Steering User Behavior with Badges

Ashton Anderson

Joint work with Dan Huttenlocher, Jon Kleinberg, and Jure Leskovec

People will work amazingly hard to earn badges

"Give me enough medals and I'll win you any war."

– Napoleon


MEDAL OF HONOR
(Army)
MEDAL OF HONOR
(Navy, Marine Corps, Coast Guard)
MEDAL OF HONOR
(Air Force)

KHAN ACADEMY

BADGE TYPES

Meteorite badges are common and easy to earn when just getting started.

Moon badges are uncommon and represent an investment in learning.

Earth badges are rare. They require a significant amount of learning.

Sun badges are epic. Earning them is a true challenge, and they require impressive dedication.

Black Hole badges are legendary and unknown. They are the most unique Khan Academy awards.

Challenge Patches are special awards for completing topic challenges.


WIKIPEDIA
Den fria encyklopedin


user page
User
SPAM
Wiki

foursquare®

- Altruist × 2694
- Analytical × 421
- Announcer × 13
- Archaeologist ×
- Autobiographer
- Benefactor × 14
- Beta × 2525
- Booster × 744
- Caucus × 8516
- Citizen Patrol ×
- Civic Duty × 21
- Cleanup × 1300
- Commentator ×
- Constituent × 2
- Convention × 1
- Copy Editor × 7
- Critic × 106518
- Custodian × 59
- Deputy × 2322
- Disciplined × 46
- Editor × 473573
- Electorate × 3426
- Enlightened × 800
- Enthusiast × 4539
- Epic × 352
- Excavator × 2911
- Famous Question
- Fanatic × 7992
- Favorite Question
- Generalist × 466
- Good Answer × 5
- Good Question ×
- Great Answer × 6
- Great Question ×
- Guru × 15701
- Informed × 21165
- Investor × 5386
- Legendary × 117
- Marshal × 480
- Mortarboard × 13183
- Necromancer × 7199
- Nice Answer × 2676
- Nice Question × 113
- Notable Question ×
- Organizer × 45228
- Outspoken × 411
- Peer Pressure × 213
- Popular Question ×
- Populist × 2976
- Precognitive
- Promoter × 25419
- Proofreader × 2862
- Publicist × 302
- Pundit × 3026
- Quorum × 12075
- Research Assistant
- Reversal × 139
- Reviewer × 3847
- Revival × 80126
- Scholar × 45361
- Self-Learner × 3
- Sportsmanship
- Stellar Question
- Steward × 989
- Strunk & White
- Student × 60236
- Suffrage × 1436
- Supporter × 3543
- Synonymizer × 4
- Tag Editor × 894
- Talkative × 3169
- Taxonomist × 61
- Teacher × 44264
- Tenacious × 138
- Tumbleweed × 2
- Unsung Hero × 4
- Vox Populi × 661
- Yearling × 22885

Badges play multiple roles:

– can recognize a wide range of types of activities
– serve both as credentials and create incentives

Despite surface-level simplicity, badges are complex

? How do badge criteria translate into effects on user behavior?

? How should site designers define badges to achieve a particular outcome?

Need a model of user behavior
in the presence of badges

This talk:

1. Develop a model of user behavior in the presence of badges (theory)

2. Validate qualitative model predictions with real-world data (empirical analysis)

3. Investigate how to optimally design badges (algorithms and simulations)

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Model Goals

✦ Assume that badges have value to users

✦ A user trades off between her preferred mix of activities and the goal of winning badges

✦ We'd like to see this produce effects on both overall engagement and "steering" – balancing activities differently

Our Model

There is a population of users and a site designer

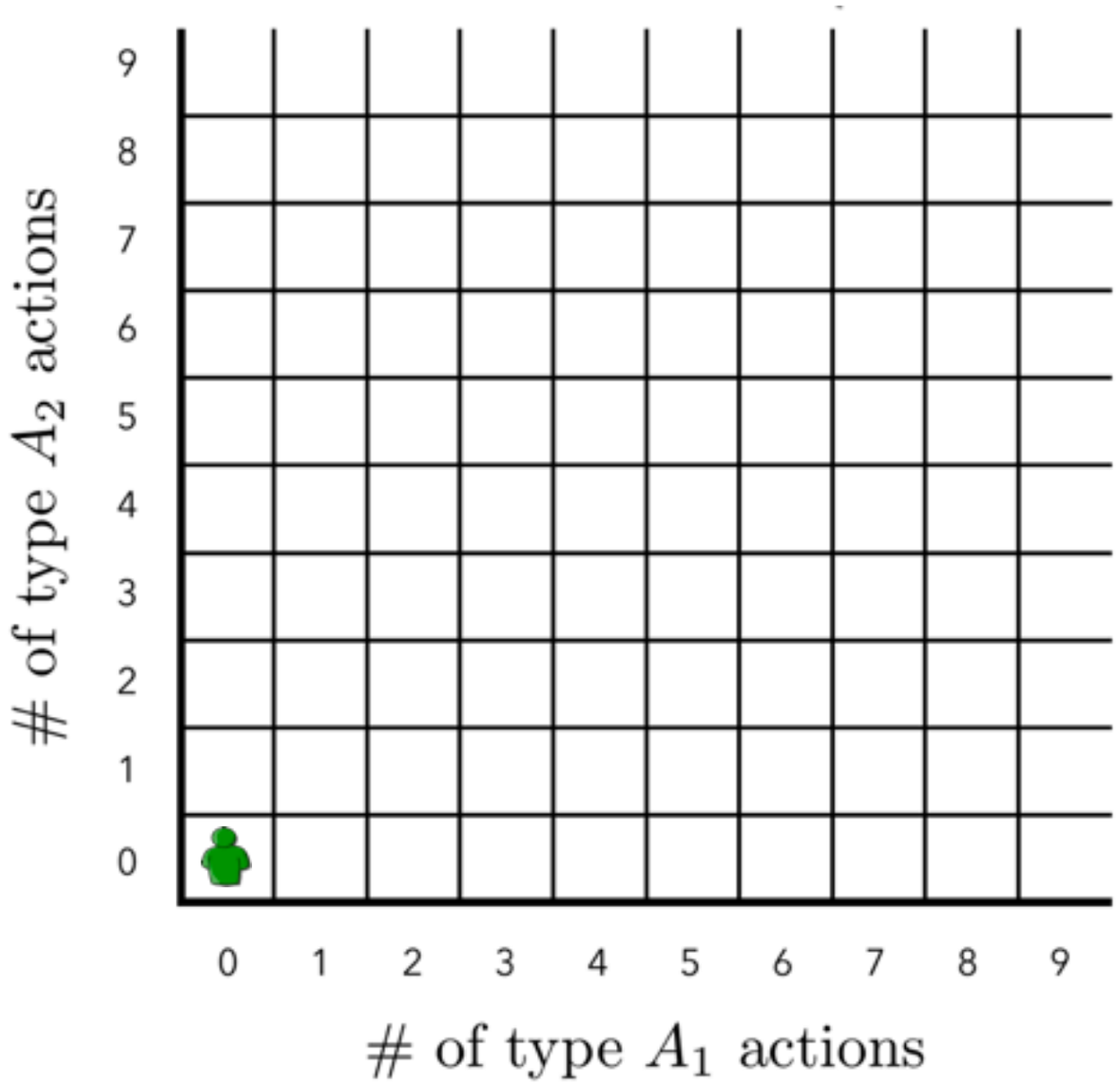
users

site designer

The Action Space

There are action types A_1, A_2, ..., A_{n+1} that form an

action space



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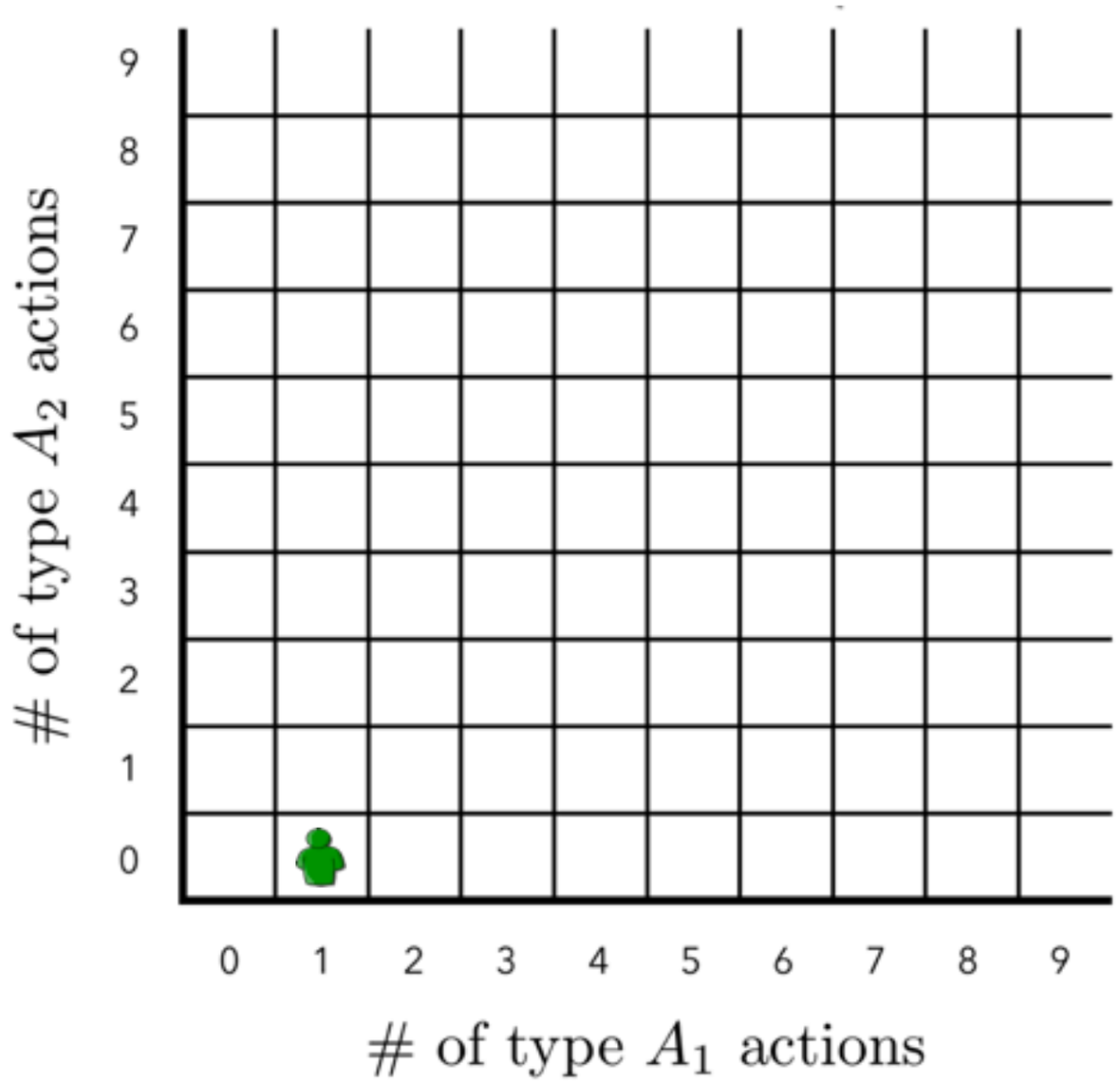

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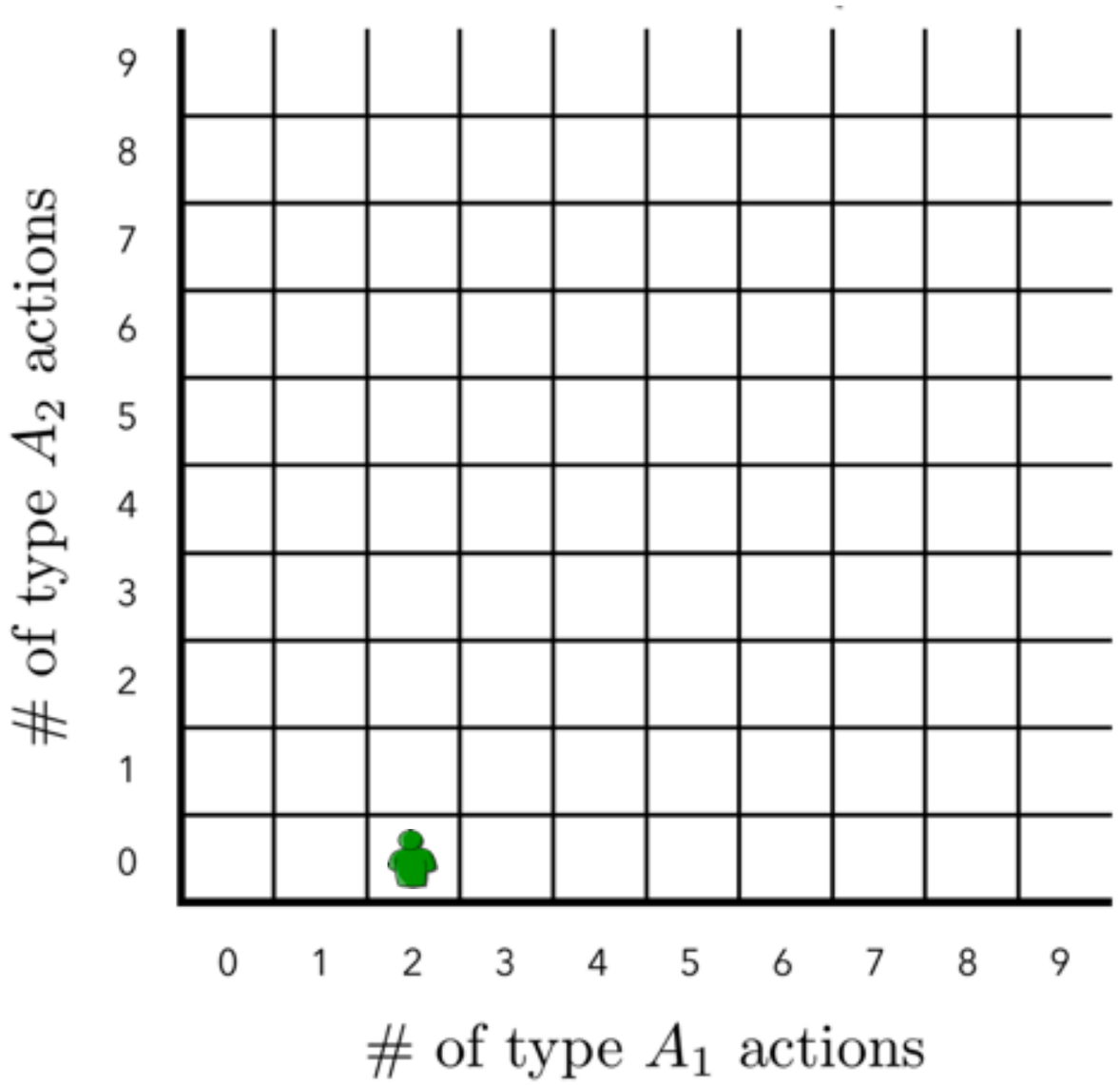

