‘Bayesian’ and ‘Frequentist’ approaches to data-analysis

J. Hanley

Department of Epidemiology, Biostatistics and Occupational Health
McGill University

Round Table Discussion
Statistical Society of Montreal

April 23, 2010

I distinguish 3 situations

- Life in general
- Single-study data-analysis
- Research-synthesis

In Life: we use Bayes Theorem to learn/update

Bayesian integration in sensorimotor learning

Konrad P. Körding & Daniel M. Wolpert *Nature 427; 15 Jan 2004.*

"When we learn a new motor skill, such as playing an approaching tennis ball, both our sensors and the task possess variability. [...] We show that subjects internally represent both the statistical distribution of the task and their sensory uncertainty, combining them in a manner consistent with a performance-optimizing bayesian process. The central nervous system therefore employs probabilistic models during sensorimotor learning."

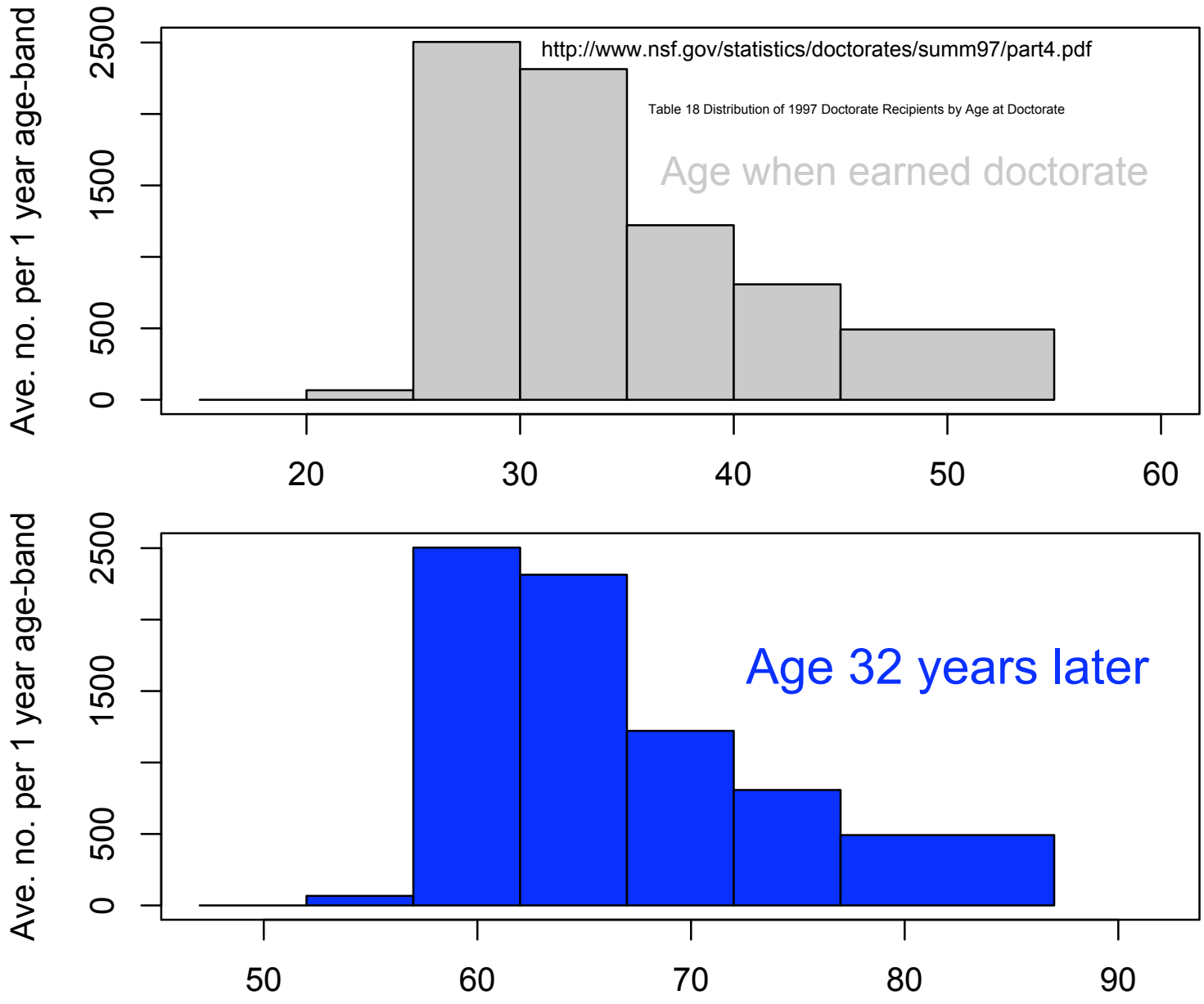
The New York Times
nytimes.com

January 20, 2004

Subconsciously, Athletes May Play Like Statisticians

What age is this person?

