

There's Something About Bayes

Effective Probabilistic Programming for the Rest of Us

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Programs are doing (probabilistic) inference, even if they don't realise it. drawing conclusions from evidence

```
GeoCoordinate Loc = GPS.GetLocation();  
if (GPS.Distance(Loc, Home) < 200) evidence  
    OpenGarageDoor(); conclusion
```



```
bool HasBeard = BeardRecognizer(Photo);  
if (HasBeard) conclusion evidence  
    Avatar.AddBeard();
```

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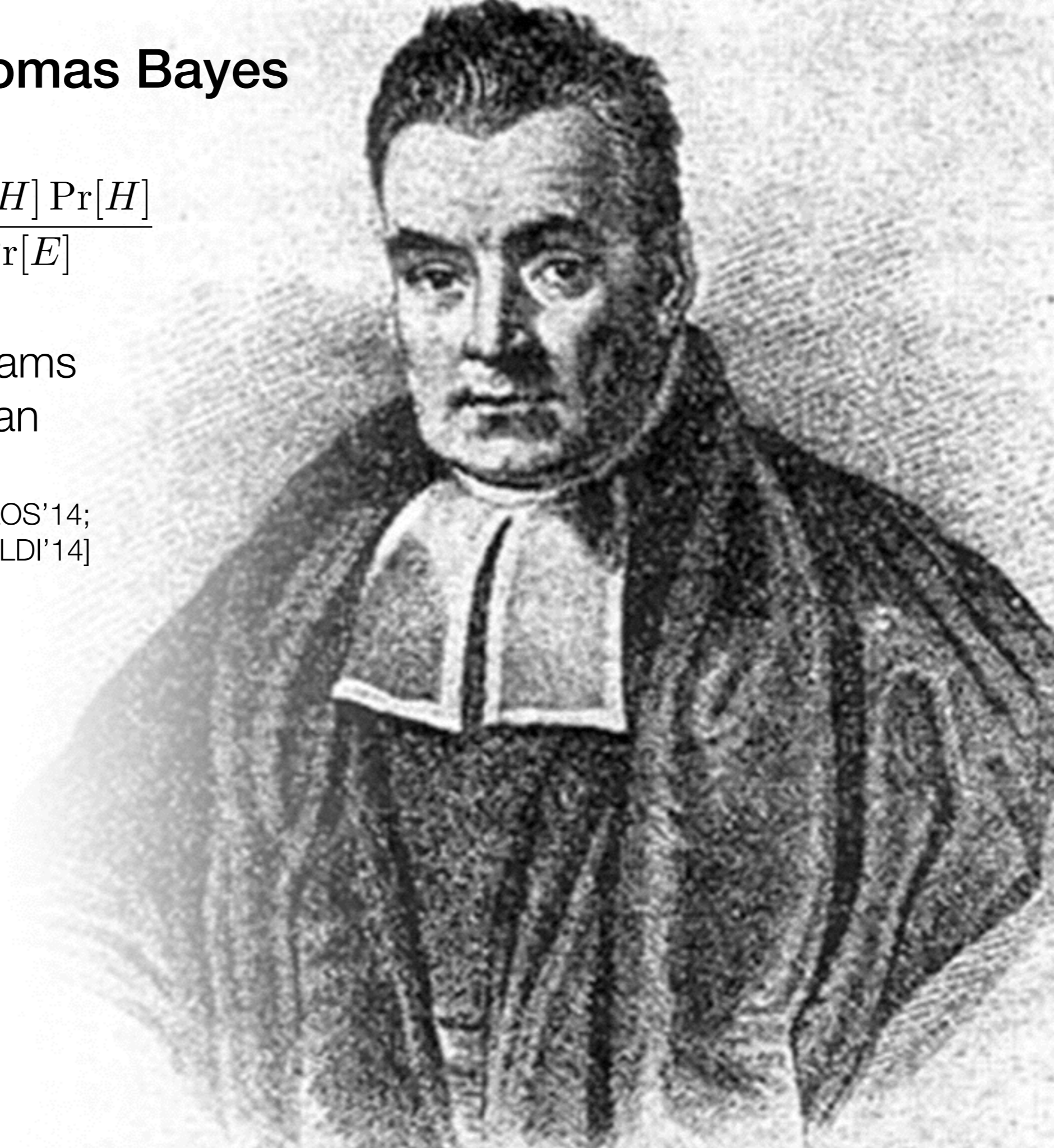
...but the user is male