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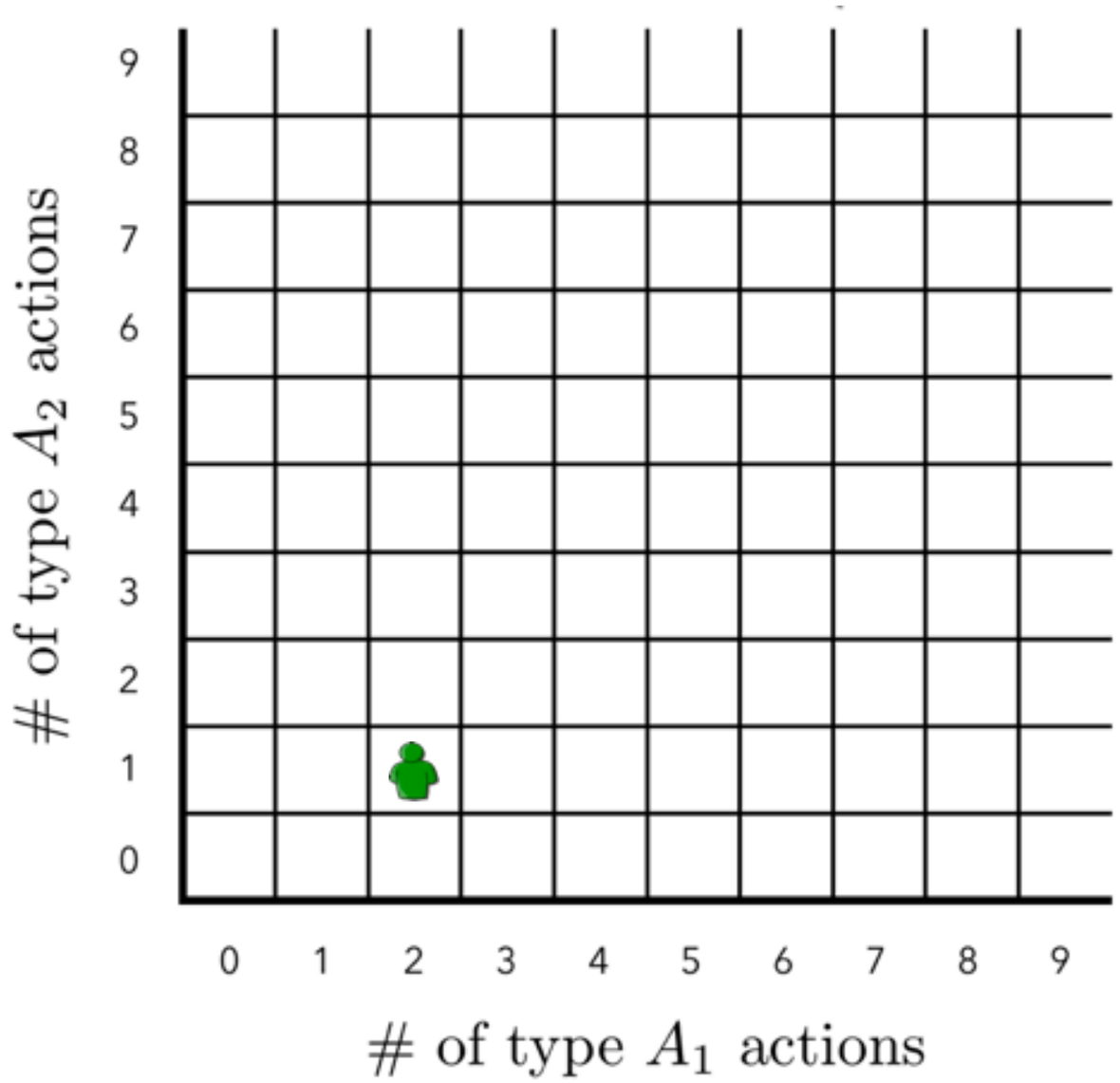

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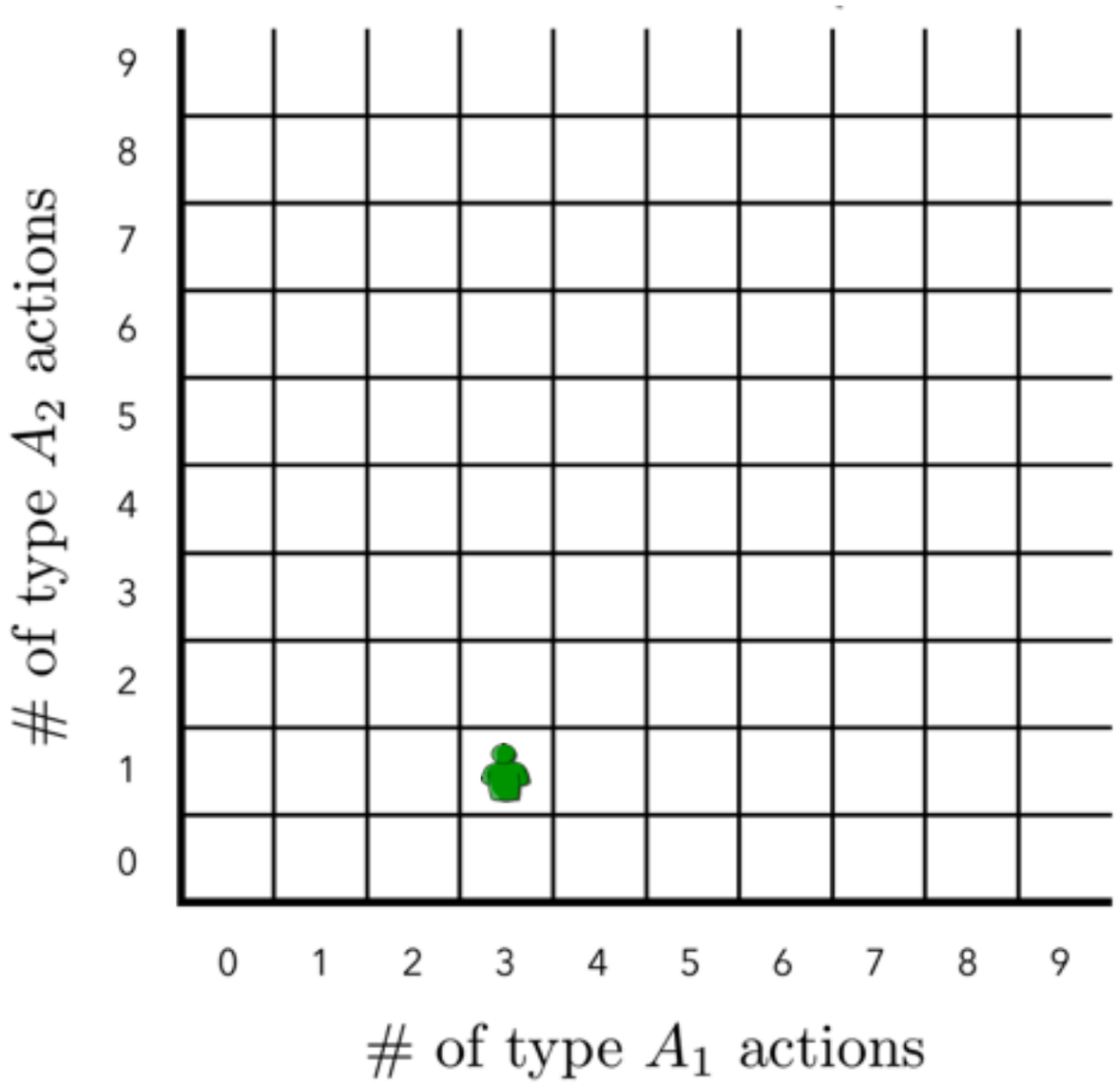

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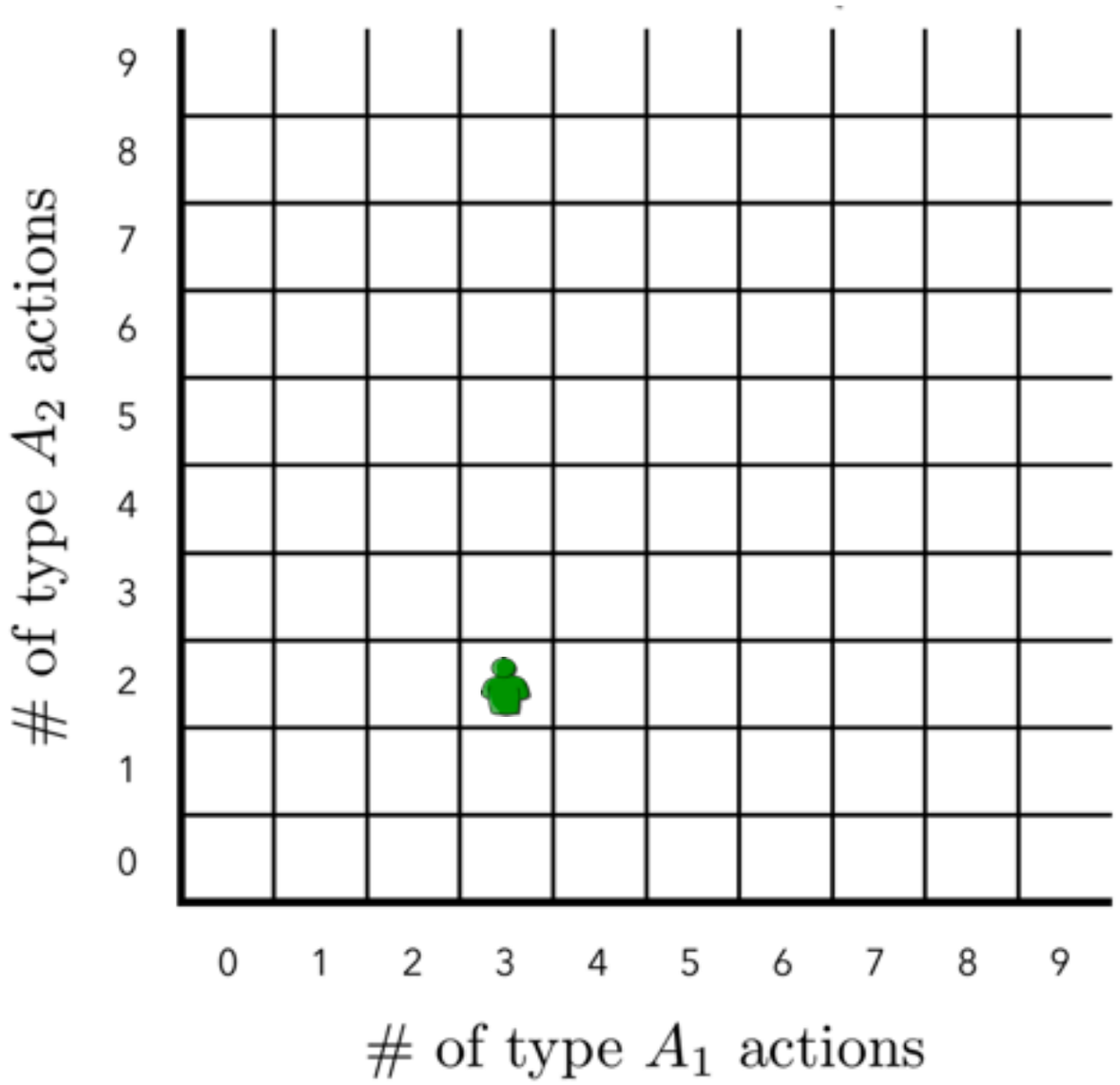

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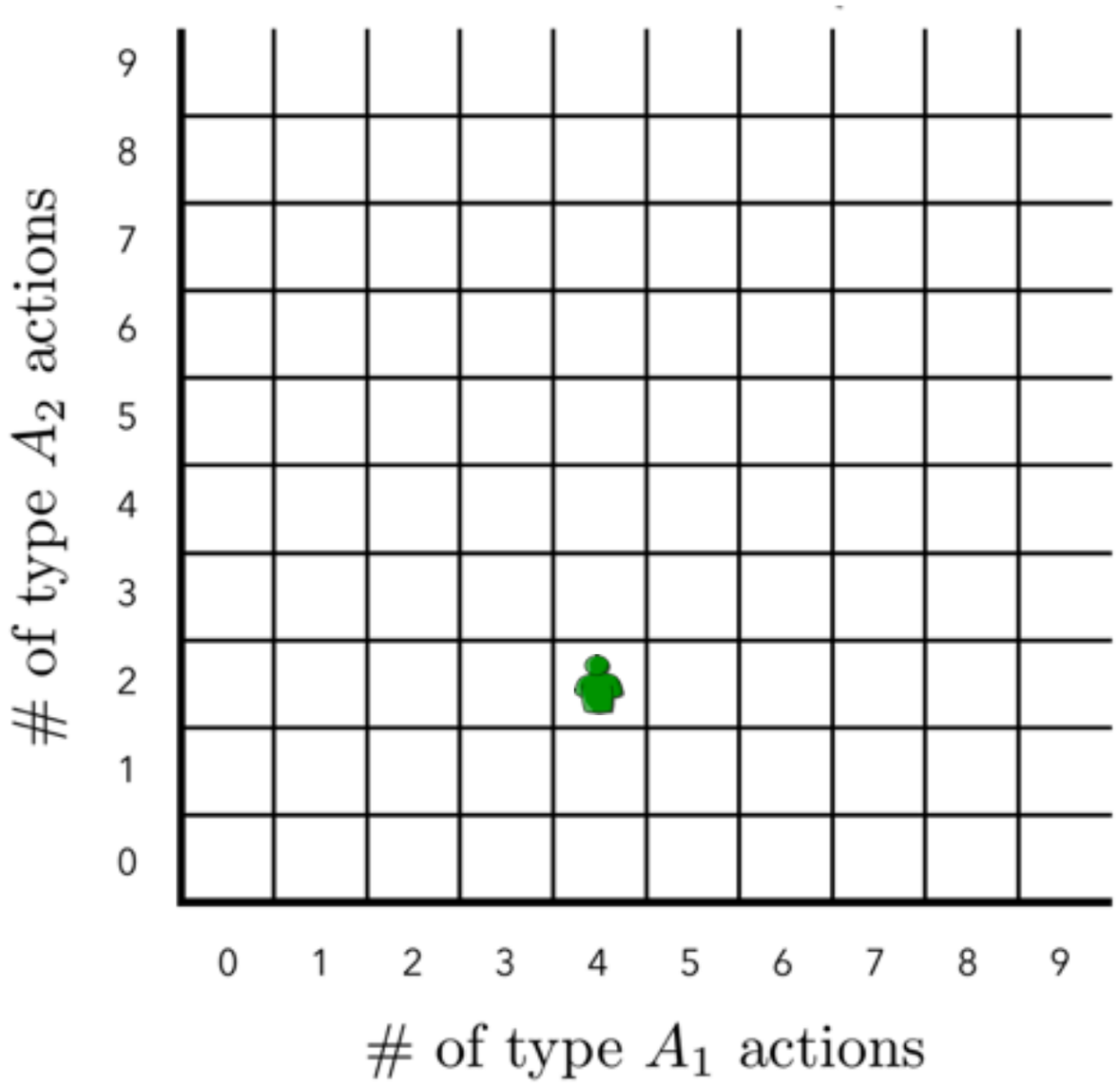

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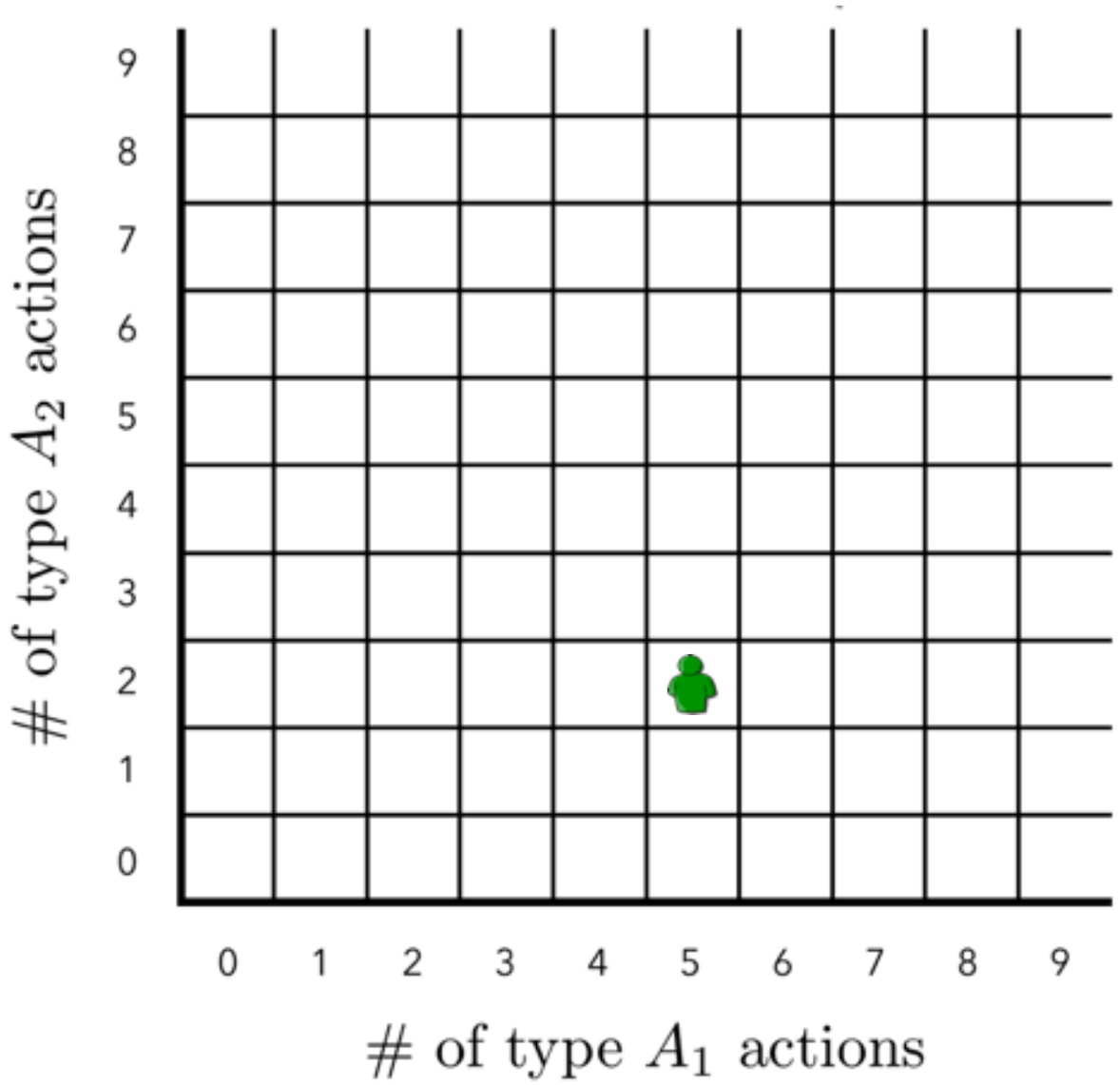

