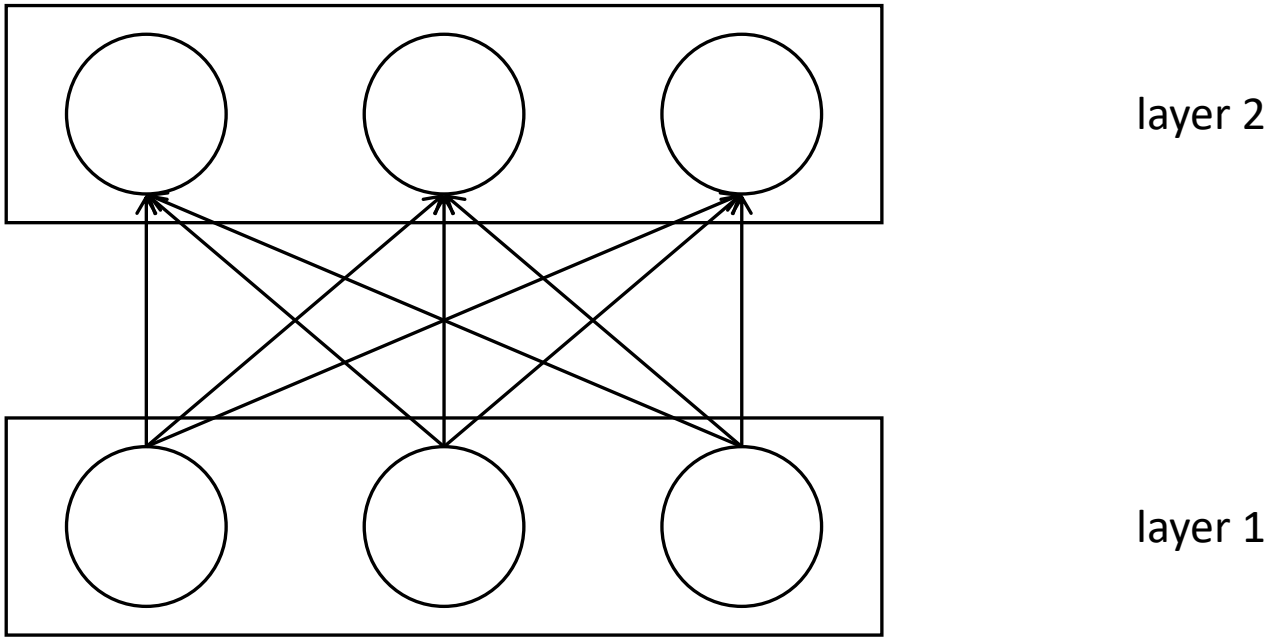
Artificial Neural Networks: Biological Inspiration

- Family of machine learning techniques (≈ Deep Learning)
- Inspired by signal processing of biological neurons



Artificial Neural Networks: Layer-Based Arrangement

- Organized in layers for efficient computation
- Signal flows in one direction only
- Signal gets transformed by passing it to next layer

