The Logic of Science

(or why common sense makes sense)

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The Answer

$$
\begin{aligned}
P(H_f|D) &= P(H_f)\frac{(P(D|H_f)}{P(D)} \\
&= \frac{P_f L_f}{P_f L_f + P_p L_p + \sum P_i L_i} \\
&\sim 0.47
\end{aligned}
$$

The Wonderment

I wonder ....

Can cityscapes **influence** weather?

I wonder ....

Can cityscapes **influence** weather?

Can cityscapes **generate** weather?

I wonder ....

Can cityscapes **influence** weather?

Can cityscapes **generate** weather?

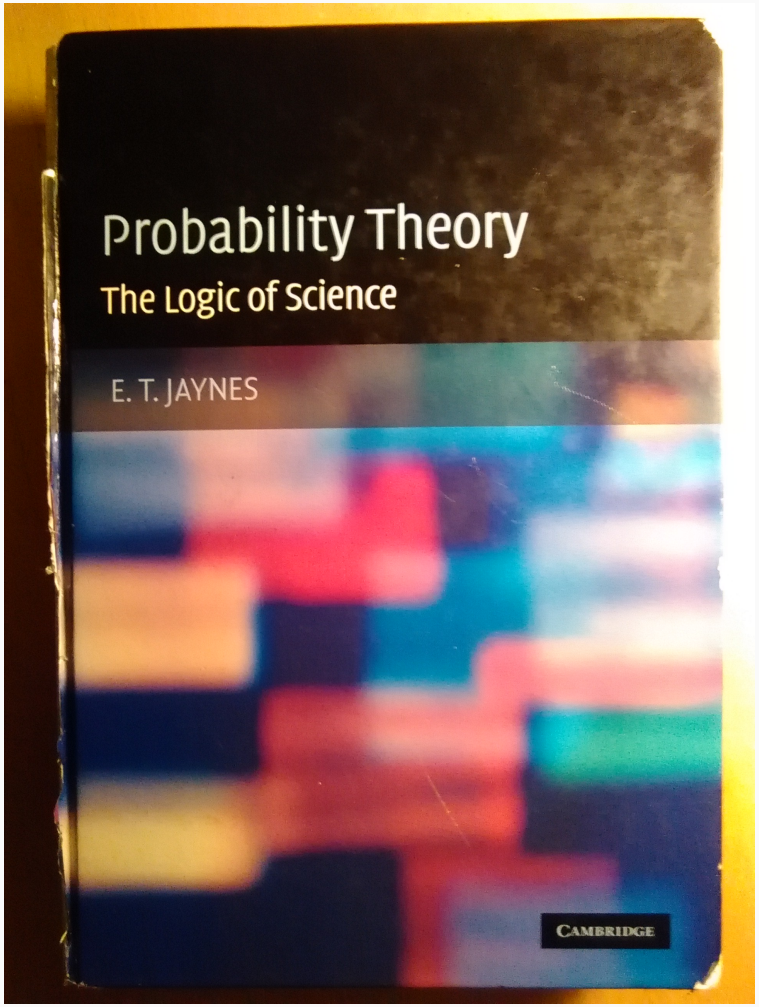
Can cityscapes **cause** thunderstorms?

