Octocat, here and elsewhere, by GitHub https://octodex.github.com

Lessons in Social Coding

Software Analytics in the Age of GitHub

Bogdan Vasilescu
CMU

@b_vasilescu http://bvasiles.github.io

SSE 2016, Seattle

THE EVOLUTION OF THE "SOCIAL PROGRAMMER"

github SOCIAL CODING

ashley williams
ashleygwilliams

npm, inc
ridgewood, queens, NYC
http://ashleygwilliams.github.io/
Joined on Oct 31, 2011

776 Followers **38** Starred **15** Following

Organizations

Contributions | Repositories | Public activity

Follow

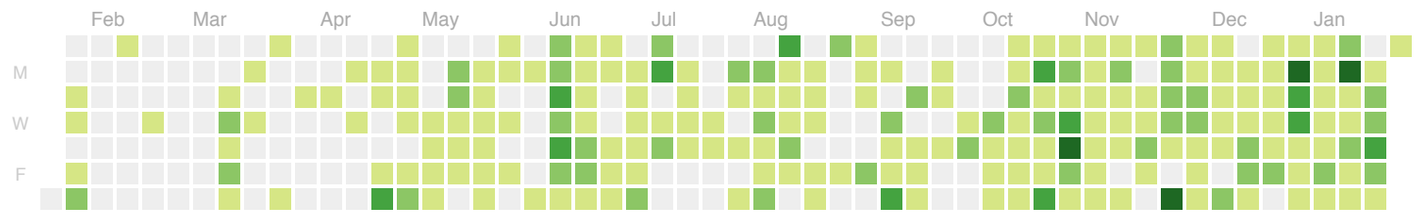
Popular repositories

- **breakfast-repo** — a collection of videos, recordings, and podcast… — 208 ★
- **x86-kernel** — a simple x86 kernel, extended with Rust — 48 ★
- **ashleygwilliams.github.io** — hi, i'm ashley. nice to meet you. — 37 ★
- **jsconf-2015-deck** — deck for jsconf2015 talk, "if you wish to learn e… — 32 ★
- **ratpack** — sinatra boilerplate using activerecord, sqlite, a… — 32 ★

Repositories contributed to

- npm/**docs** — The place where all the npm docs live. — 44 ★
- mozilla/**publish.webmaker.org** — The teach.org publishing service for goggles a… — 2 ★
- npm/**marky-markdown** — npm's markdown parser — 104 ★
- artisan-tattoo/**assistant-frontend** — ember client for assistant-API — 5 ★
- npm/**npm-camp** — a community conference for all things npm — 1 ★

Public contributions



Summary of pull requests, issues opened, and commits. Learn how we count contributions.

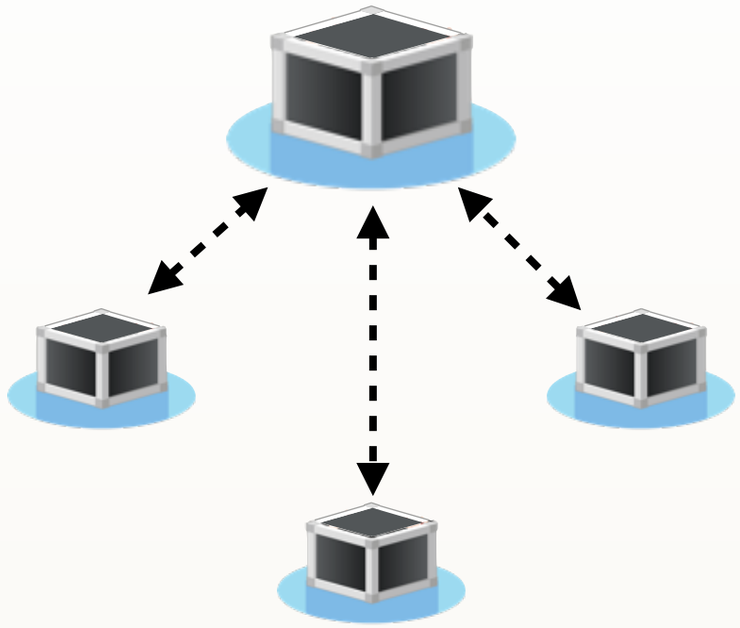
Less More

Contributions in the last year	Longest streak	Current streak
1,886 total	37 days	7 days
Jan 24, 2015 – Jan 24, 2016	October 7 – November 12	January 18 – January 24

https://github.com/ashleygwilliams

- Programming in a socially networked world: the evolution of the social programmer
  C Treude, F Figueira Filho, B Cleary, MA Storey.
  FutureCSD-CSCW 2012
- Social coding in GitHub: transparency and collaboration in an open software repository
  L Dabbish, C Stuart, J Tsay, J Herbsleb.
  CSCW 2012
- Social networking meets software development: Perspectives from GitHub, MSDN, Stack Exchange, and TopCoder
  A Begel, J Bosch, MA Storey.
  IEEE Software 2013

“SOCIAL CODING”: CODE IS MEANT TO BE SHARED



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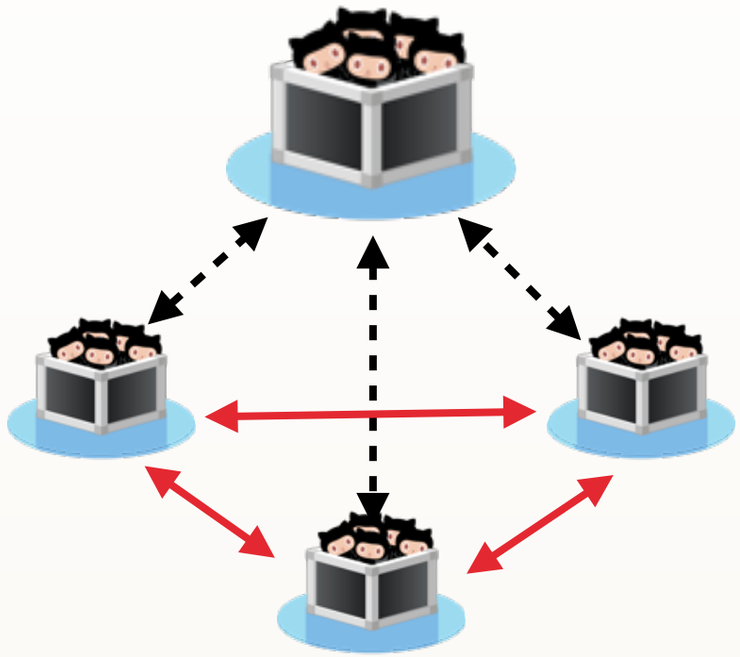
github SOCIAL CODING

GIT



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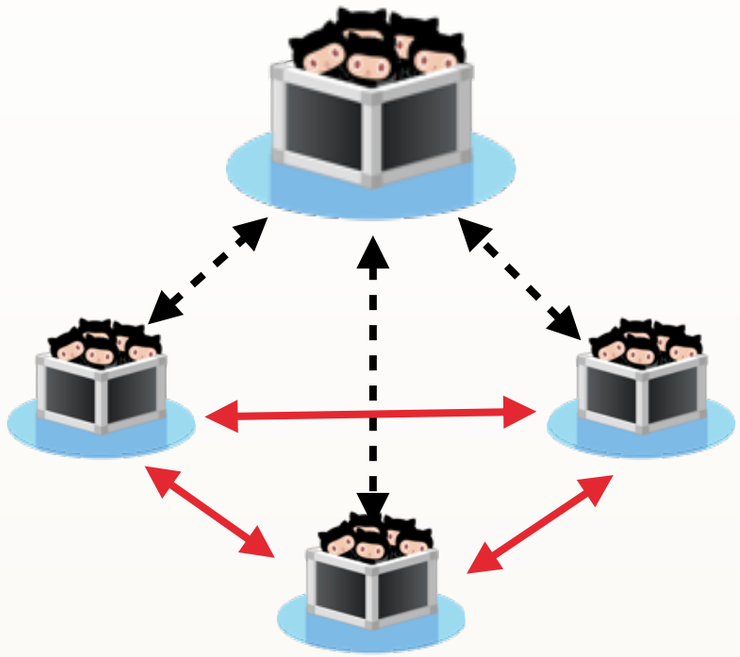
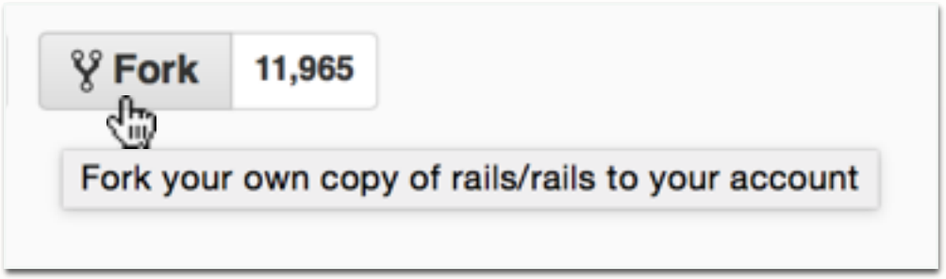
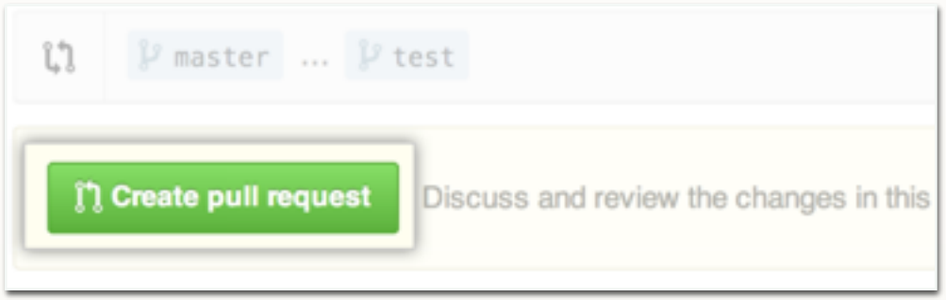


GITHUB UI





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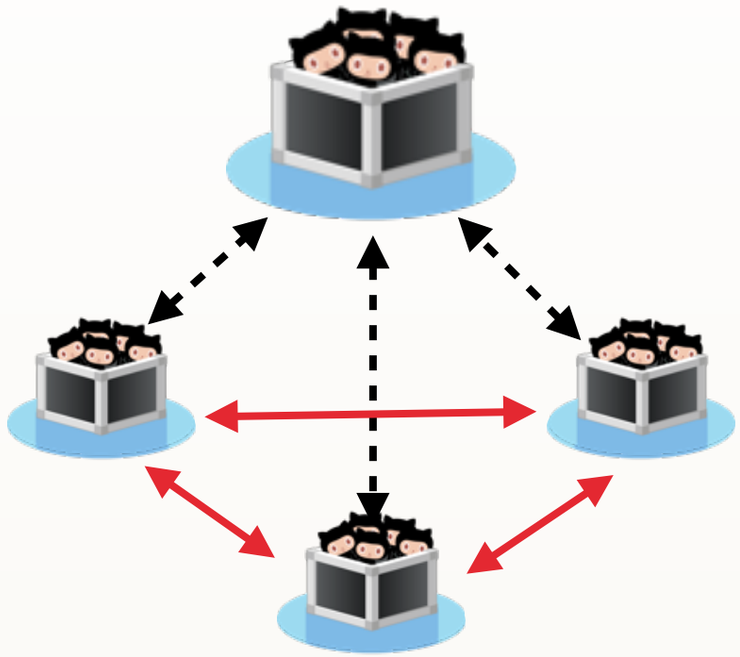

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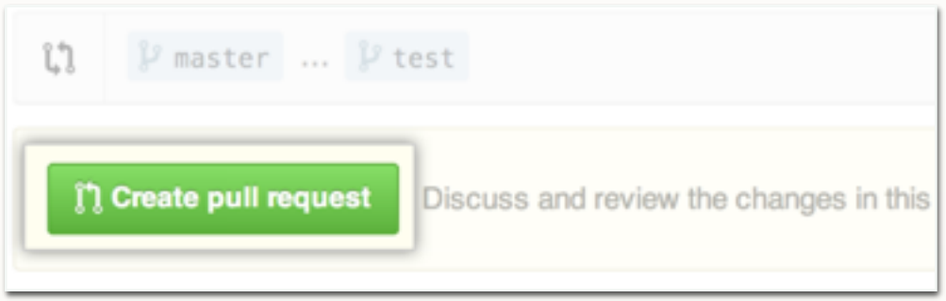
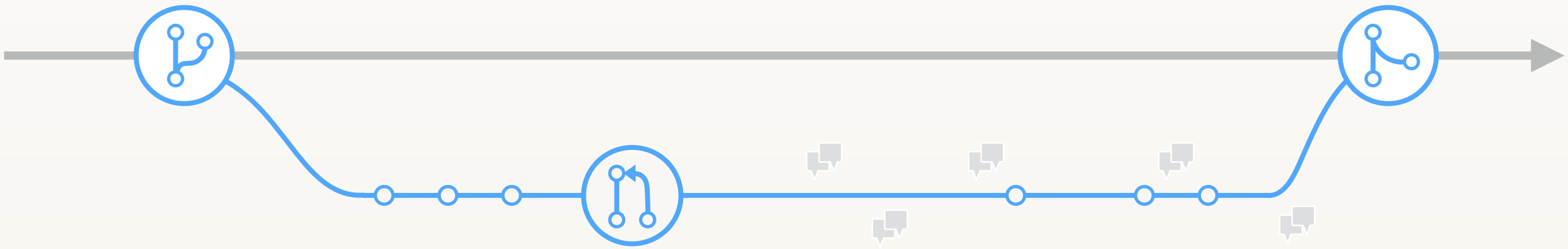


THE “PULL REQUEST” MODEL

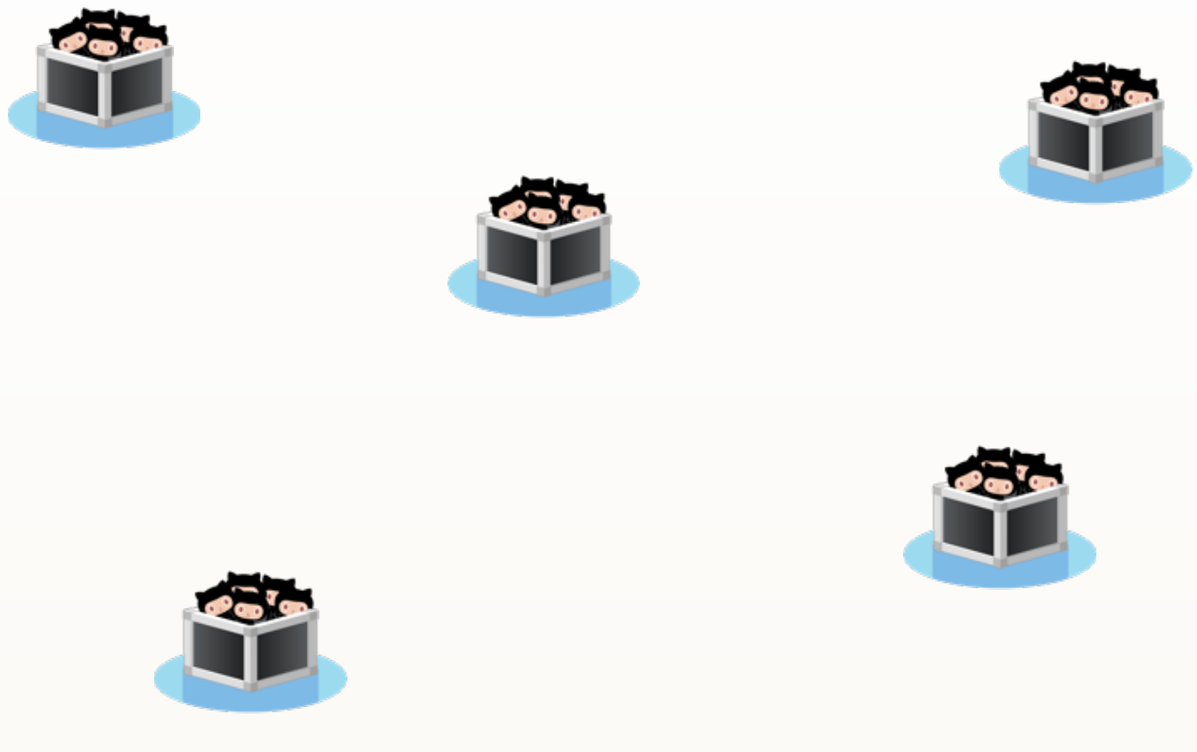


Unified development, testing, code review, integration → DEVOPS

Lowest ever barrier to entry for newcomers

Democratic, open, social process

LARGE, DIVERSE, COMPLEX, SOCIAL ECOSYSTEM



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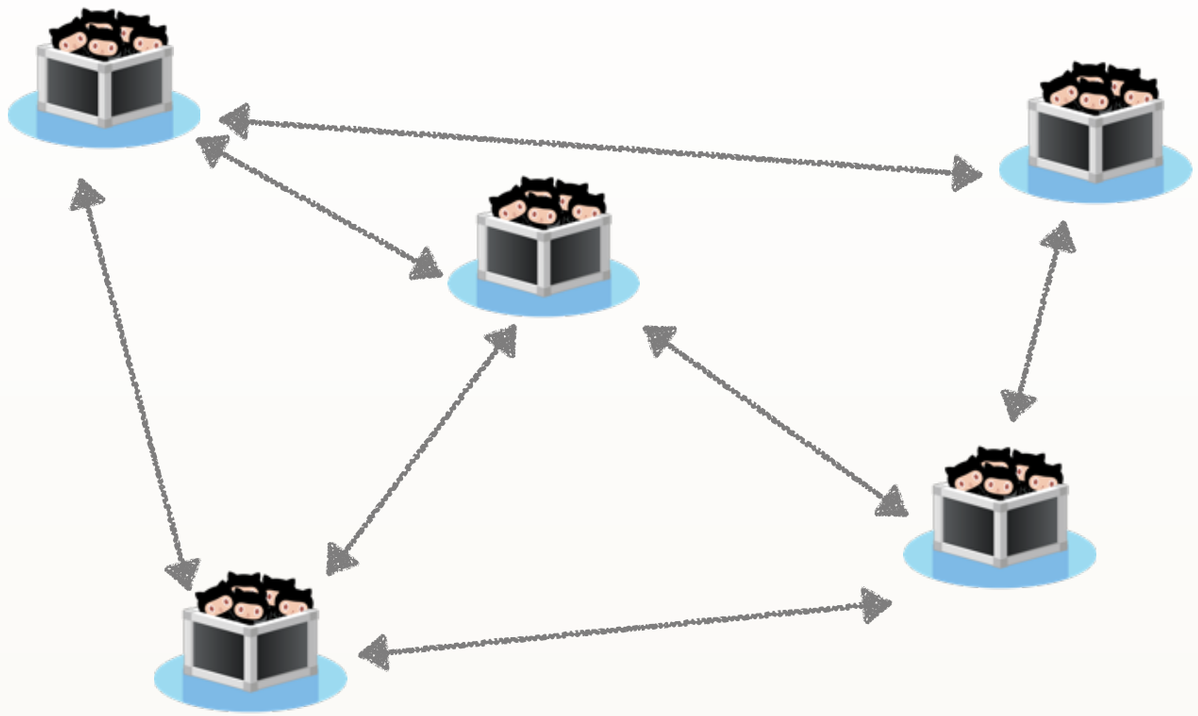

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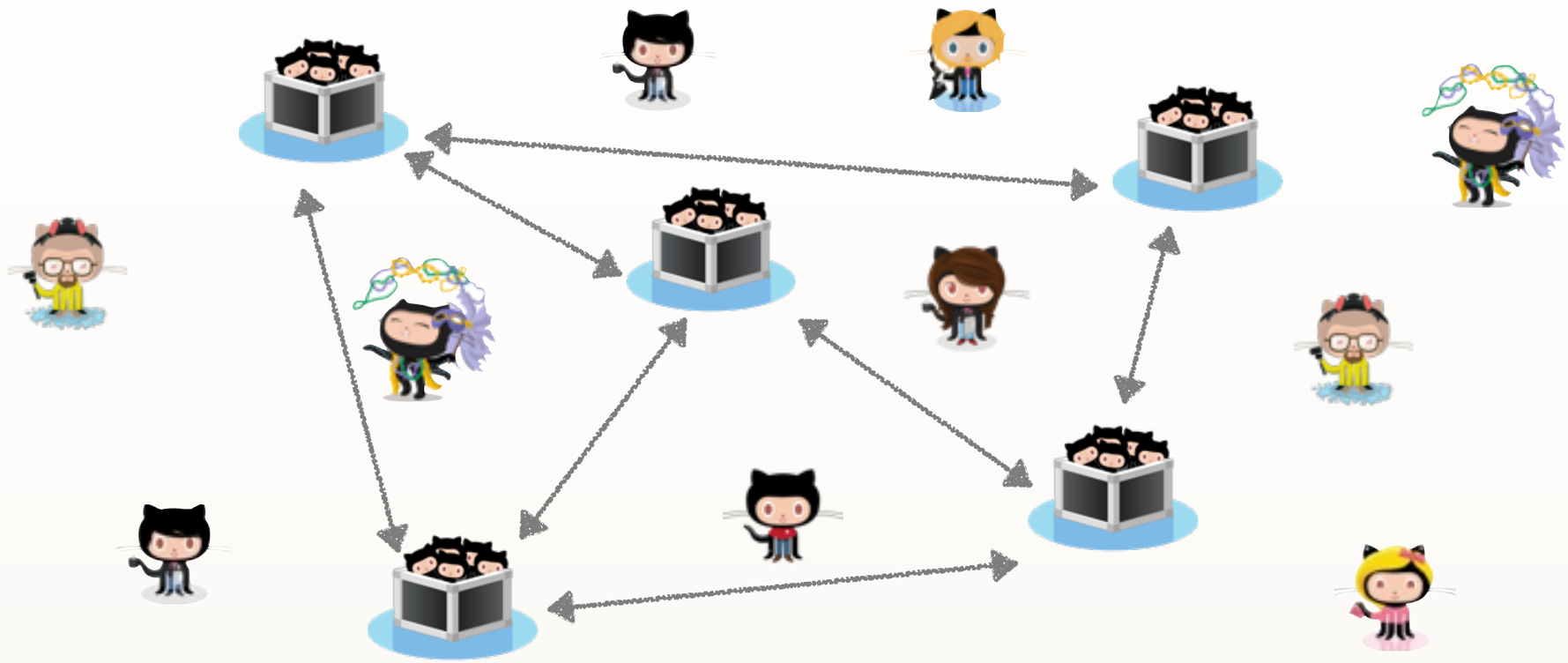