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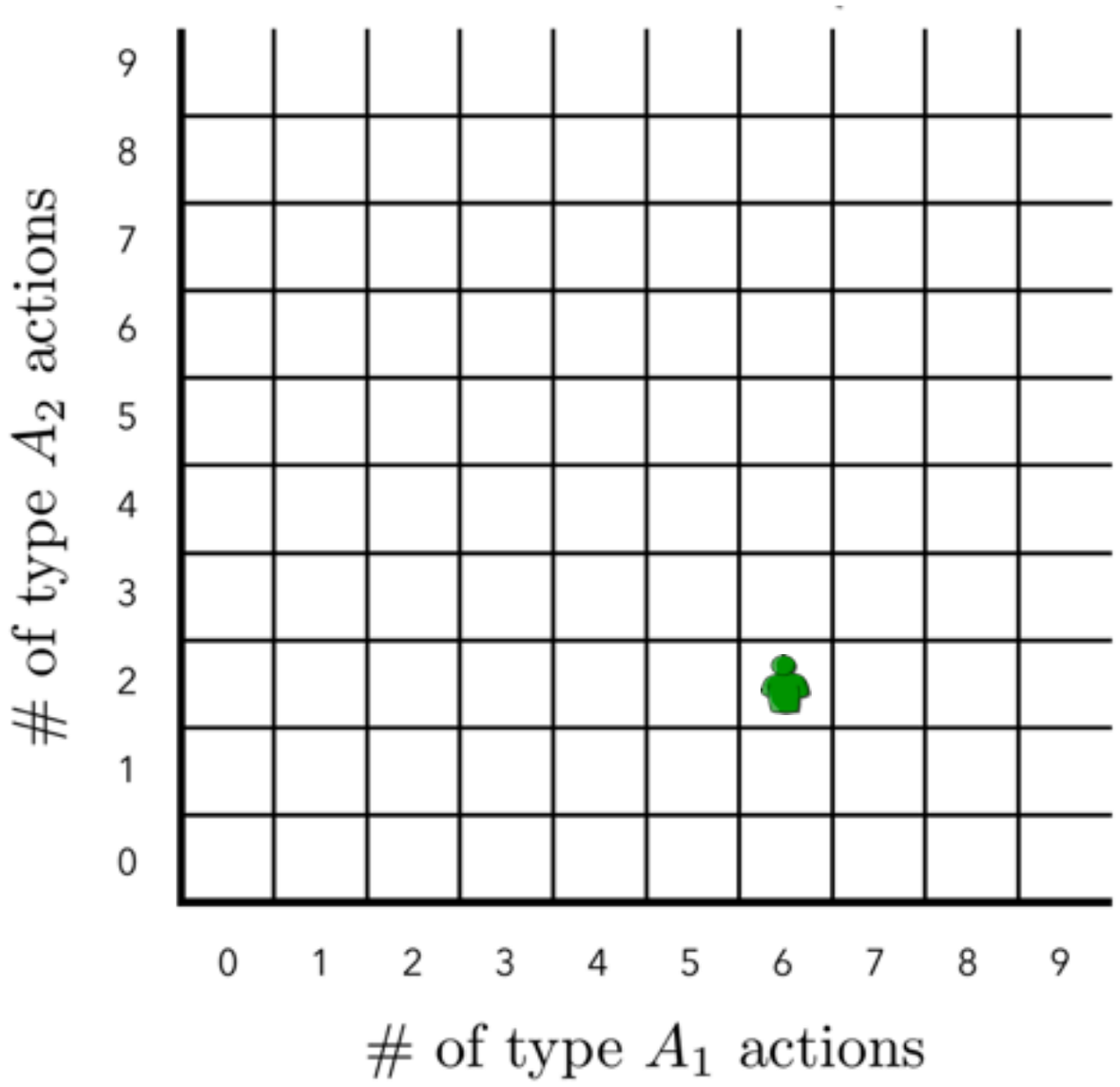
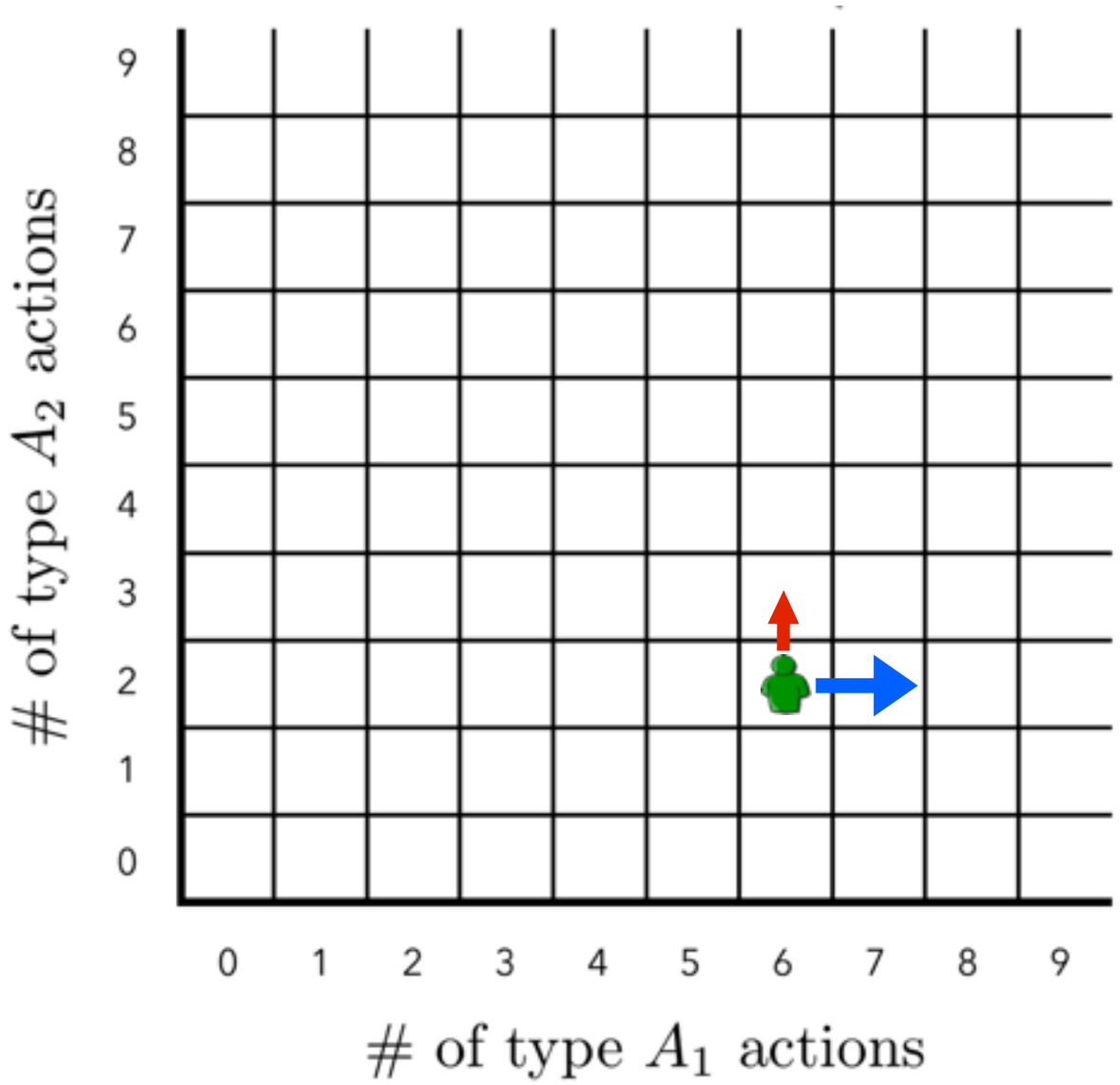


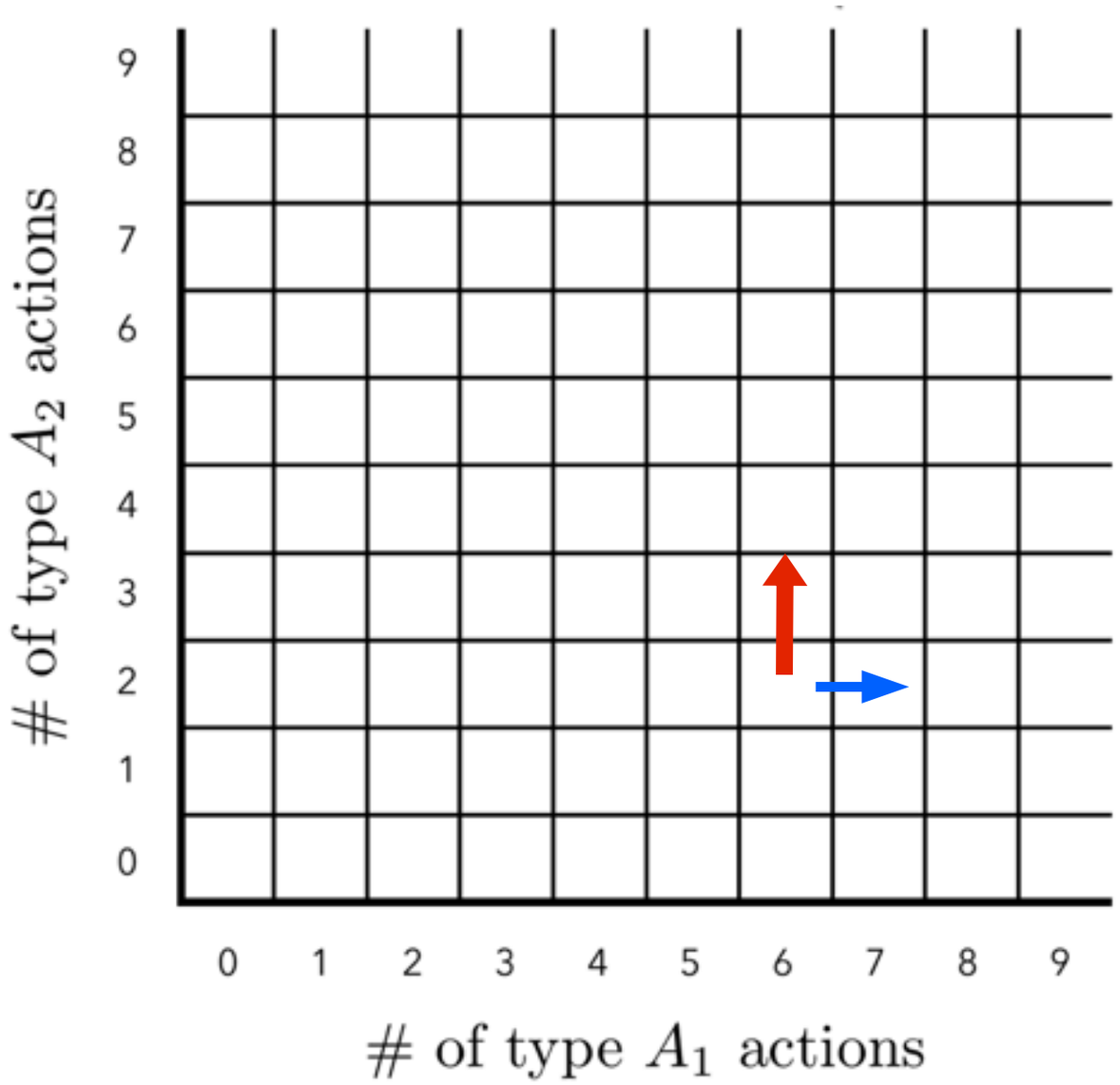
Probabilistic Actions

At each step, choose a probability distribution $\mathbf{p_a}$ to draw next action from (and exit with probability $1 - \theta$)



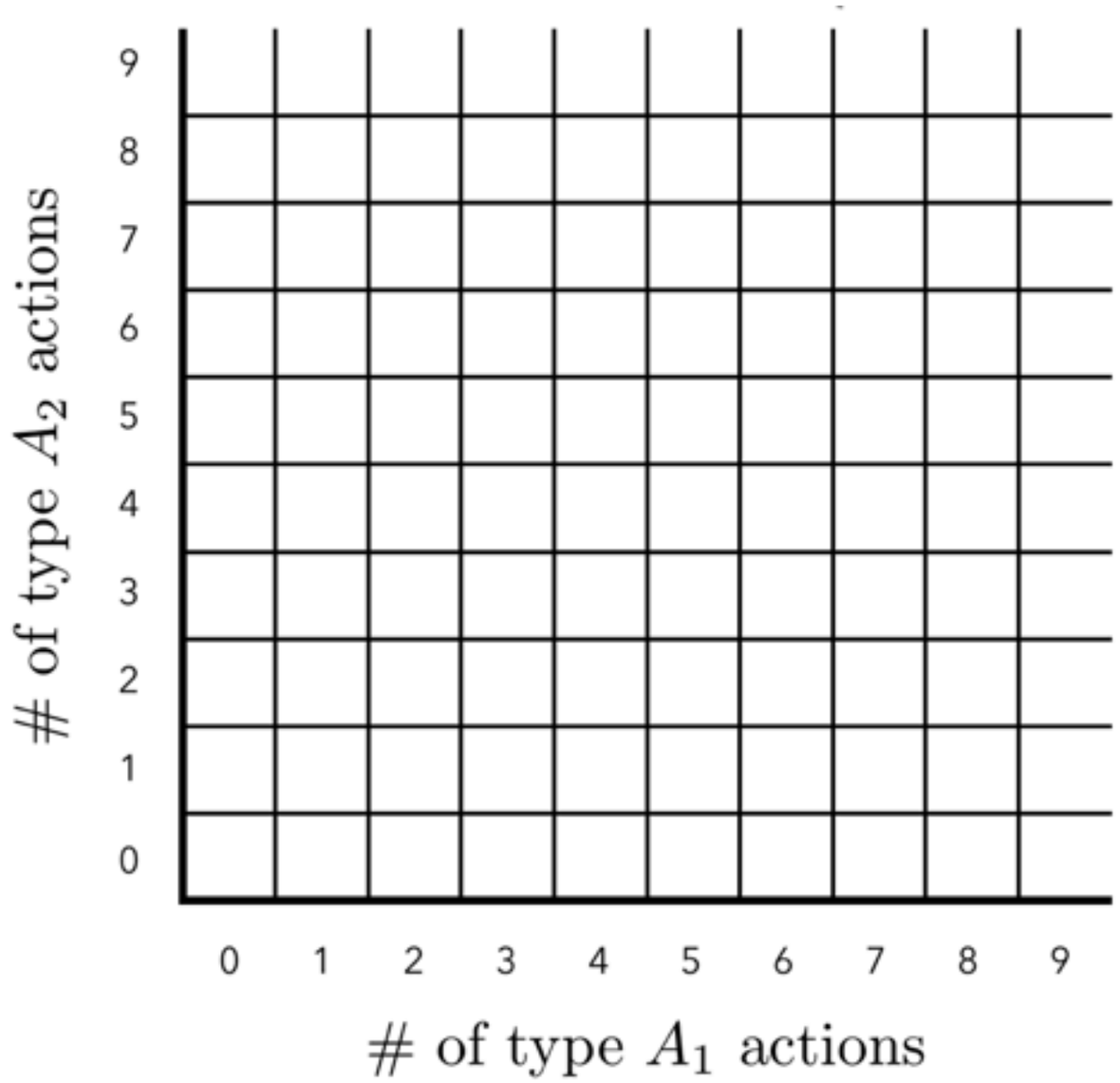
Preferred Distribution

Users prefer certain actions over others: each user is born with a preferred distribution over actions $\mathbf{p}$