The Master

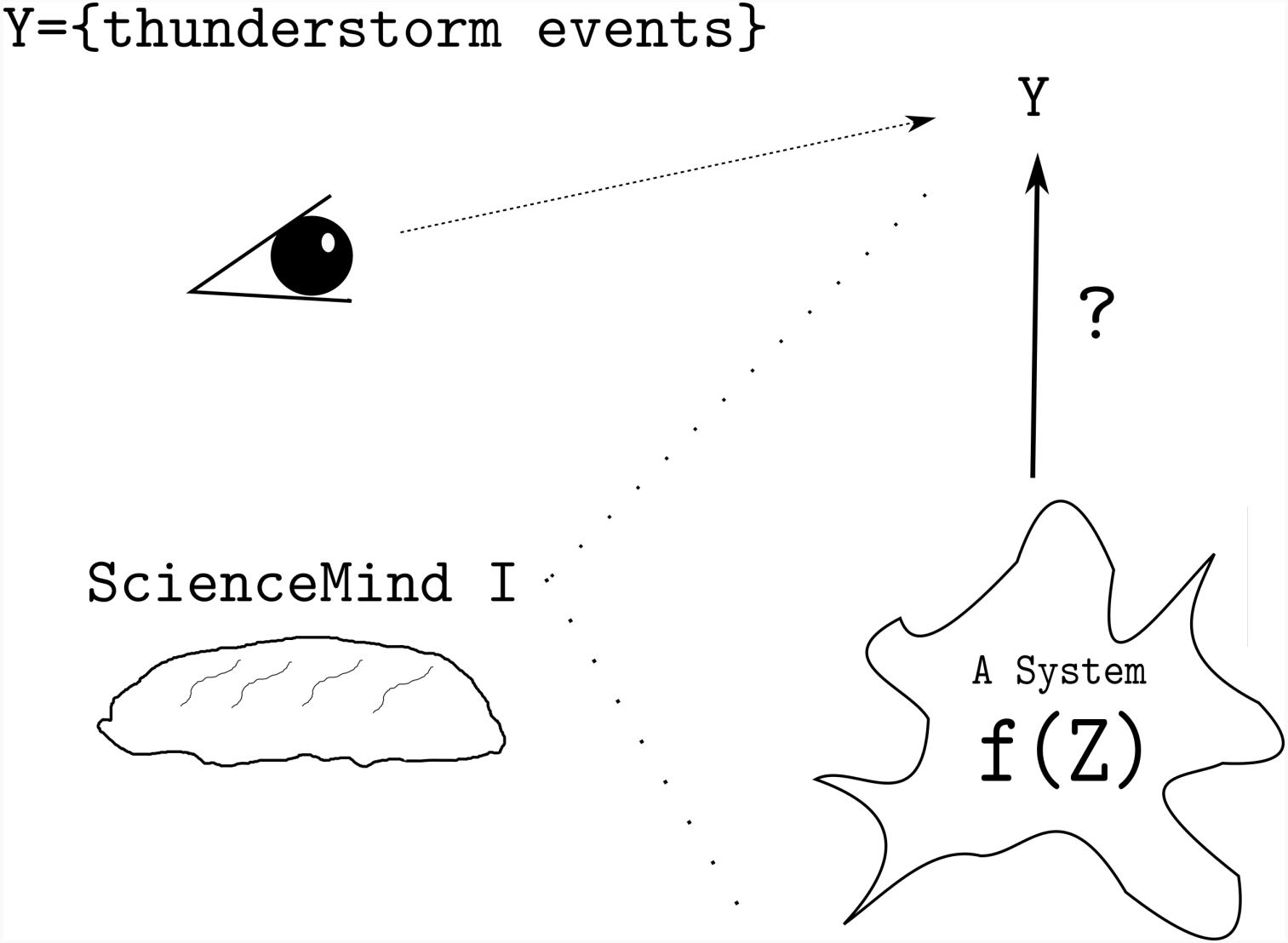
The logic of science: From reality to models and back again