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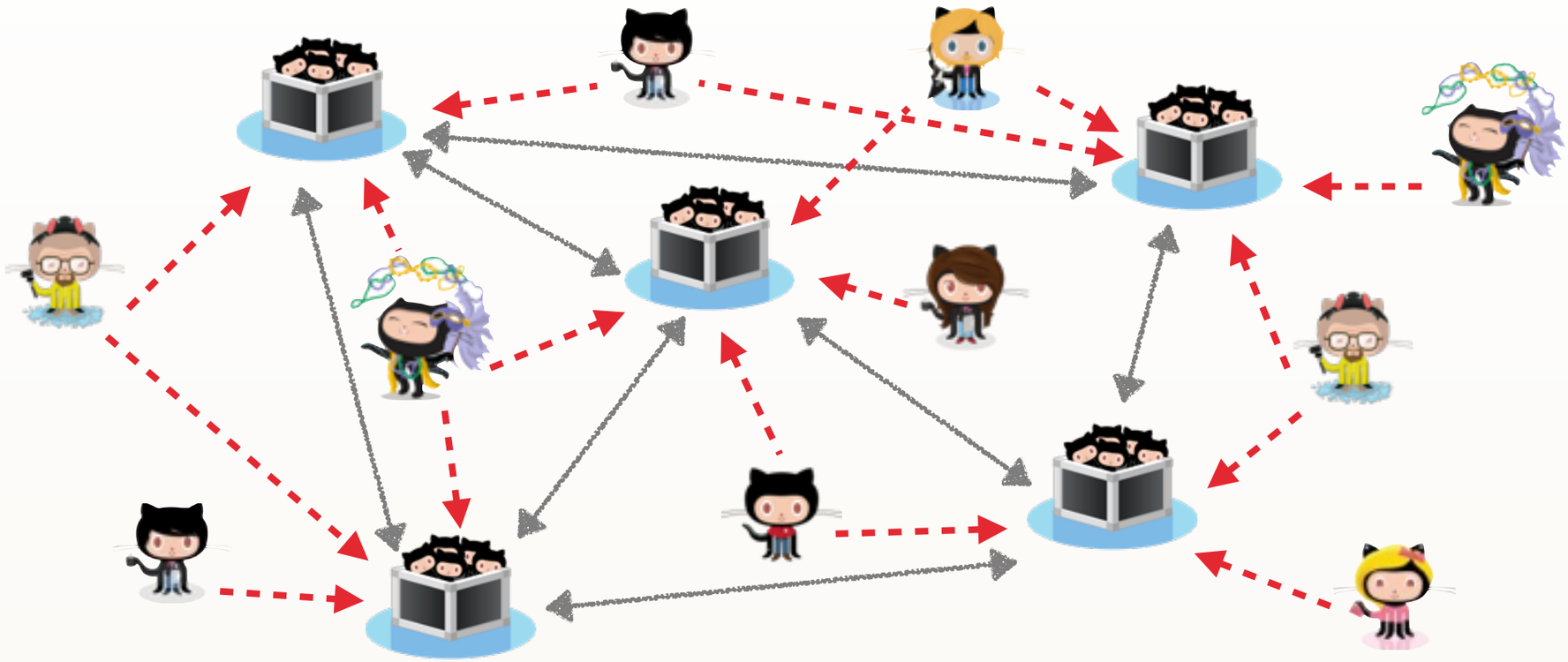
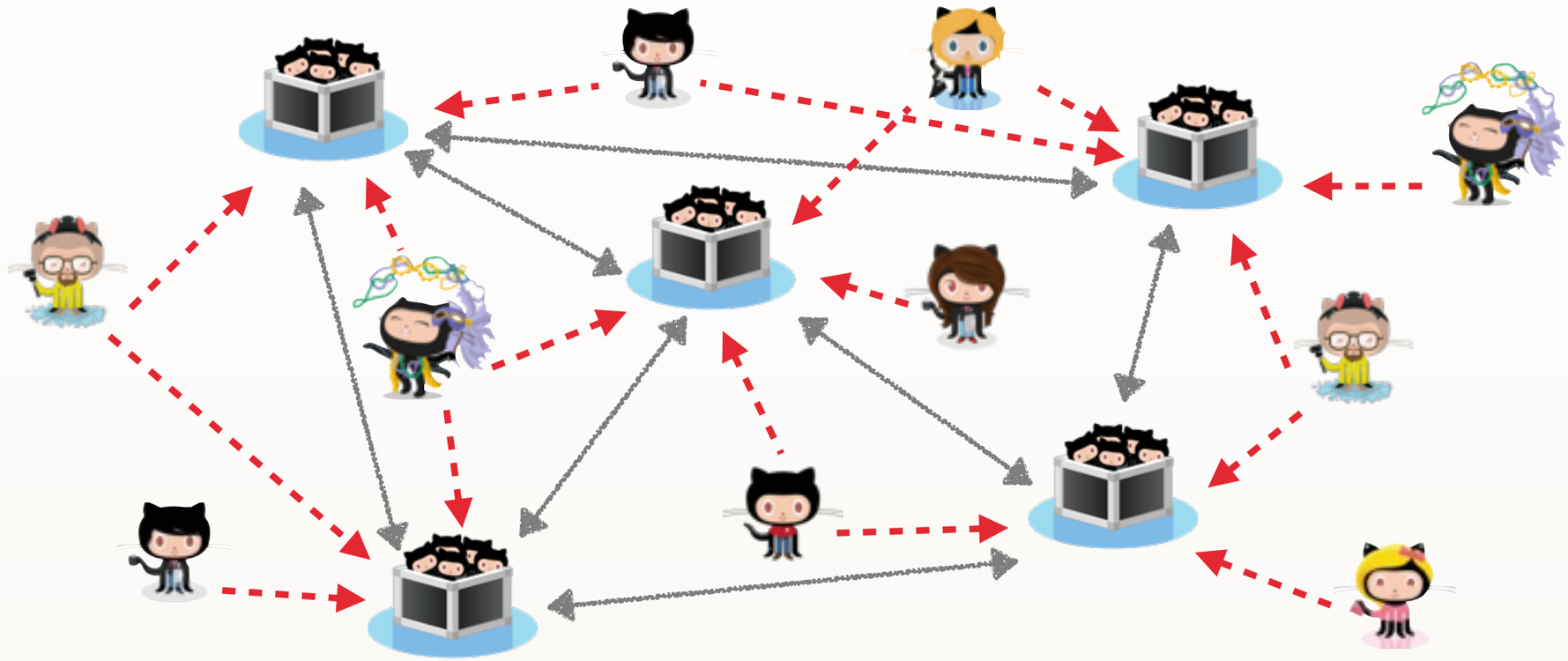


SOFTWARE DEVELOPMENT REVOLUTION



PRACTICE

- Large, distributed teams
- Process automation, DevOps
- Transparency, socialization, signaling

SOFTWARE DEVELOPMENT REVOLUTION

OPEN-SOURCE IS GROWING

Companies:

- 78% run OSS
- 66% build on top of OSS

BlackDuck 2015 survey https://goo.gl/Ltaqqs

SOFTWARE DEVELOPMENT REVOLUTION

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~~12~~ 18 M people

~~31~~ 47 M repositories

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"it's just so uncool not sharing the code in the age of social coding"

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HIRING

- **$100+** /hour:
  - owns popular OSS products;
  - stack**overflow** score > 20K; …
- **$50+** /hour:
  - active OSS contributor;
  - stack**overflow** score > 5K; …

- GitHub stats from: https://github.com/about
- World estimates from: http://goo.gl/Htnni9
- **How Much Do You Cost?** Yegor Bugayenko http://goo.gl/N0mL3F
- Activity traces and signals in software developer recruitment and hiring J Marlow, L Dabbish. *CSCW 2013*

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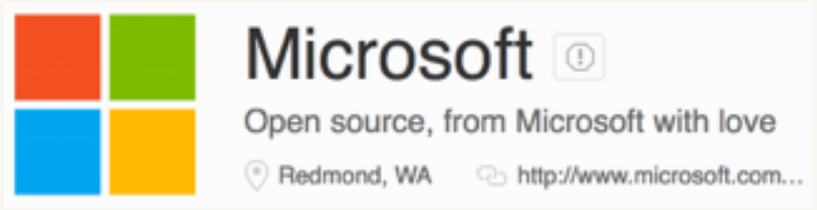
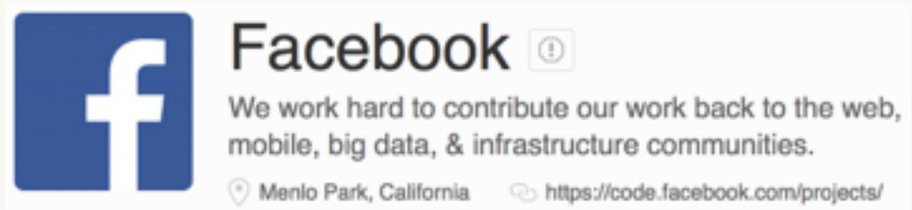
INDUSTRIAL INVOLVEMENT & ADOPTION





- GitHub stats from: https://github.com/about
- World estimates from: http://goo.gl/Htnni9
- Open source-style collaborative development practices in commercial projects using GitHub E Kalliamvakou, D Damian, K Blincoe, L Singer, DM German. *ICSE 2015*
- How Much Do You Cost? Yegor Bugayenko http://goo.gl/N0mL3F
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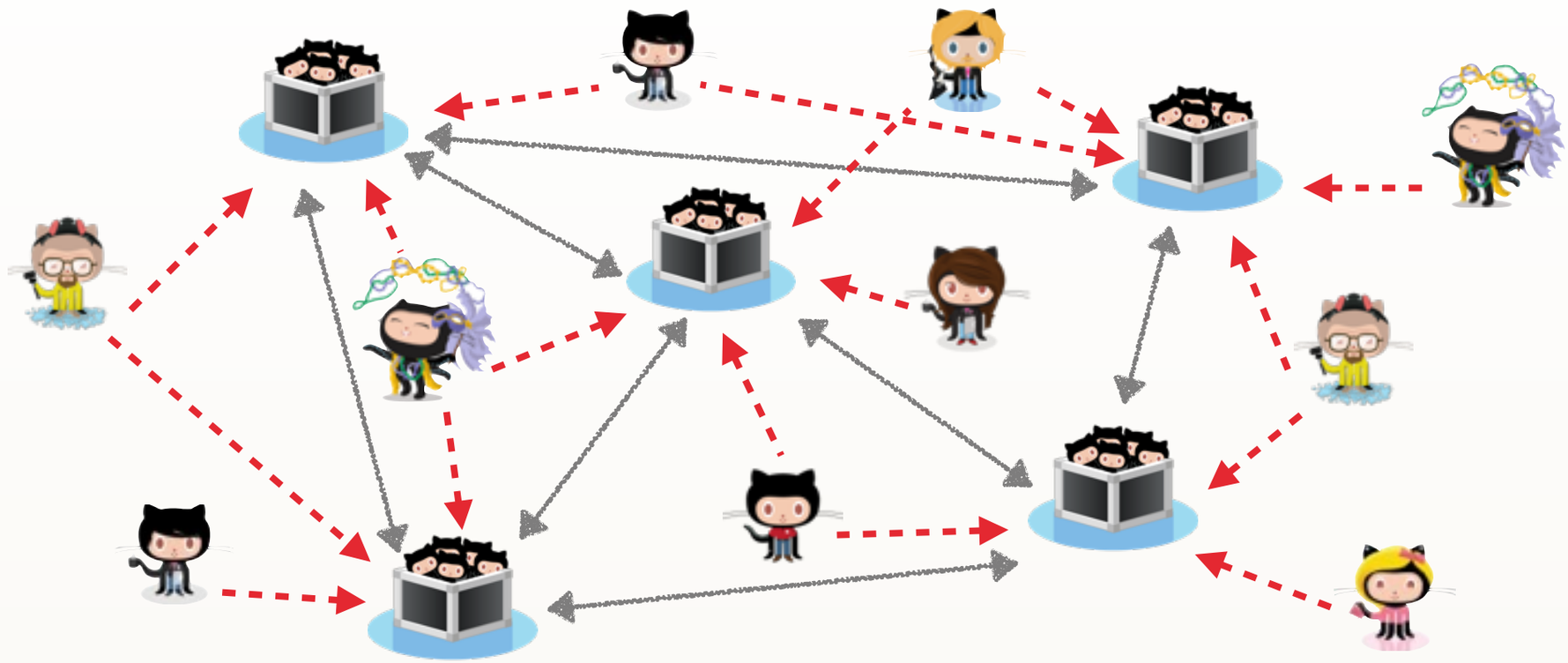
EMPIRICAL RESEARCH REVOLUTION



PRACTICE

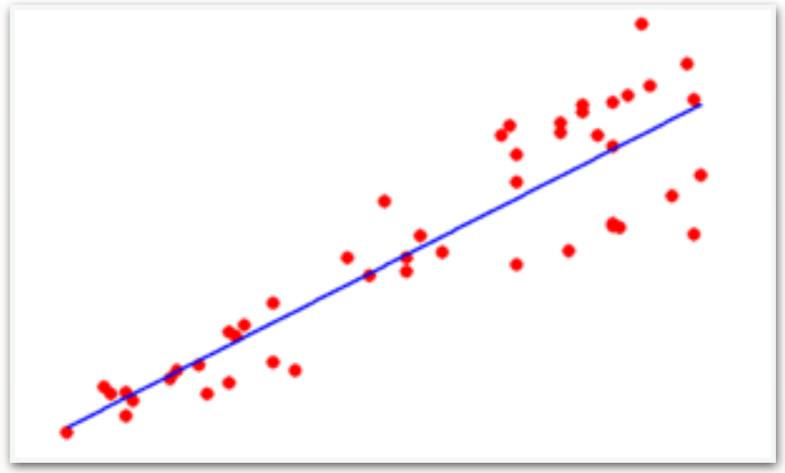
- Large, distributed teams
- Process automation, DevOps
- Transparency, socialization, signaling

RESEARCH

- Breadth of topics, from impression formation to programming languages and software quality
- “Big data”, mixed methods

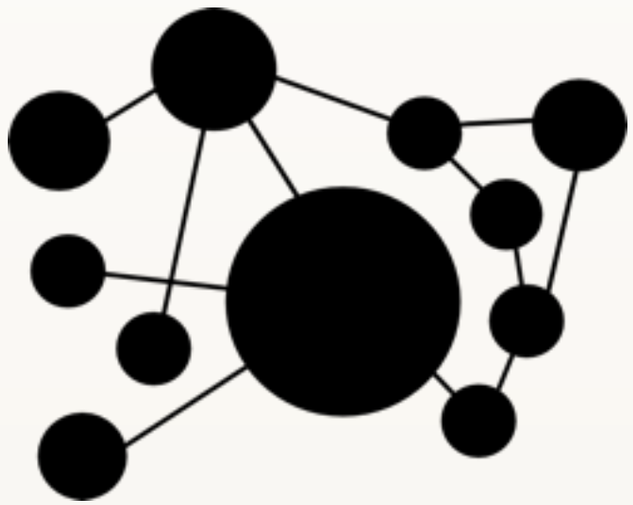
TOOLKIT FOR SOCIAL SOFTWARE ENGINEERING RESEARCHERS

THEORY



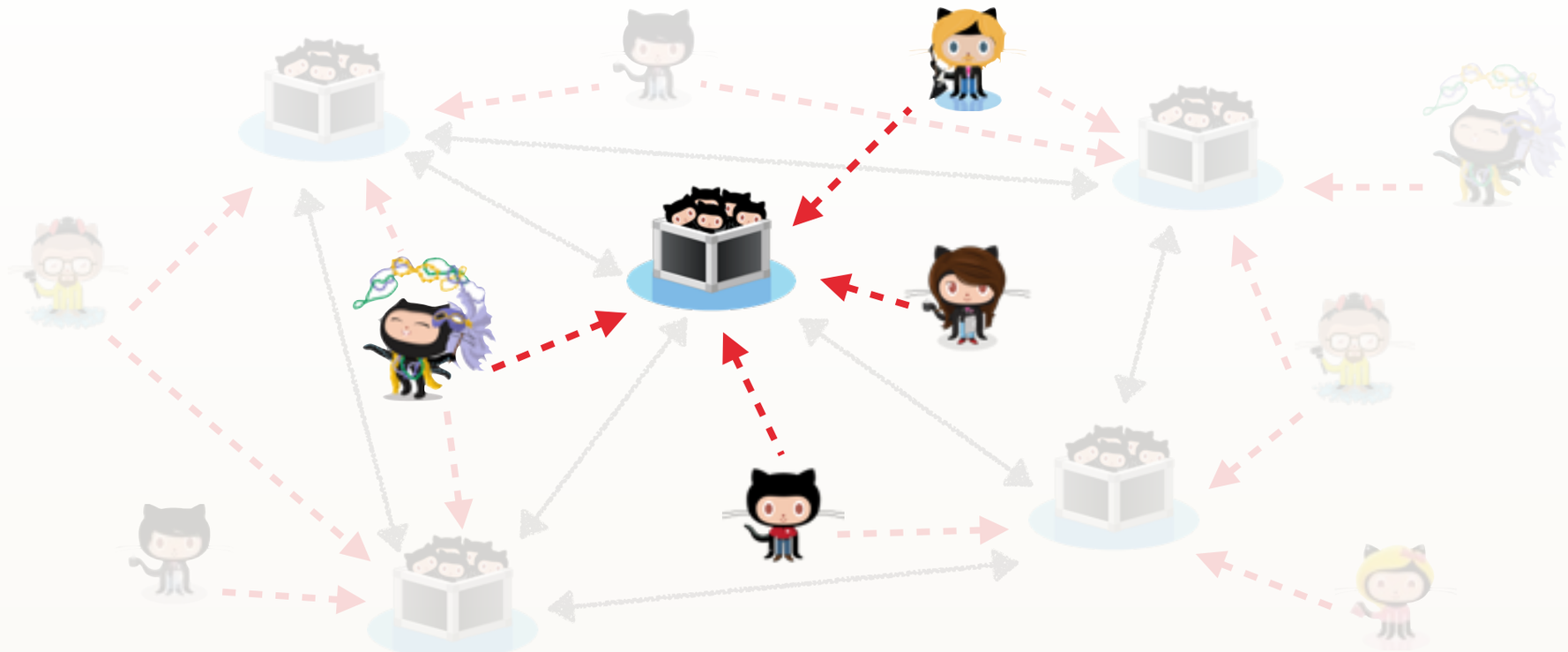
STATISTICS

QUALITATIVE METHODS



NETWORK SCIENCE

EXAMPLE 1: PULL REQUEST EVALUATION TIME



rails / rails

Watch 2,305 | Star 33,378 | Fork 13,615

Code | Issues 554 | Pull requests 667 | Projects 0 | Pulse | Graphs

Filters | is:pr is:open | Labels | Milestones | New pull request

667 Open | 16,951 Closed | Author | Labels | Milestones | Assignee | Sort

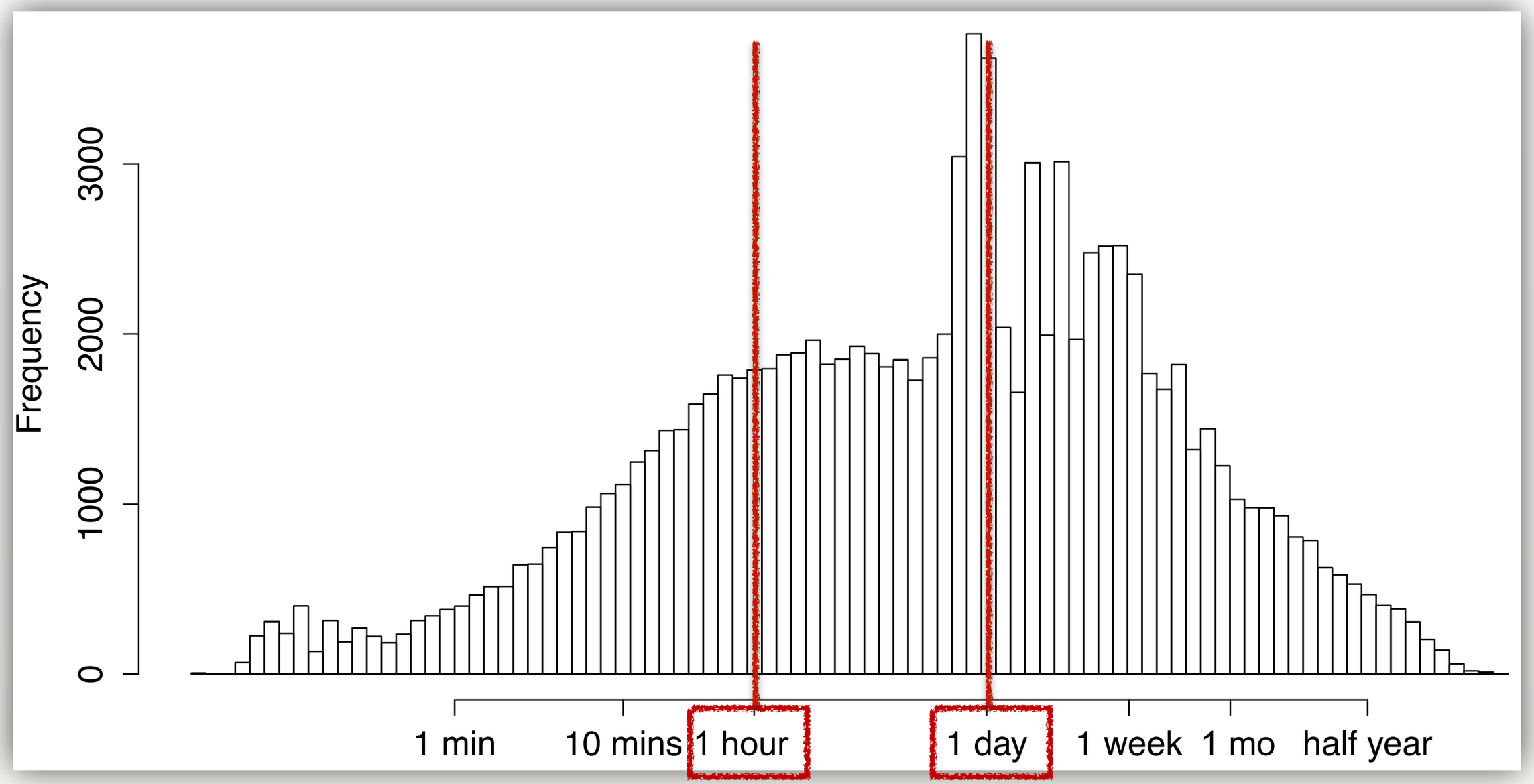
Schema cache in YAML
#27042 opened 23 minutes ago by kirs — 1

Add `:skip_sprockets` to `Rails::PluginBuilder::PASSTHROUGH_OPTIONS` railties
#27040 opened 4 hours ago by ttanimichi — 1

Remove Active Support deprecations activesupport needs feedback
#27035 opened 16 hours ago by pixeltrix — 2

EXAMPLE 1: PULL REQUEST EVALUATION TIME

HOW TO PREDICT?