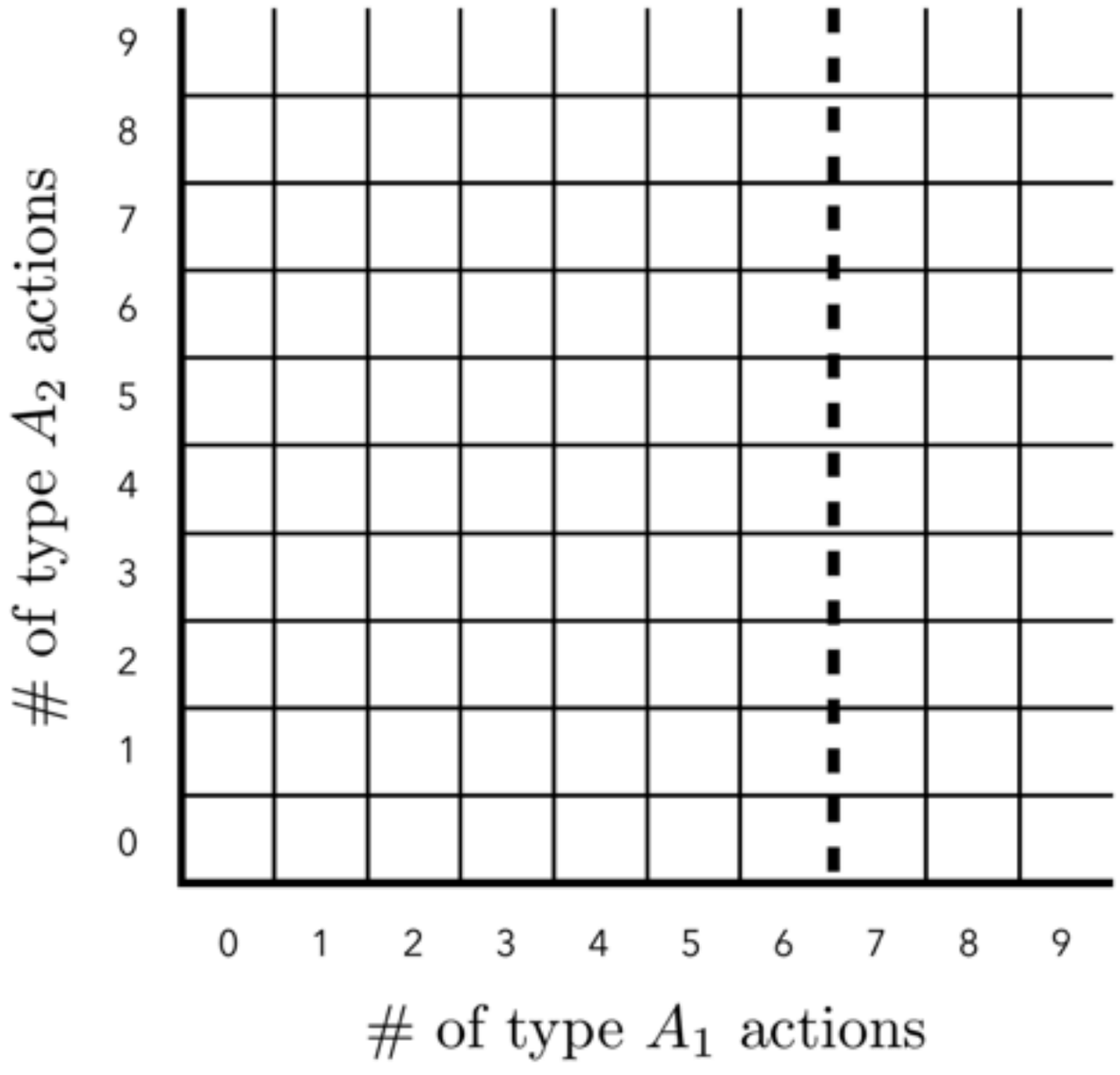
Cost for deviating

If the user picks probability distribution **p'**, then he incurs a utility penalty $g(\mathbf{p}, \mathbf{p'}) = \|\mathbf{p} - \mathbf{p'}\|_2^2$



Badges

- ✦ Set of badges B
- ✦ Each badge b is a subset of cells in action space and has value V_b



User's Utility Function

User's utility is composed of three parts:

1. Value from badges won
2. Cost for deviating from $\mathbf{p}$
3. (Recursively) Utility from next state

Utility from won badges

Cost

$$f(\mathbf{a}) = \overbrace{\sum_{b \text{ won}} V_b} + \underbrace{\theta[\mathbf{p}_\mathbf{a}^1 \cdot f(a_1+1, a_2) + \mathbf{p}_\mathbf{a}^2 \cdot f(a_1, a_2+1)]}_{\text{Expected utility of next state}} - \overbrace{g(\mathbf{p}, \mathbf{p_a})}$$

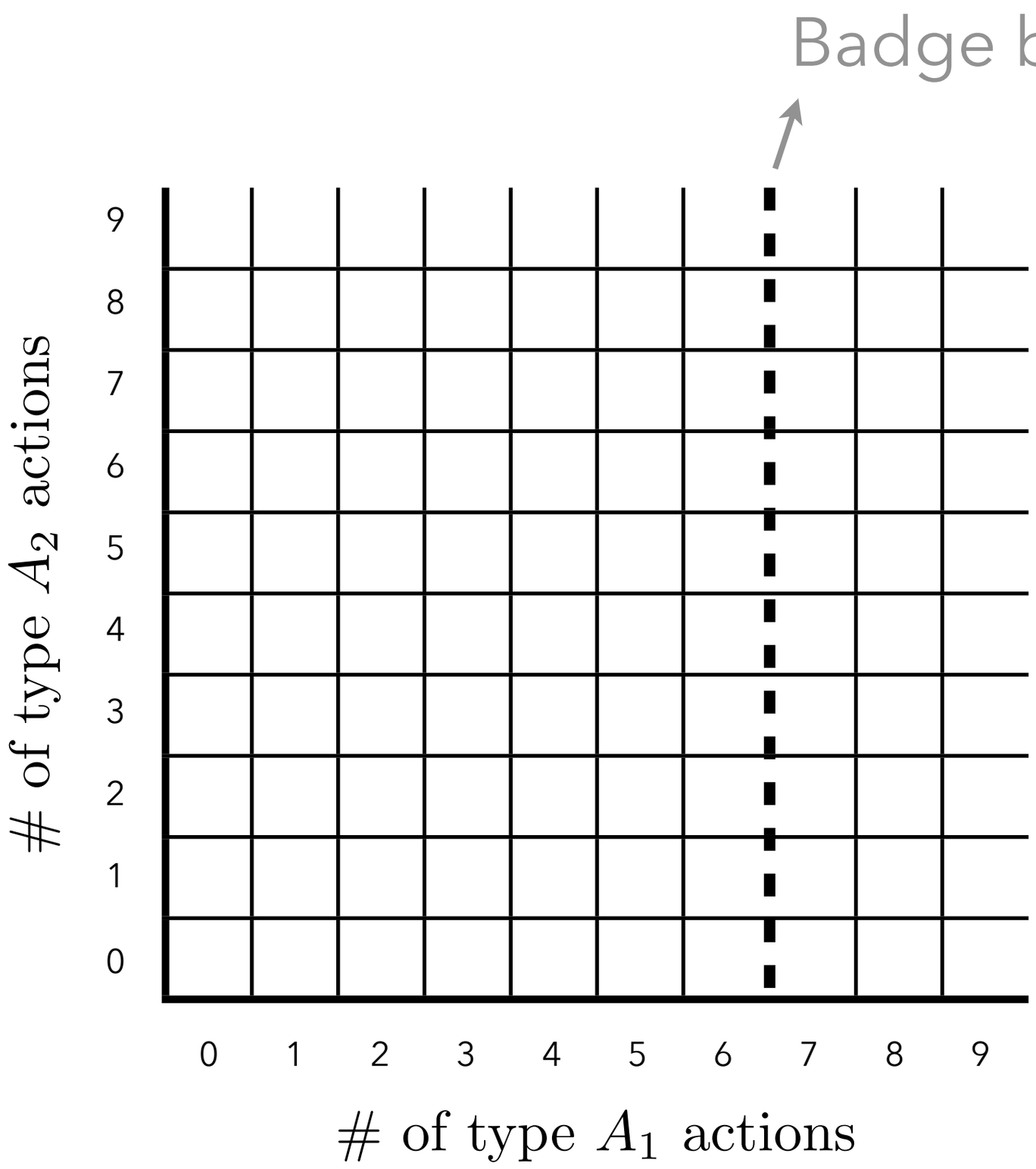
User's Utility Function

User's utility is composed of three parts:

1. Value from badges won
2. Cost for deviating from $\mathbf{p}$
3. (Recursively) Utility from next state

User's optimization problem: pick $\mathbf{p_a}$ for each state to maximize $f(\mathbf{0})$

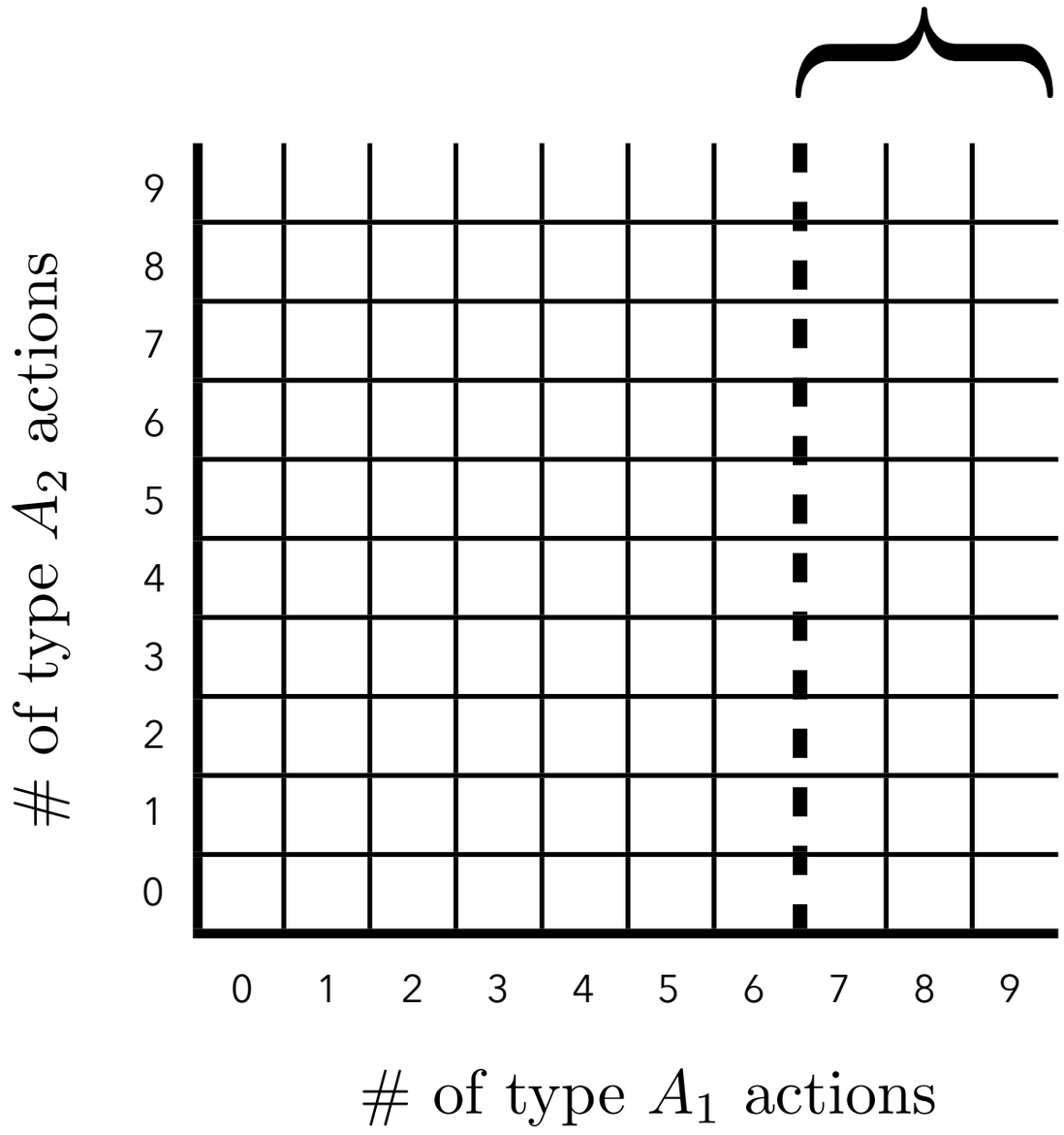
User's Optimization Problem



Example badge: $A_1 \geq 7$

Use dynamic programming to solve this problem:

Past badge boundary, no incentive to deviate from $\mathbf{p}$



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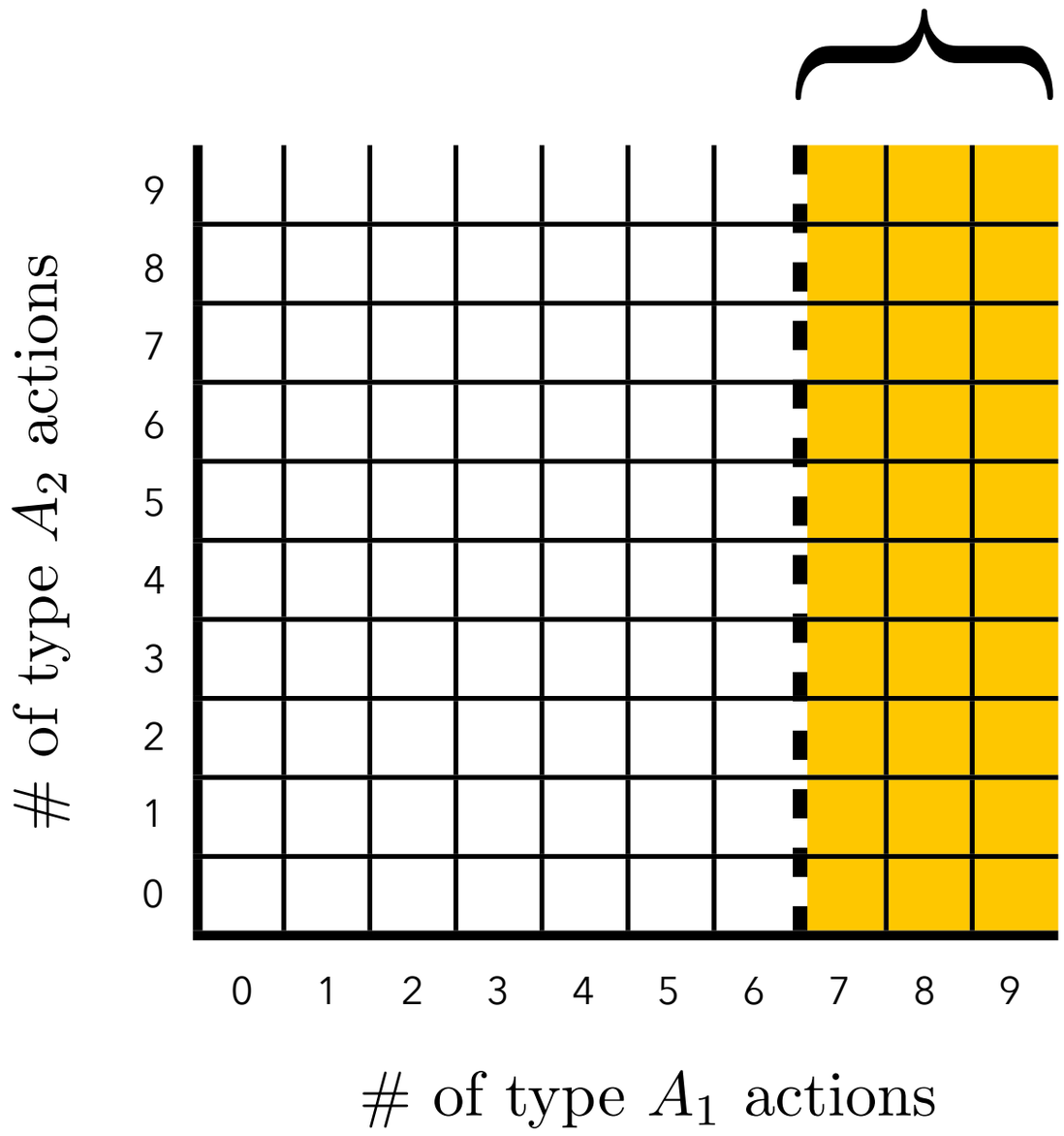
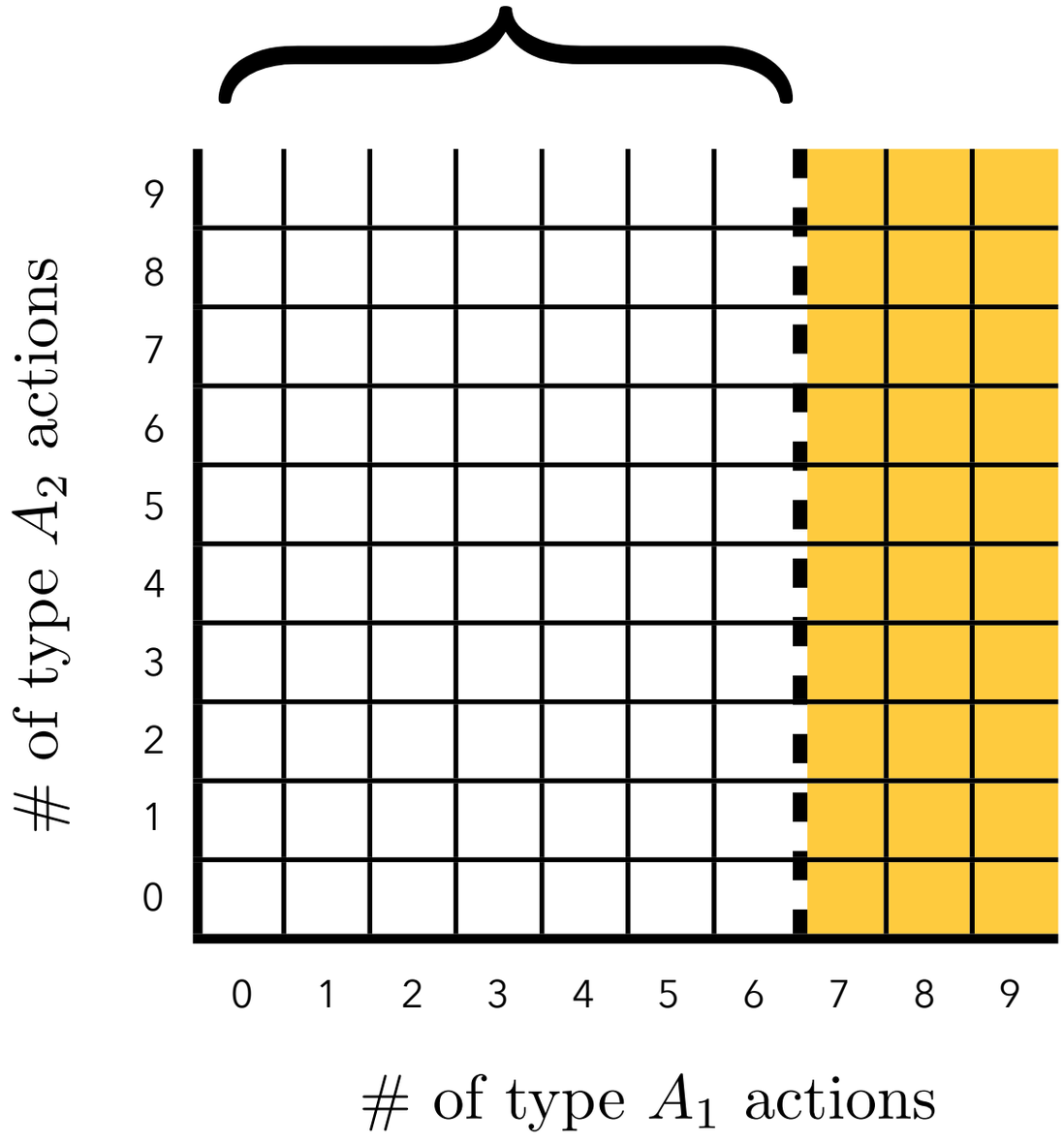


