Technical talk

Math, Diagrams, and Executable Code

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Roadmap

1. Formalize the decision problem
2. Expose the computation
3. Explain system structure
4. Connect results to evidence

Model

Sequential decisions under uncertainty

We consider an agent that repeatedly observes a state, chooses an action, and receives a reward.

- **State:** $s \in \mathcal{S}$ summarizes the information available now.
- **Action:** $a \in \mathcal{A}$ changes both reward and the next-state distribution.
- **Objective:** maximize expected discounted return over an indefinite horizon.

Modeling assumption

The current state is sufficient: conditional on s_t and a_t, the future is independent of the earlier history.

Bellman optimality equation

$$V^{\star(s)} = \max_a \quad R(s,a) \quad + \quad \gamma \quad \sum_{s'} P(s' \mid s,a) V^{\star(s')}$$

The recursion separates immediate utility from the expected value of all subsequent decisions [1].

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$$V^{\star(s)} = \max_a \underbrace{R(s,a)}_{\text{immediate reward}} + \underbrace{\gamma}_{\text{discount factor}} \underbrace{\sum_{s'} P(s' \mid s,a) V^{\star(s')}}_{\text{optimal future value}}$$

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Computation

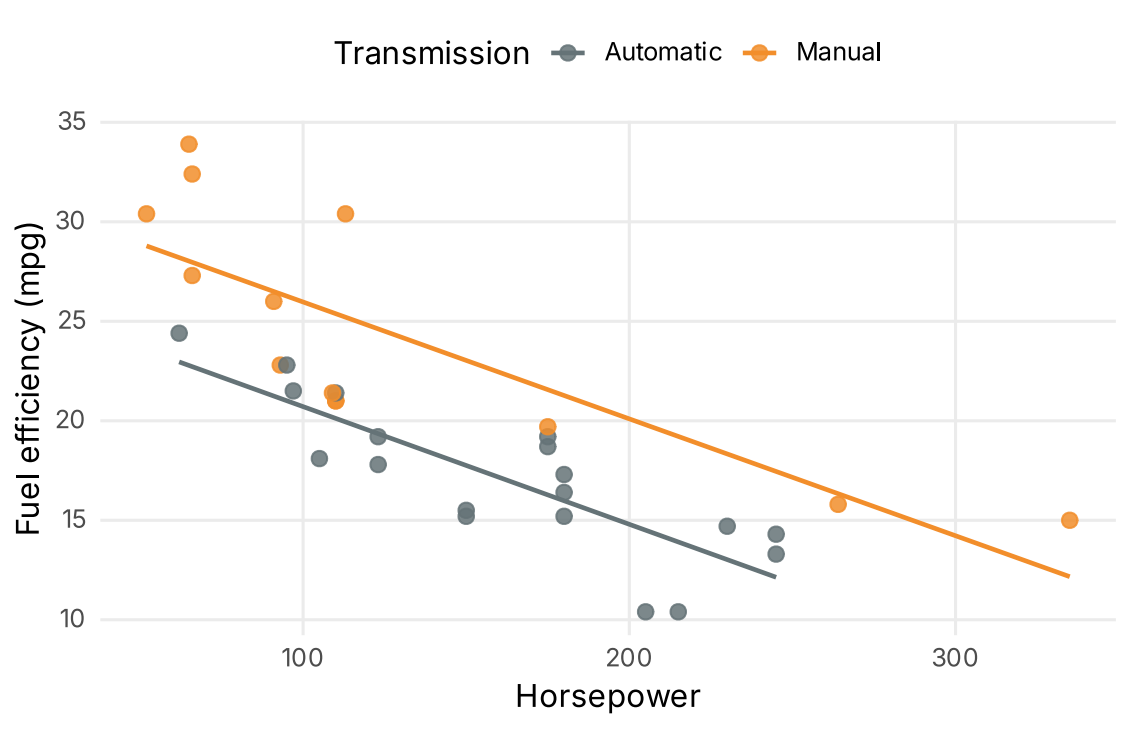
An executable analysis

The source below is executed during compilation. Its figure is cached by Calepin and placed on the following slide.

```
library(ggplot2)
fit <- lm(mpg ~ hp + factor(am), data = mtcars)

ggplot(mtcars, aes(hp, mpg, color = factor(am))) +
  geom_point(size = 2.6, alpha = 0.85) +
  geom_smooth(method = "lm", se = FALSE, linewidth = 0.9) +
  scale_color_manual(
    values = c("0" = "#657377", "1" = "#f28e2b"),
    labels = c("Automatic", "Manual")) +
  labs(x = "Horsepower", y = "Fuel efficiency (mpg)", color = "Transmission") +
  theme_minimal(base_family = "Fira Sans", base_size = 13) +
  theme(legend.position = "top", panel.grid.minor = element_blank())
```

Horsepower predicts lower efficiency



- Fuel efficiency declines as horsepower increases.
- Transmission groups occupy different regions of the sample.
- The fitted lines summarize association, not causation.