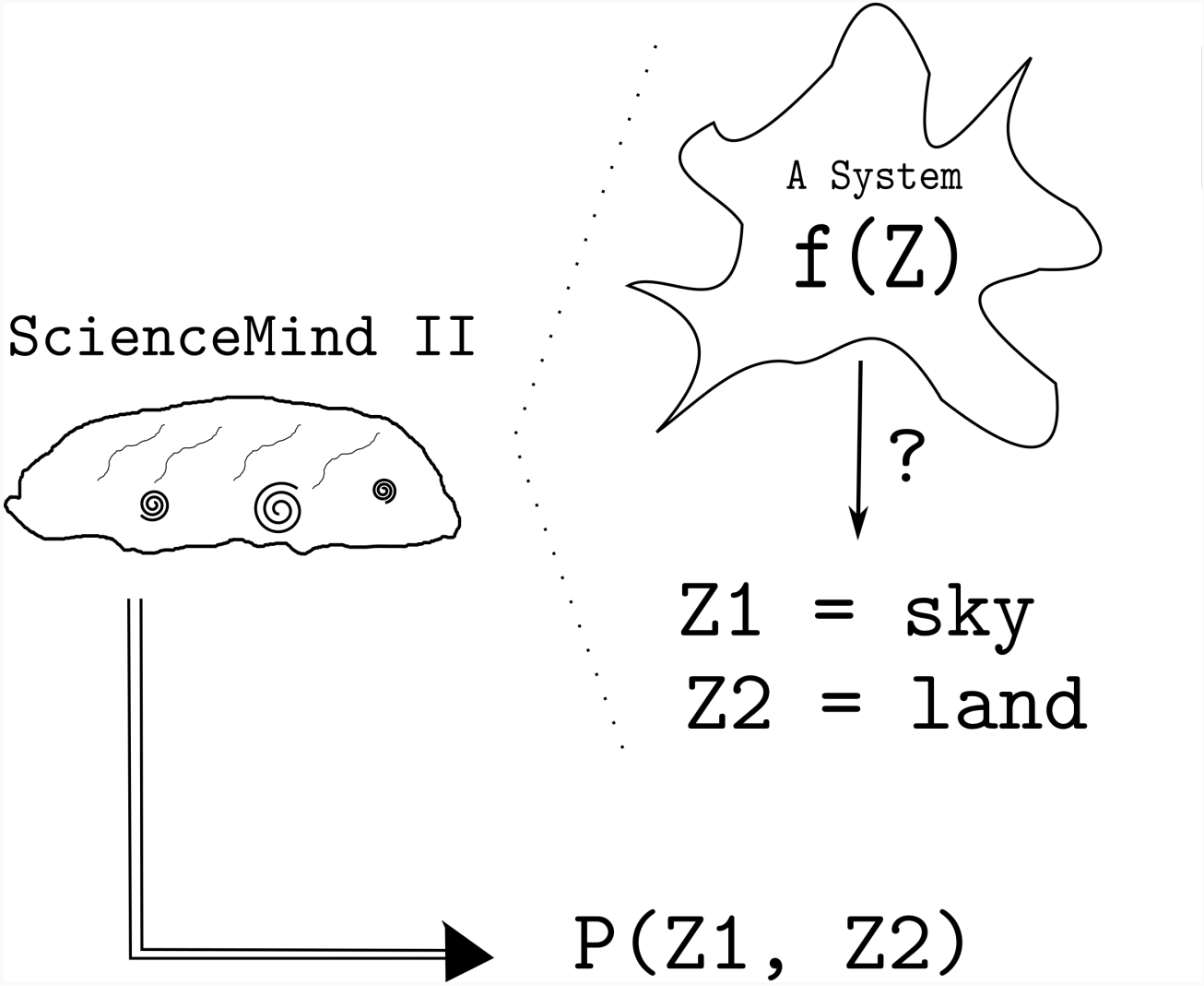
"In virtually all real problems of scientific inference...the problem facing the scientist is of the inverse type: Given the data D, what is the probability that some hypothesis H is true?"

— E.T. Jaynes (2003, p.85)



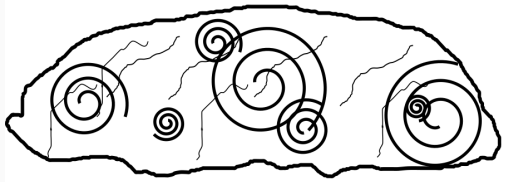
The Science

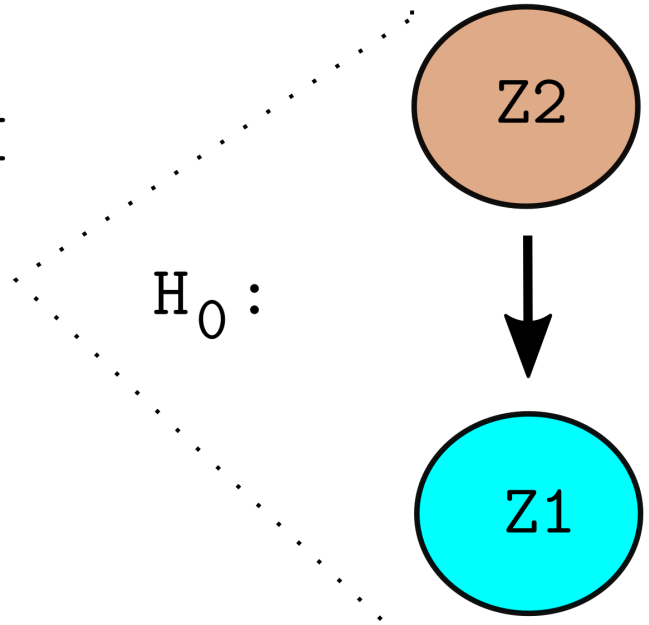

Y={thunderstorm events}
Y
?
ScienceMind I
A System
f(Z)