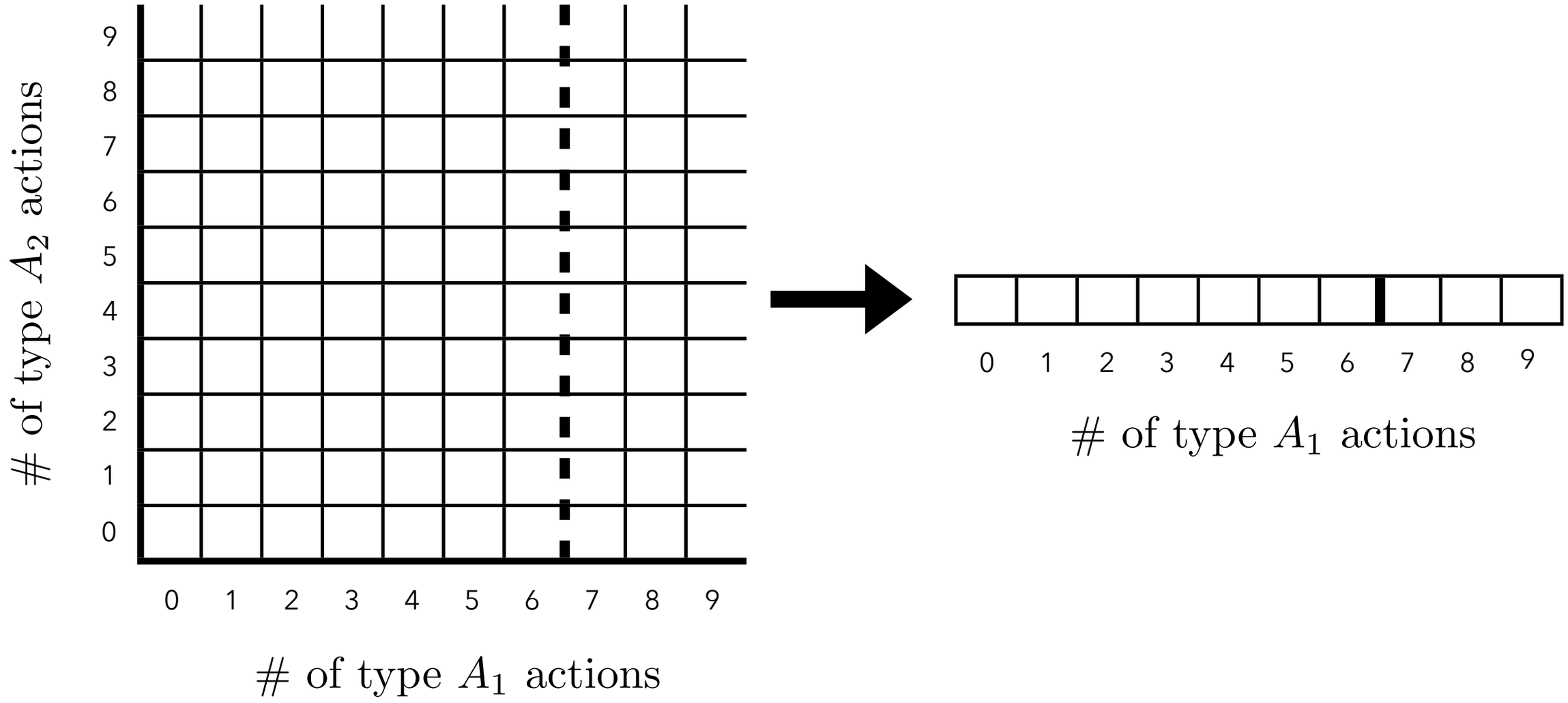
$\Rightarrow$ User sets $\mathbf{p_a} = \mathbf{p}$ for all states $\mathbf{a}$ past boundary

and value of each such state is V_b

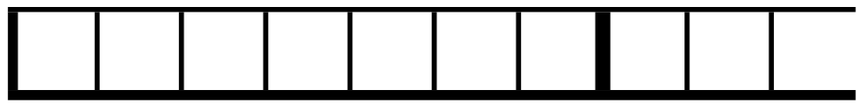
Before badge boundary, select $\mathbf{p_a}$ to maximize expected utility



In this case, collapse along A_2 dimension since $f(a_1, a_2) = f(a_1, a_2')$ for all a_1, a_2'



Problem becomes one-dimensional,
so we can solve from badge
boundary back to origin



# of site action 1 actions

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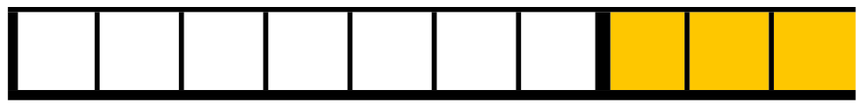

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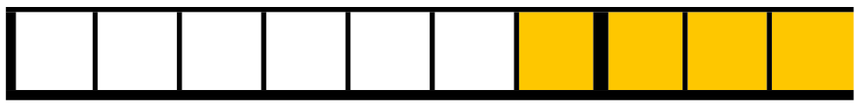

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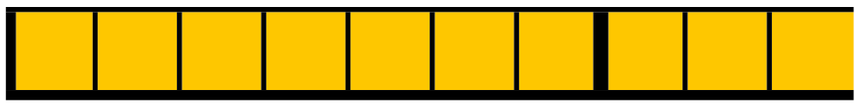
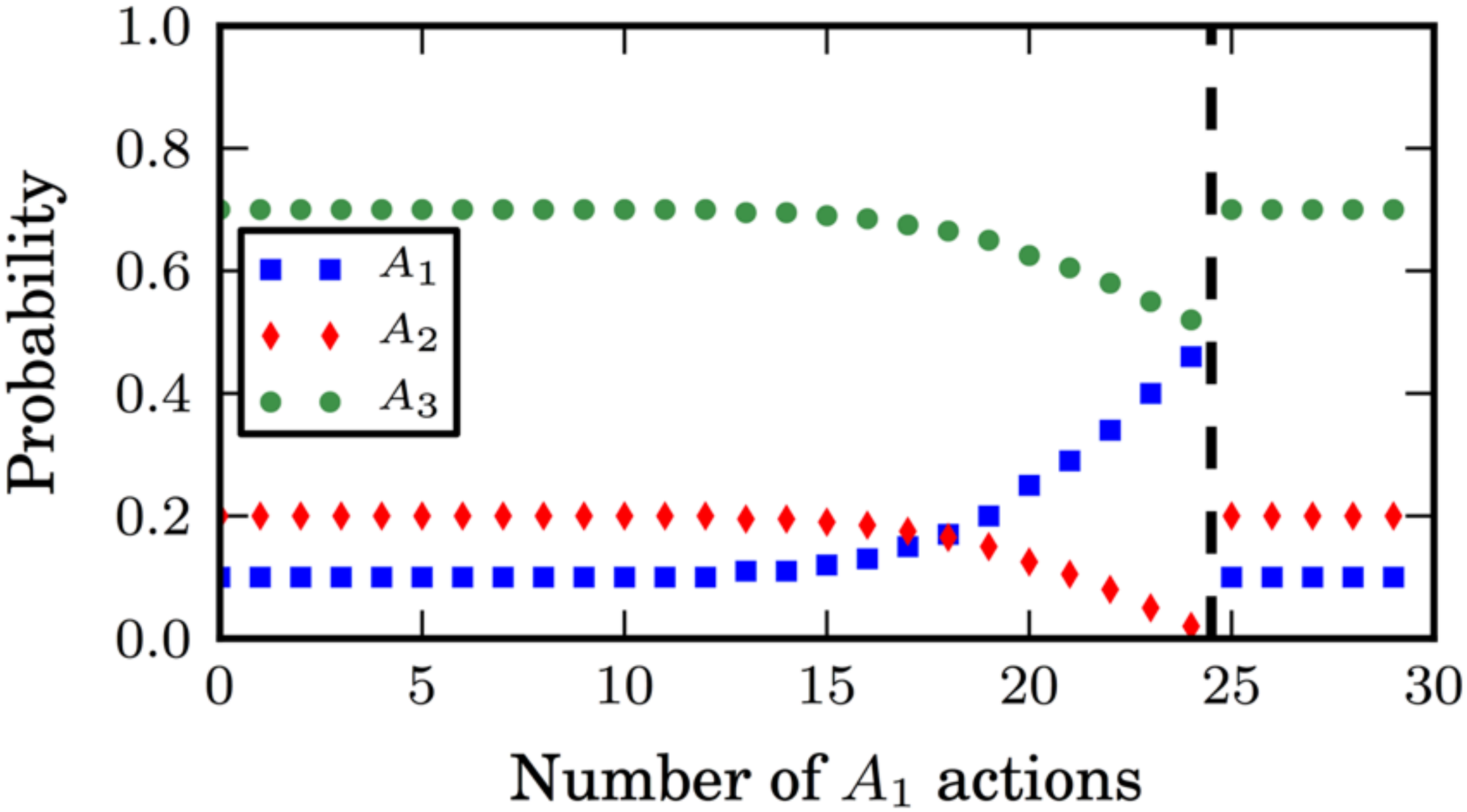


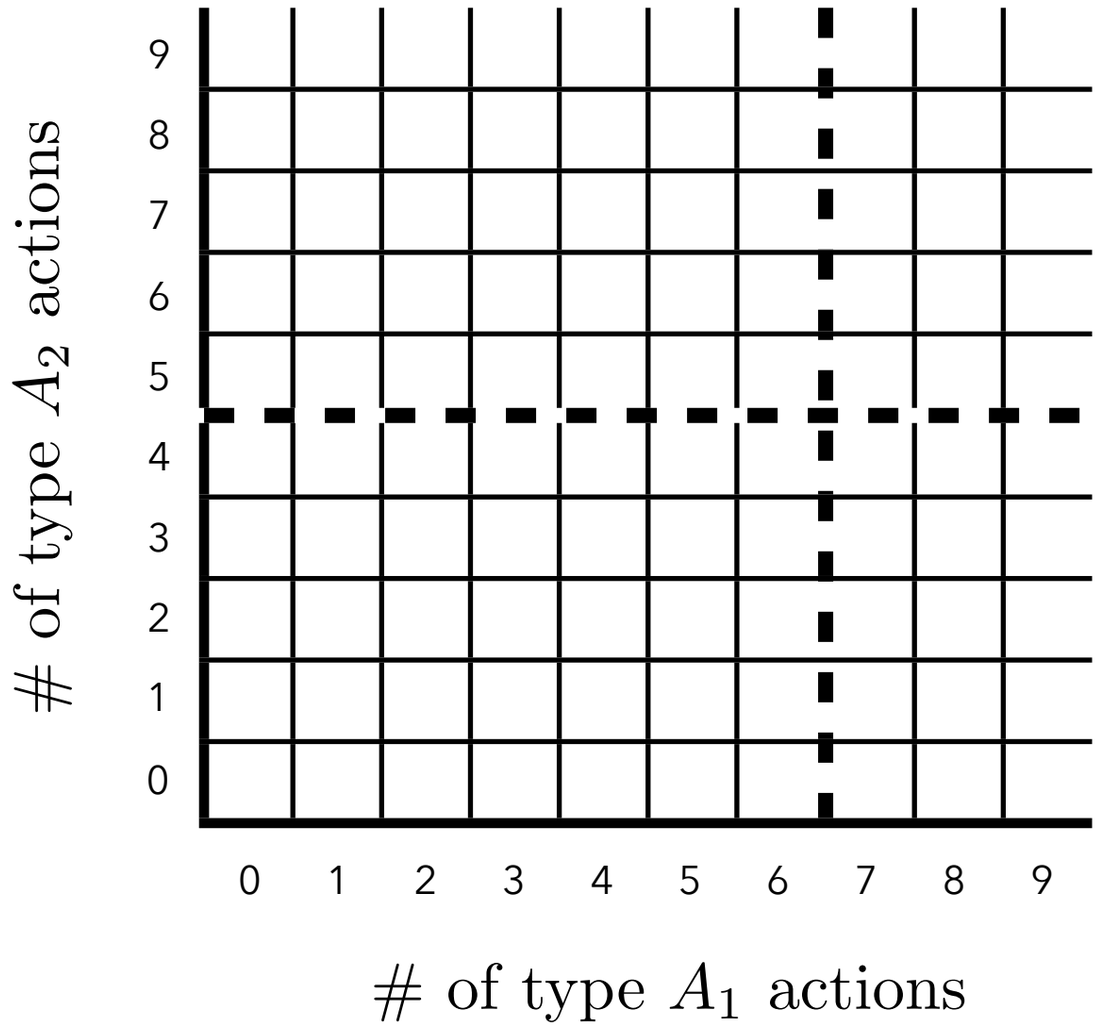
# of site action 1 actions

Example: badge at 25 type A_1 actions



Canonical behavior: user "steers" in A_1 direction as he approaches the badge boundary, then resets