Data: `mtcars`, 32 model-year 1973 to 1974 automobiles.

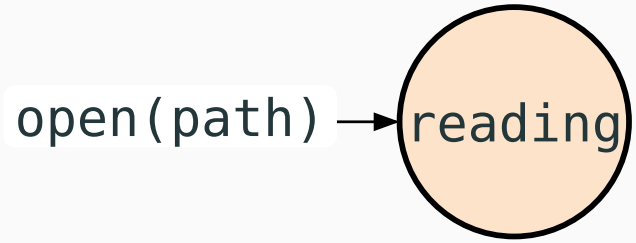
Computed model summary

The same R session retains `fit`, so numerical claims can be generated rather than copied into the deck.

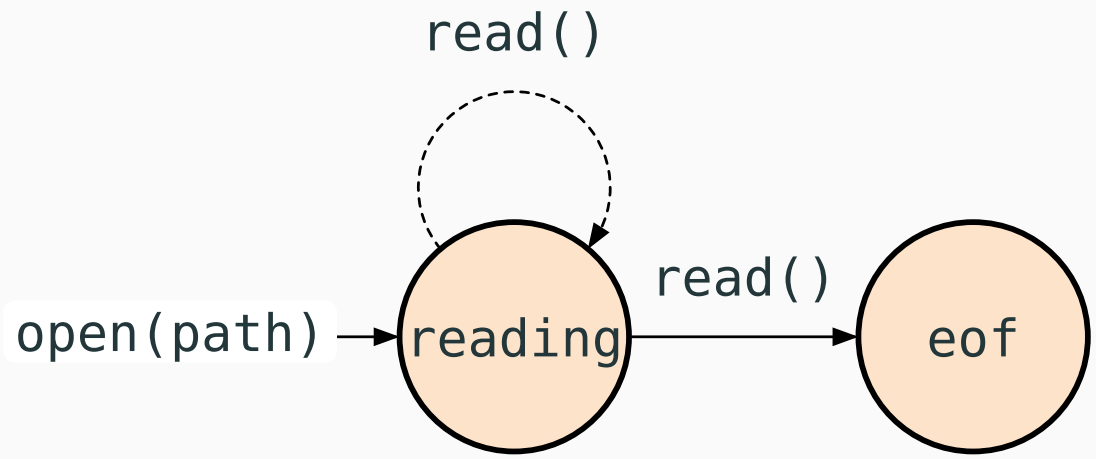
Estimated association Holding transmission fixed, an additional 10 horsepower is associated with **0.59 fewer mpg**. The model explains **78.2%** of the observed variation in fuel efficiency.