A System
f(Z)
ScienceMind II
?
Z1 = sky
Z2 = land
P(Z1, Z2)

Z1={atmospheric conditions}
Z2={land use and land cover}

ScienceMind III





$P(Z1,Z2) = P(Z2)P(Z1|Z2)$

Climatic Change (2012) 113:481–498
DOI 10.1007/s10584-011-0324-1

Urban-induced thunderstorm modification in the Southeast United States

Walker S. Ashley · Mace L. Bentley · J. Anthony Stallins

... "substantive evidence of urban effects on thunderstorm frequency and severity" ...

Geography Compass 2/3 (2008): 620–639, 10.1111/j.1749-8198.2008.00110.x

Urban Lightning: Current Research, Methods, and the Geographical Perspective

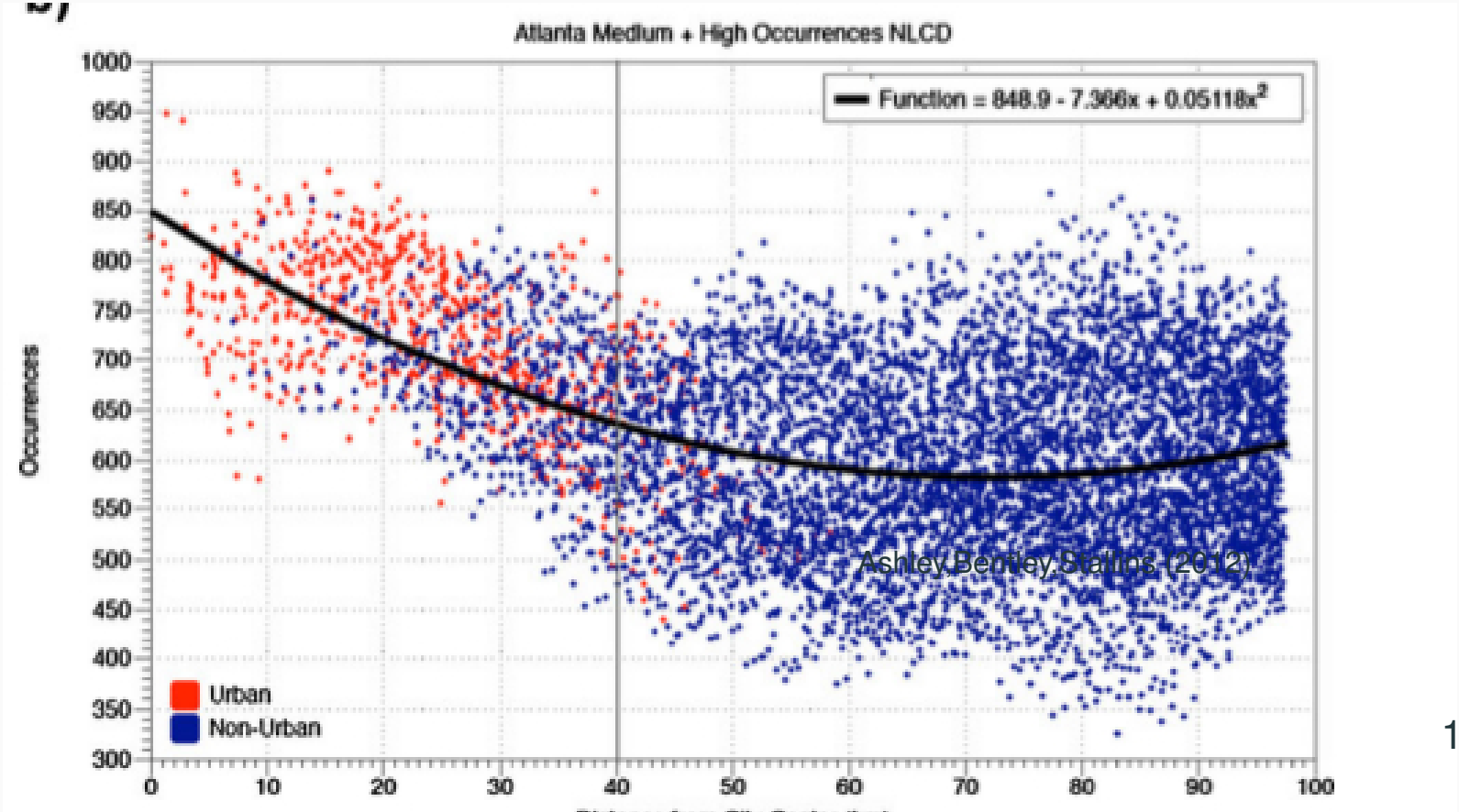
J. Anthony Stallins* and L. Shea Rose
Department of Geography, Florida State University