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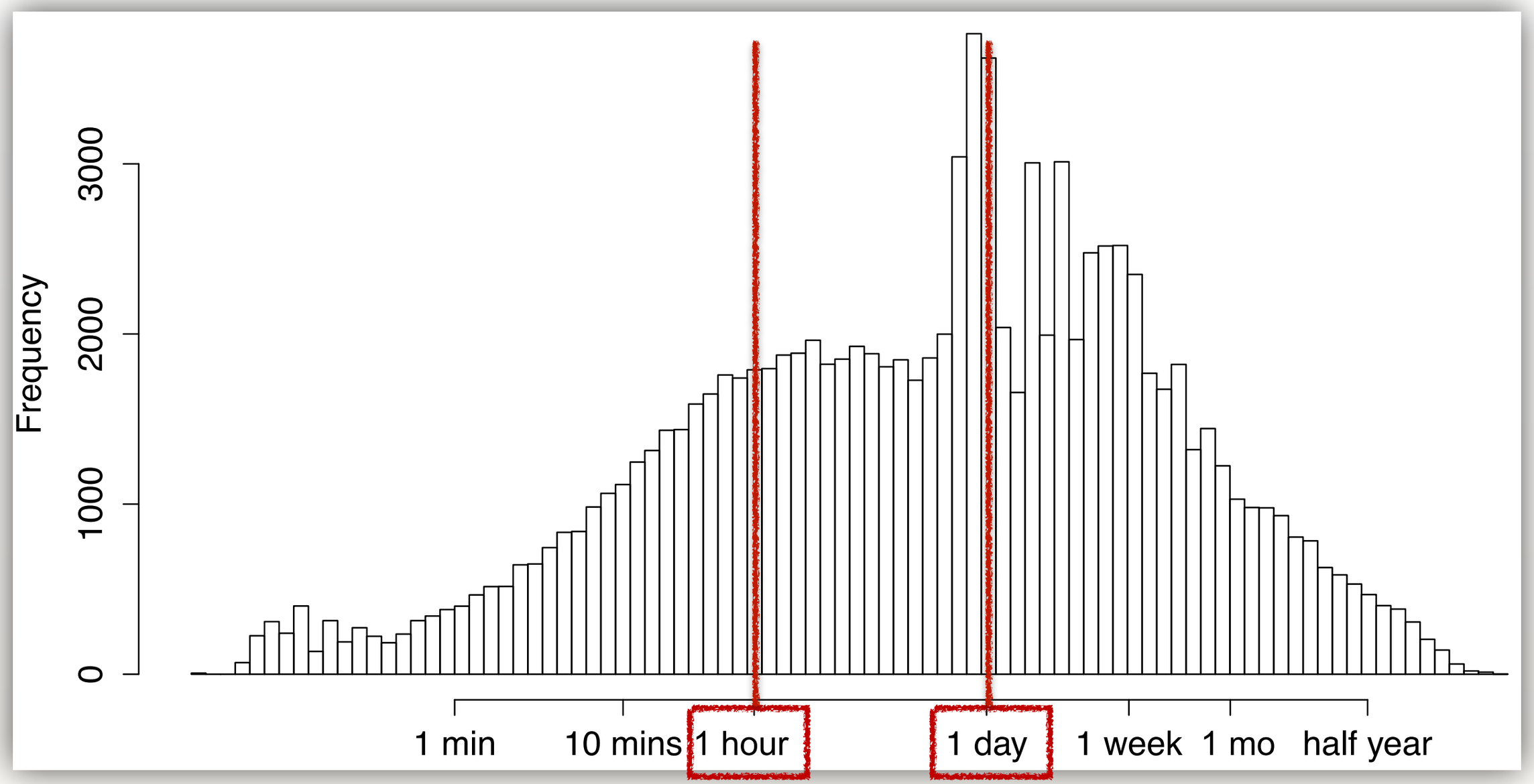
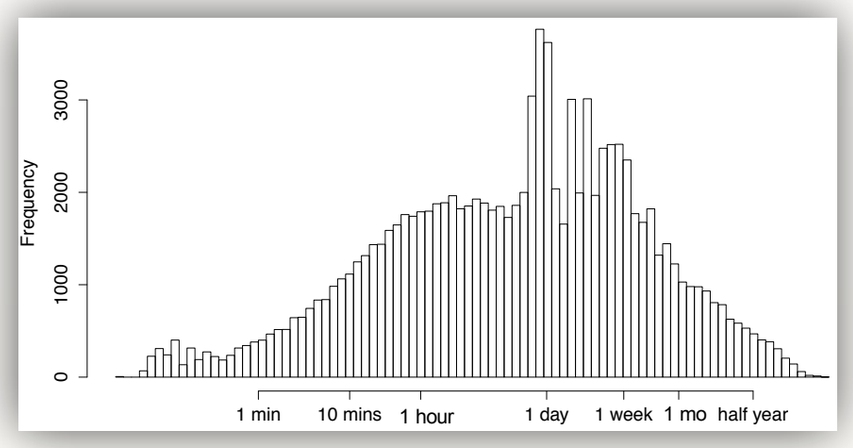


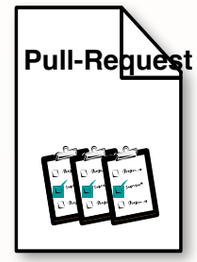
Hypothesis:

Technical attributes dominate: Size, Complexity, Having Tests

EXAMPLE 1: PULL REQUEST EVALUATION TIME

FACTORS





Size

- n_additions
- n_commits

Review

- n_comments

Experience & Social Connections

- merge_rate
- connection_strength
- n_followers

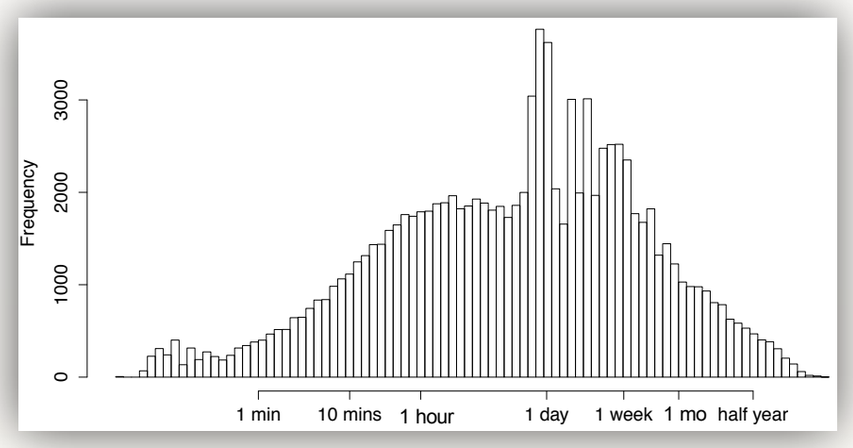
[Gousios et al, ICSE'14, ICSE'15]
[Tsay et al, ICSE'14, FSE'14]

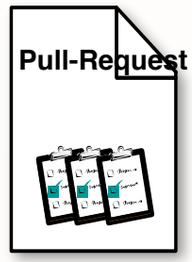
EXAMPLE 1: PULL REQUEST EVALUATION TIME

MODELS

M1: Previously-identified factors

✓ $R^2 = 36.2\%$





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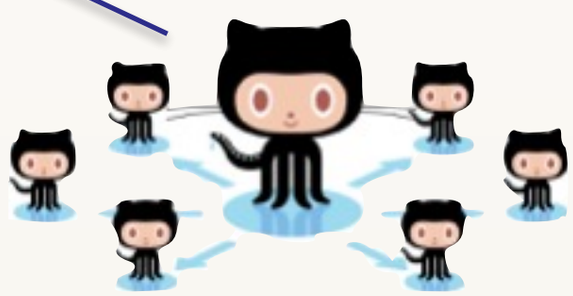

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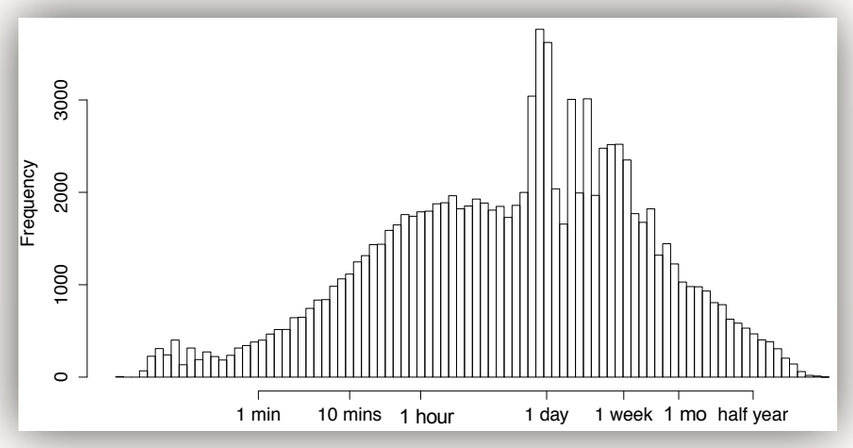
EXAMPLE 1: PULL REQUEST EVALUATION TIME

MODELS

M2: M1 + process-related factors + continuous integration

Title & description

- n_tokens



[MSR 2015]

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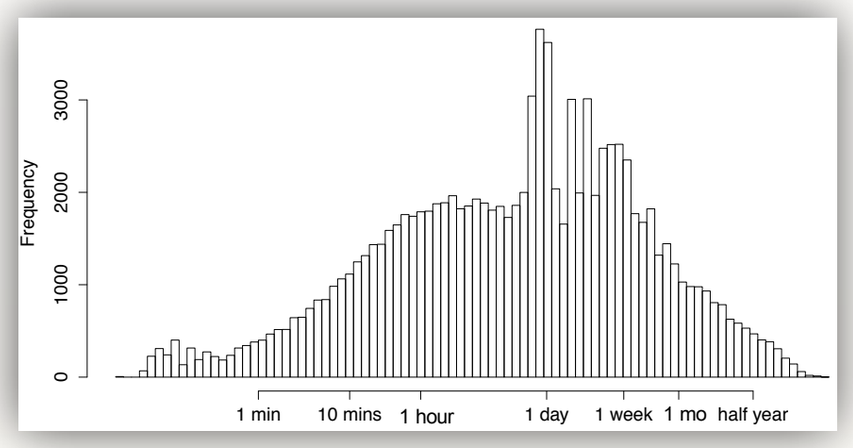

Title & description

- n_tokens

Management

- workload
- availability

[MSR 2015]

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MODELS

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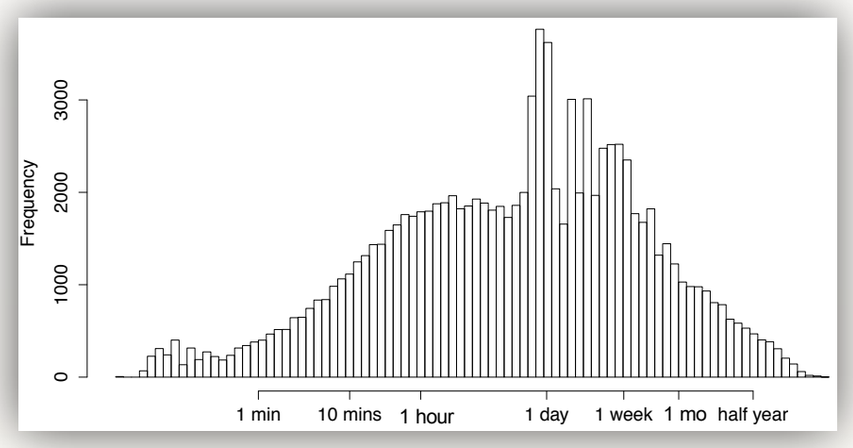


Title & description

- n_tokens

Priority

- time_to_first _response

Continuous Integration

- response time

Management

- workload
- availability

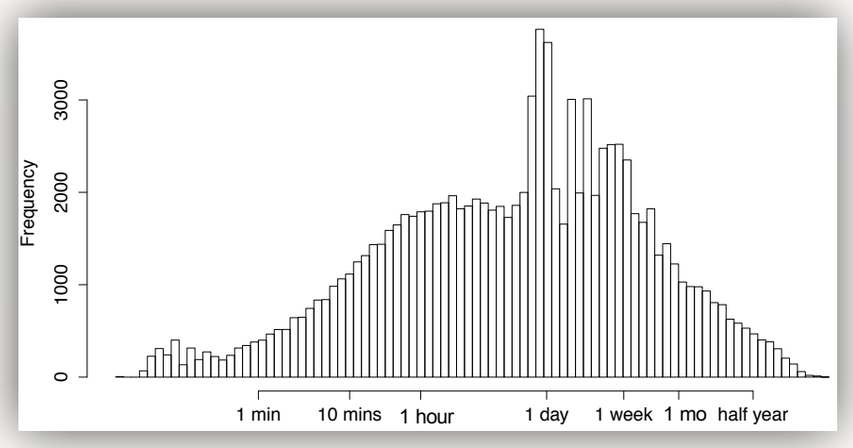
[MSR 2015]

EXAMPLE 1: PULL REQUEST EVALUATION TIME

MODELS

M2: M1 + process-related factors + continuous integration

✓ $R^2 = 58.7\%$



Title & description
- n_tokens

Priority
- time_to_first _response

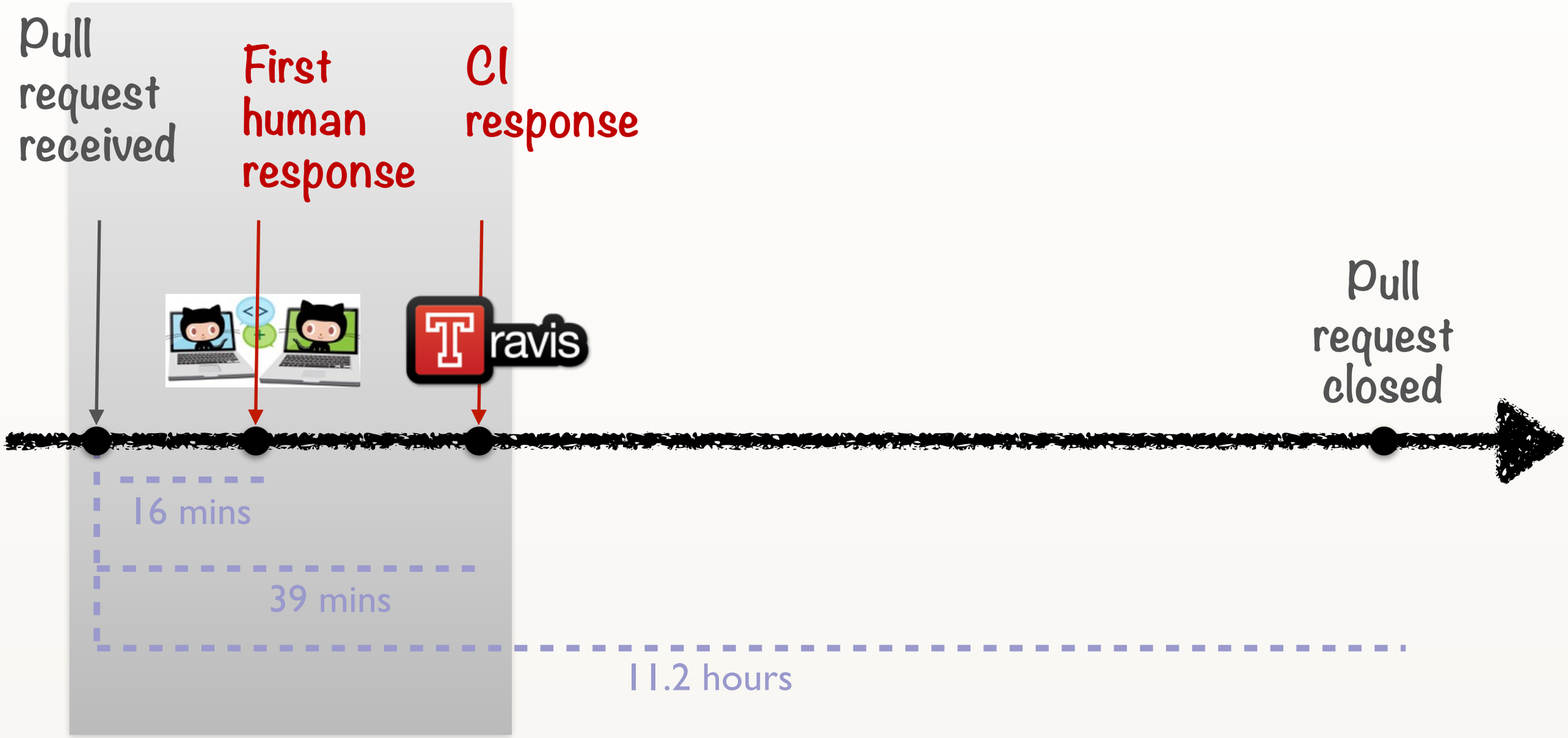
Continuous Integration
- response time

Management
- workload
- availability

Social tagging
- @mention
- #issue

[MSR 2015]

EXAMPLE 1: PULL REQUEST EVALUATION TIME IS PREDICTABLE

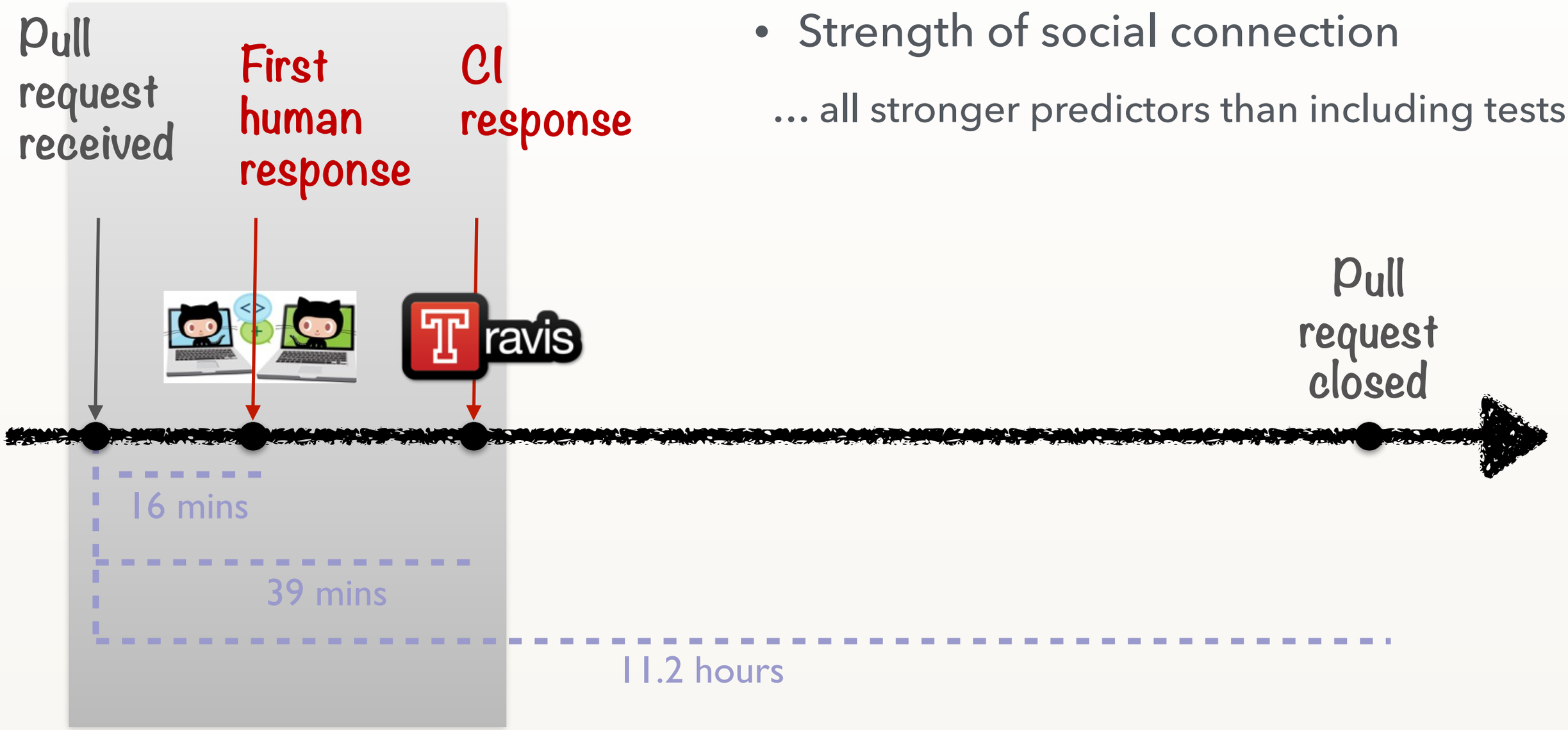


EXAMPLE 1: PULL REQUEST EVALUATION TIME

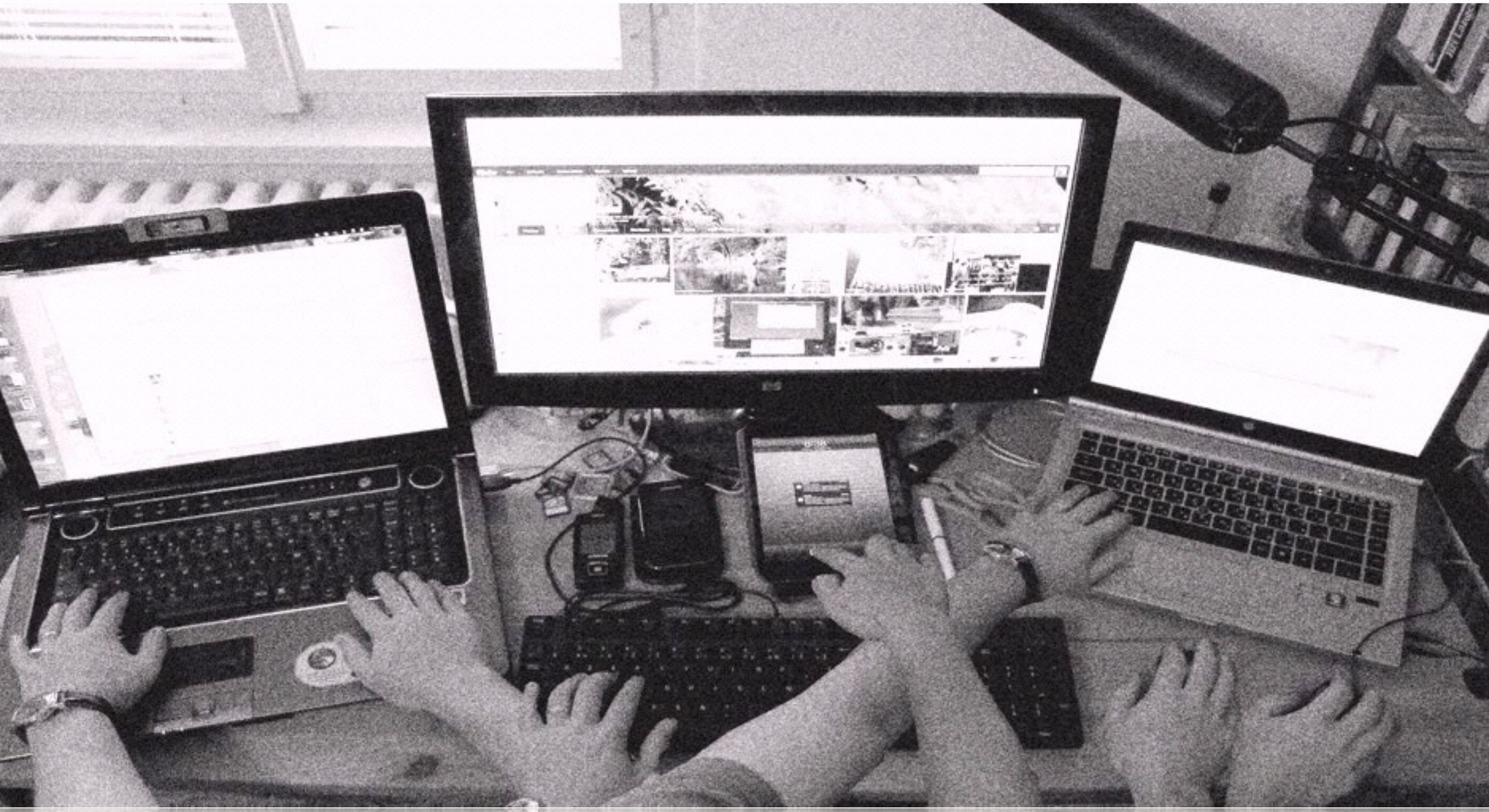
SOCIAL CODING!