Structure

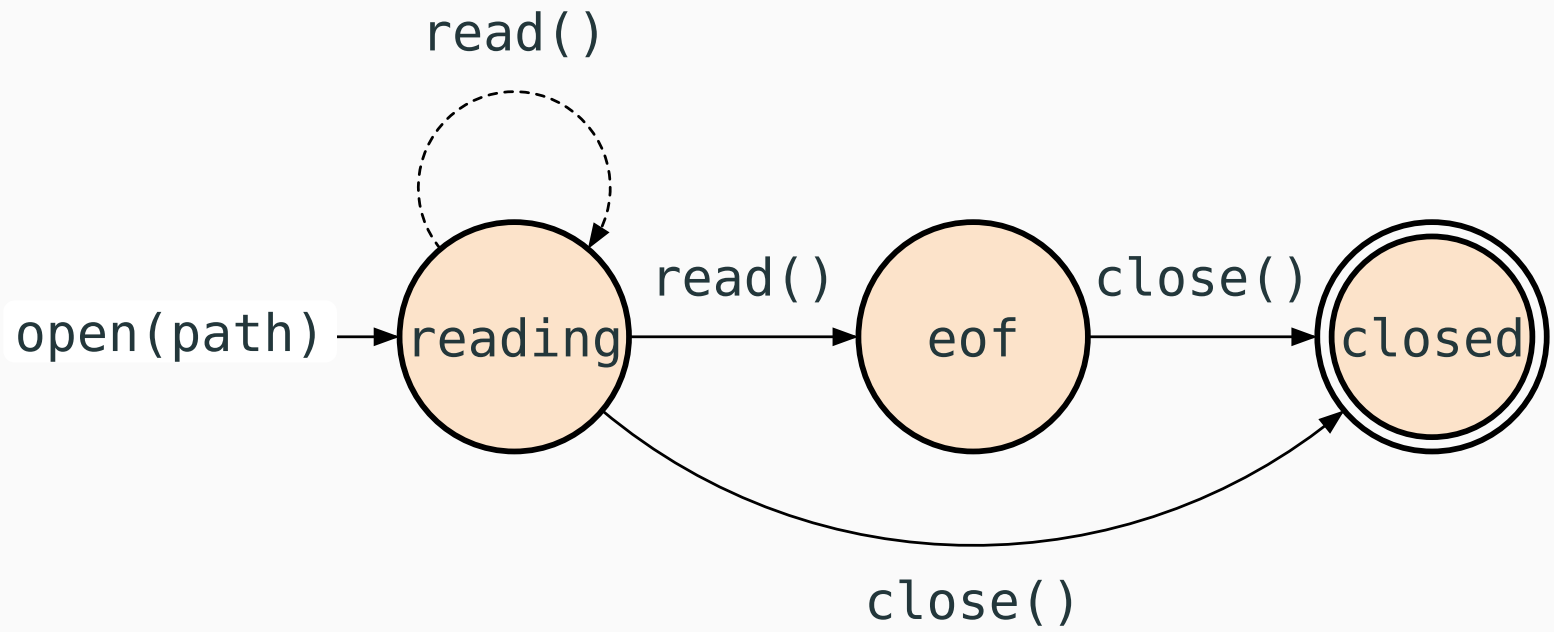
File-reader state machine



File-reader state machine

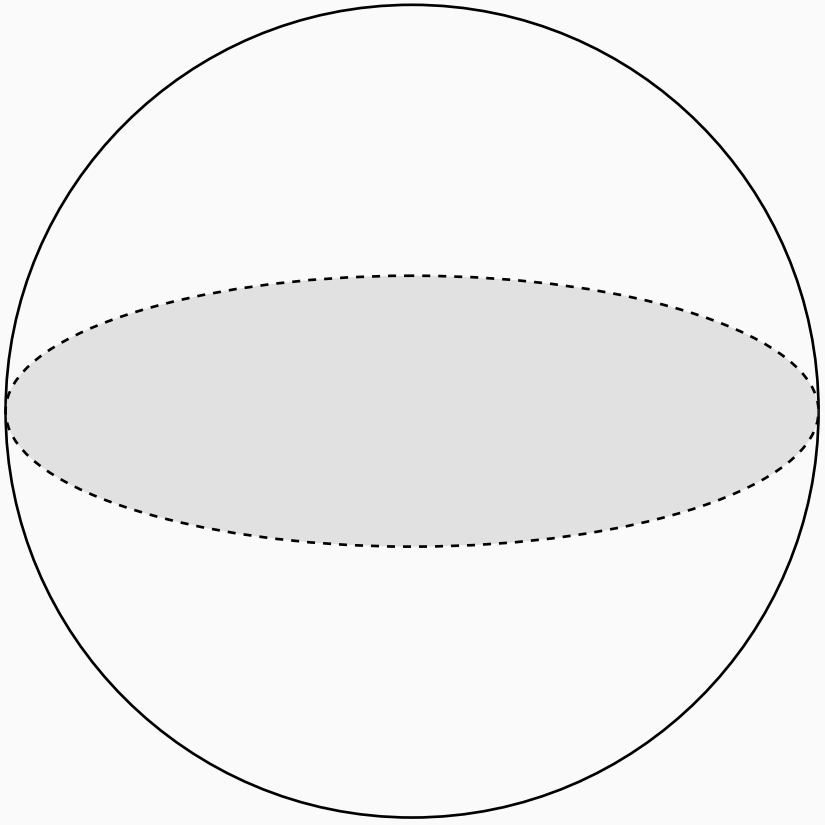


File-reader state machine

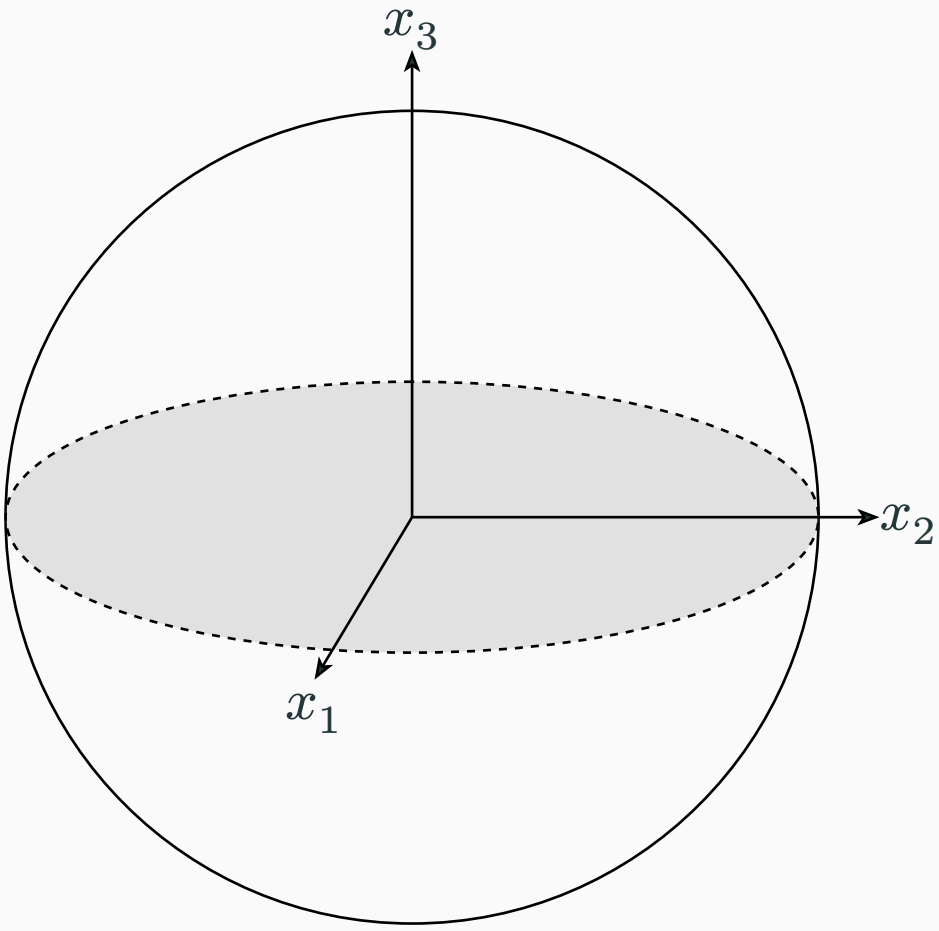


Geometry

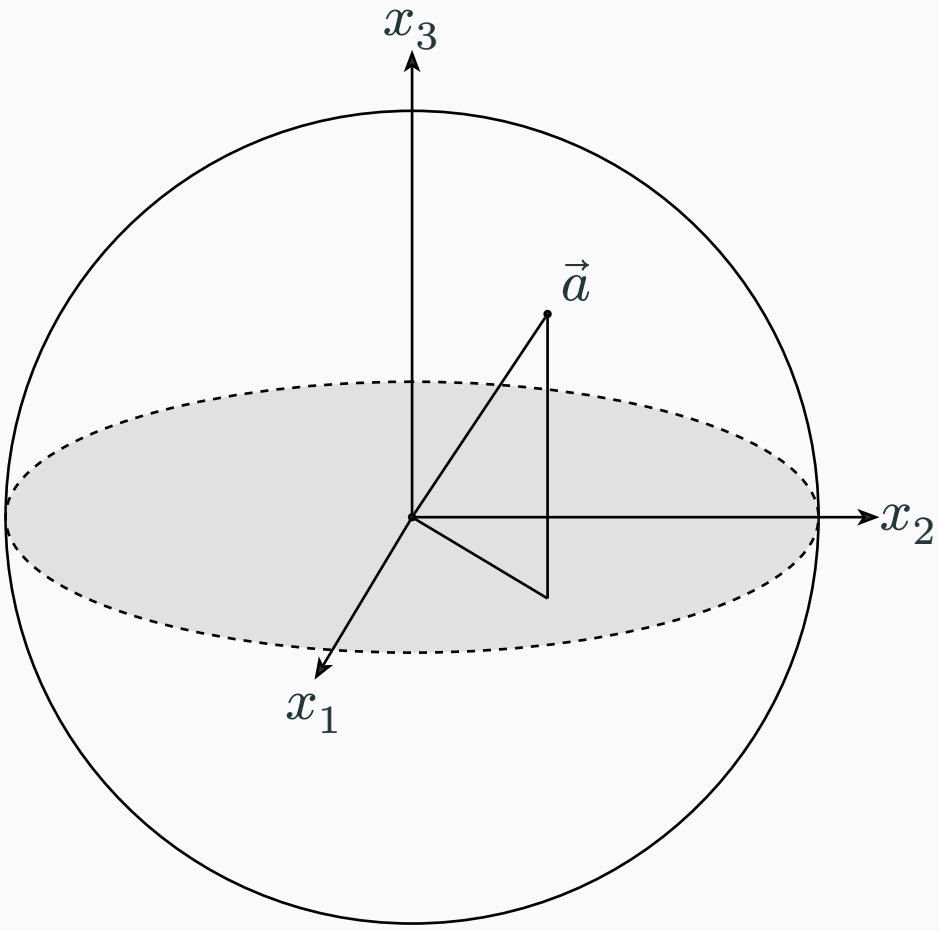