Two-dimensional scenario: a badge on each dimension



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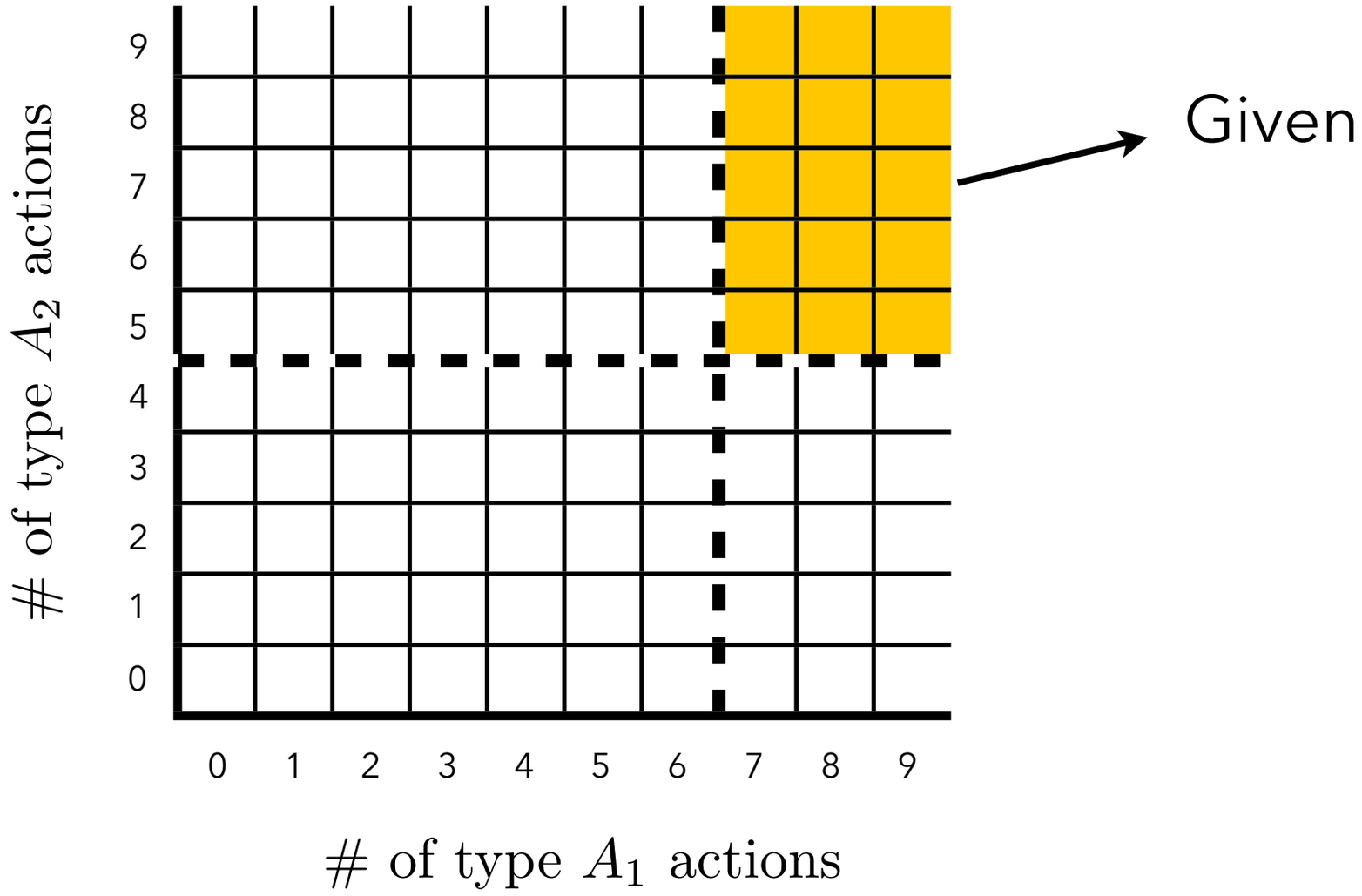

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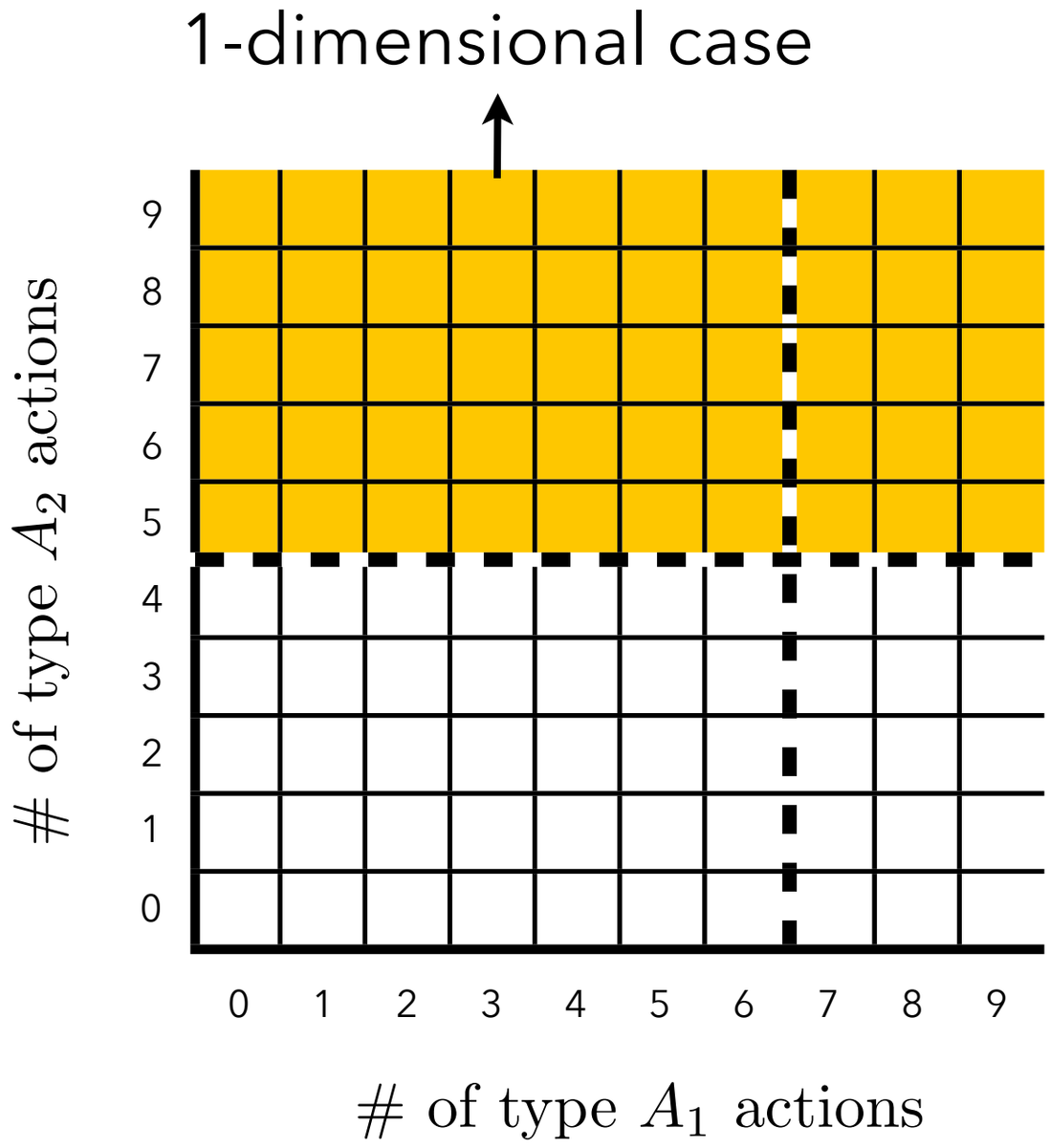

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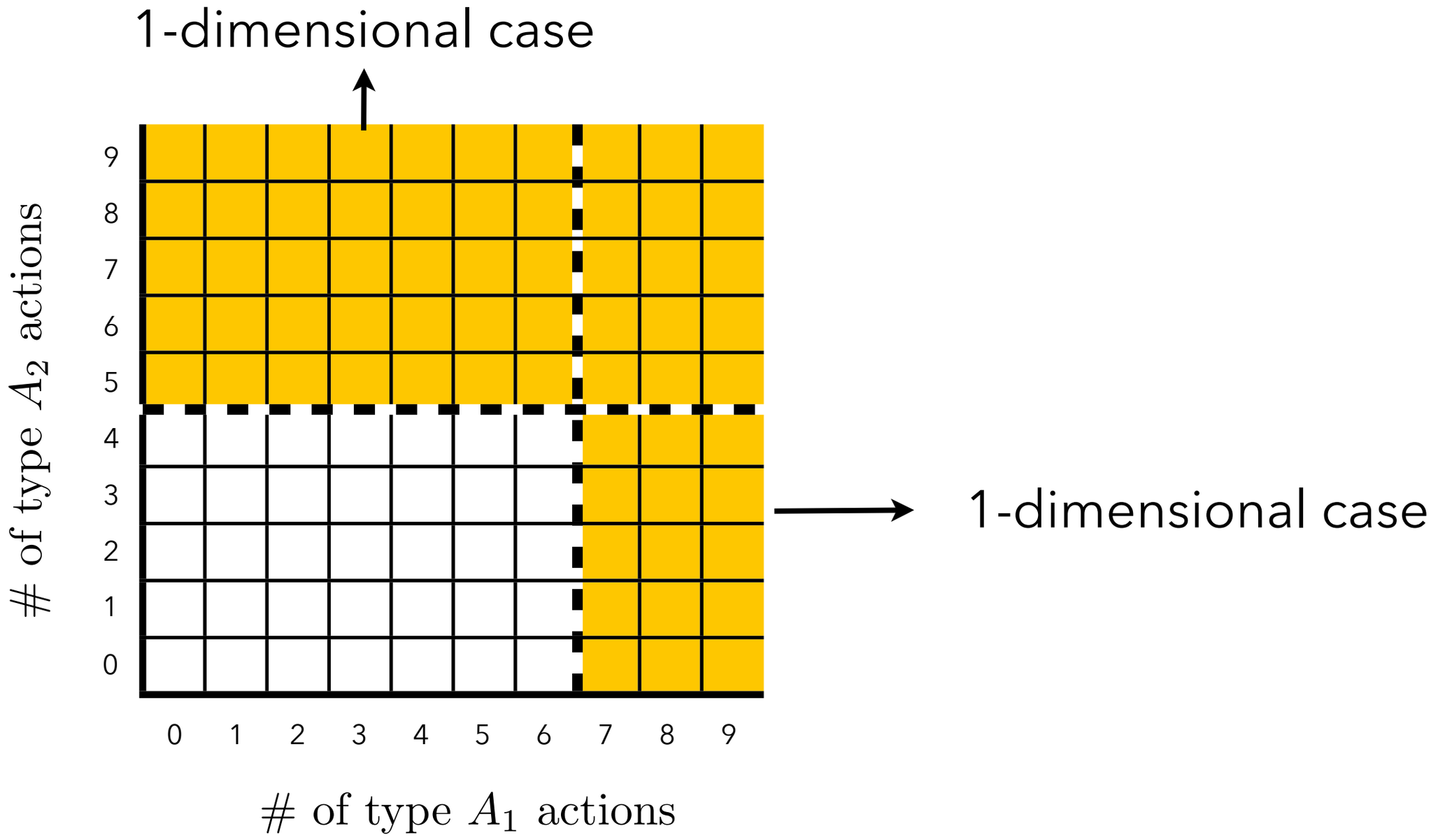

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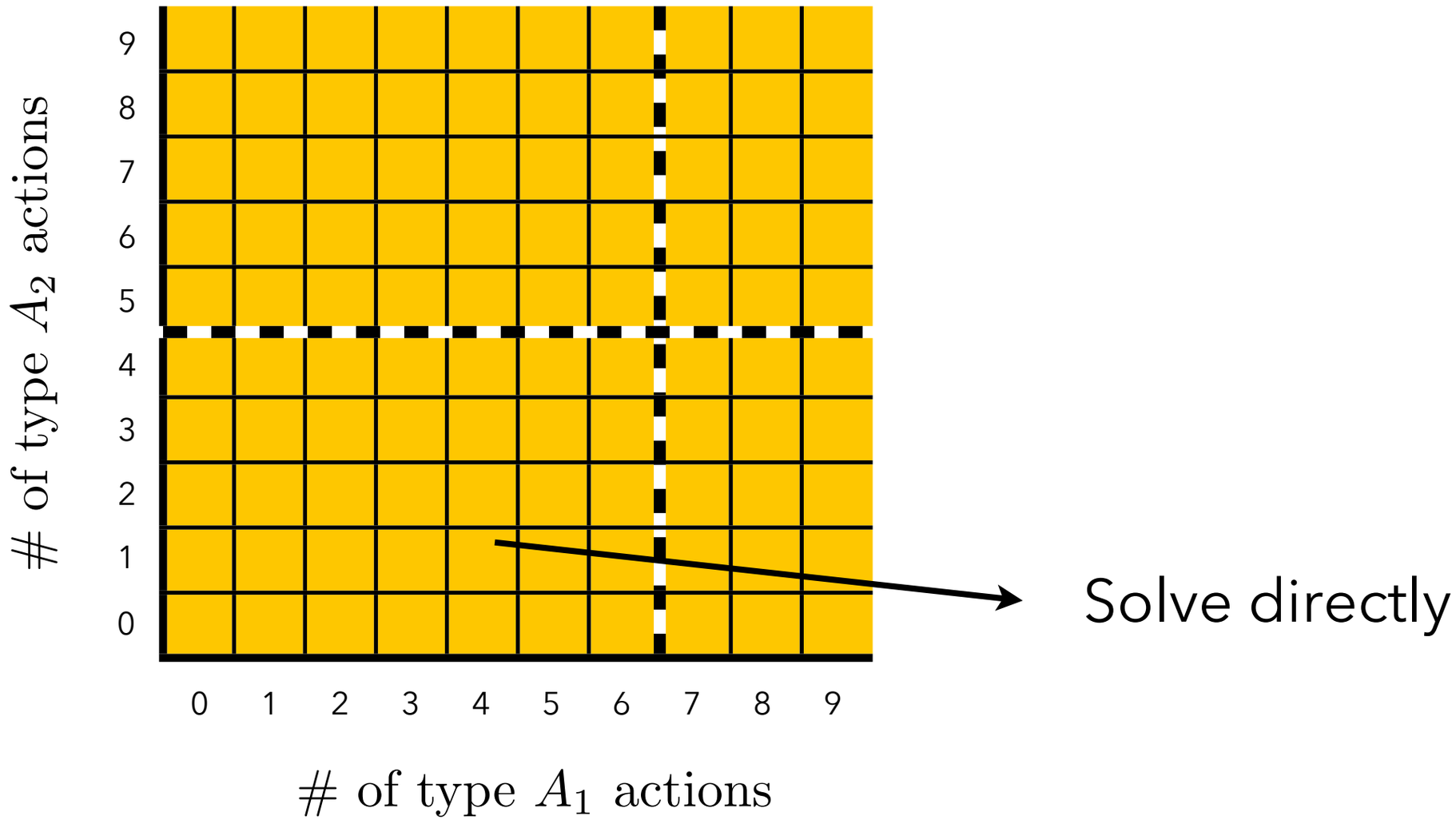
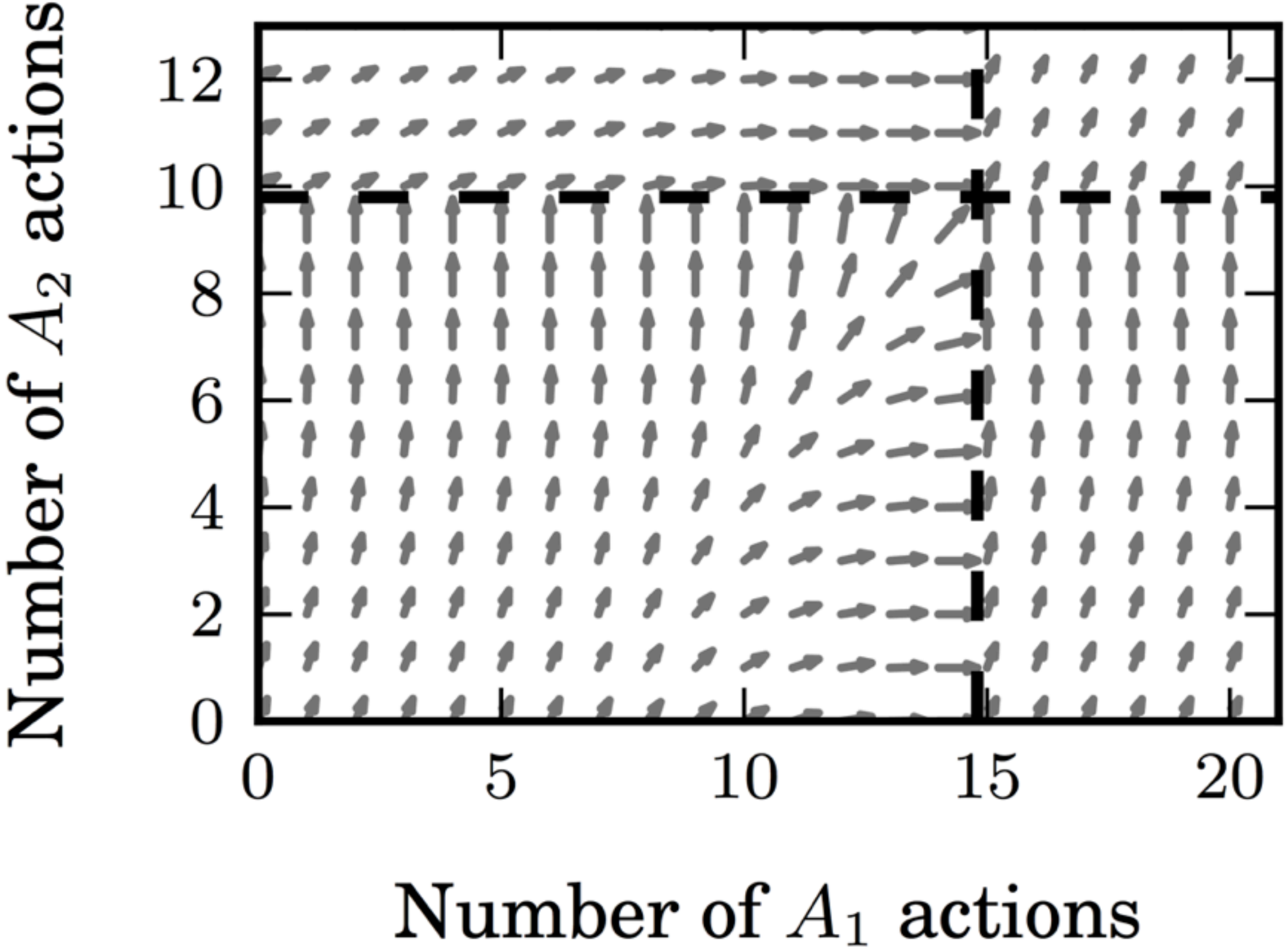