Additional info: He obtained his PhD 32 years earlier



Single-study data-analysis

- Likelihood-based parameter-fitting + frequentist-based interval estimation
- IF intractable ML fitting issues, measurement error, hierarchical models, ... , use a computer-intensive MCMC approach using a non-informative prior.
- In simple cases, (Frequentist) confidence intervals $\approx$ (Bayesian) credible intervals. Since credible intervals involve Prob($\theta \mid$ *data*) rather than Prob(*data* $\mid \theta$), they are more natural, and easier to explain correctly.
- Present evidence just from study in question, preferably in a form [Likelihood] that can be merged with evidence from other studies.

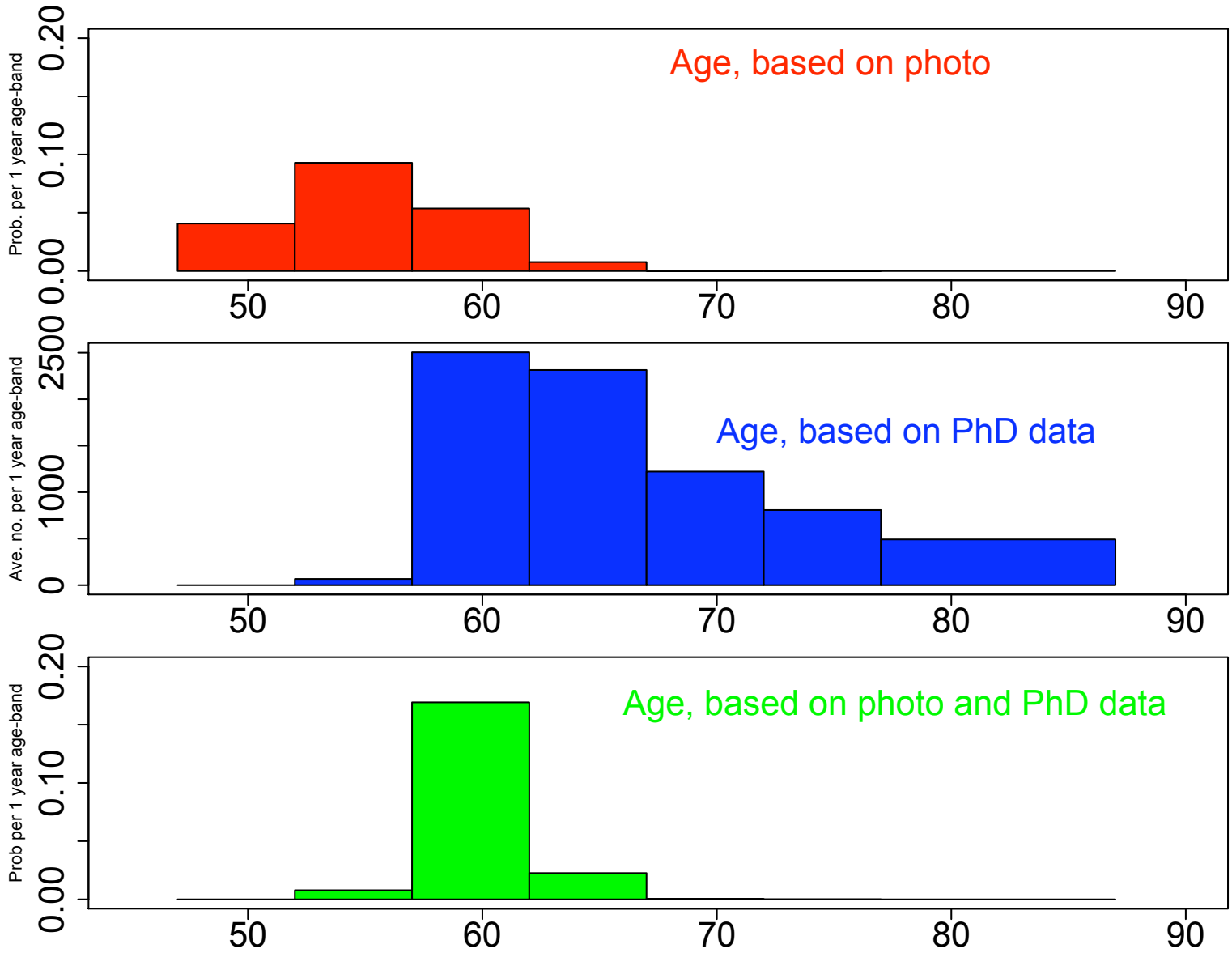
Synthesis of data from several sources

- Simplest case: meta-analysis
- If no unanimity about past evidence, present range of posteriors based on range of pessimistic $\leftrightarrow$ optimistic priors.
- Combining prior + data: is it same as adding (log) probability densities ?

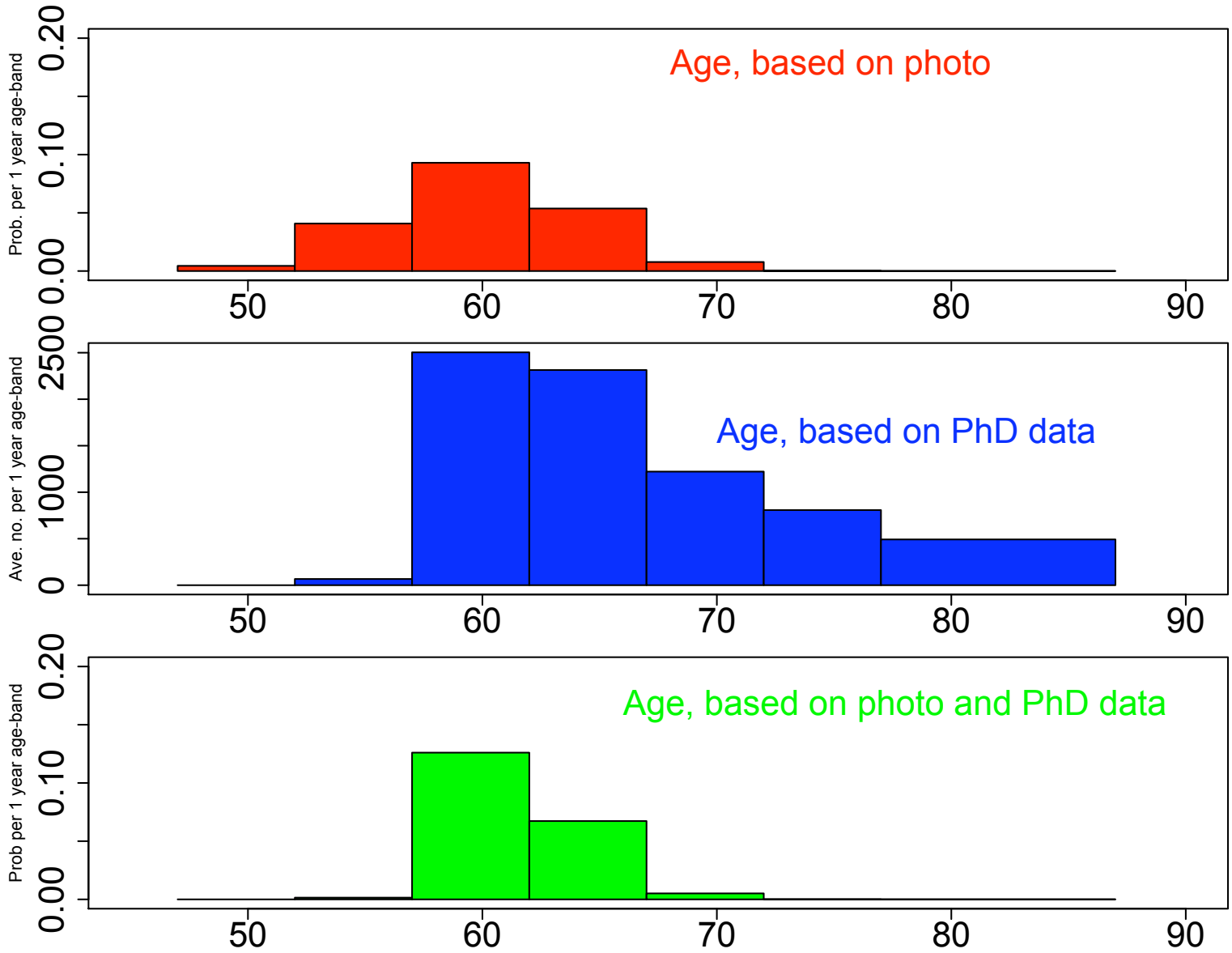
$$p_{photo+PhD}(age) \propto p_{photo}(age) \times p_{ageAtPhD}(age - 32)$$