- Submitter is core developer
- Number of followers
- Strength of social connection

... all stronger predictors than including tests

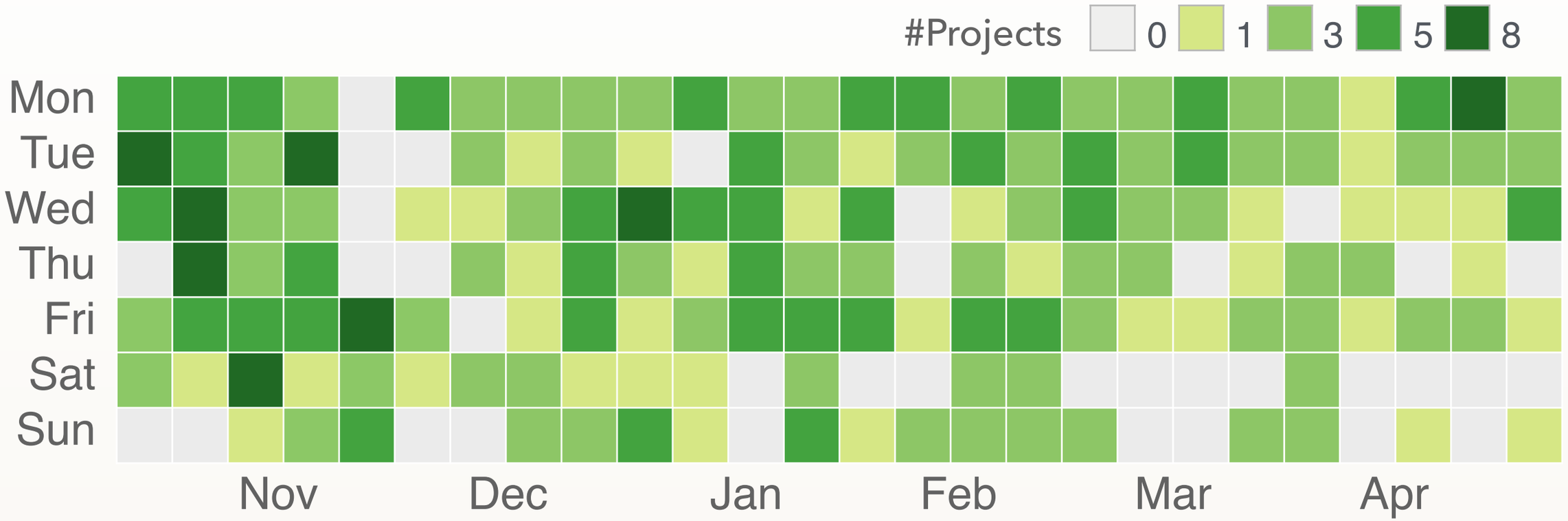


EXAMPLE 2: MULTITASKING



SOFTWARE DEVELOPERS MULTITASK TOO

EXAMPLE: GitHub developer (25 Nov 2013 – 18 May 2014)



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github SOCIAL CODING

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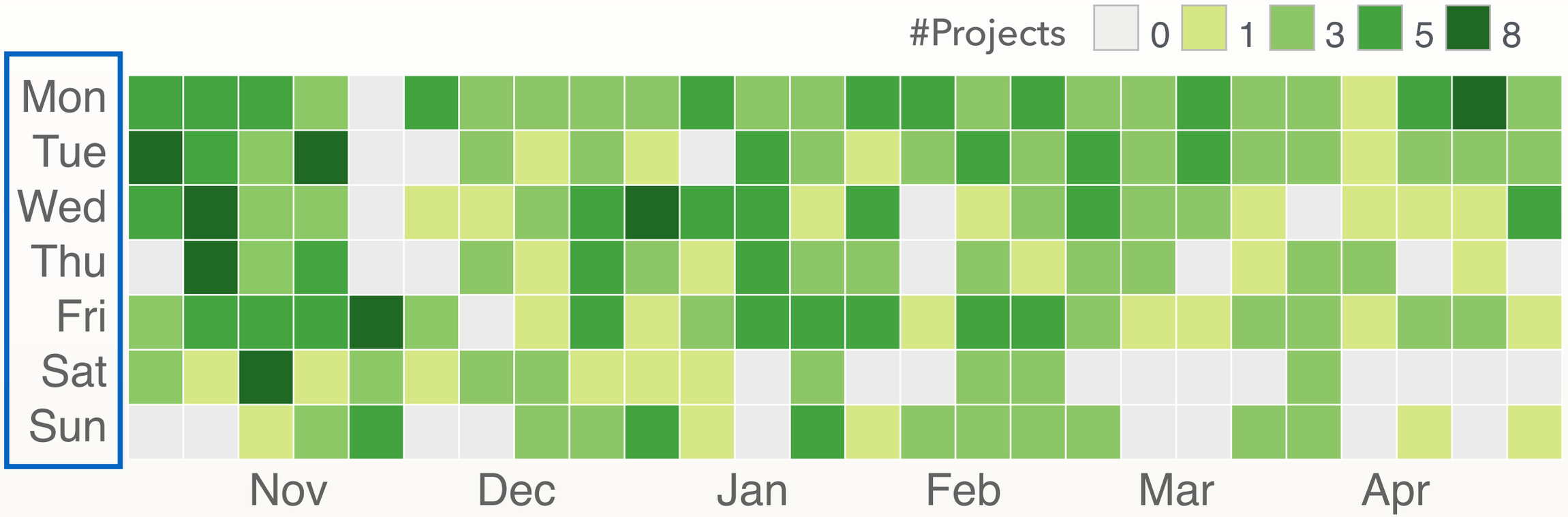

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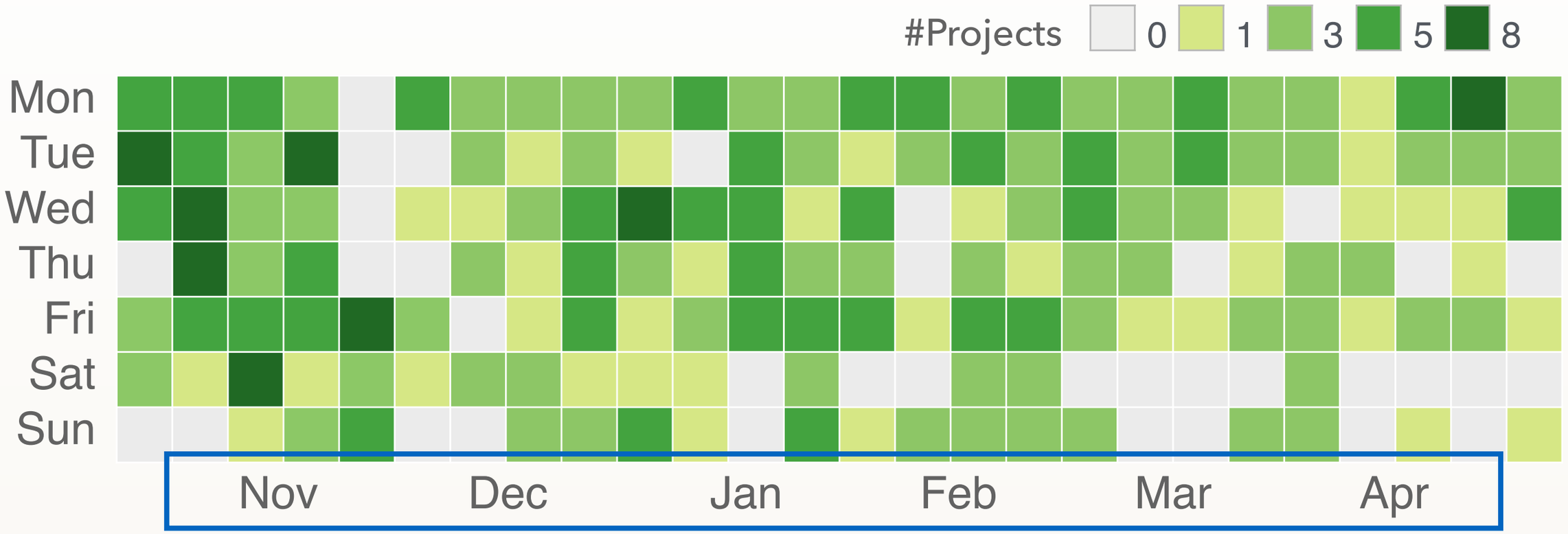

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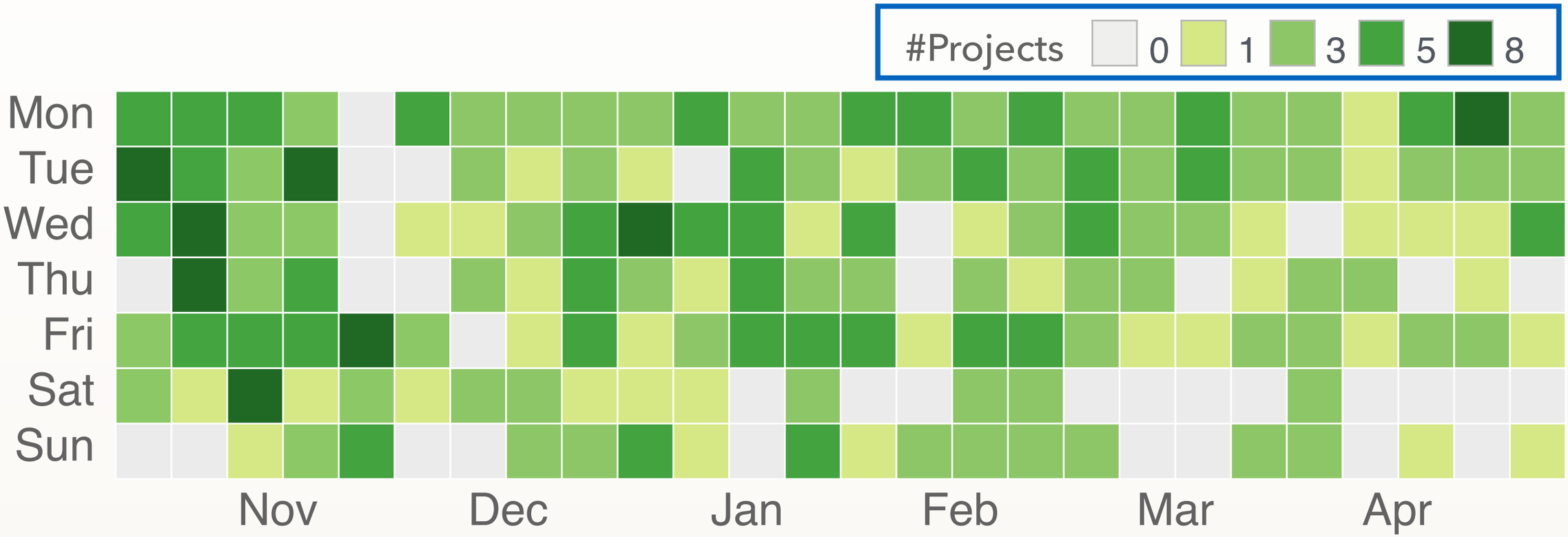

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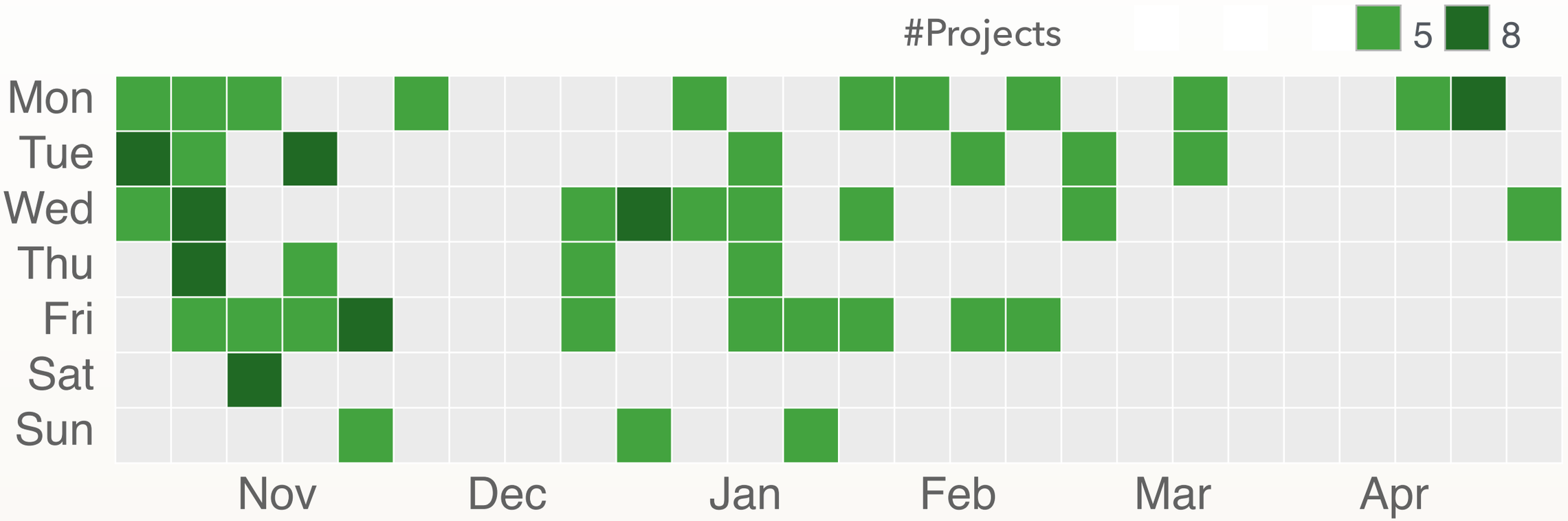

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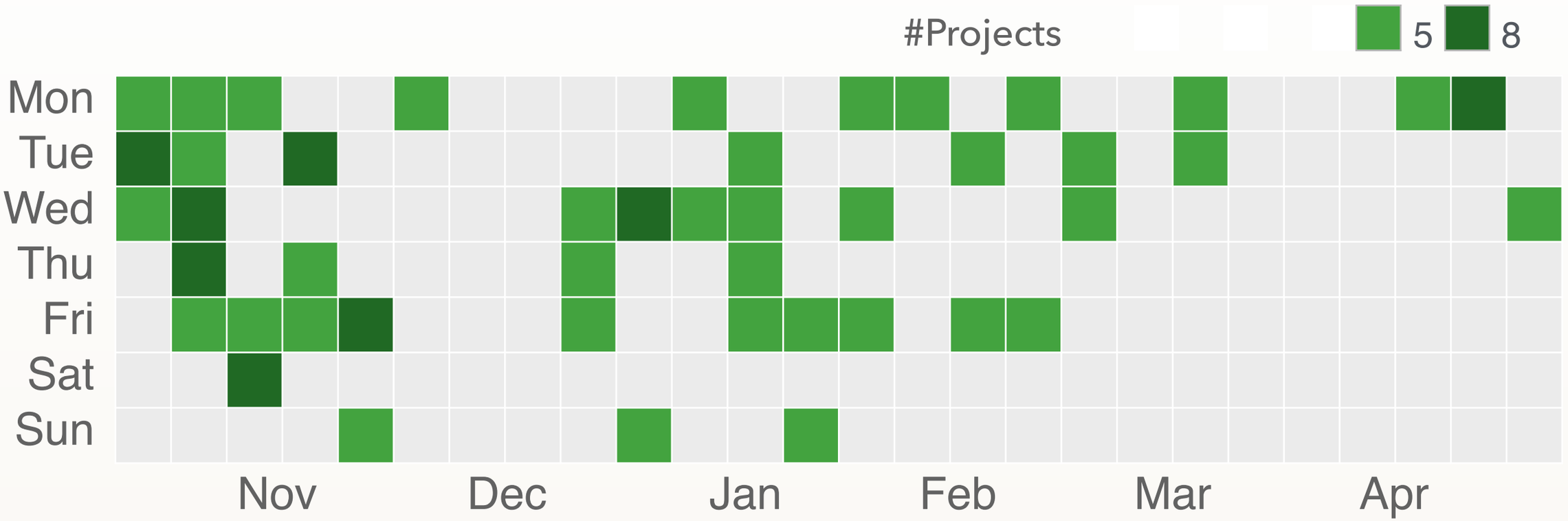

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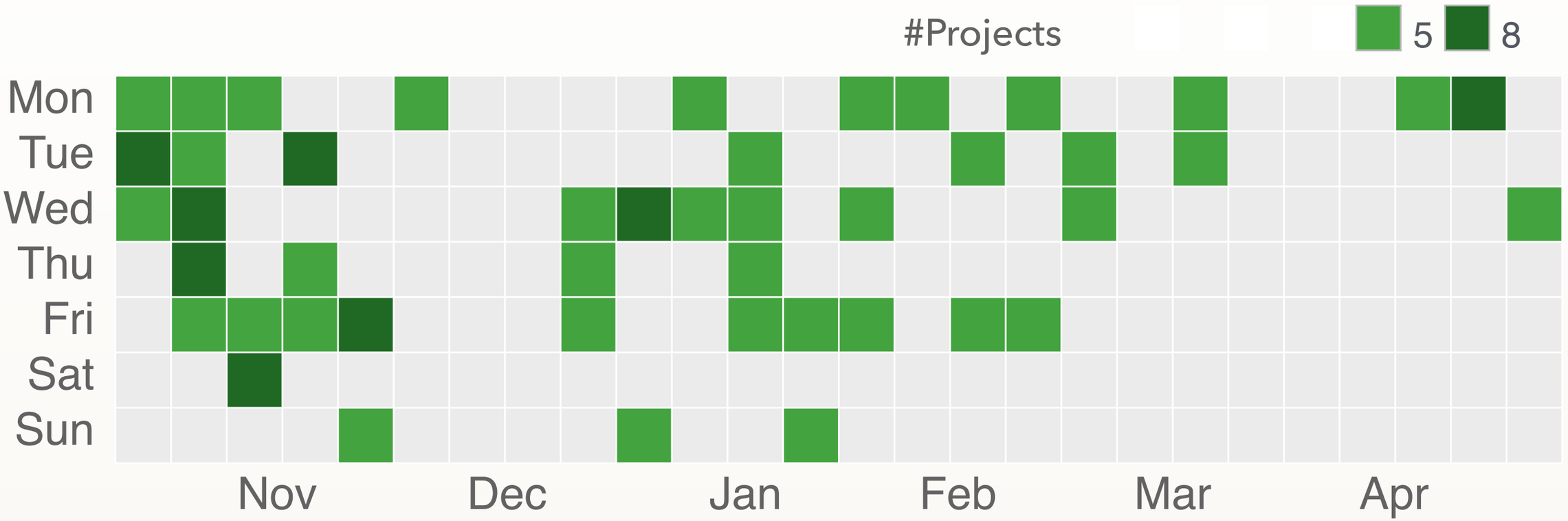

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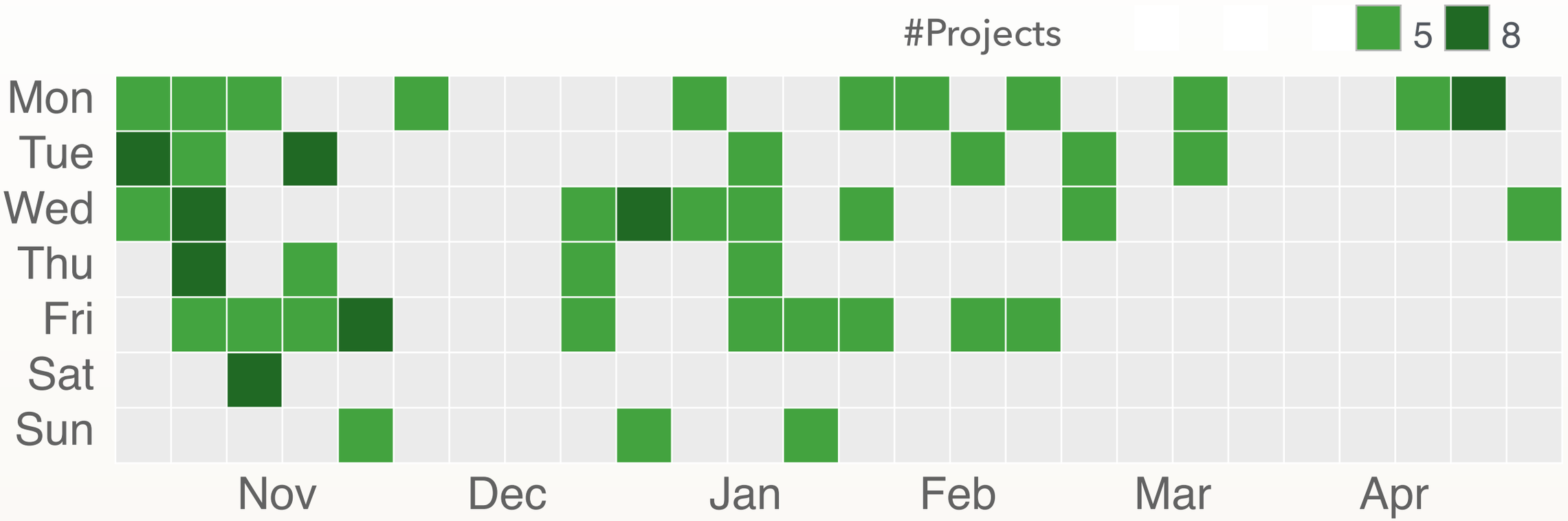

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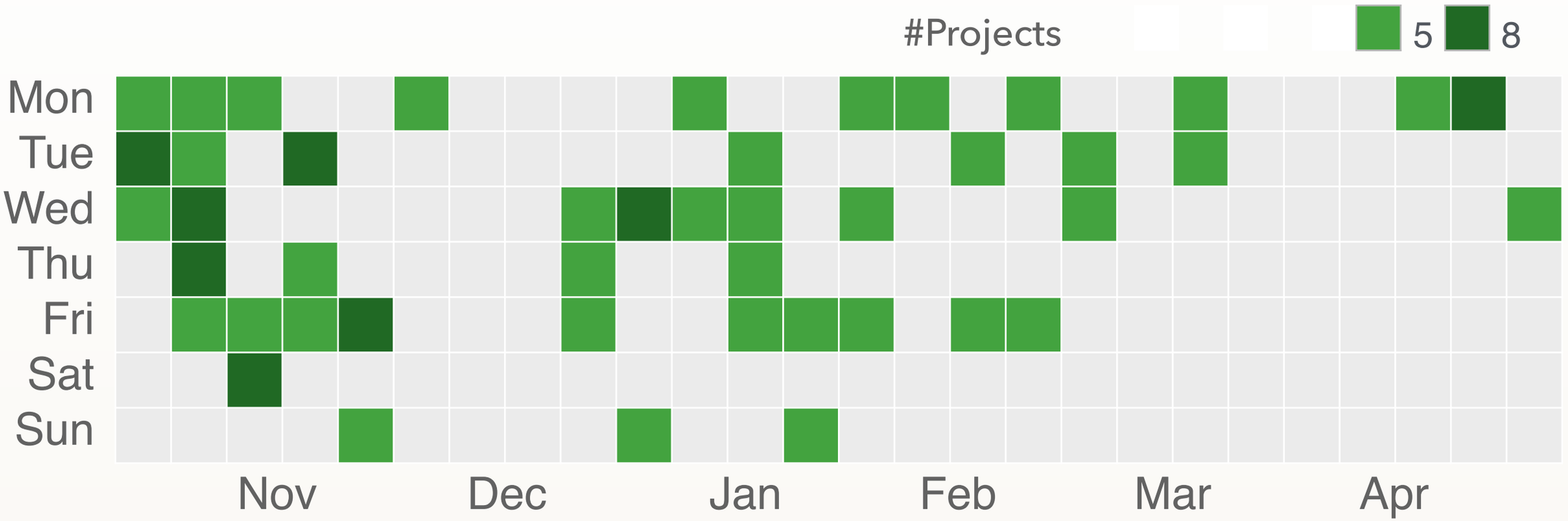

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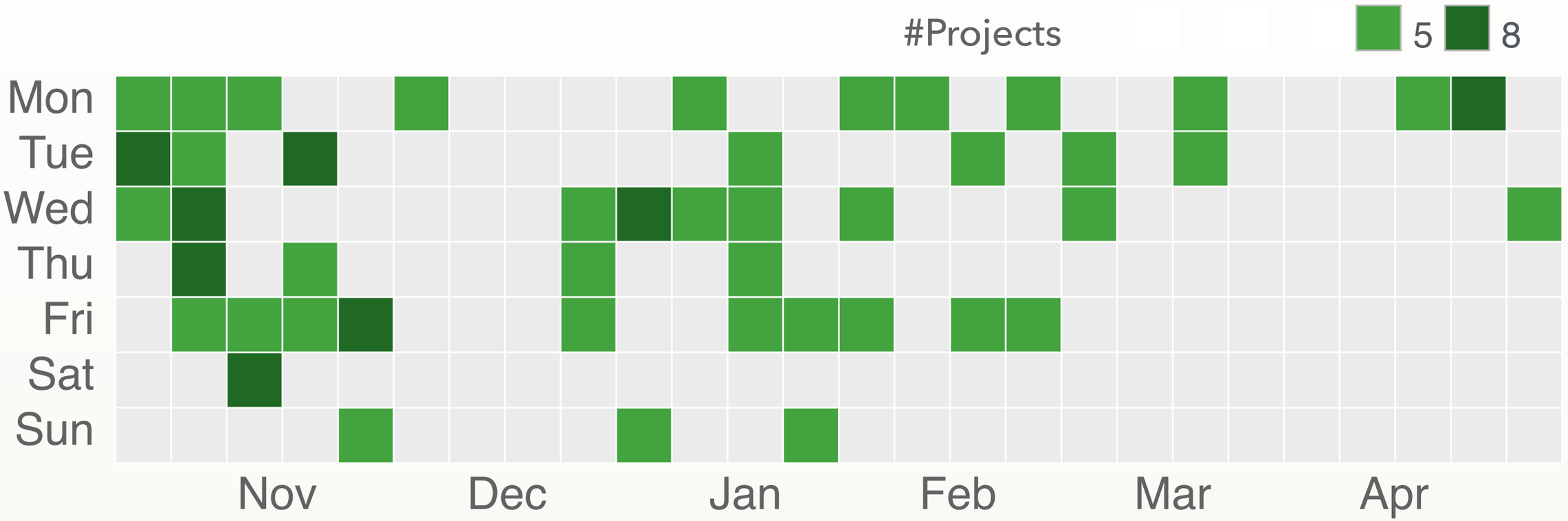

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CONS

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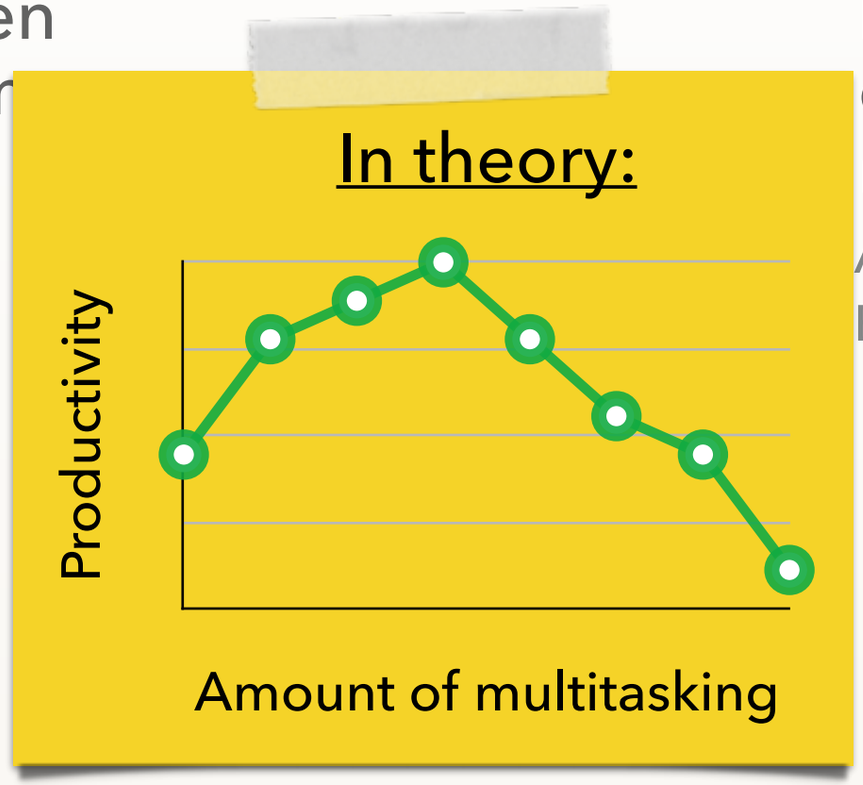