Number of A_2 actions
0
2
4
6
8
10
12
0
5
10
15
20
Number of A_1 actions

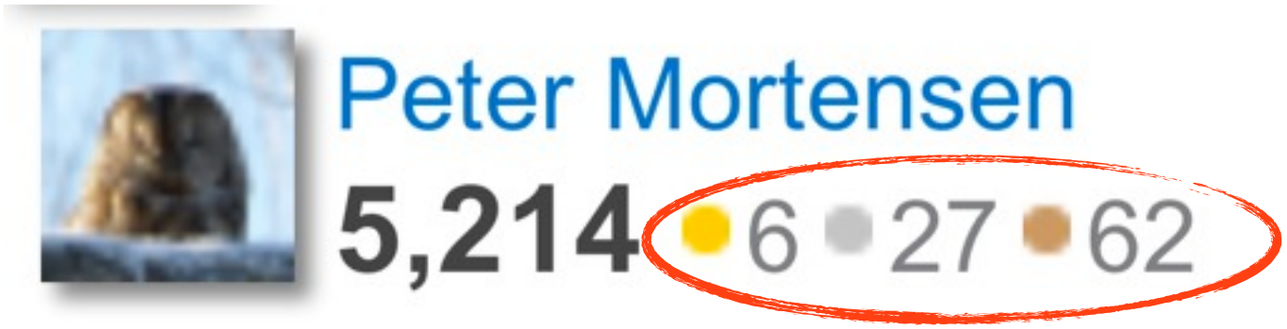
1. Develop a model of user behavior in the presence of badges (theory)

2. Validate qualitative model predictions with real-world data (empirical analysis)

3. Investigate how to optimally design badges (algorithms and simulations)

stackoverflow

- ✦ Programming-related Q&A answering site
- ✦ Heavy use of badges



Badge counts

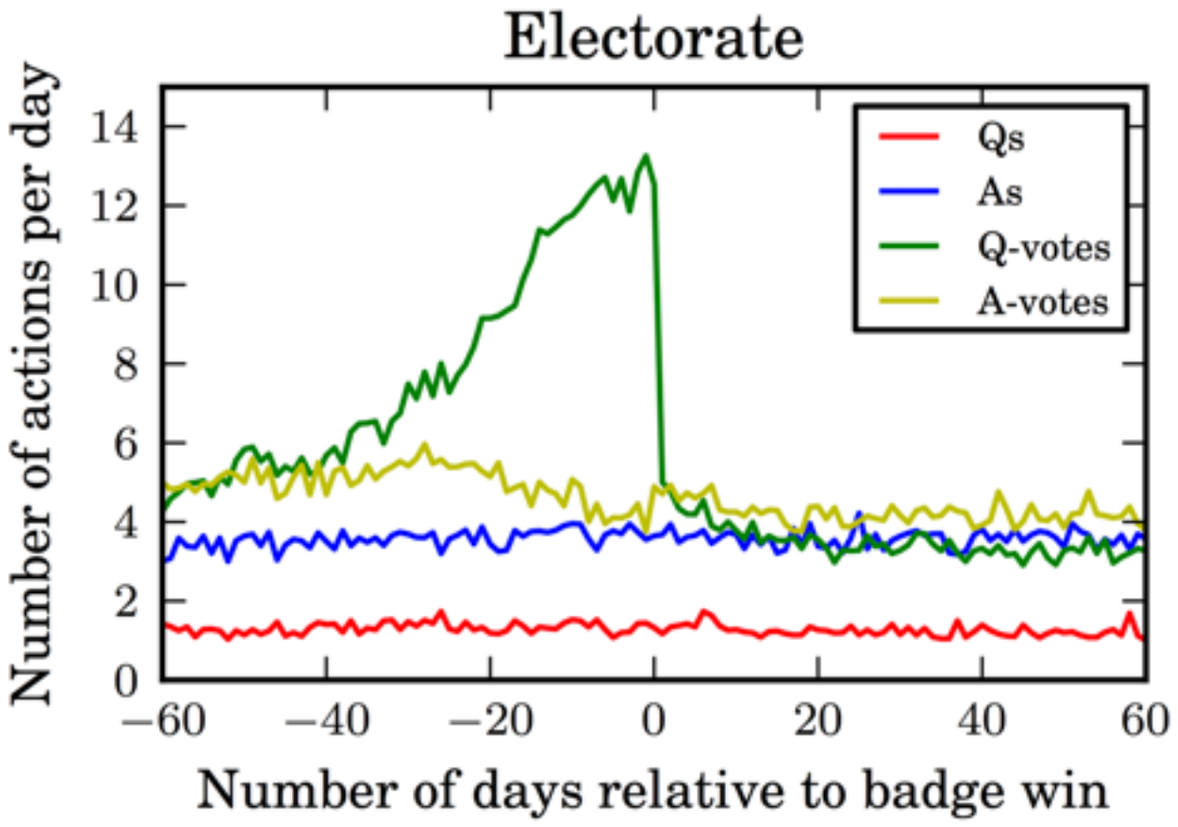
stackoverflow

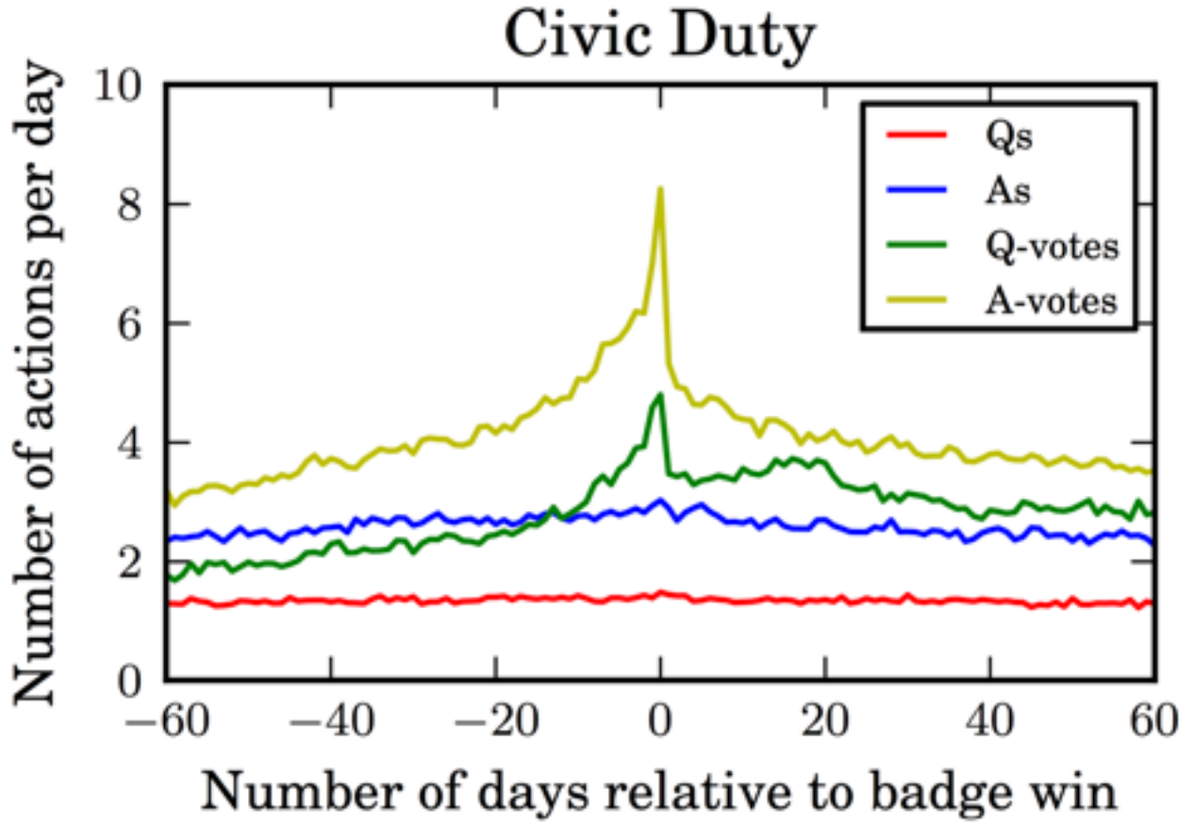
Electorate

Won when a user votes
on 600 questions

Civic Duty

Won when a user votes
300 times





Users accelerate as they approach the badge boundary

1. Develop a model of user behavior in the presence of badges (theory)

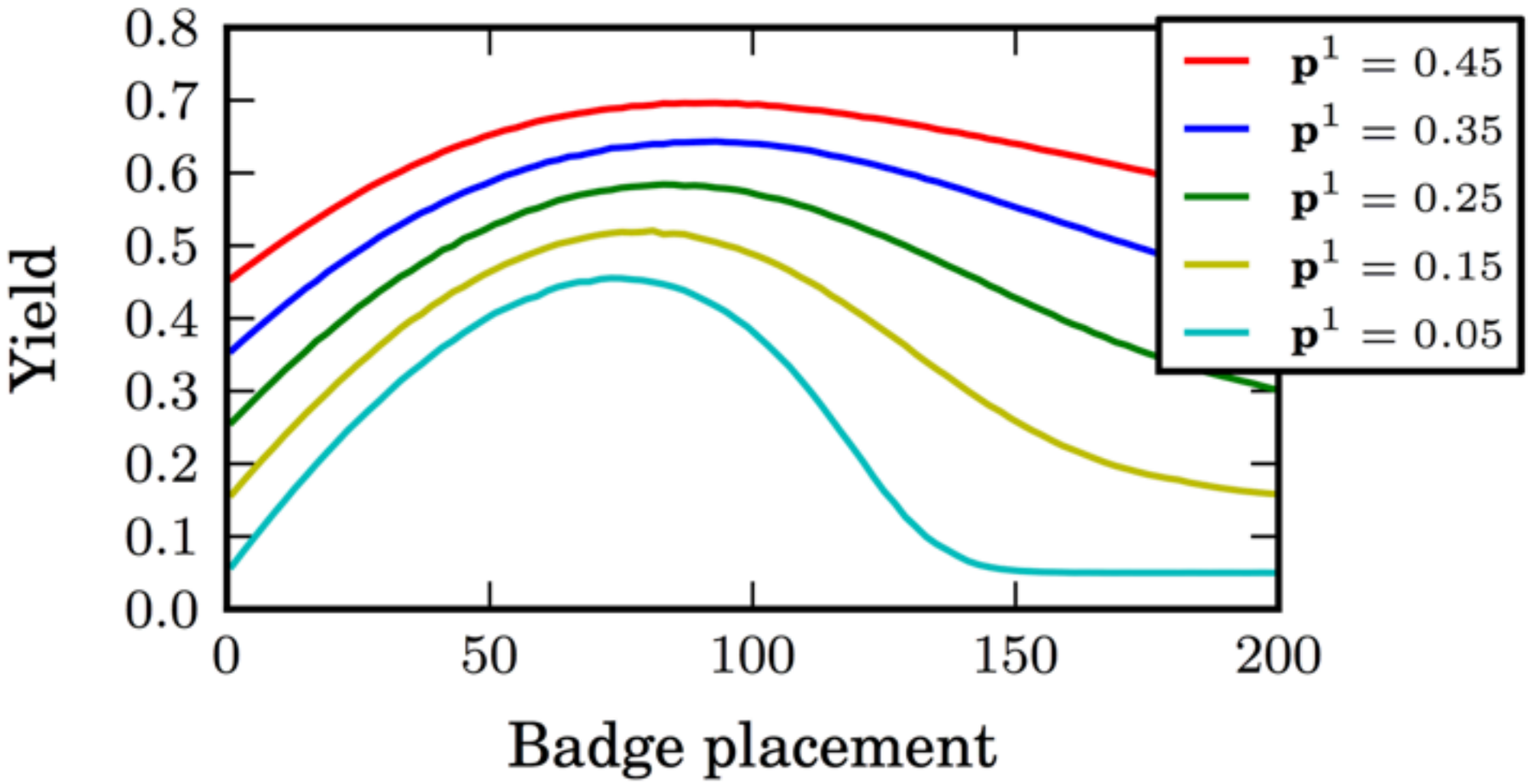
2. Validate qualitative model predictions with real-world data (empirical analysis)

3. Investigate how to optimally design badges (algorithms and simulations)

Badge placement problem:

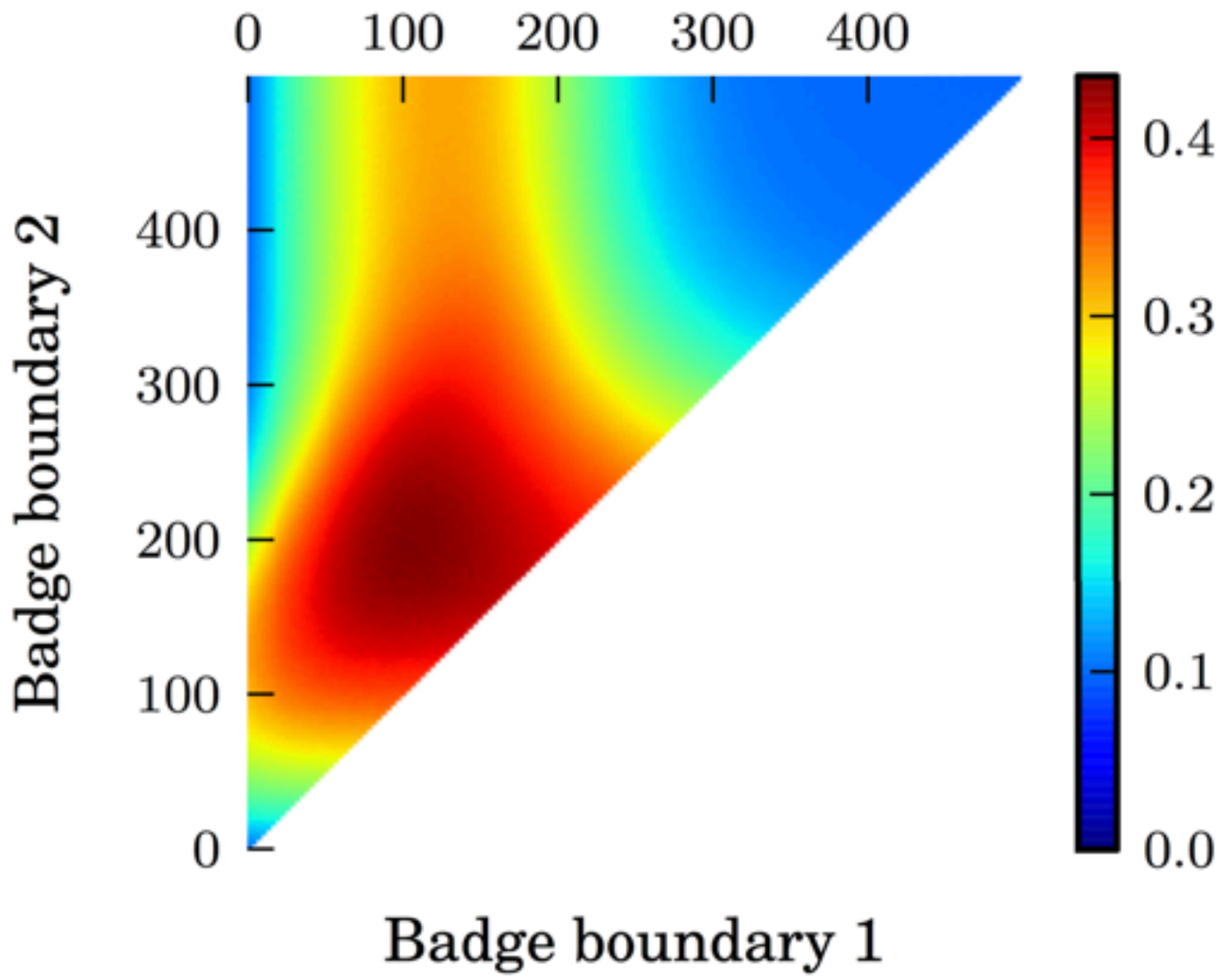
General question: how should the site designer "place" badges in action space to achieve desired effects?

