A Testable Theory of Memory and Choice

Stefan Bucher (joint with Andrew Caplin), NYU
stefan.bucher@nyu.edu

22nd February 2019

Introduction

- How are choices affected by information gathered in the past?
- Goal: Theory of memory as pertaining to choice
- Model memory as goal-directed costly information acquisition
    - Where goal is unknown/blurry at time of acquisition

Importance and Context

Context

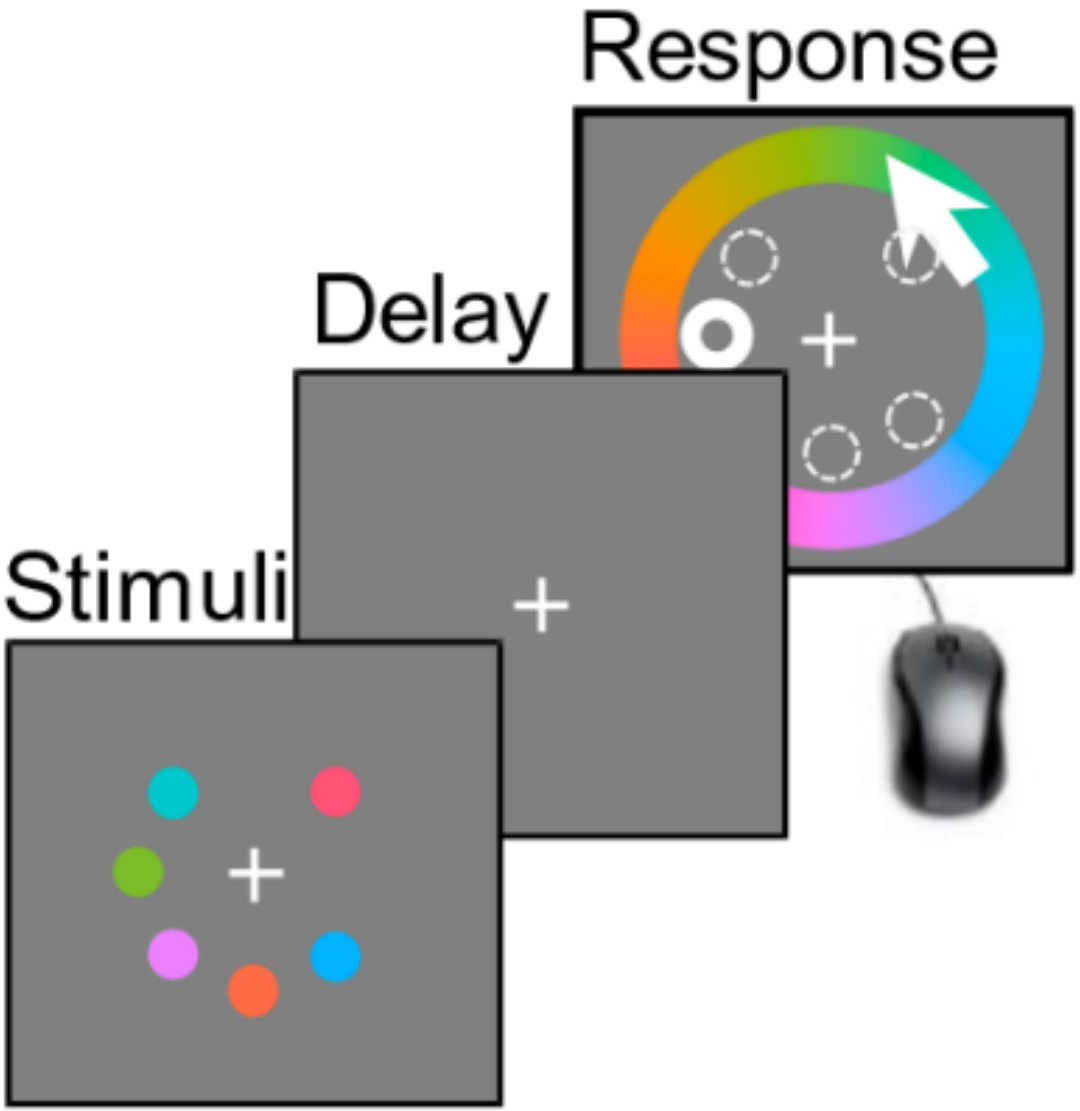
- Memory is imperfect and limits what information is available when making a choice. Consider e.g.
  - choice of restaurant based on what we remember about it
  - doctor in the ER
  - multiple choice exam