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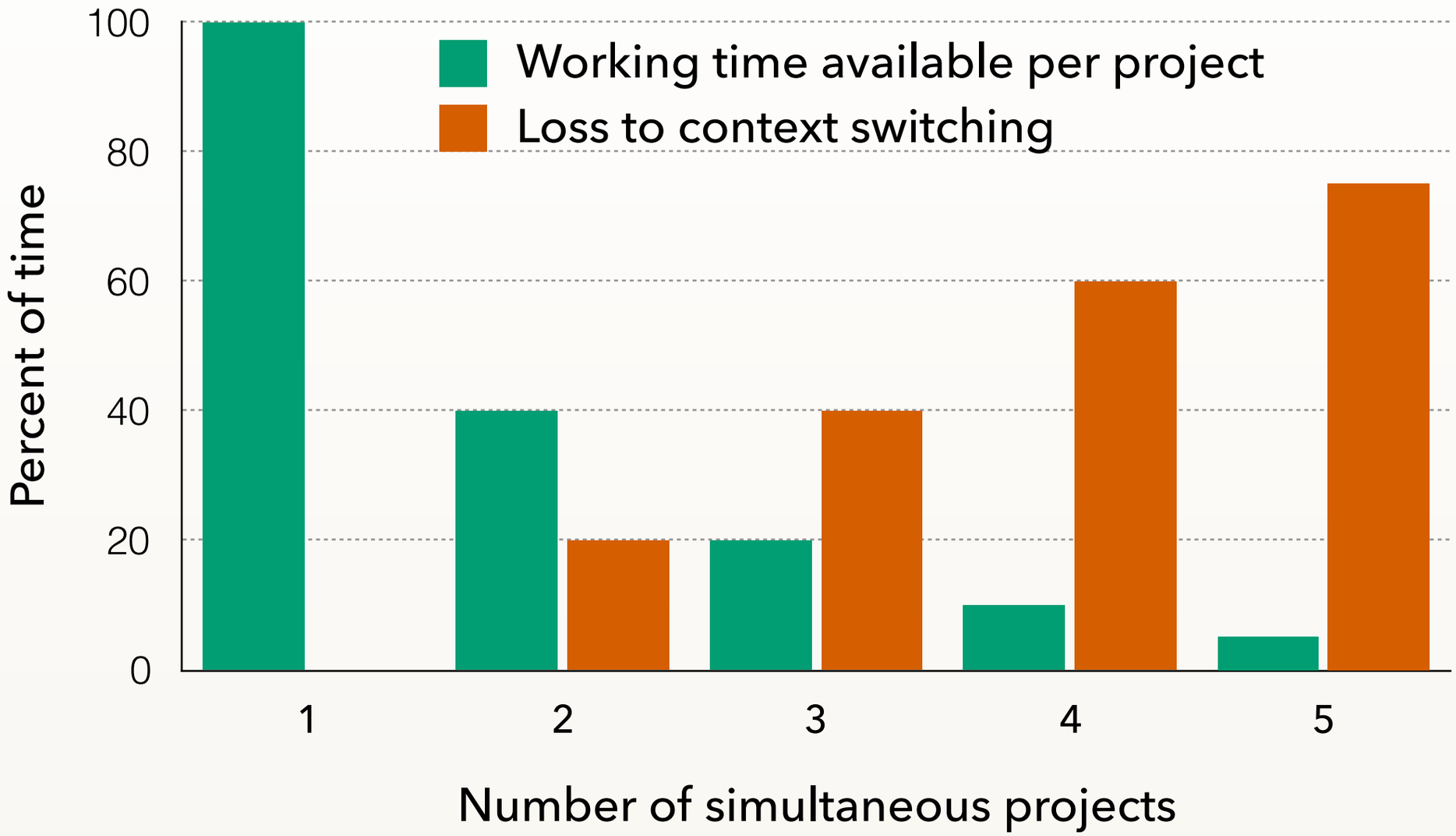
HARDLY ANY EMPIRICAL EVIDENCE

Rule of thumb (Weinberg, 1992) - not based on data



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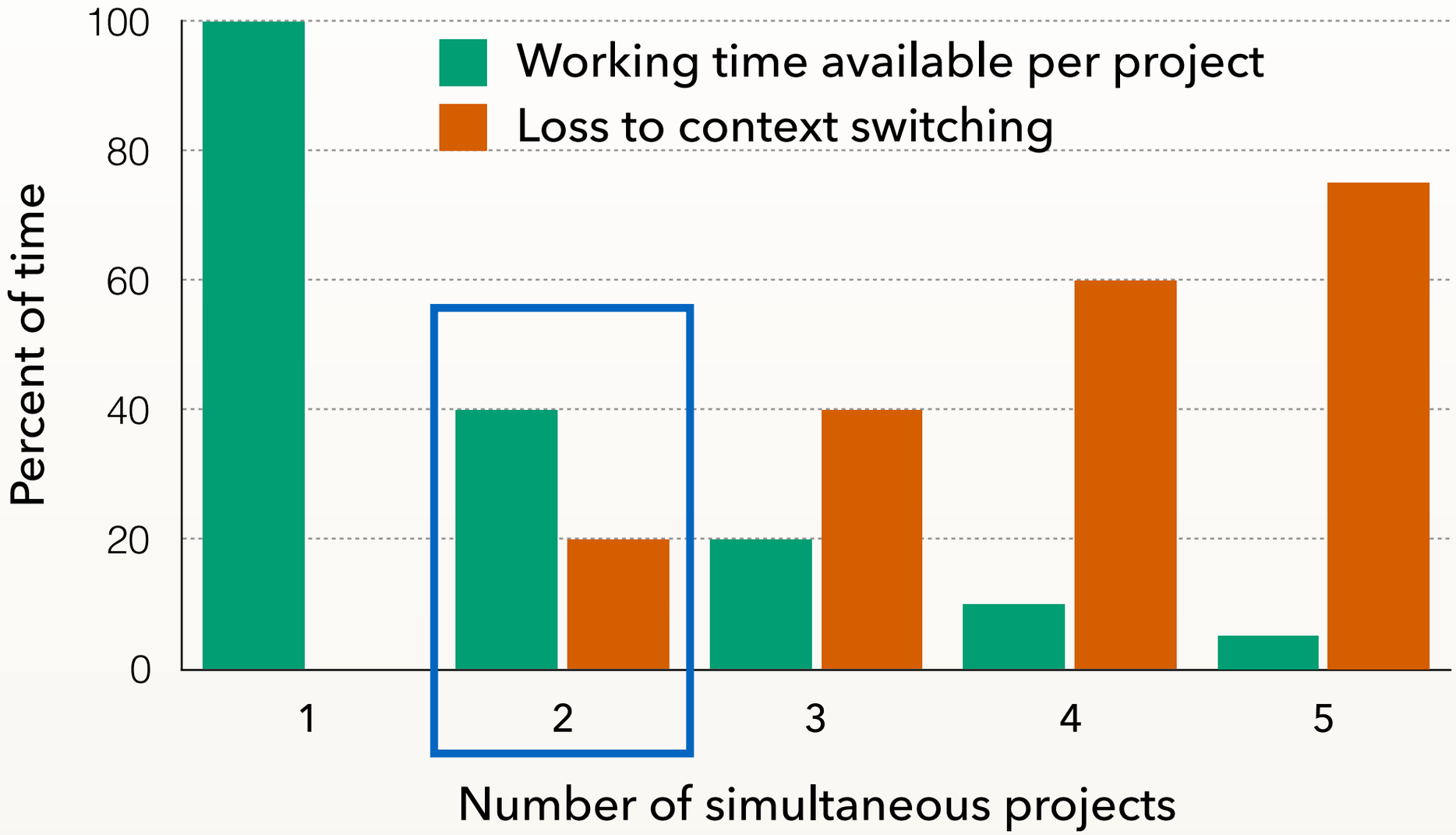

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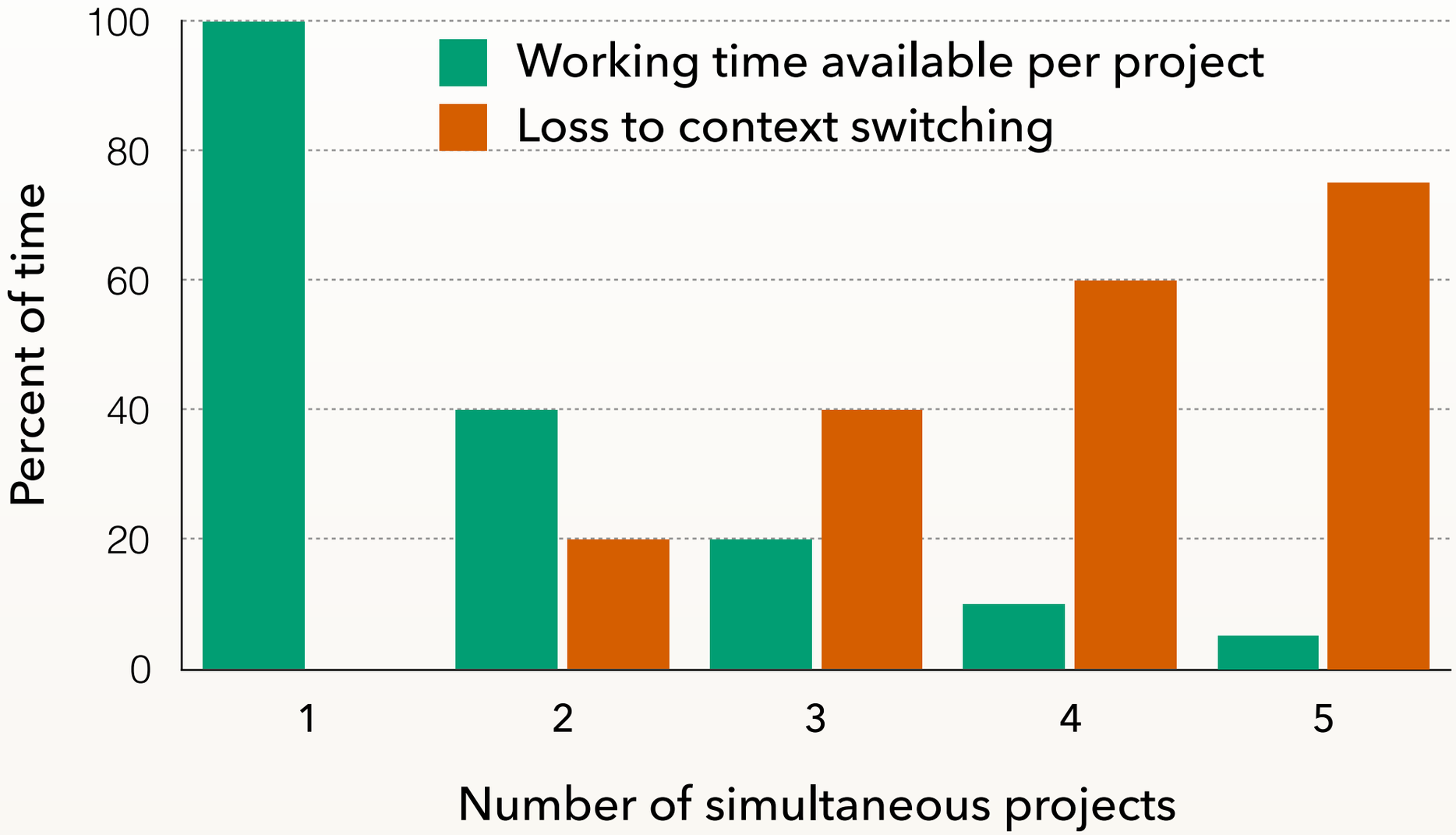

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Recent work:

- Resuming interrupted tasks
  (Parnin and DeLine, 2010)
- Work fragmentation
  (Sanchez, Robbes, and Gonzalez, 2015)

THIS WORK: LARGE-SCALE EMPIRICAL STUDY

WHAT?

Multitasking across projects

? Trends ? Reasons ? Effects ? Limits

HOW?

Sample:

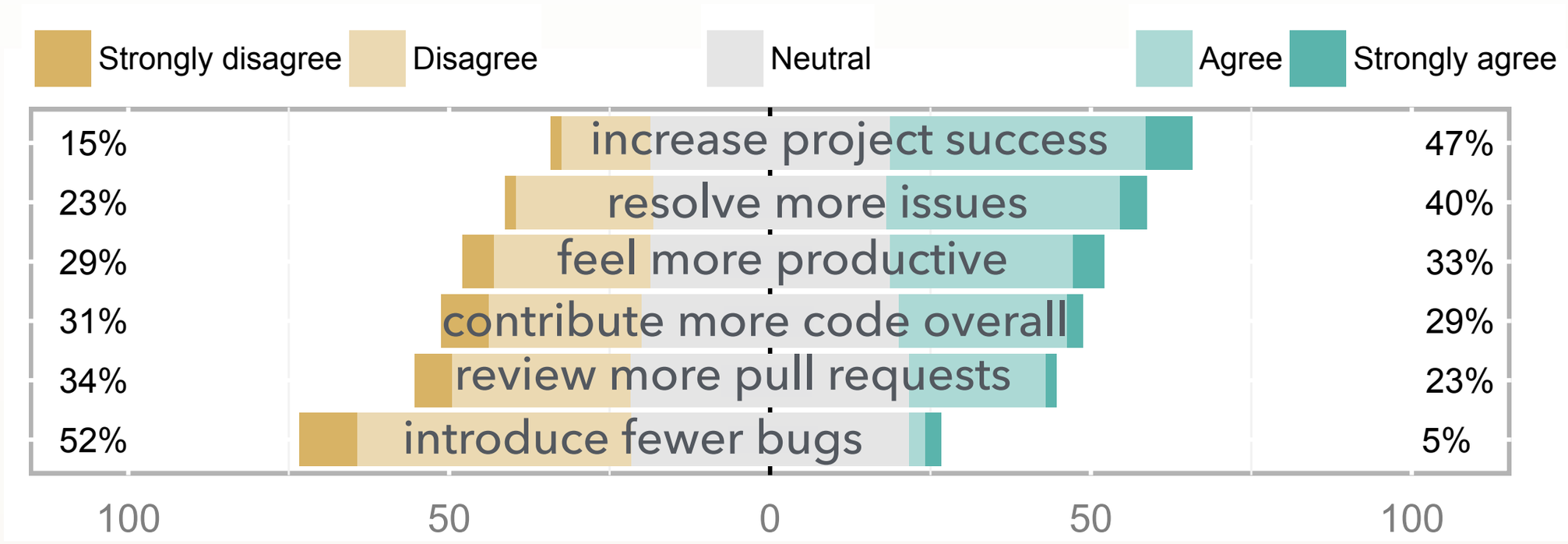
- 1,200 programmers
- 5+ years of activity
- 50,000+ projects total

Data mining + User survey
(15% resp. rate)

EFFECTS: PERCEPTION VS. DATA

PERCEPTION

"When contributing to multiple projects in parallel, I:"



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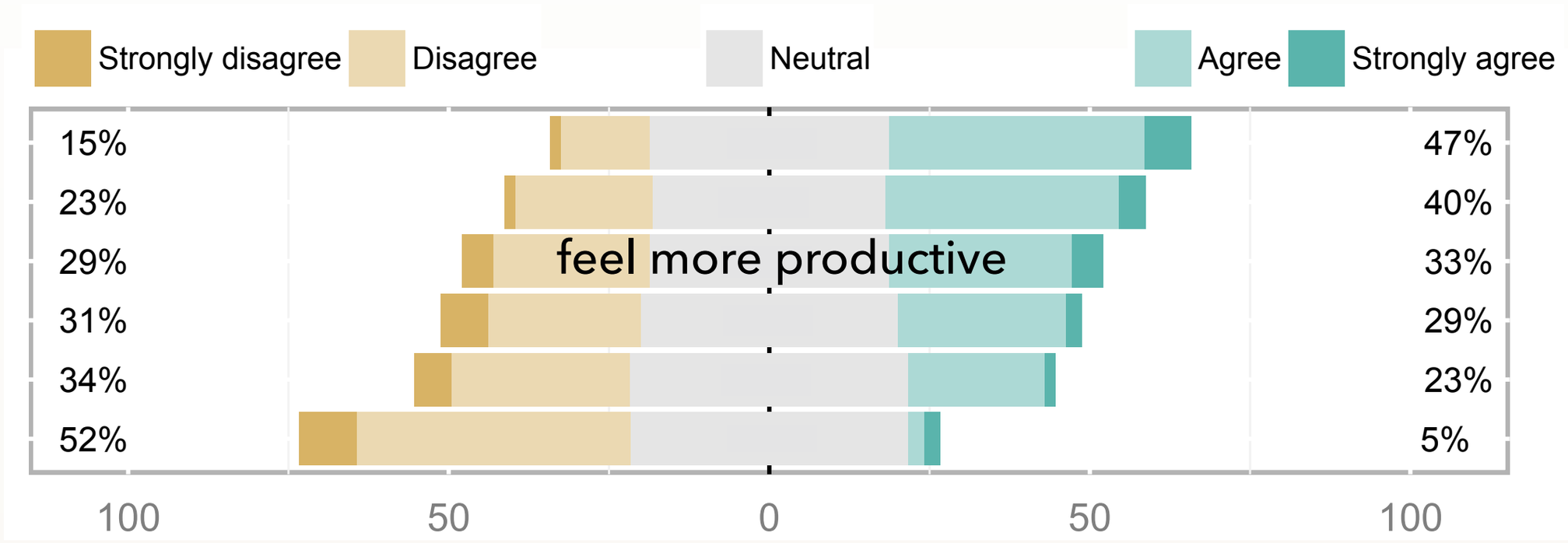

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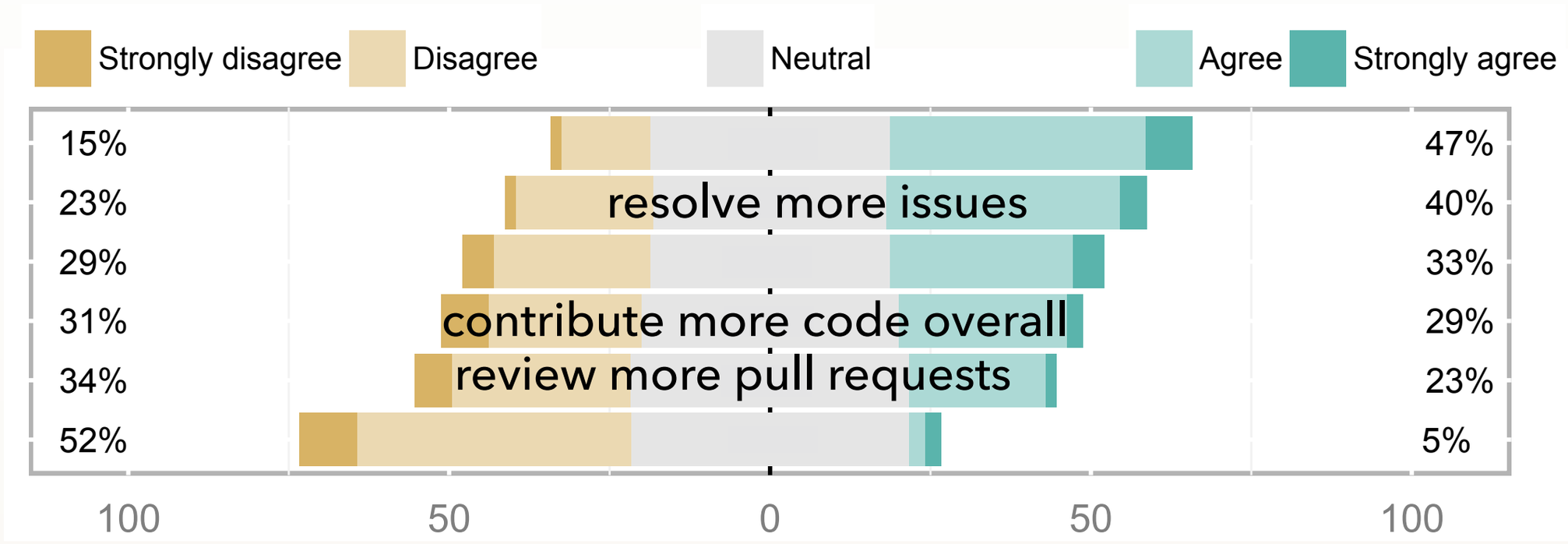

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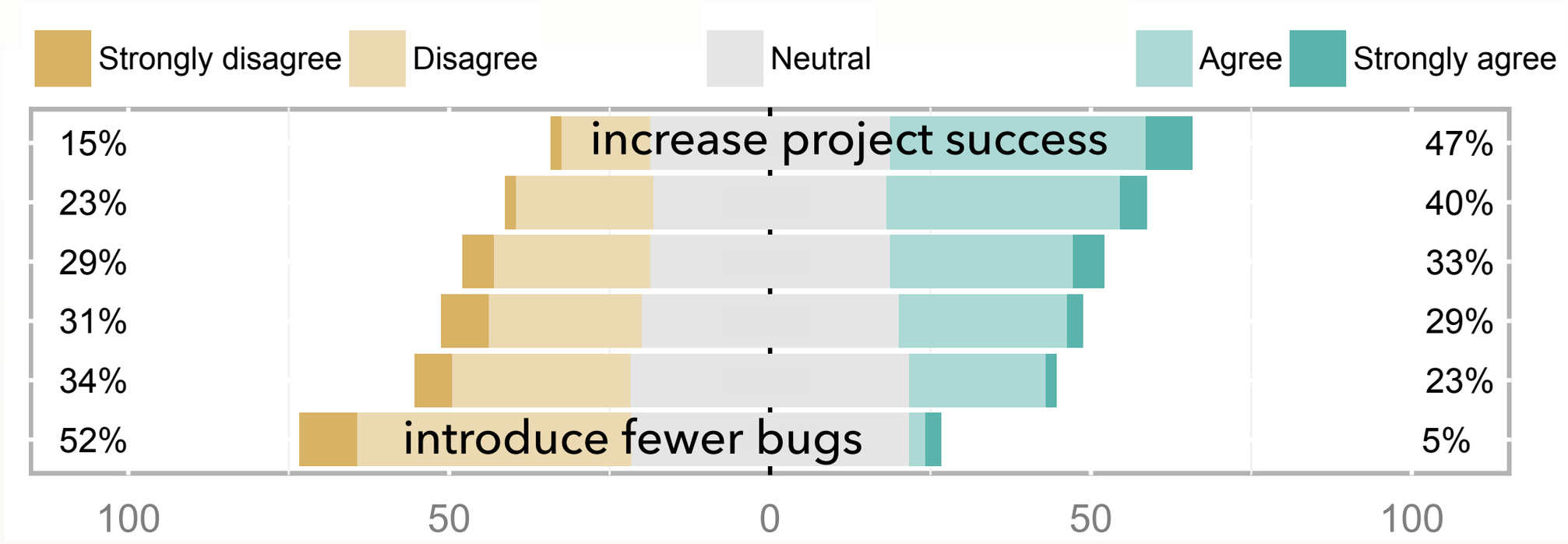