Concrete question: If the site designer can place one badge and wants to maximize actions on a particular dimension, where should she put it?



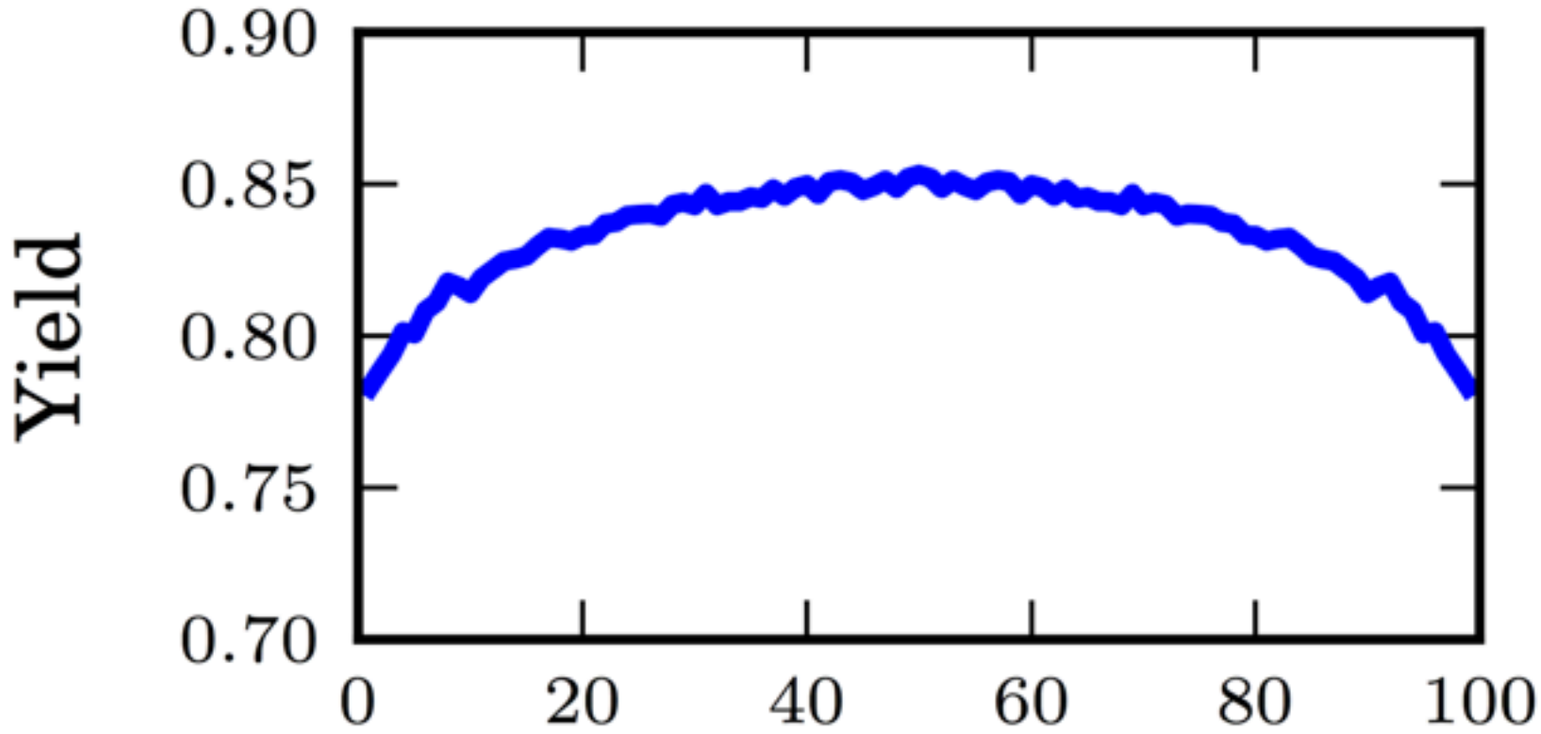
Optimal badge placement at internal optimum

Two badges on same action type



Given two badges of fixed value, the designer should place them approximately evenly apart for maximum effect

Two badges, same total value



$$V_{b_1} = 100 - V_{b_2}$$

Given a fixed amount of value, an even split of value optimizes yield

Conclusions

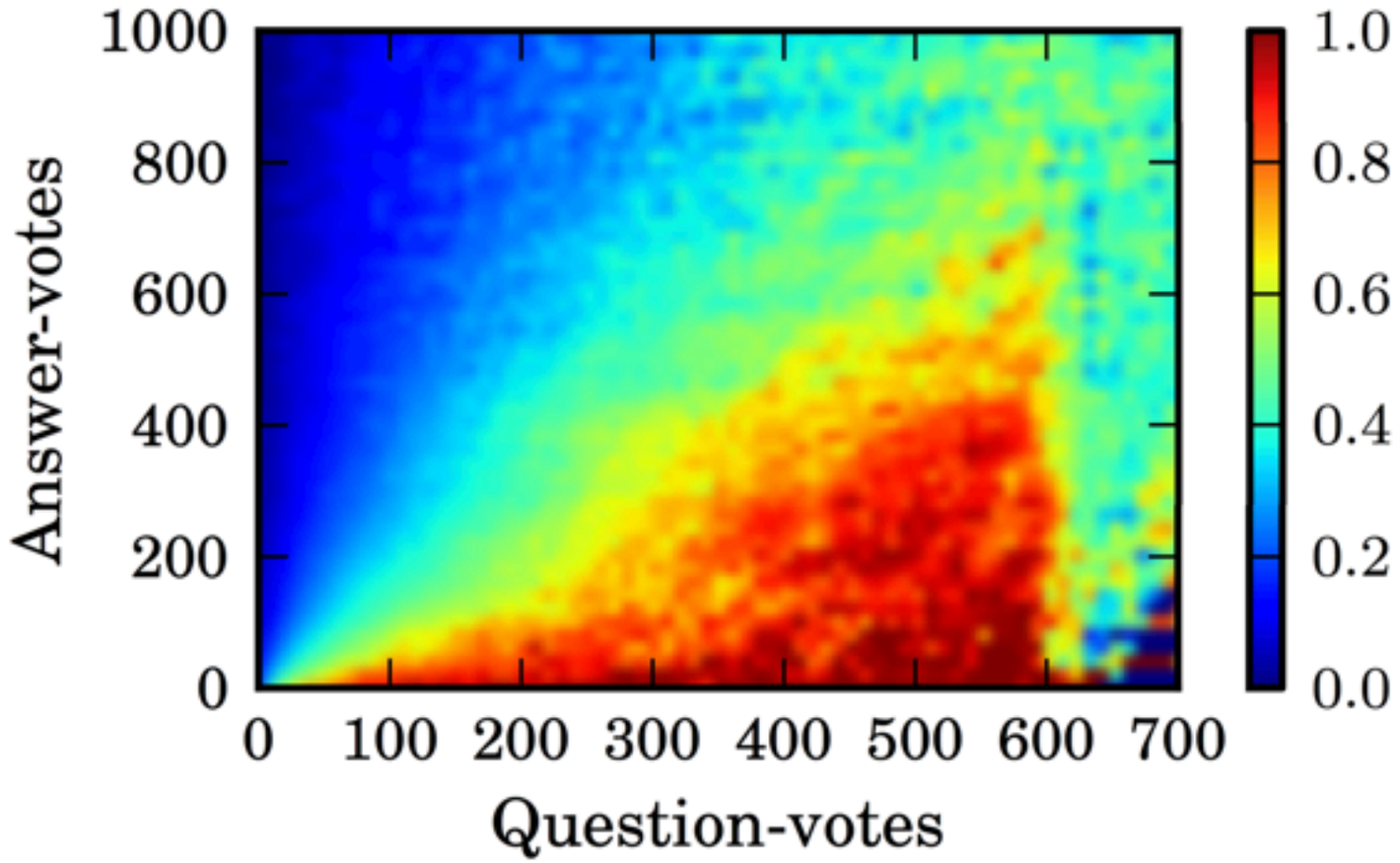
– We introduced a model of user behavior in the presence of badges

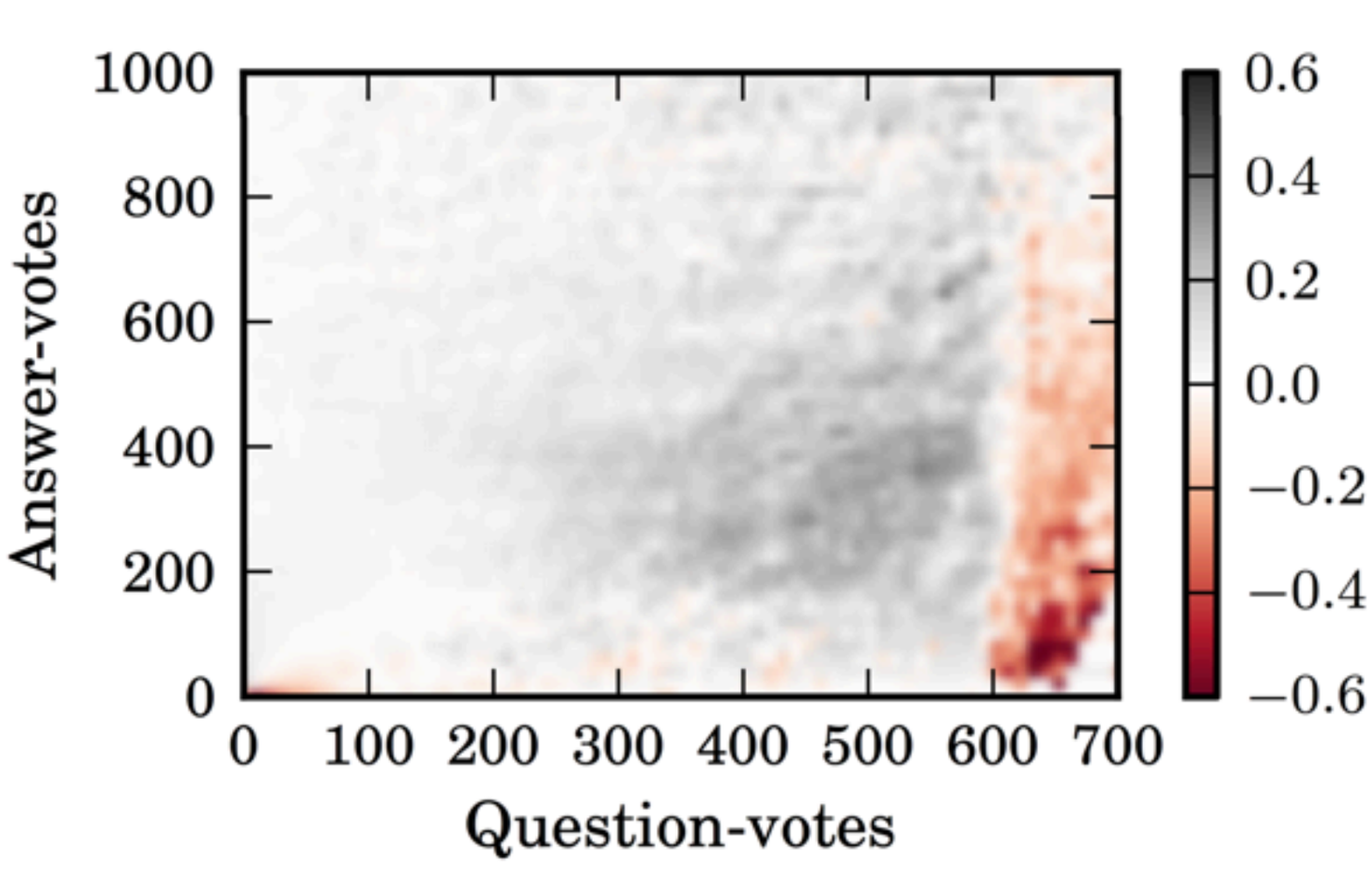
– Model predicts that users steer between actions and engage more

– Validated the model's predictions against real-world Stack Overflow data

– Introduced and investigated the badge placement problem

Thanks

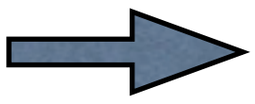

Answer-votes
1000
800
600
400
200
0
0 100 200 300 400 500 600 700
Question-votes
1.0
0.8
0.6
0.4
0.2
0.0


Answer-votes
1000
800
600
400
200
0
0 100 200 300 400 500 600 700
Question-votes
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6

Overjustification Effect

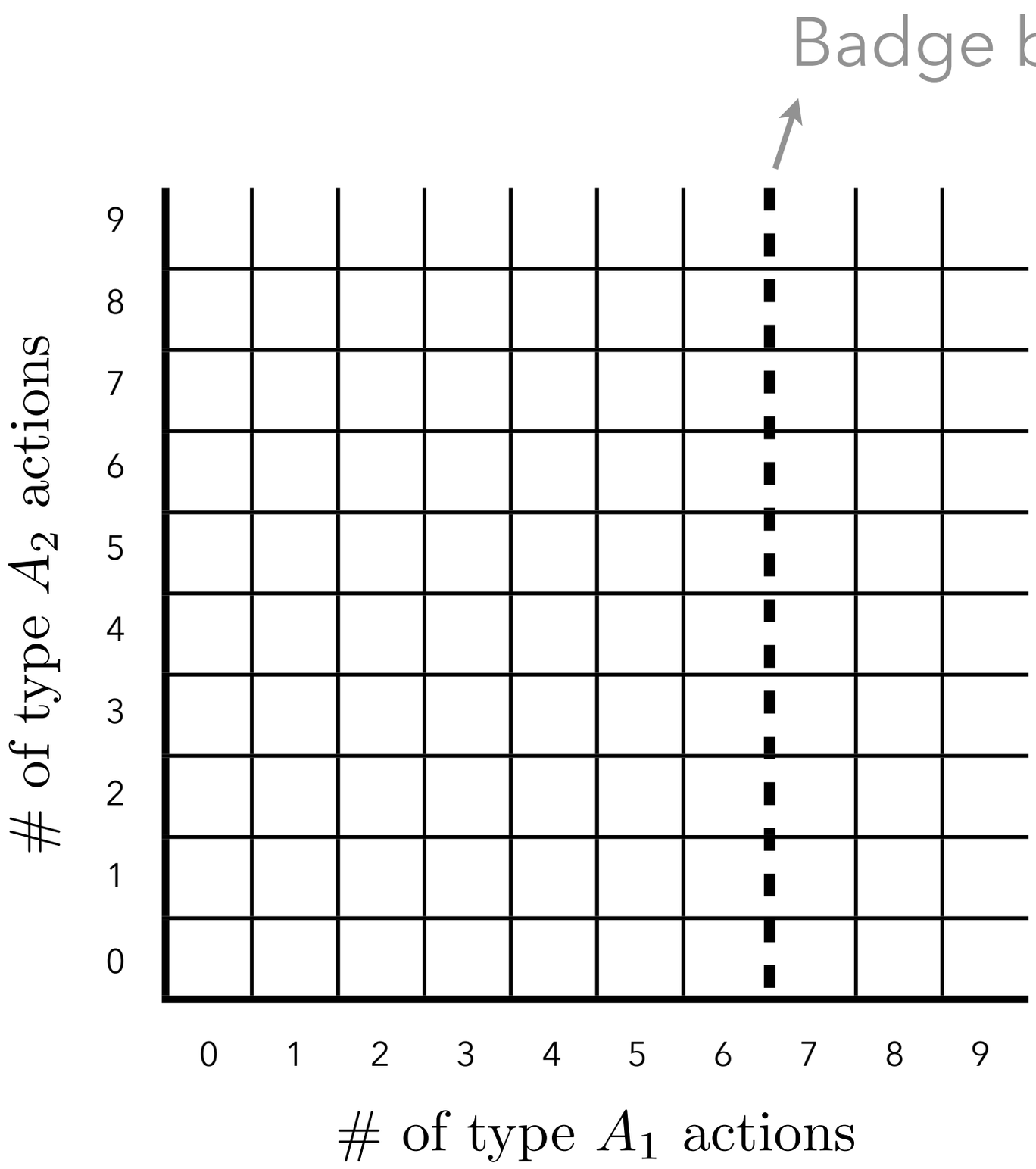
when an expected external incentive decreases a person's intrinsic motivation to perform a task

e.g. paying for blood donations reduces the number of donors



Very possible for badges to backfire!

Our Model



Example badge: $A_1 \geq 8$