The Reverend Thomas Bayes

$$\Pr[H|E] = \frac{\Pr[E|H] \Pr[H]}{\Pr[E]}$$

These inference programs
already have a Bayesian
interpretation.

[Bornholt et al, ASPLOS'14;
Sampson et al, PLDI'14]



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GeoCoordinate GPSLoc = GPS.GetLocation();  
if (GPS.Distance(Loc, Home) < 200)  
    OpenGarageDoor();
```

```
GeoCoordinate GPSLoc = GPS.GetLocation();  
U<GeoCoordinate> Loc = Bayes(GPSLoc, GPS.GetMapPrior());  
if (GPS.Distance(Loc, Home) < 200)  
    OpenGarageDoor();
```

```
GeoCoordinate GPSLoc = GPS.GetLocation();  
U<GeoCoordinate> Loc = Bayes(GPSLoc, GPS.GetMapPrior());  
if (GPS.Distance(Loc, Home) < 200)  
    OpenGarageDoor();
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U<bool> HasBeard = BeardRecognizer(Photo);  
if (HasBeard)  
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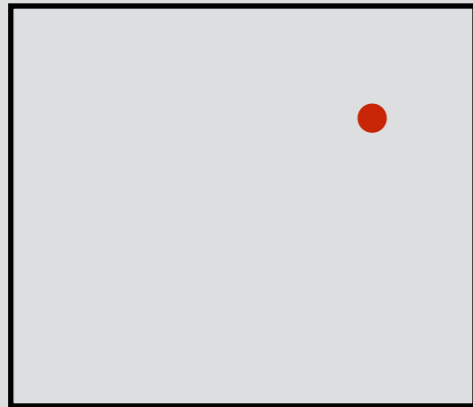


```
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U<GeoCoordinate> Loc = Bayes(GPSLoc, GPS.GetMapPrior());
if (GPS.Distance(Loc, Home) < 200)
    OpenGarageDoor();
```

```
U<bool> HasBeard = BeardRecognizer(Photo);
double BeardProbability = IsMale ? 0.2 : 0.01;
HasBeard = Bayes(HasBeard, Bernoulli(BeardProbability));
if (HasBeard)
    Avatar.AddBeard();
```

```
GeoCoordinate GPSLoc = GPS.GetLocation();
U<GeoCoordinate> Loc = Bayes(GPSLoc, GPS.GetMapPrior());
if (GPS.Distance(Loc, Home) < 200)
    OpenGarageDoor();
```

Rejection sampling



no constraints
poor performance

Infer.NET

```
Variable<GeoCoordinate> Location
    = GPS.GetMapPrior();
Variable<GeoCoordinate> GPSLoc
    = GPS.GetLocationDist(Location);
GPSLoc.ObservedValue = GPS.GetLocation();
var ie = new InferenceEngine();
var NewLocation = ie.Infer(Location);
```



Your PC ran into a problem and needs to restart. We're just collecting some error info, and then we'll restart for you. (0% complete)

If you'd like to know more, you can search online later for this error: HAL_INITIALIZATION_FAILED

Not everyone can make the same **compromises as current probabilistic programming languages.**

- R2: probabilistic program slicing [Hur et al, PLDI'14], program analysis [Chaganty et al, AISTATS'13]
- Approximate Bayesian computation (ABC)/Likelihood-free MCMC
- Likelihood weighting/importance sampling + sequential hypothesis testing (Wald)

Probabilistic programming is great, but please... think of the rest of us!