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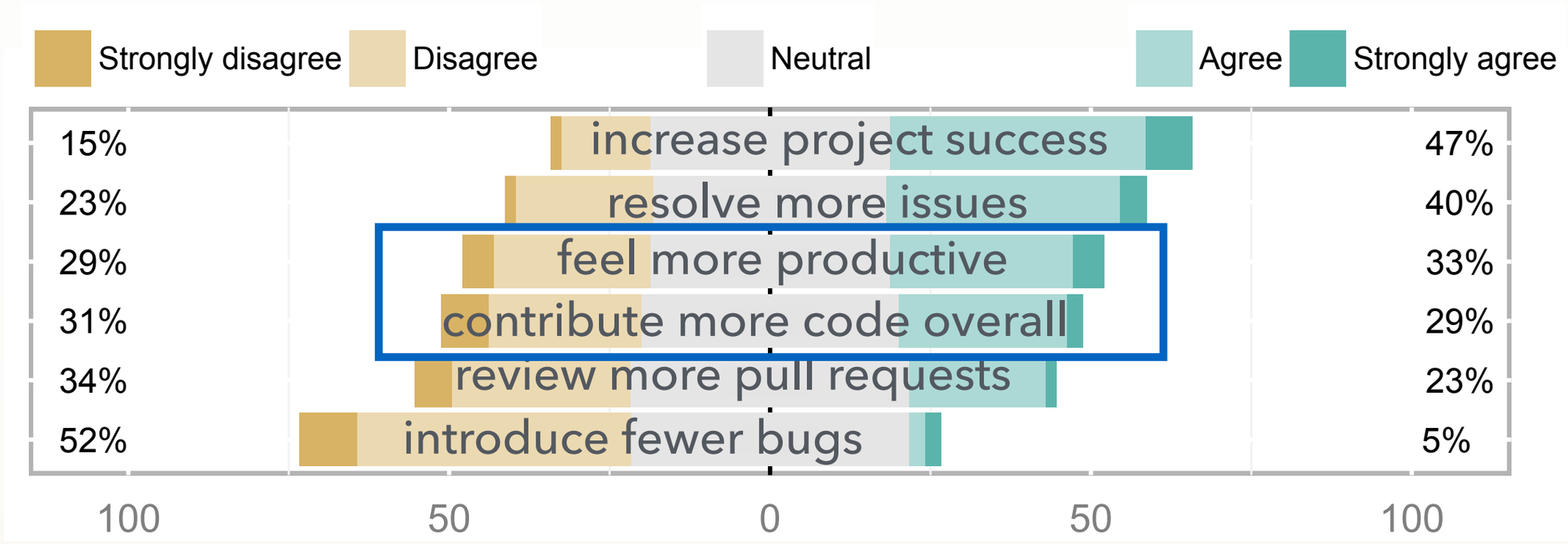

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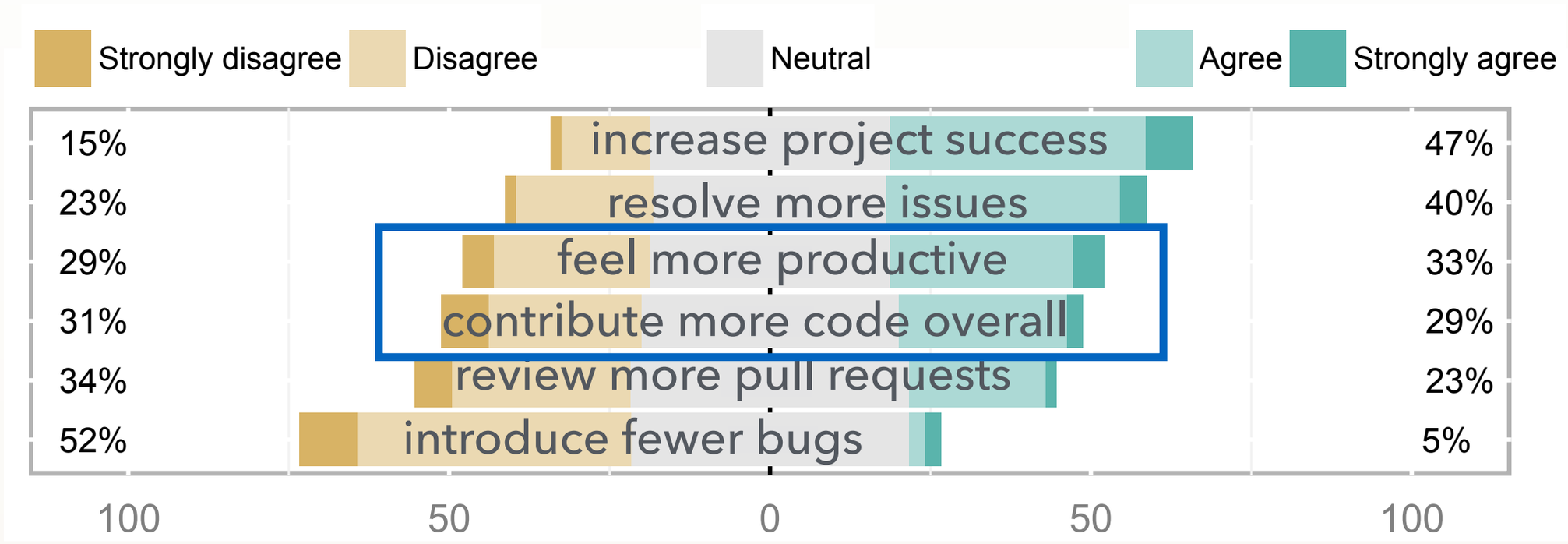

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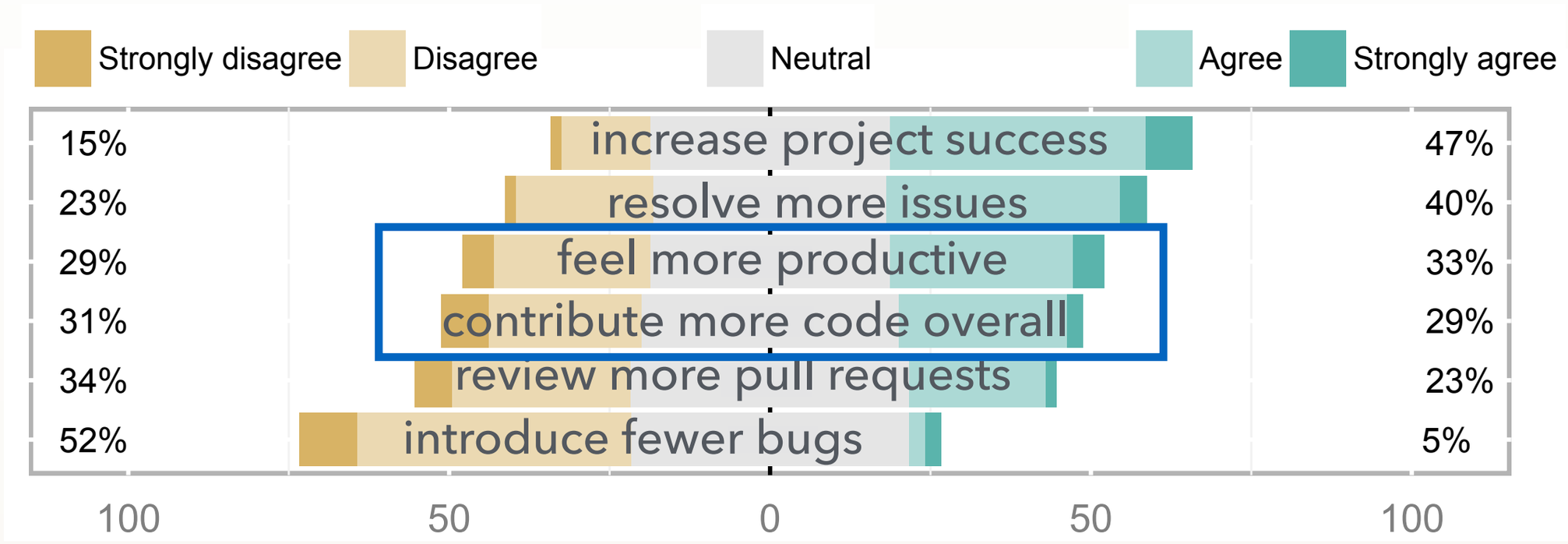

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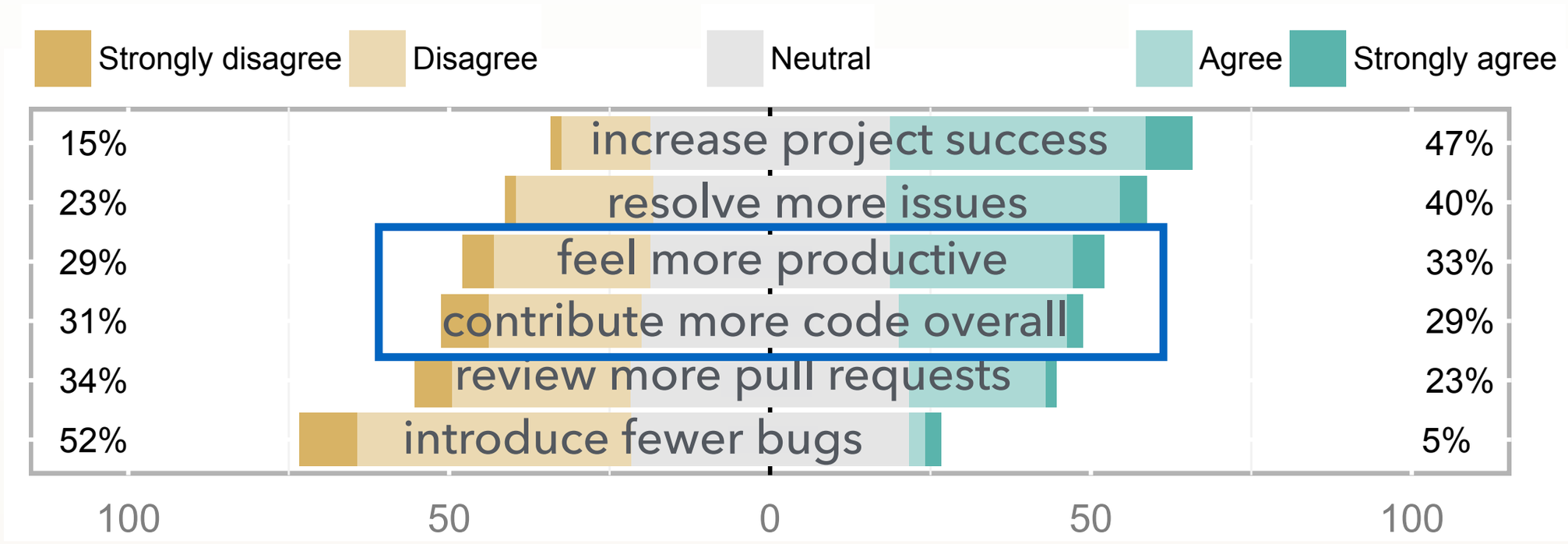

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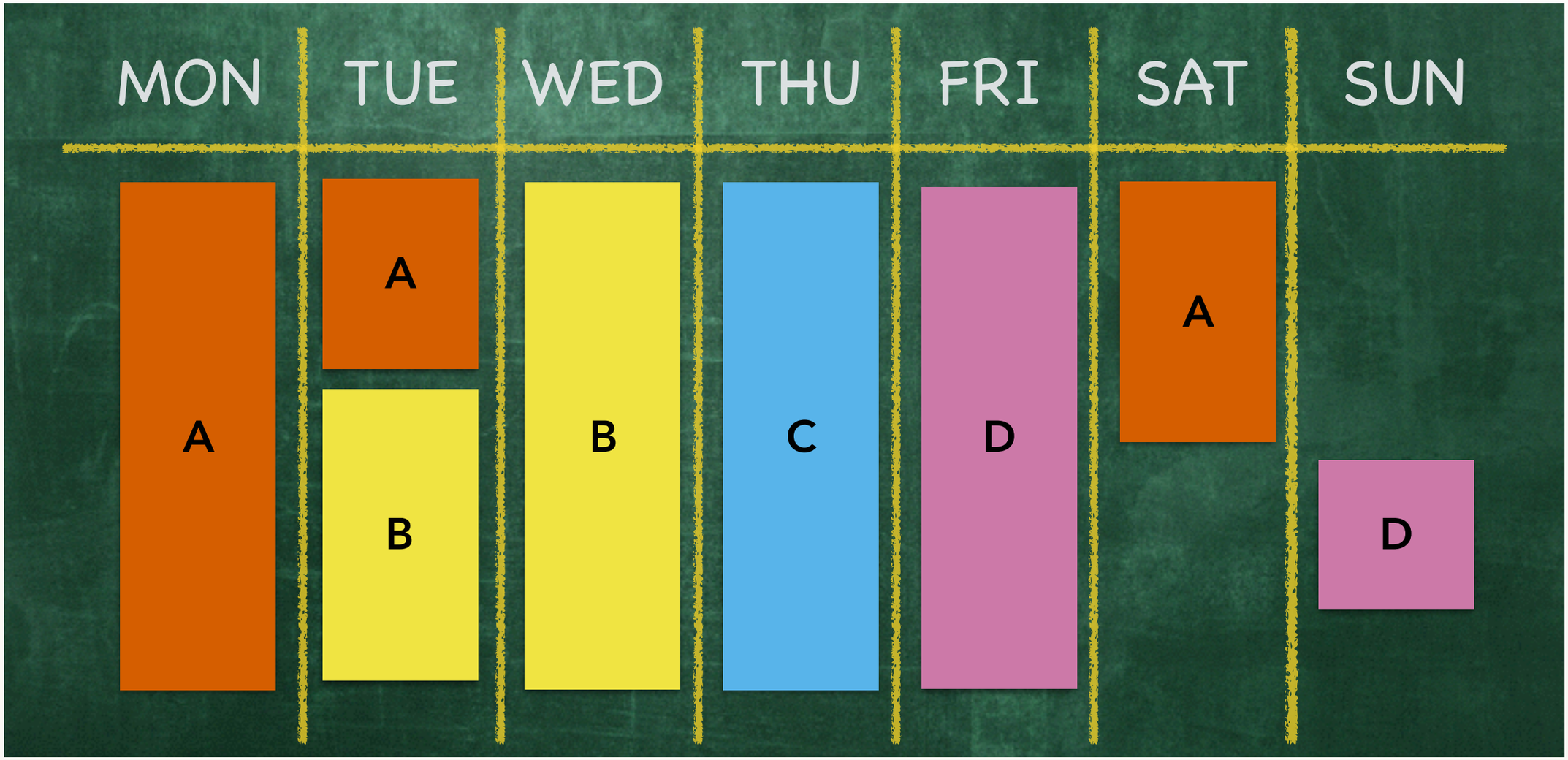
No scheduling is productive beyond 5 projects/week

MODELING MULTITASKING

- Period matters



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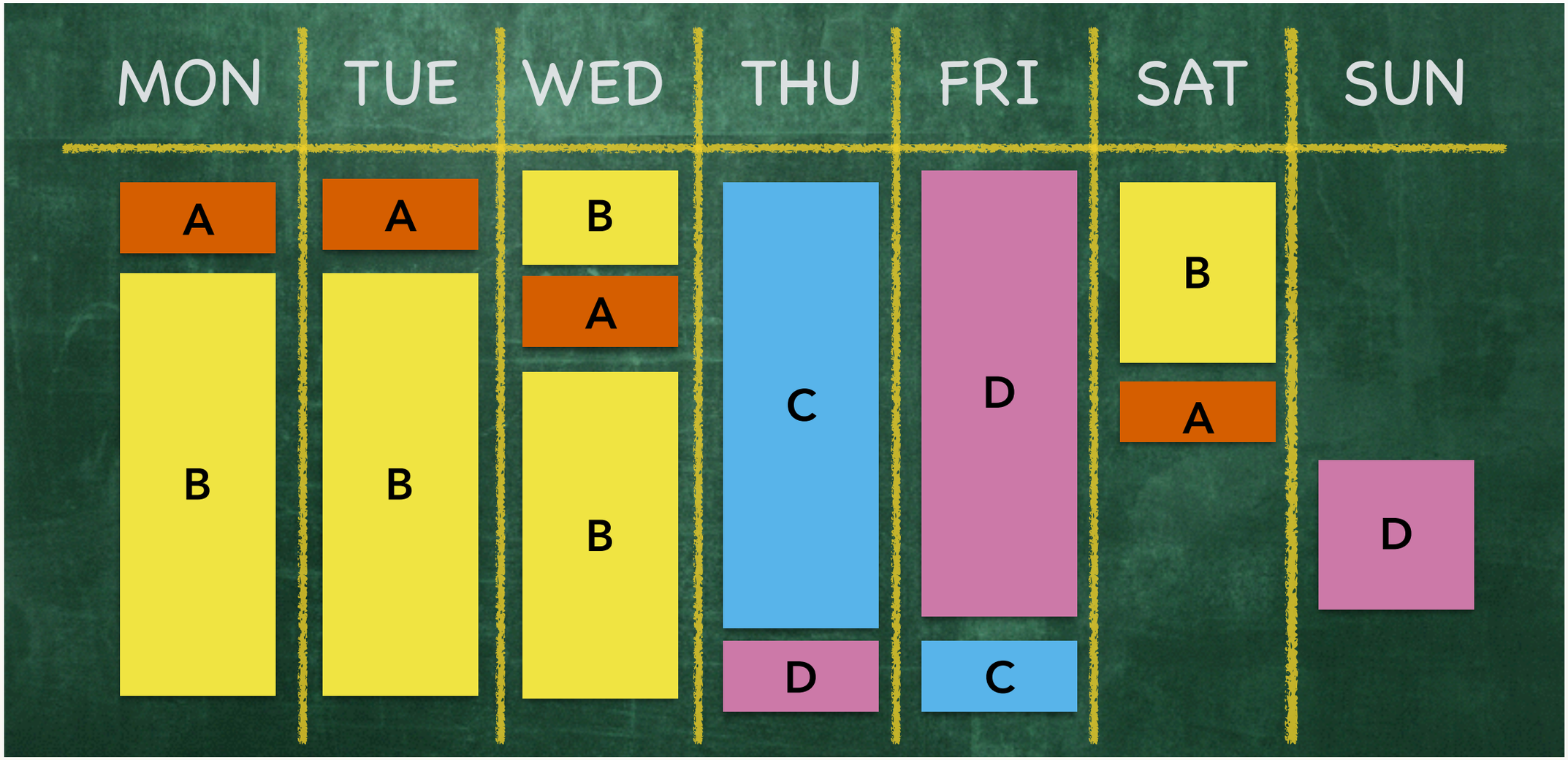

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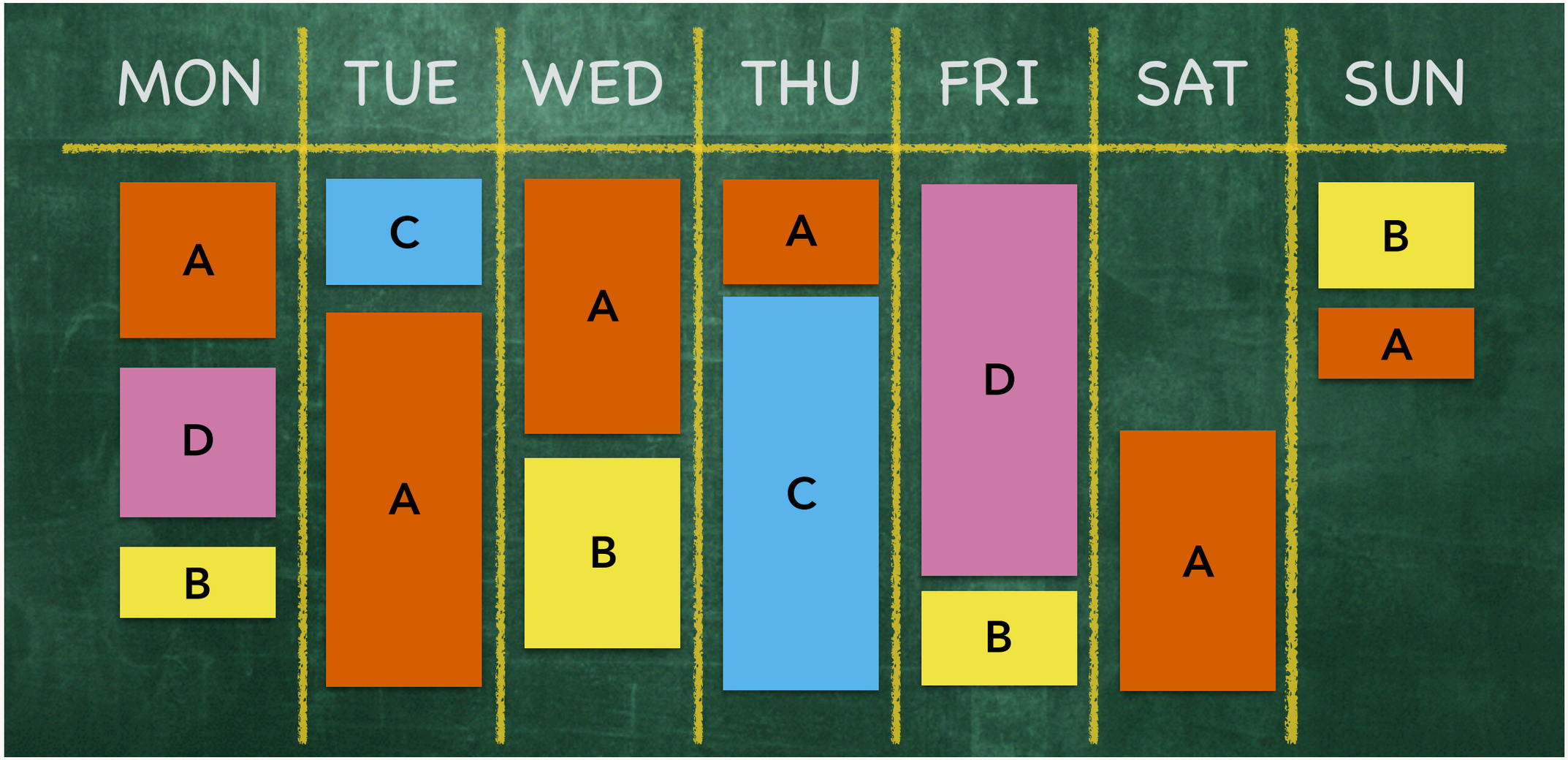
- …



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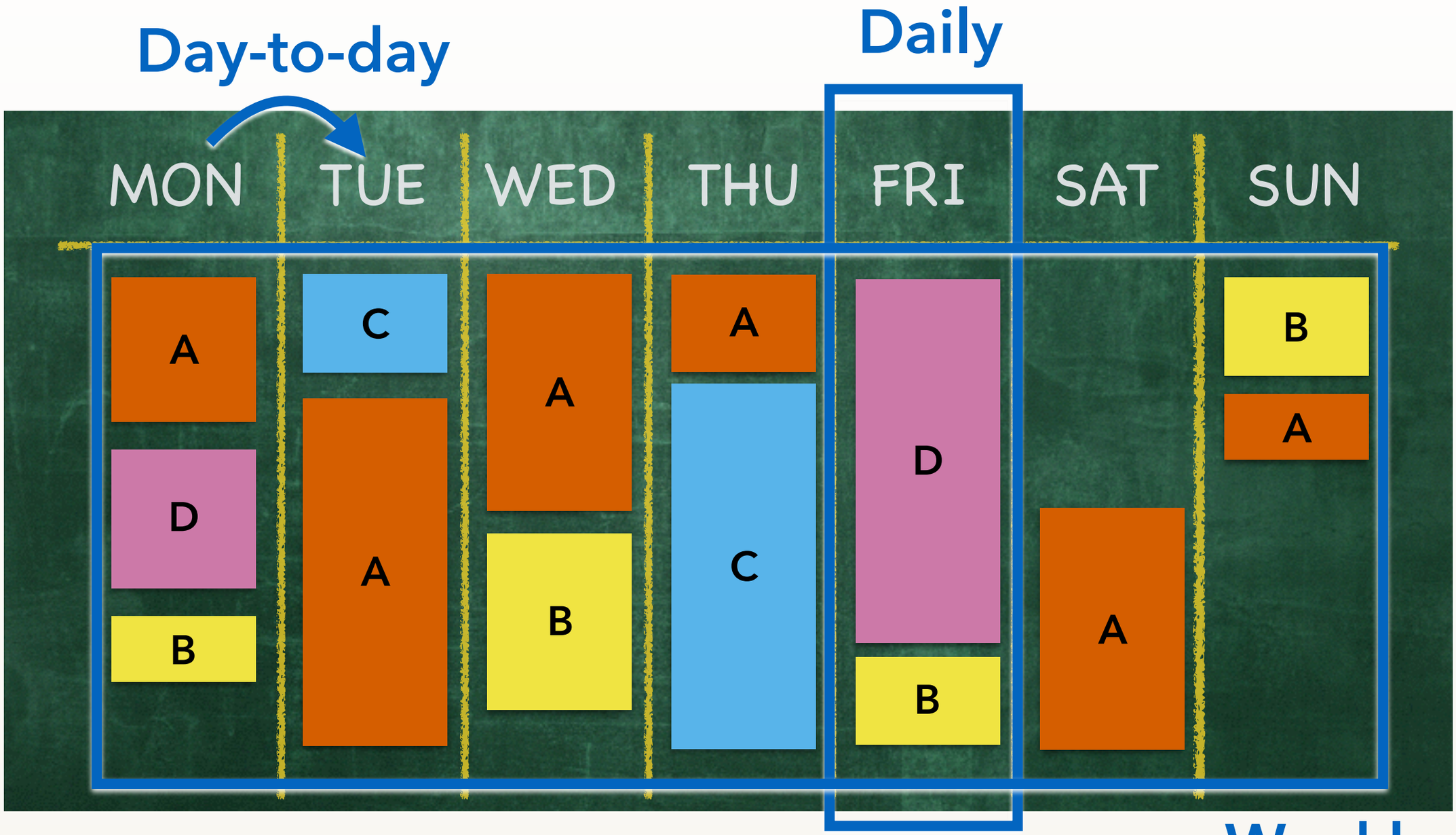