$$\propto p_{photo}(age) \times p_{ageAtPhD+32}(age)$$

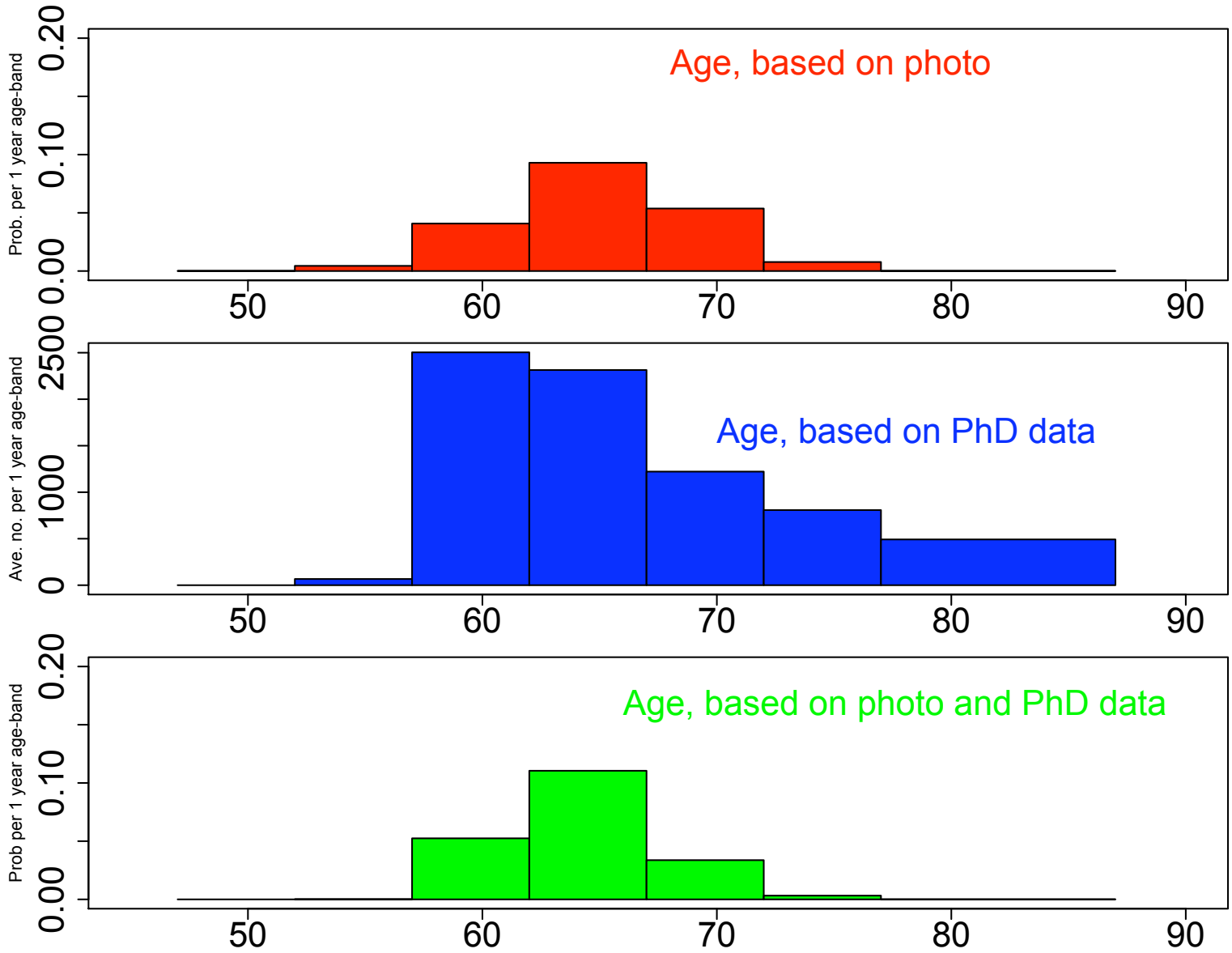
What age is this person?



What age is this person?



What age is this person?



FUNDING & CO-ORDINATES

Natural Sciences and Engineering Research Council of Canada

Le Fonds québécois de la recherche sur la nature et les technologies

James.Hanley@McGill.CA

http://www.biostat.mcgill.ca/hanley