Context

- Memory is imperfect and limits what information is available when making a choice. Consider e.g.
  - choice of restaurant based on what we remember about it
  - doctor in the ER
  - multiple choice exam
- Potential for fruitful dialogue
  - Importance of memory recognized by economics (Bordalo, Gennaioli, Shleifer 2017)
  - Resource-rational models of working memory in psychology (van den Berg&Ma 2018)

The Research Process

Delayed Estimation Task



van den Berg&Ma (2018)

Research Plan

- Key feature of memory: Information was acquired for a more general context than the decision problem at hand
- We model DM acquiring costly information while unsure about decision to be faced

Research Plan

- Key feature of memory: Information was acquired for a more general context than the decision problem at hand
- We model DM acquiring costly information while unsure about decision to be faced
- Currently exploring model predictions
- Application to economic settings
- Results and experiments to follow

We model DM facing choice set A_n with probability F_n

- μ: prior over states $\omega \in \Omega$
- $u(a_n, \omega)$: utility of choosing a_n in state ω

We model DM facing choice set A_n with probability F_n

- μ: prior over states $\omega \in \Omega$
- $u(a_n, \omega)$: utility of choosing a_n in state ω

Model Timing

- Stage 1: Given F and μ, choose with what signal structure to memorize ω (at a cost, e.g. mutual information)
- n and signal realize
- Stage 2: Given signal, choose action from A_n

We model DM facing choice set A_n with probability F_n

- μ: prior over states $\omega \in \Omega$
- $u(a_n, \omega)$: utility of choosing a_n in state ω

Model Timing

- Stage 1: Given F and μ, choose with what signal structure to memorize ω (at a cost, e.g. mutual information)
- n and signal realize
- Stage 2: Given signal, choose action from A_n

Temporal separation of acquisition and use of information by n.
For $N = 1$ this is a rational inattention problem.

Agenda

Importance and Context

The Research Process

- Example 1: Delayed Estimation Problem
- Example 2: Delayed Accept/Reject Decision

Challenges and Questions

Delayed Estimation Problem

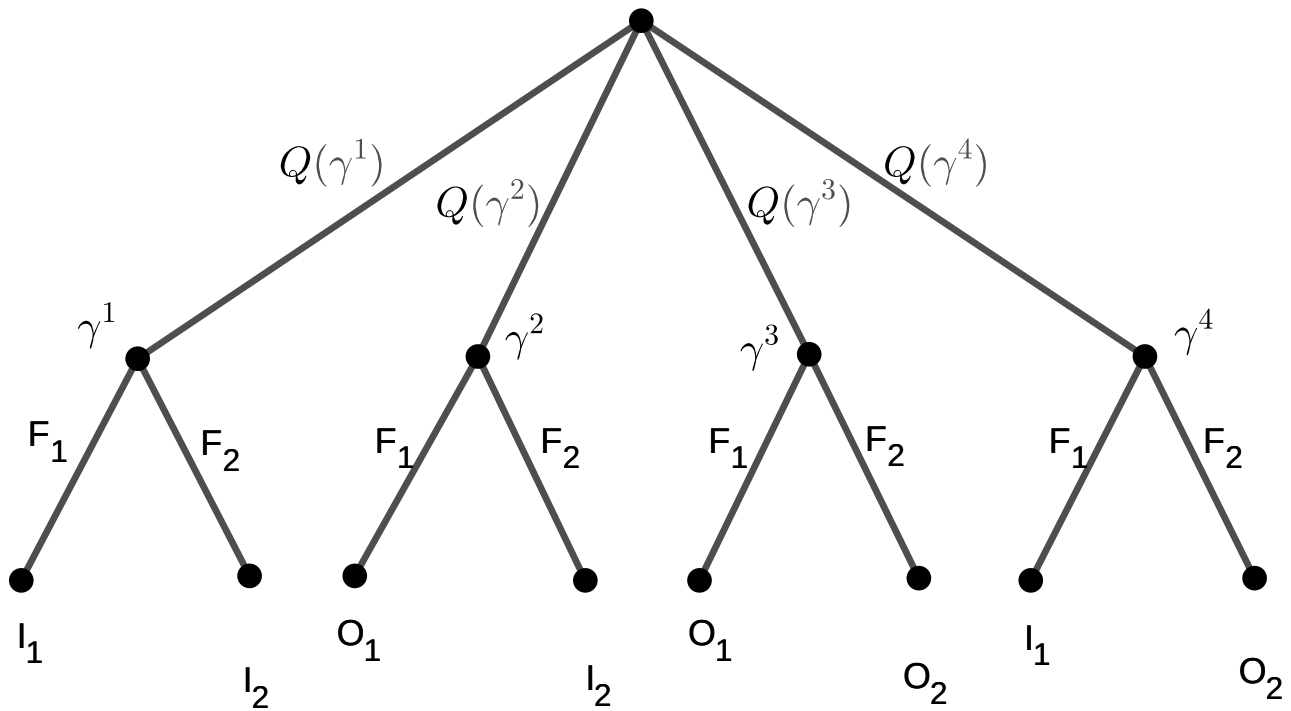
- State: N-dimensional vector ω with $\omega_n \in \{I, O\}$
- Action set $A_n = \{I, 0\}$ encountered with probability F_n
- Utility $u(a_n, \omega) = \mathbb{1}\{a_n = \omega_n\}$
- E.g. for $N = 2$:

$u(a,\omega)$	$\begin{pmatrix} I \\ I \end{pmatrix}$	$\begin{pmatrix} I \\ O \end{pmatrix}$	$\begin{pmatrix} O \\ I \end{pmatrix}$	$\begin{pmatrix} O \\ O \end{pmatrix}$
I^1	1	1	0	0
O^1	0	0	1	1
I^2	1	0	1	0
O^2	0	1	0	1

$$A = \begin{cases} A_1 = \{I^1, O^1\} & \textit{with probability } F_1 \\ A_2 = \{I^2, O^2\} & \textit{with probability } 1 - F_1 \end{cases}$$

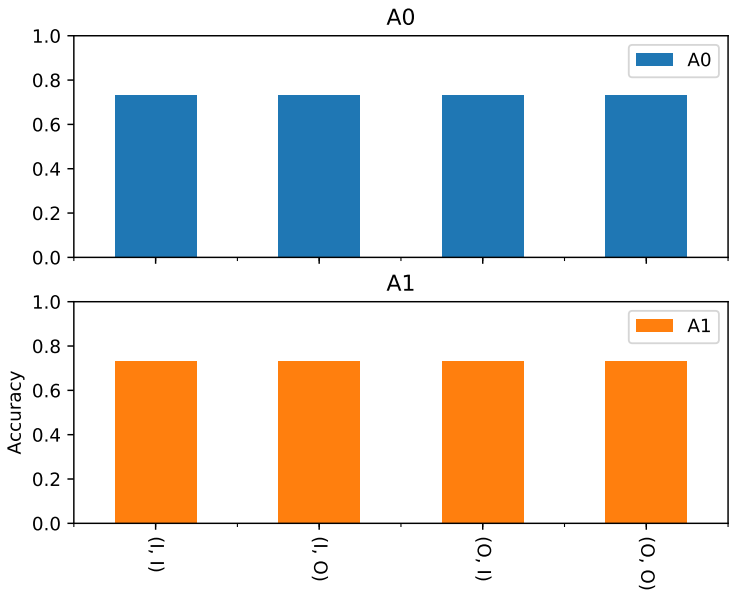
Illustration

Stage 2 choice is contingent on n and γ, and can thus be formulated as choice of n-contingent action plan. We establish formal equivalence to a rational inattention problem. Equivalent Problem

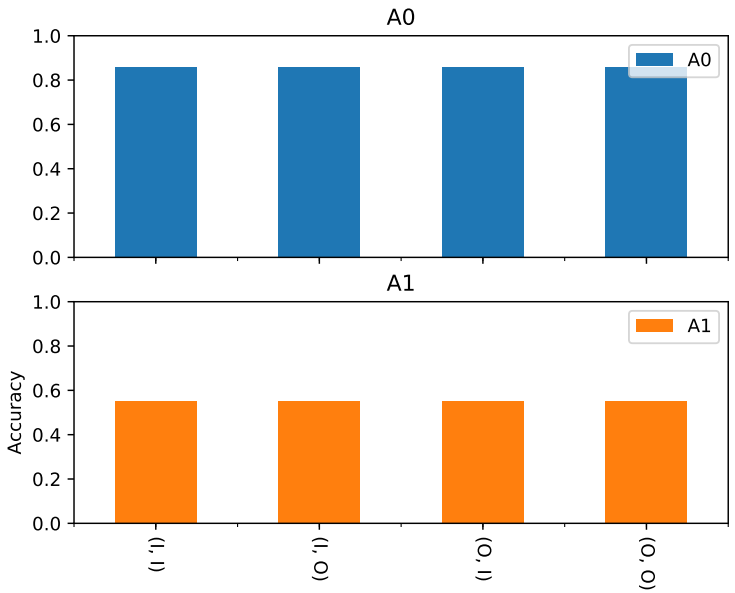


Accuracy in each problem depends on F

For μ uniform:

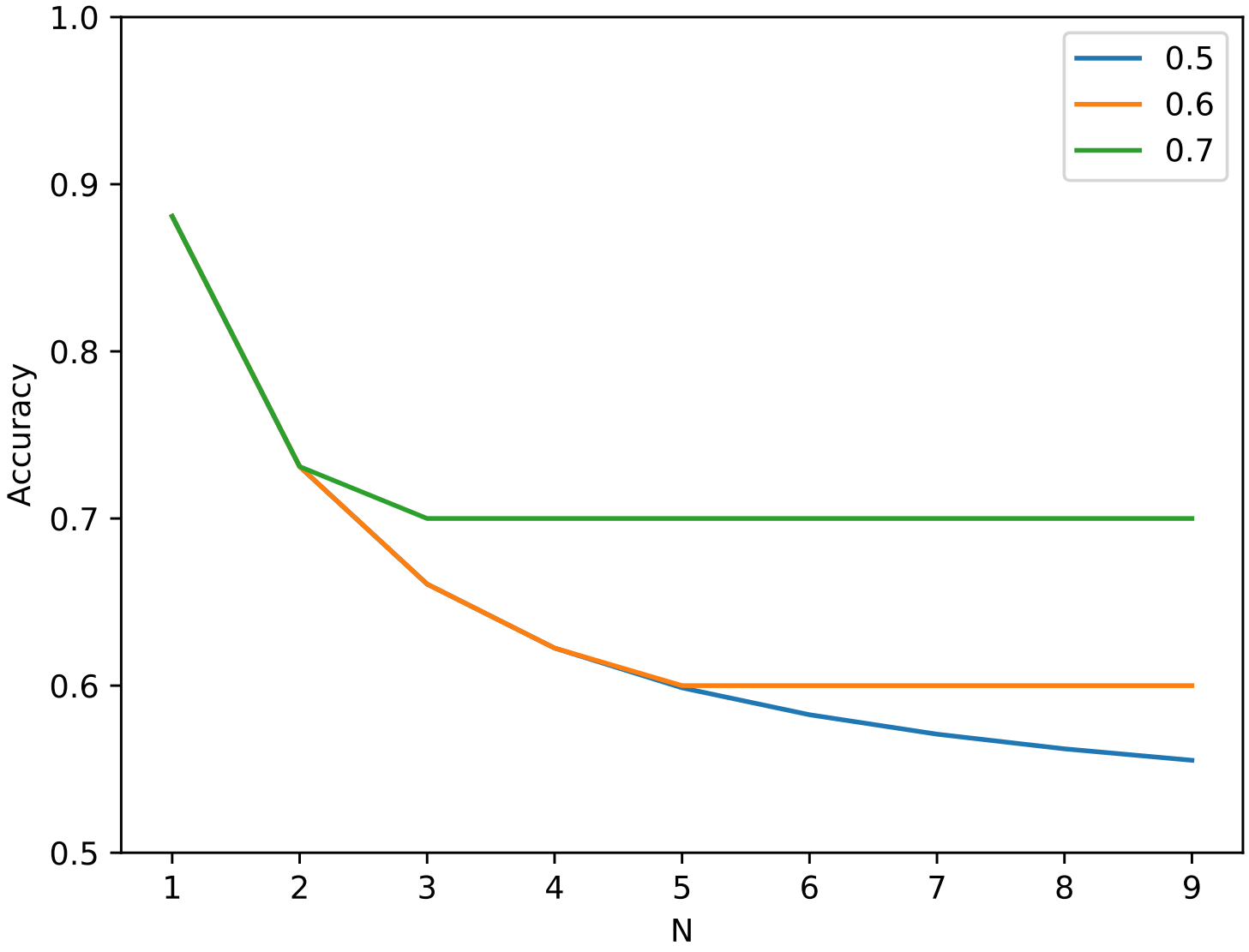


$F_1 = 0.5$



$F_1 = 0.9$

Set Size Effects: Increasing N for uniform F, different μ



Agenda

Delayed Accept/Reject Decision

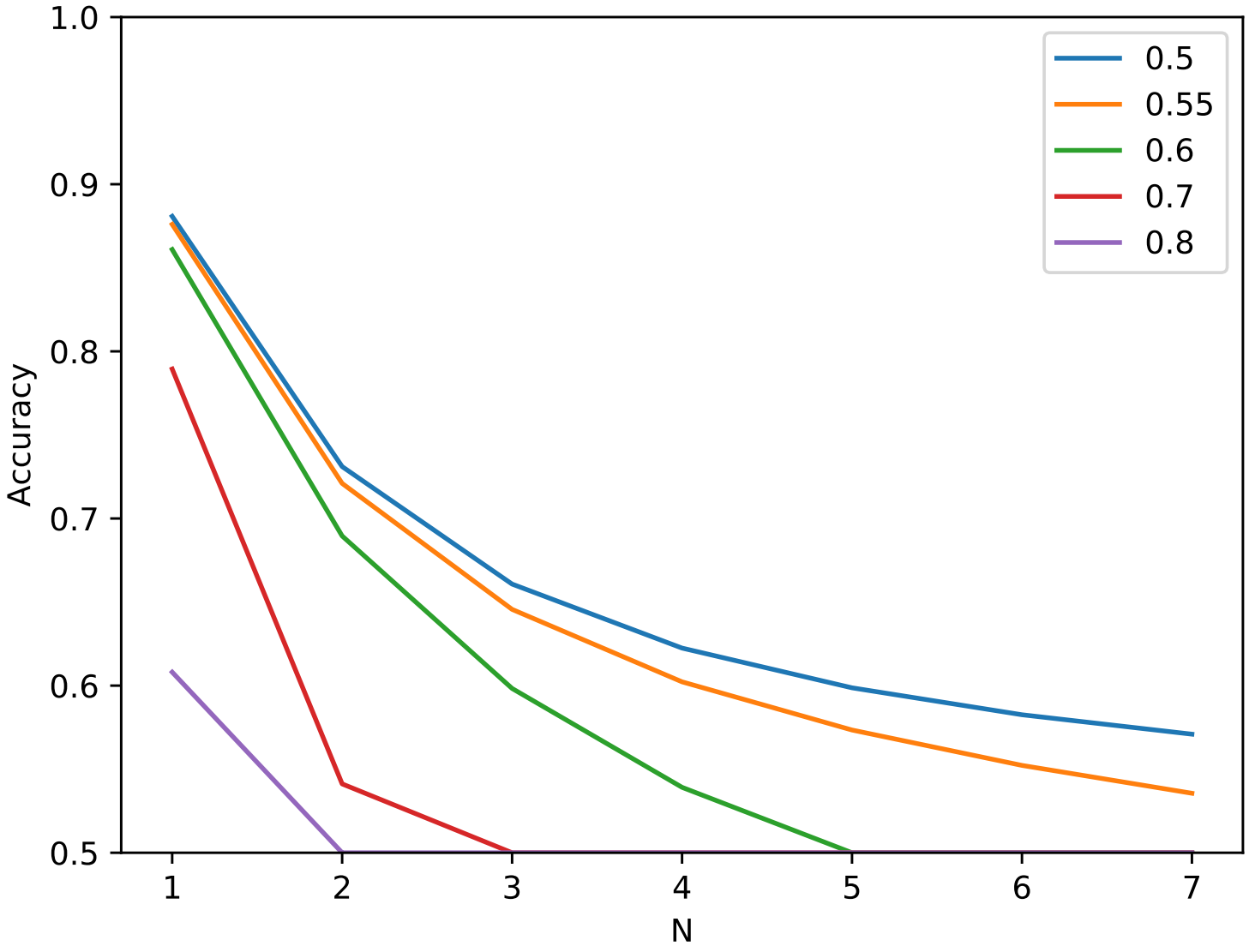
- State: N-dimensional vector ω with $\omega_n \in \{I, O\}$
- Action set $A_n = \{accept, reject\}$
- These are encountered with probability F_n and give utility

$$u(accept, \omega) = \omega_n$$

$$u(reject, \omega) = u_0$$

$u(a, \omega)$	$\begin{pmatrix} I \\ I \end{pmatrix}$	$\begin{pmatrix} I \\ O \end{pmatrix}$	$\begin{pmatrix} O \\ I \end{pmatrix}$	$\begin{pmatrix} O \\ O \end{pmatrix}$
$accept^1$	1	1	0	0
$reject$	u_0	u_0	u_0	u_0
$accept^2$	1	0	1	0
$reject$	u_0	u_0	u_0	u_0

Picking the good option, for different N and outside options u_0



Challenges and Questions

Challenges and Questions

- Next step: Extend framework to account for time and forgetting
- Impact of time scale: seconds vs. years
- Most economically interesting comparative statics
  - Choice probabilities as a function of memory cost
  - As a function of prior