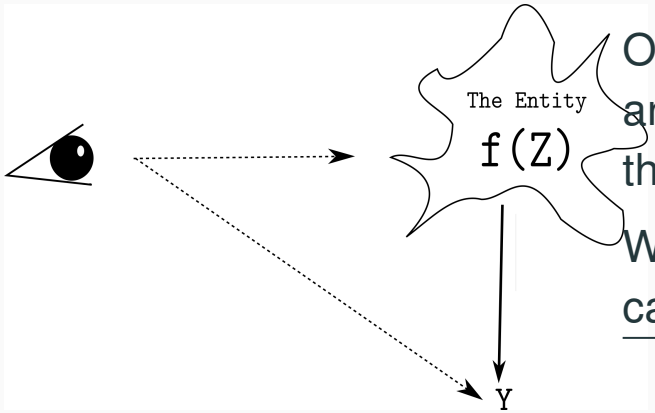
"Urban lightning research is still in the descriptive, pattern-identifying stage, with some inroads into mechanism."

$$P(Z1, Z2) = P(Z2)P(Z1|Z2)$$

(dBZ = *decibels radar reflectivity* $\Rightarrow Z1$; *NLCD code* $\Rightarrow Z2$)

Occurrences $\geq$ 40 dBZ for each 2-km grid cell vs. distance from city center

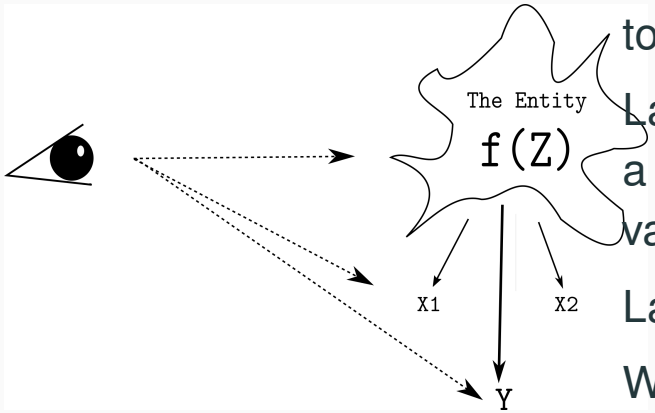




We observe an entity in Nature that we suspect generates non-random patterns of information

Our states of knowledge about the causal relationships and processes, $f(\cdot)$, that are operating as well as about the inputs, Z, are limited; often severely

We assume that some observable outcome, Y, is causally related to the entity as $f(Z) \Longrightarrow \{Y\}$



We assume that some observable and measurable attributes (data), $\{X1, X2\}$ are logically related to the entity's internal processes as, $\{X1, X2\}|f(Z)$

Lacking full knowledge of the entity's processes, we use a probability model and consider $X1$, $X2$, Y as random variables with a joint probability distribution function

Lacking complete datasets, we accept sampled datasets

We make inductive inferences from the sampled datasets back to $f(Z)$ by assuming sampling distributions, evaluating our prior knowledge, and using the (weaker) syllogisms of plausible reasoning coupled with probability theory