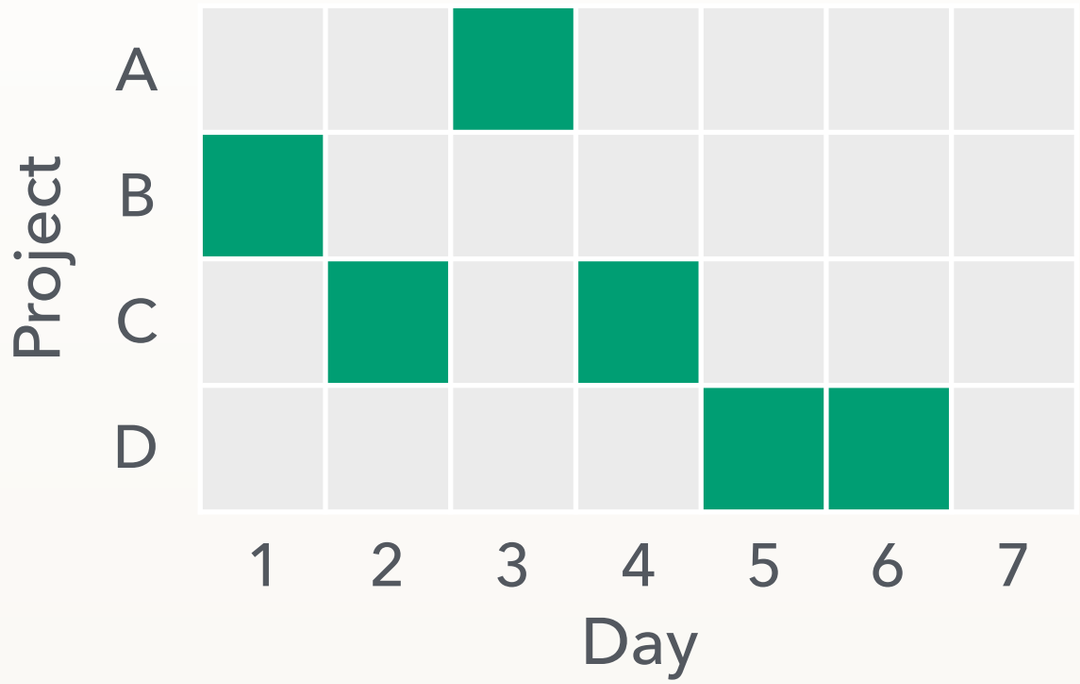
WE MODELED:

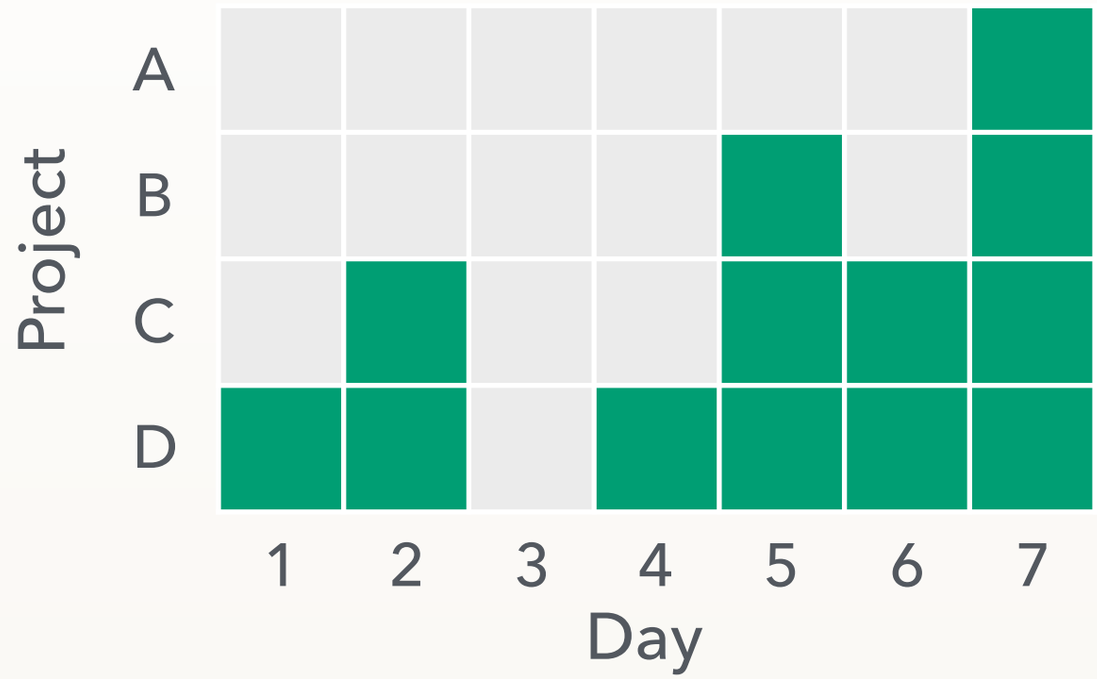
- One-week panels
- Three dimensions

MULTITASKING DIMENSIONS

1. PROJECTS PER DAY

Working sequentially vs. Within-day multitasking





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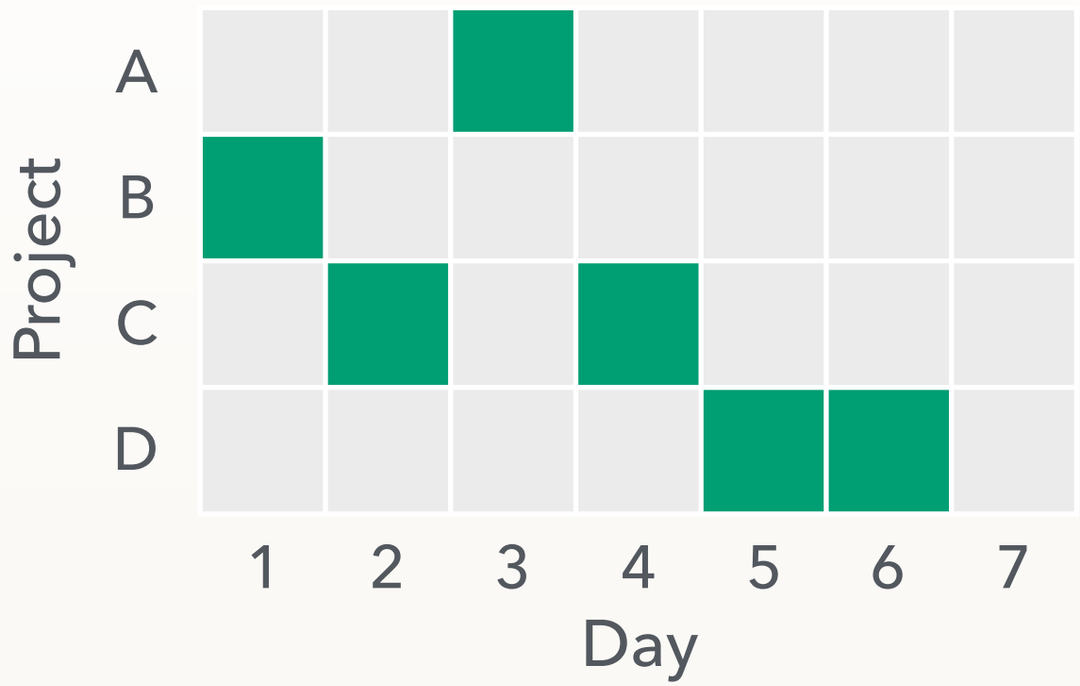
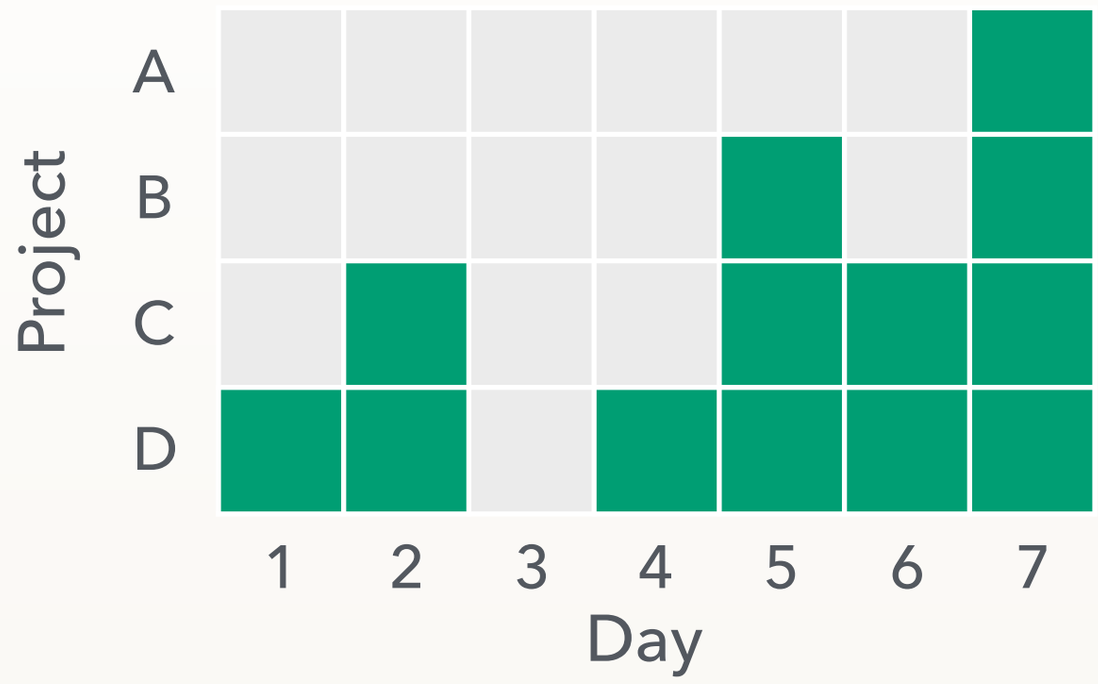


$$\text{AvgProjectsPerDay} = 1$$

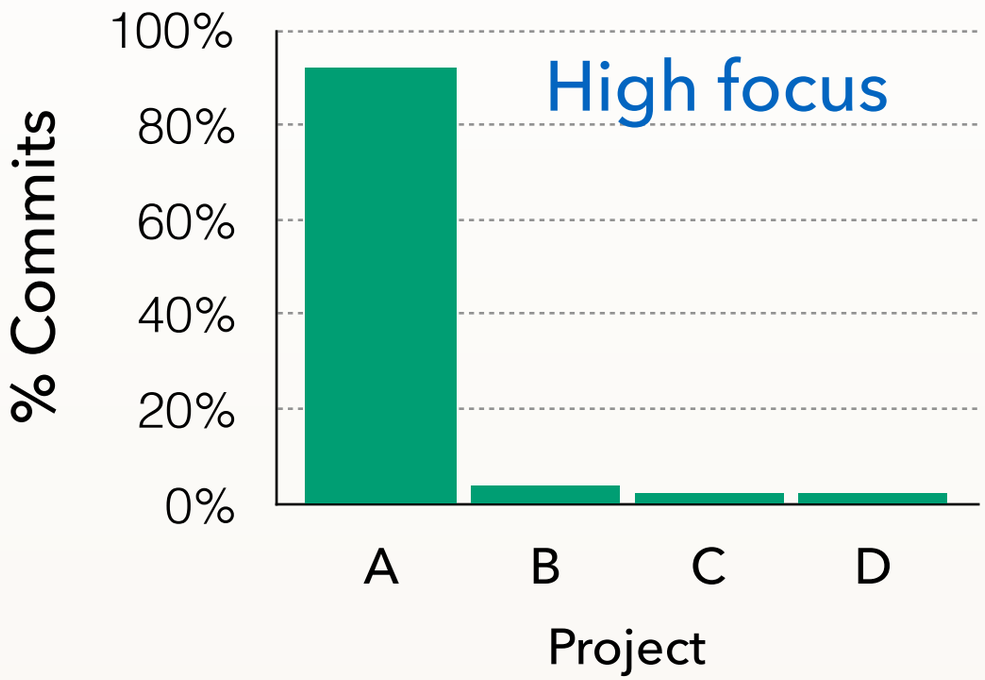


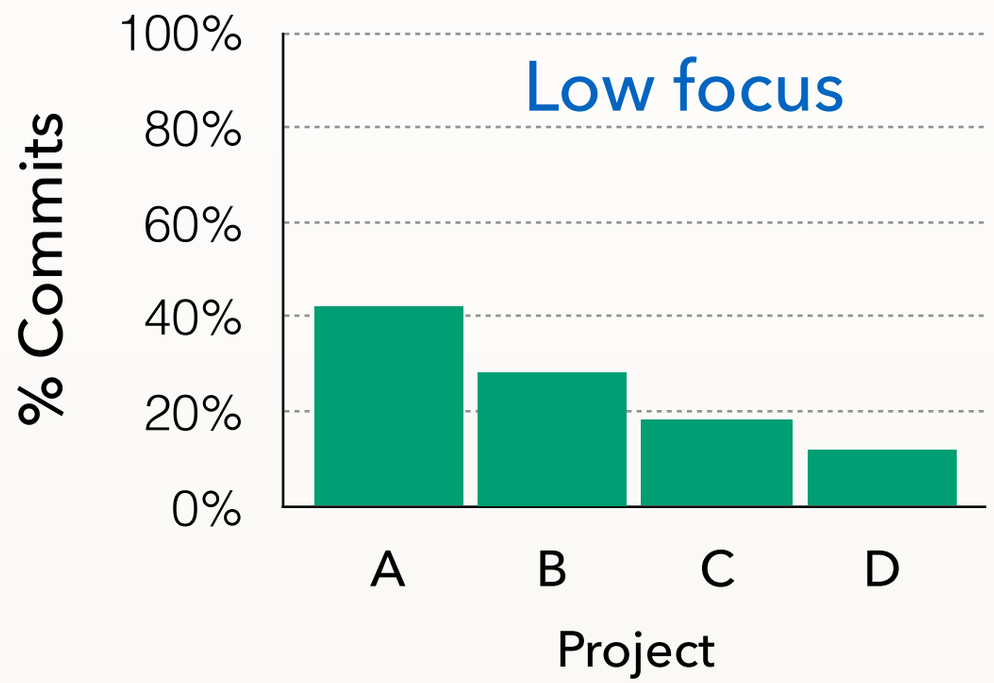
$$\text{AvgProjectsPerDay} = 2.2$$

MULTITASKING DIMENSIONS

2. WEEKLY FOCUS

Focusing on one project vs. Contributing evenly to all





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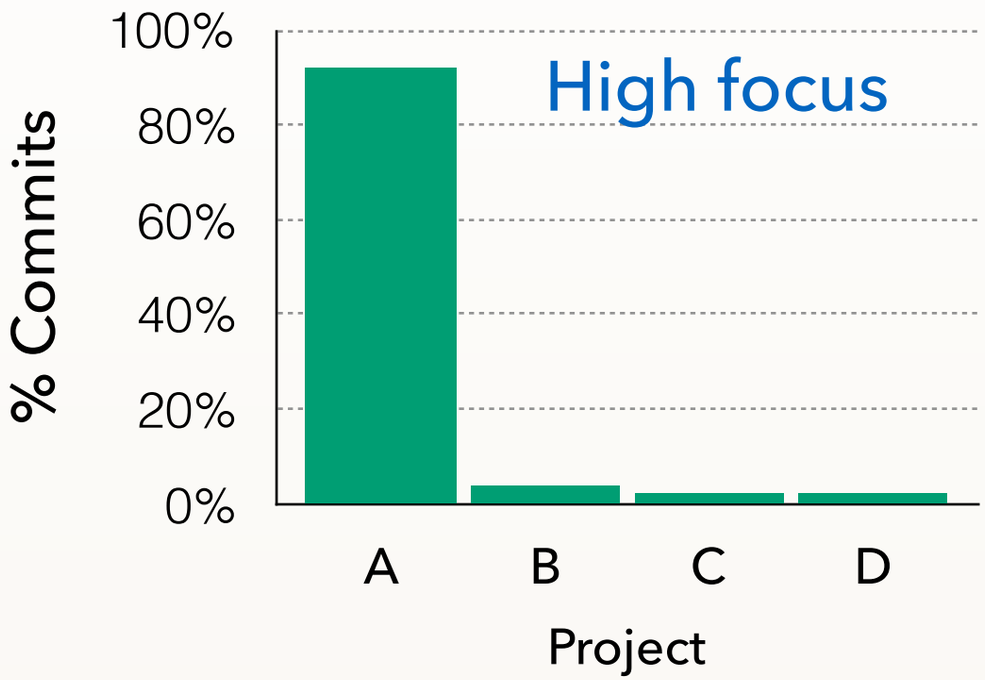
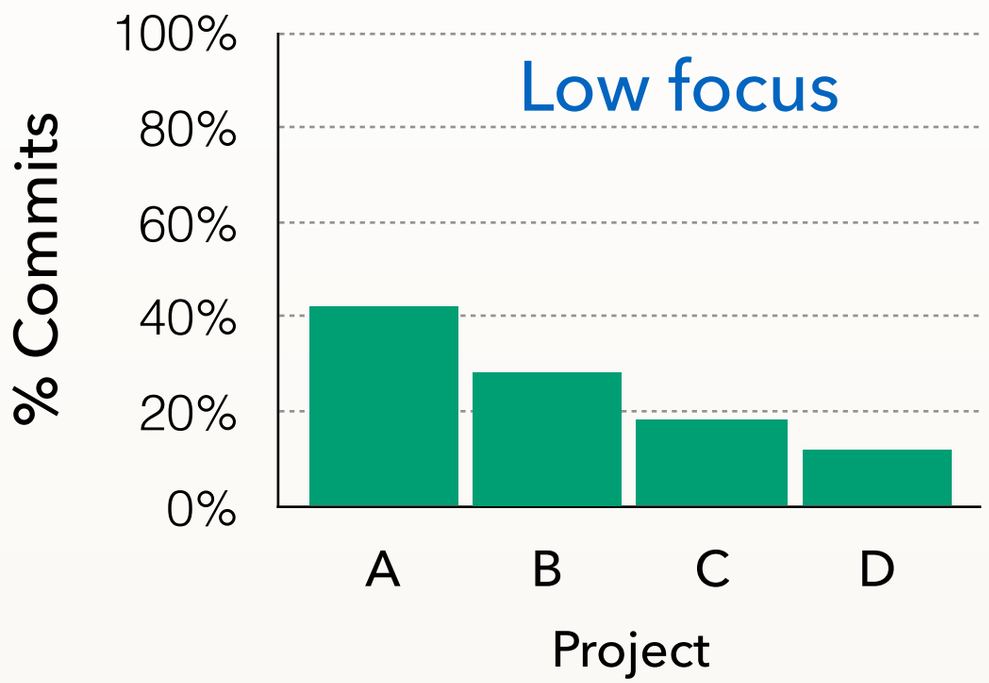


$$S_{\text{Focus}} = 0.25$$



$$S_{\text{Focus}} = 1.85$$

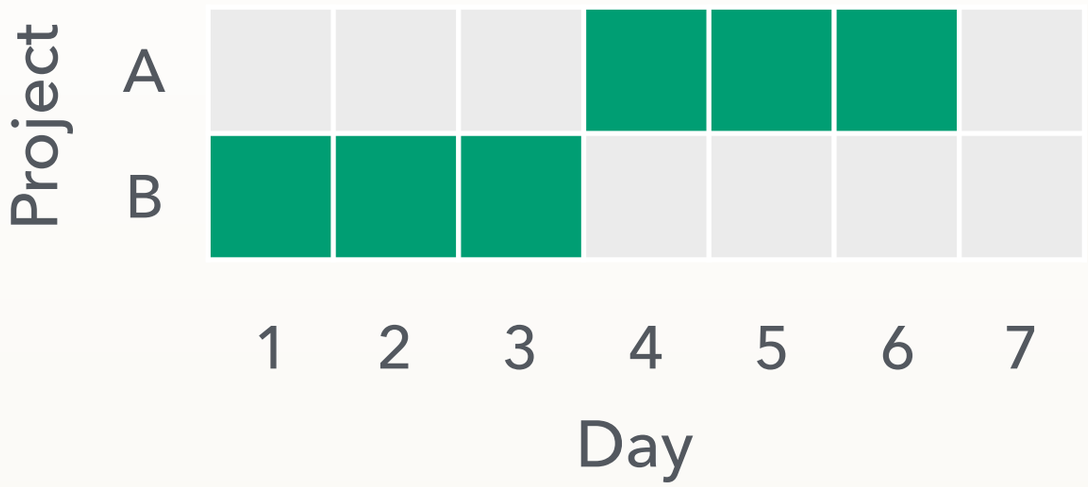
Shannon entropy: $S_{\text{Focus}} = -\sum_{i=1}^{N} p_i \log_2 p_i$

Fraction commits in project i

MULTITASKING DIMENSIONS

3. DAY-TO-DAY FOCUS

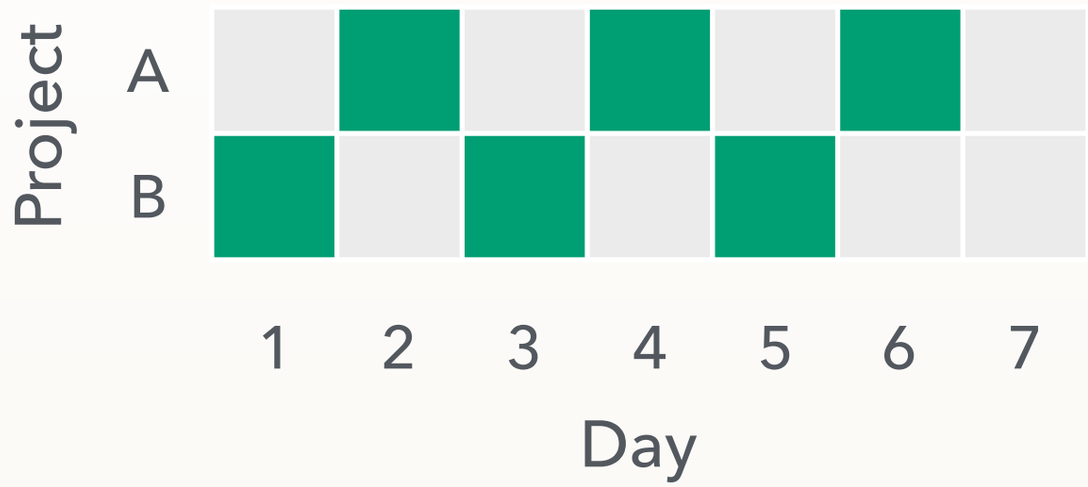
Repetitive day-to-day



$$\text{AvgProjectsPerDay} = 1$$
$$S_{\text{Focus}} = 1$$

vs.