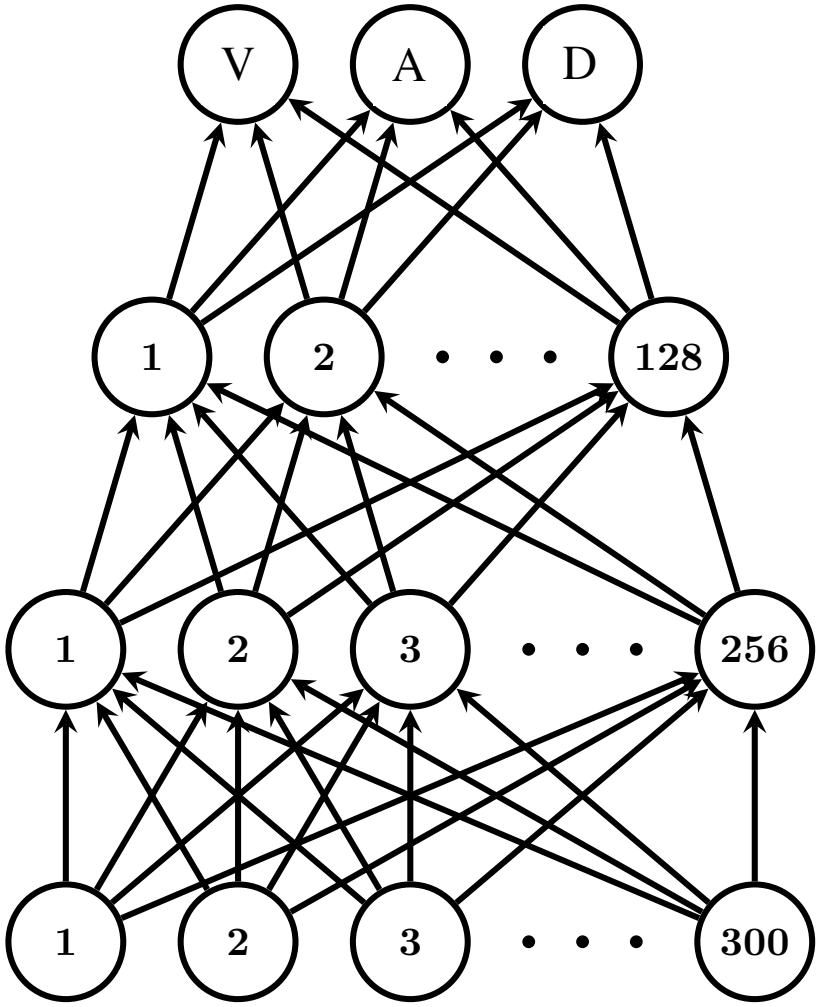


Artificial Neural Networks: Modeling Word Emotion

Output layer

Hidden layers

Input layer



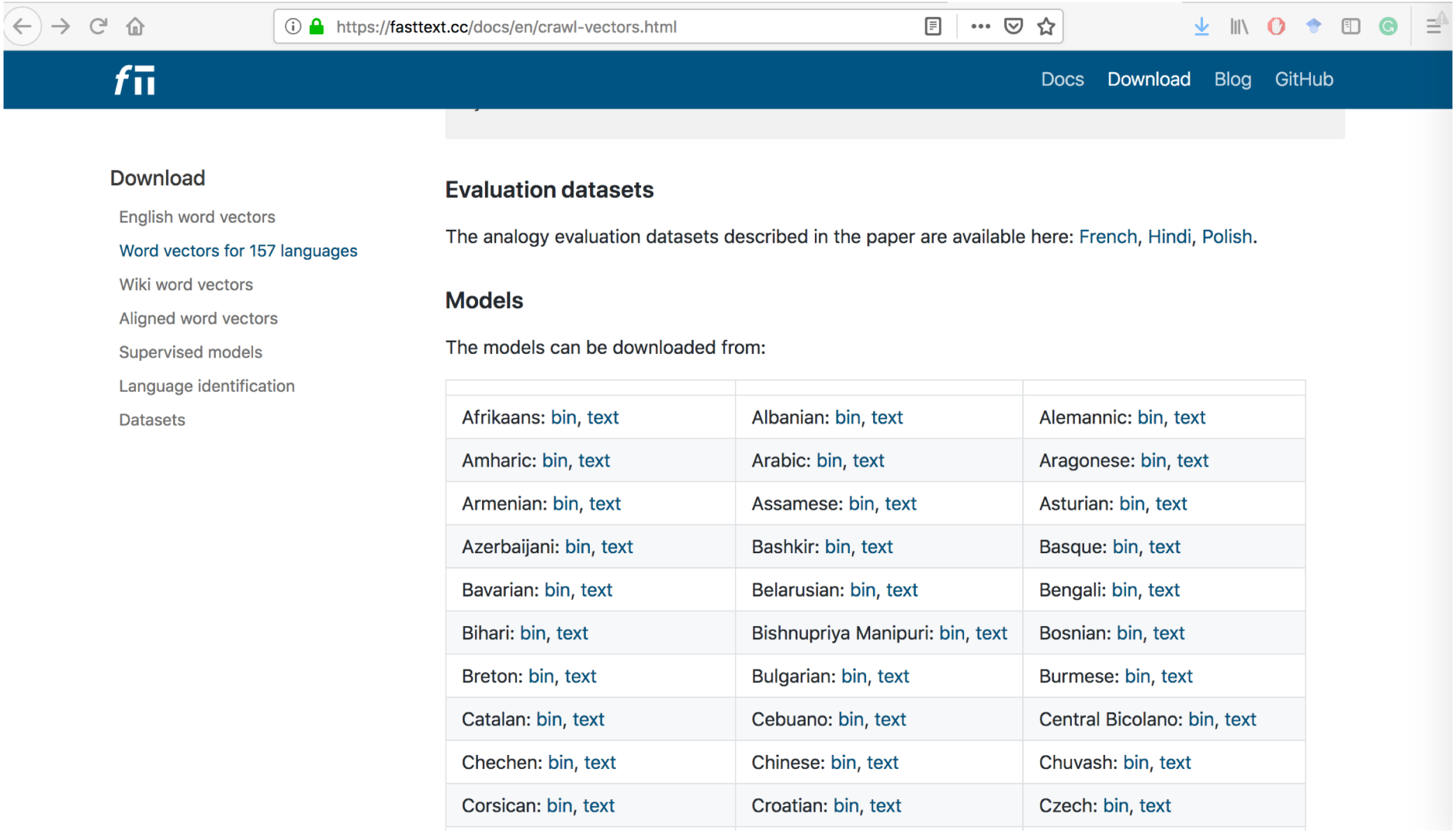
Initialize with word embedding

How to Evaluate the Model?

What Datasets to Evaluate on?

Source	ID	Language	Format	# Entries
Bradley and Lang (1999)	EN	English	VAD	1,034
Warriner et al. (2013)	EN+	English	VAD	13,915
Redondo et al. (2007)	ES	Spanish	VAD	1,034
Stadthagen-Gonzalez et al. (2017)	ES+	Spanish	VA	14,031