A qubit as a Bloch vector



A qubit as a Bloch vector



A qubit as a Bloch vector



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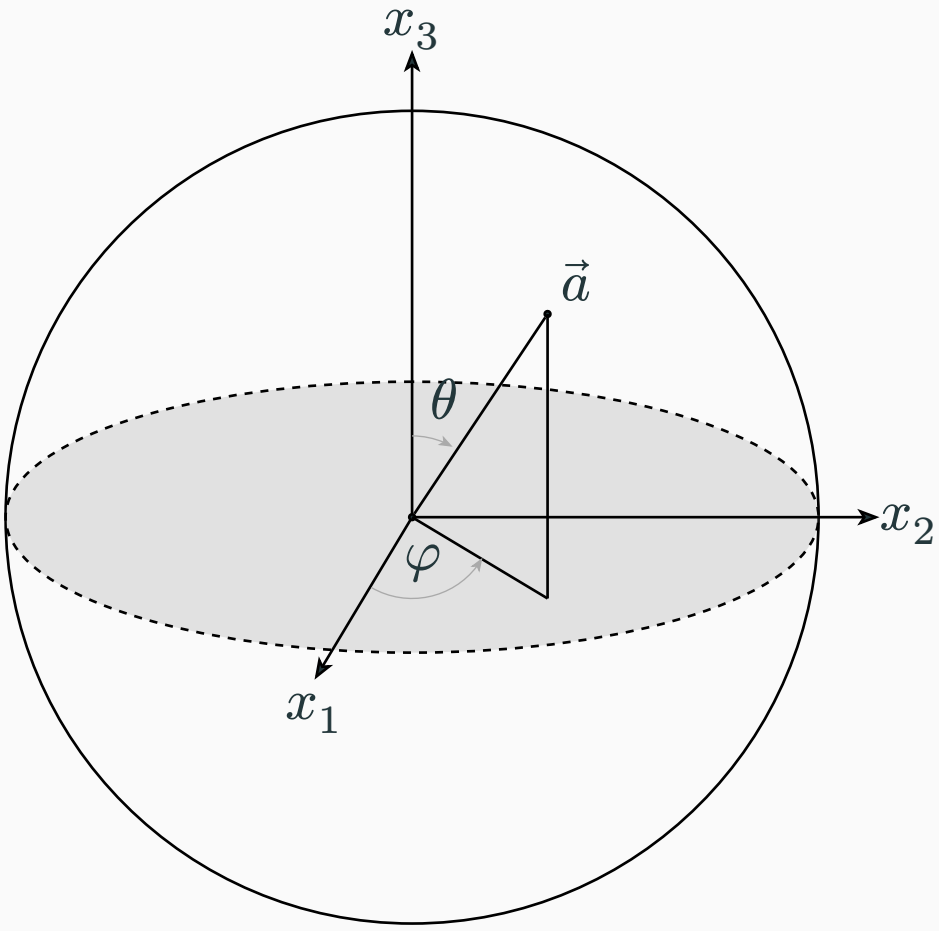

Evidence

What makes a technical slide?

Include

- a question or claim
- units and definitions
- reproducible computation
- a stated interpretation

Avoid

- unlabelled decorative plots
- numbers copied by hand
- animation without exposition
- citations disconnected from claims

Questions?

References

[1] R. Bellman, *Dynamic Programming*. Princeton University Press, 1957.