Schmidtke et al. (2014)	DE	German	VAD	1,003
Yu et al. (2016a)	ZH	Chinese	VA	2,802
Imbir (2016)	PL	Polish	VAD	4,905
Montefinese et al. (2014)	IT	Italian	VAD	1,121
Soares et al. (2012)	PT	Portuguese	VAD	1,034
Moors et al. (2013)	NL	Dutch	VAD	4,299
Sianipar et al. (2016)	ID	Indonesian	VAD	1,490

Where to Get the Word Embeddings?



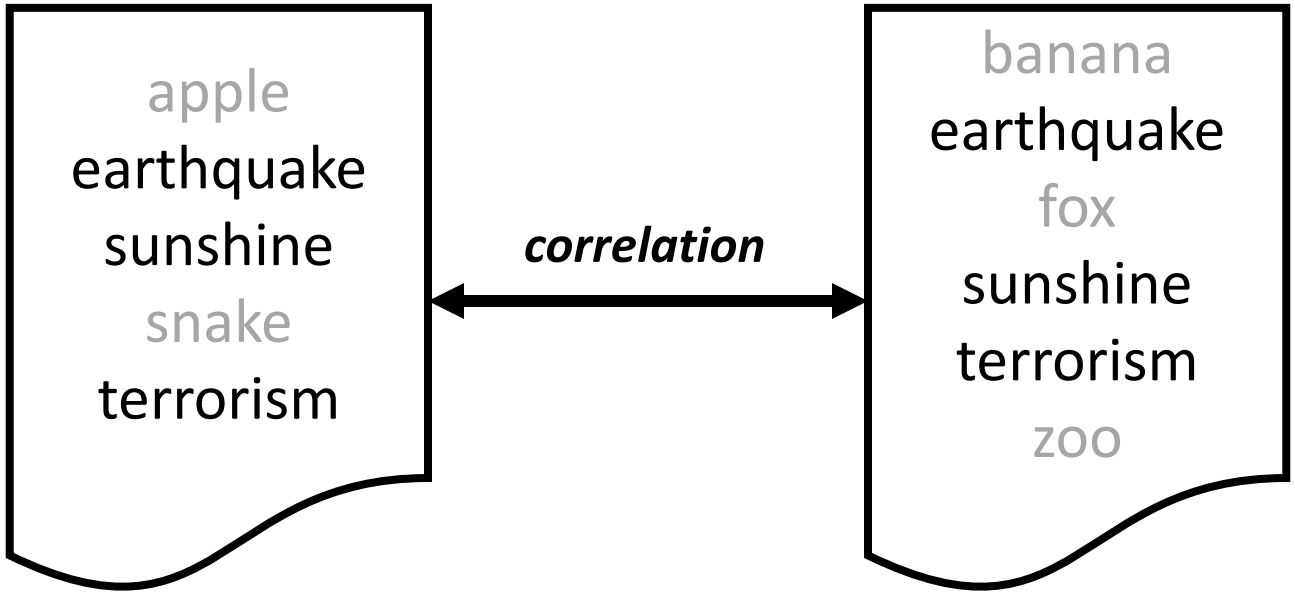
Evaluation Set-Up

- 9 languages
- Compare our model against 5 reference methods
- Performance measured in Pearson's *r*

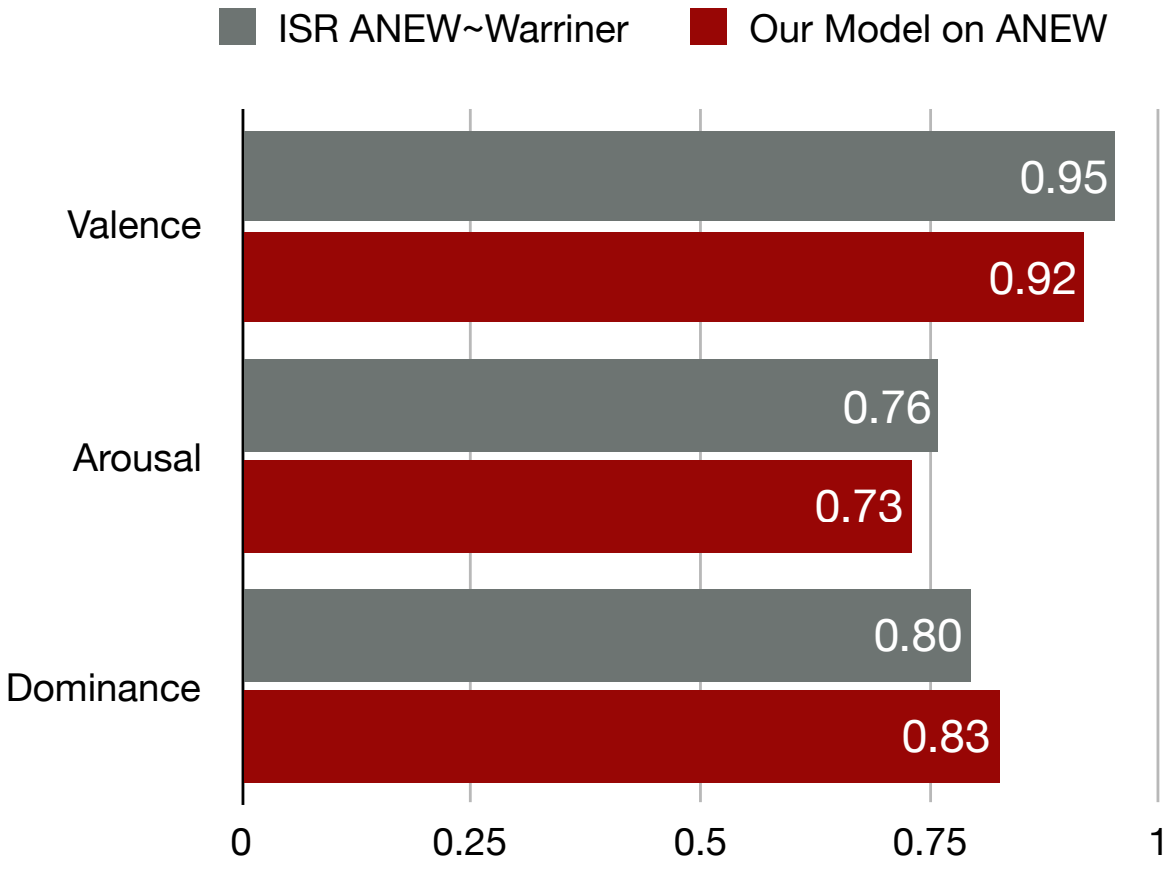
➢ *Best current approach for predicting word emotion*

Comparison against Human Reliability

- How does our model compare against Inter-Study Reliability (ISR)
- Correlation between Ratings in ANEW ∩ Warriner



Competitive against Human Reliability



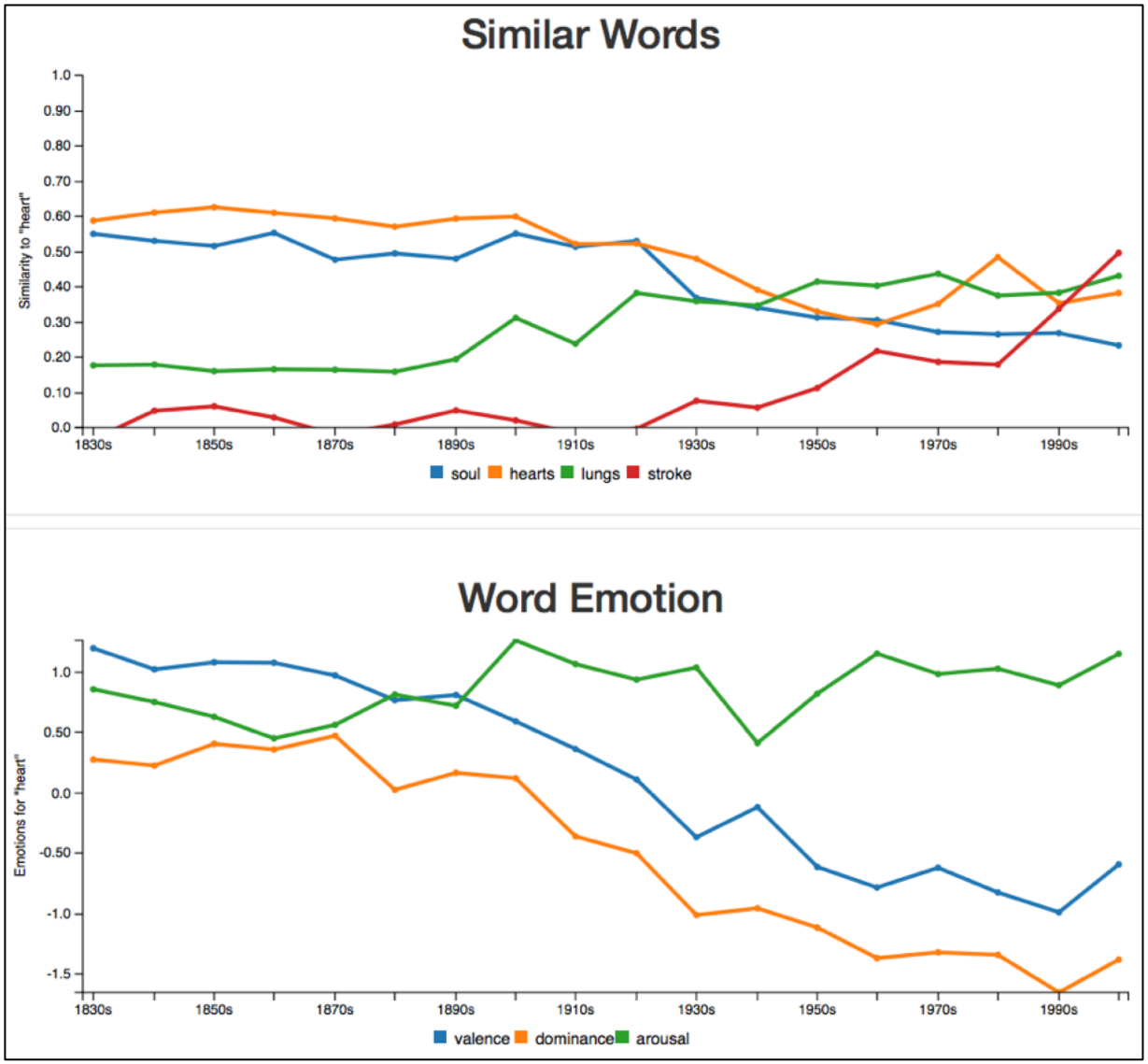
- Consistent with results from split-half reliability

Conclusion

Conclusion

- Affective word meaning: Emotion evoked in recipients
- Introduced VAD approaches to emotion representation
- Described how word embeddings and ANNs can be used for modeling affective word meaning
- Reported on experiments involving many different languages and prior computational approaches
- Our model is current state-of-the-art and performs competitive to human reliability

Bonus: Diachronic Word Emotions — *heart*



JeSemE.org

(Hellrich et al., COLING 2018)

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