Switching focus



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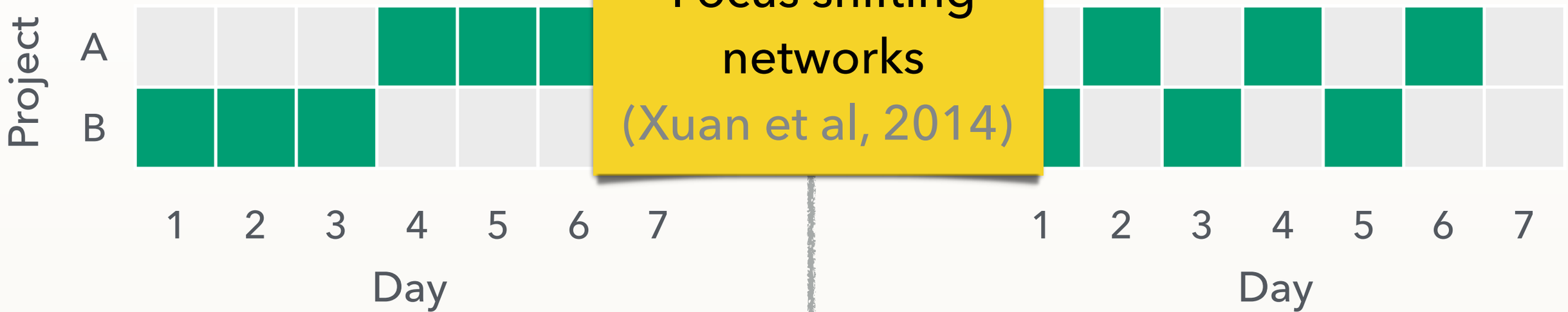
Repetitive day-to-day vs. Switching focus



Focus shifting networks (Xuan et al, 2014)

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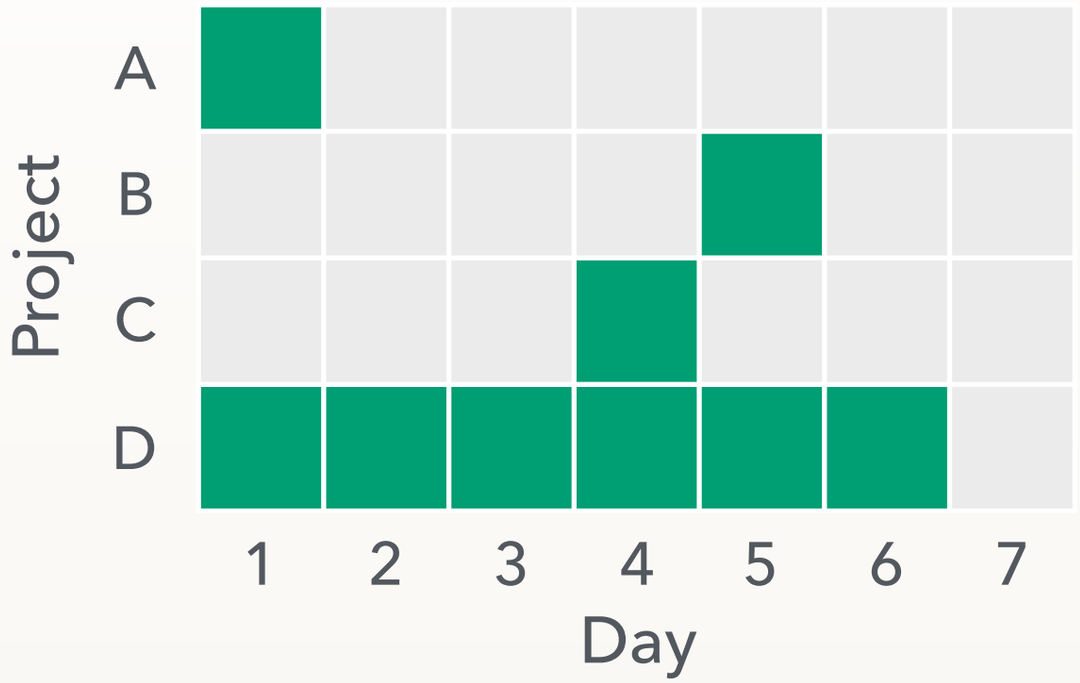

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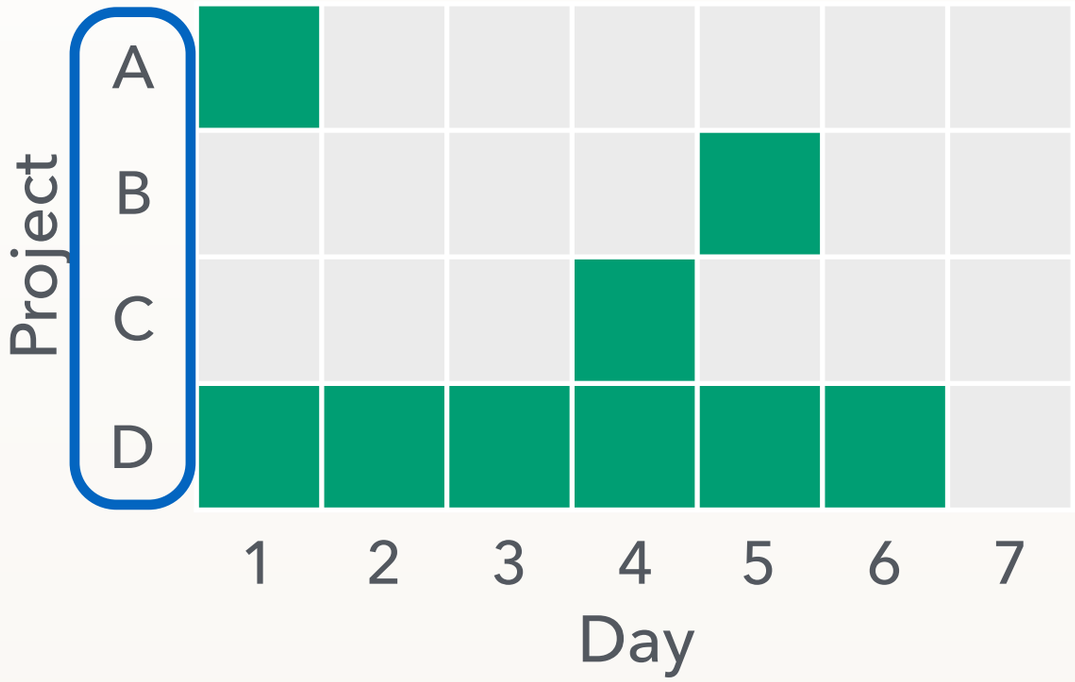

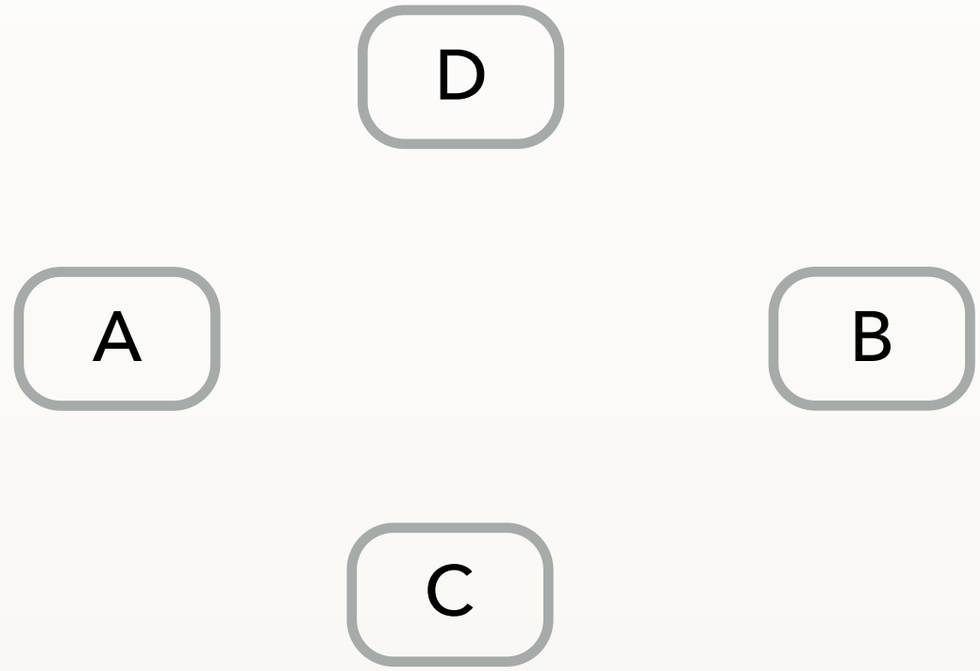

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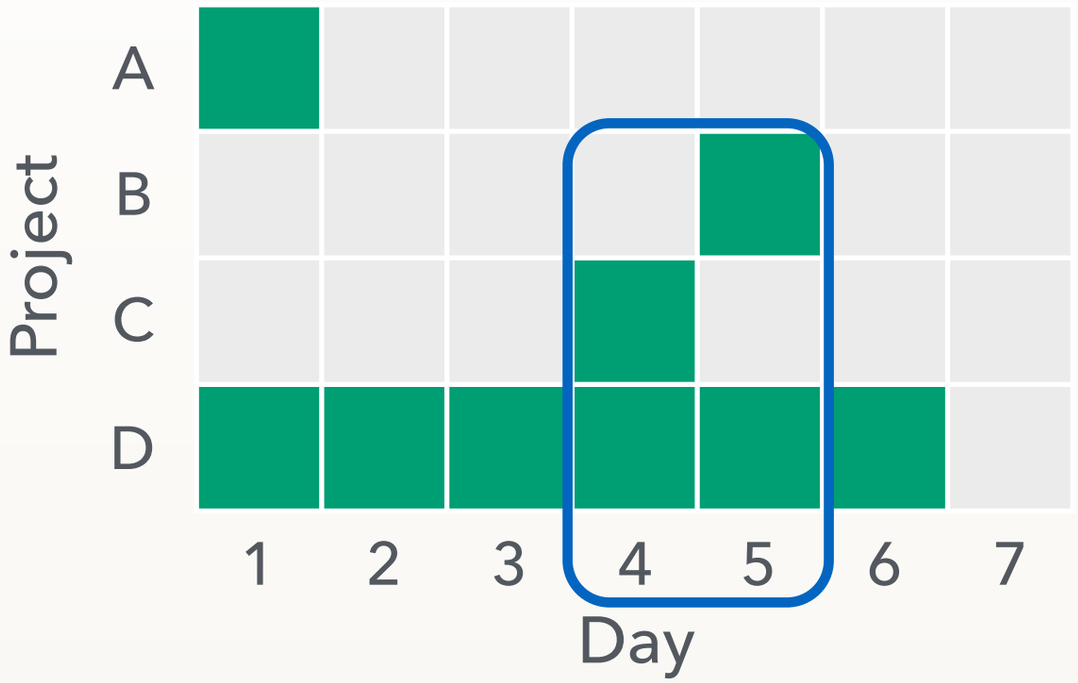

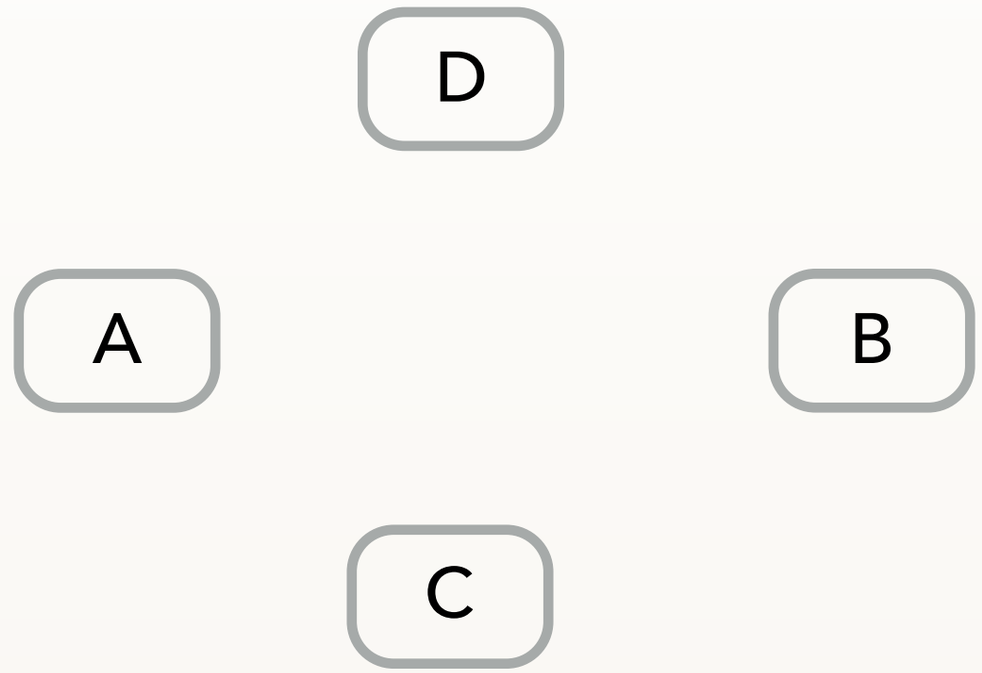

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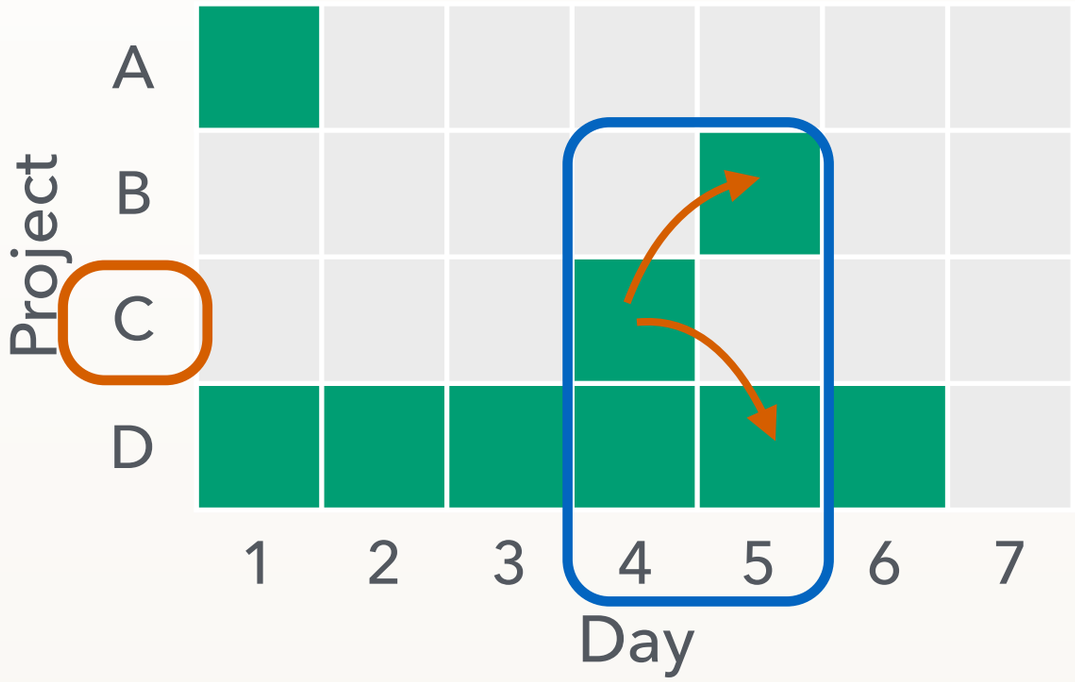

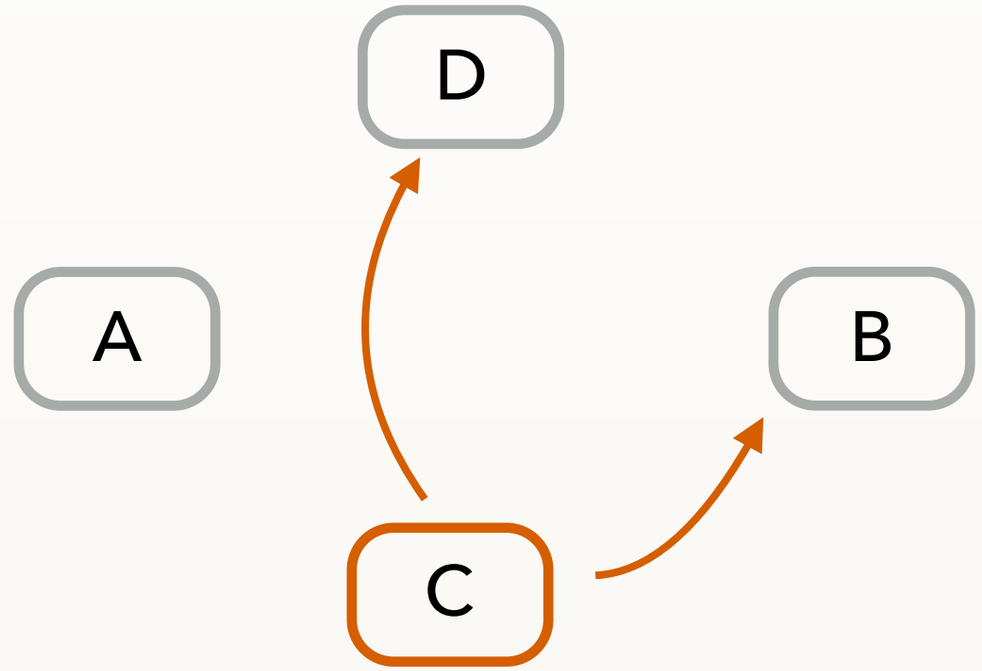

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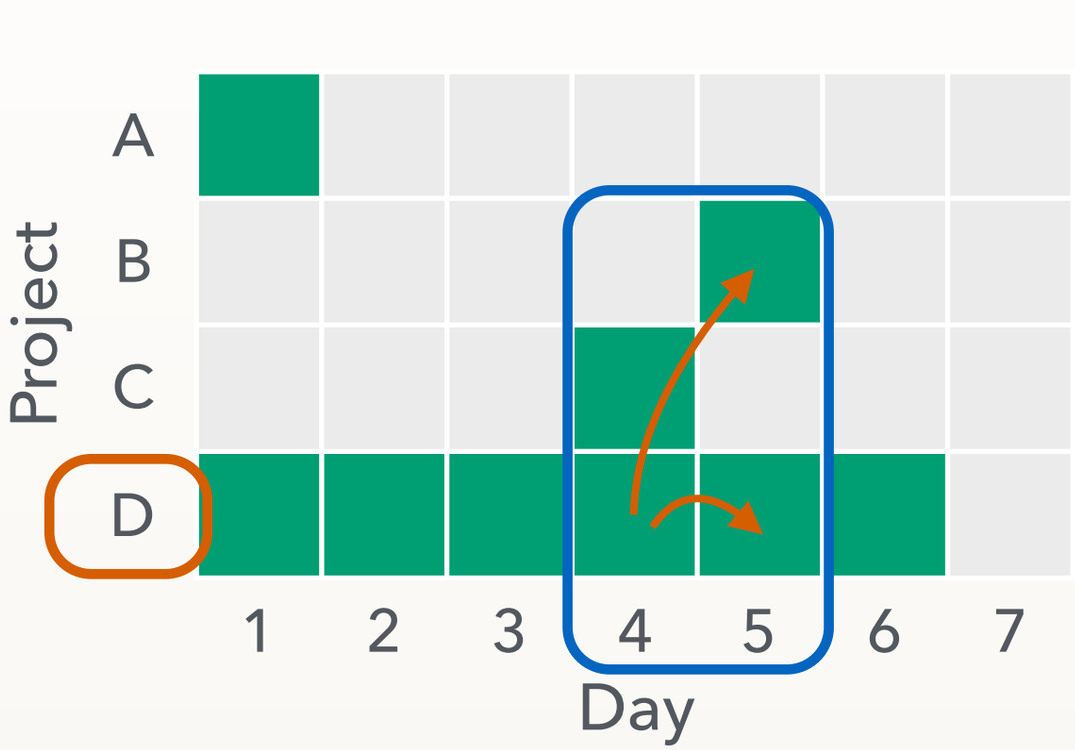

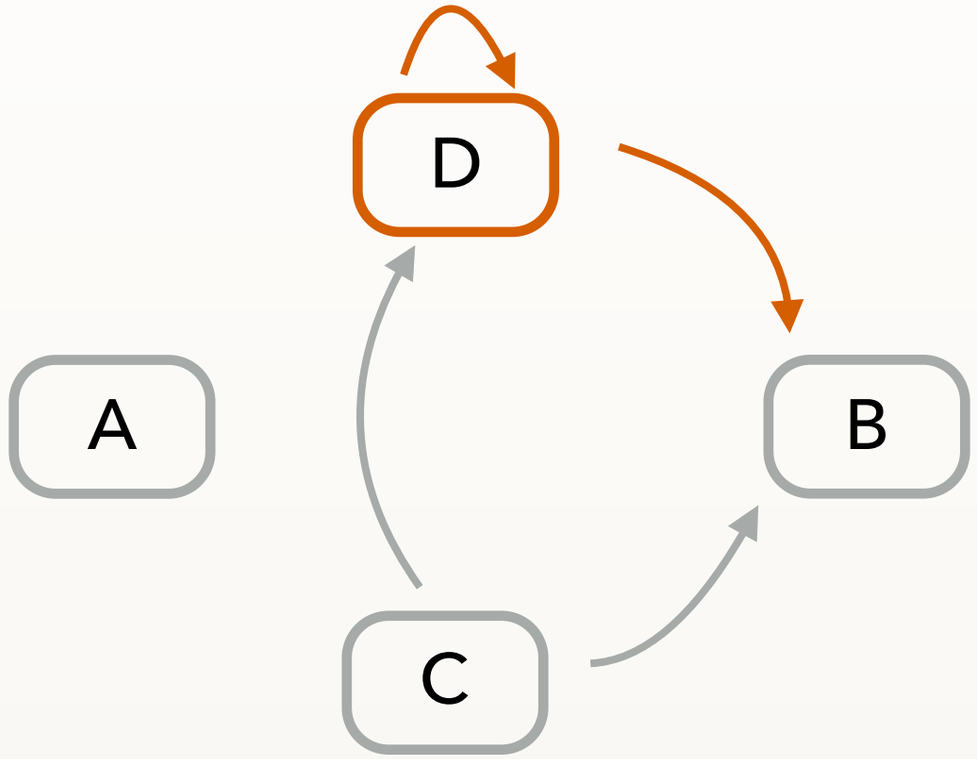

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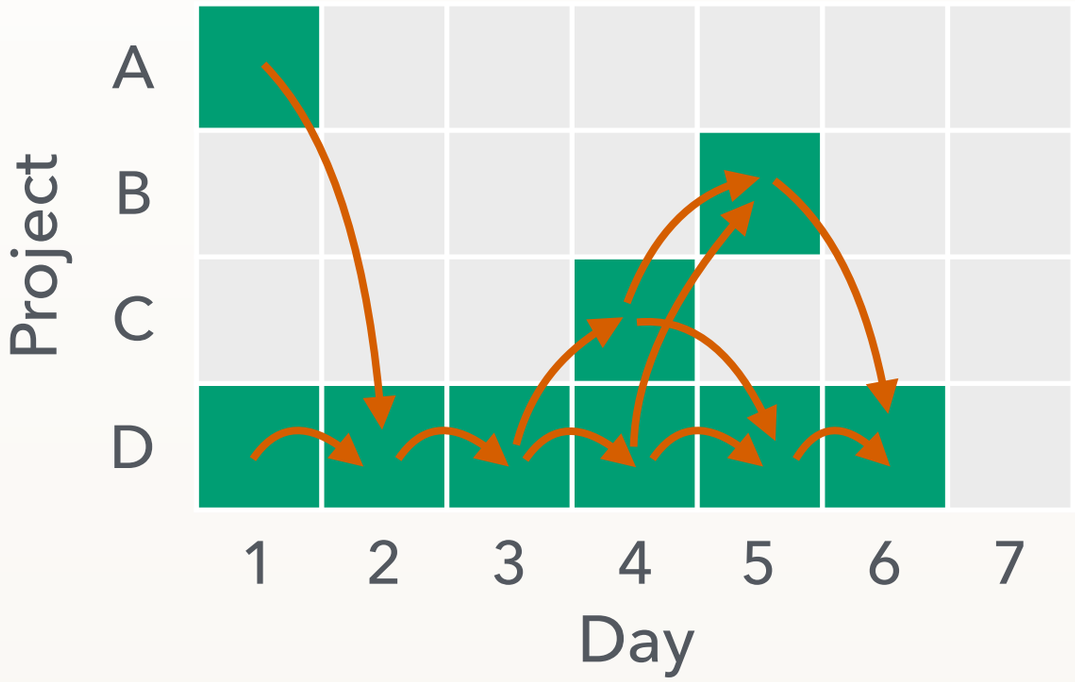
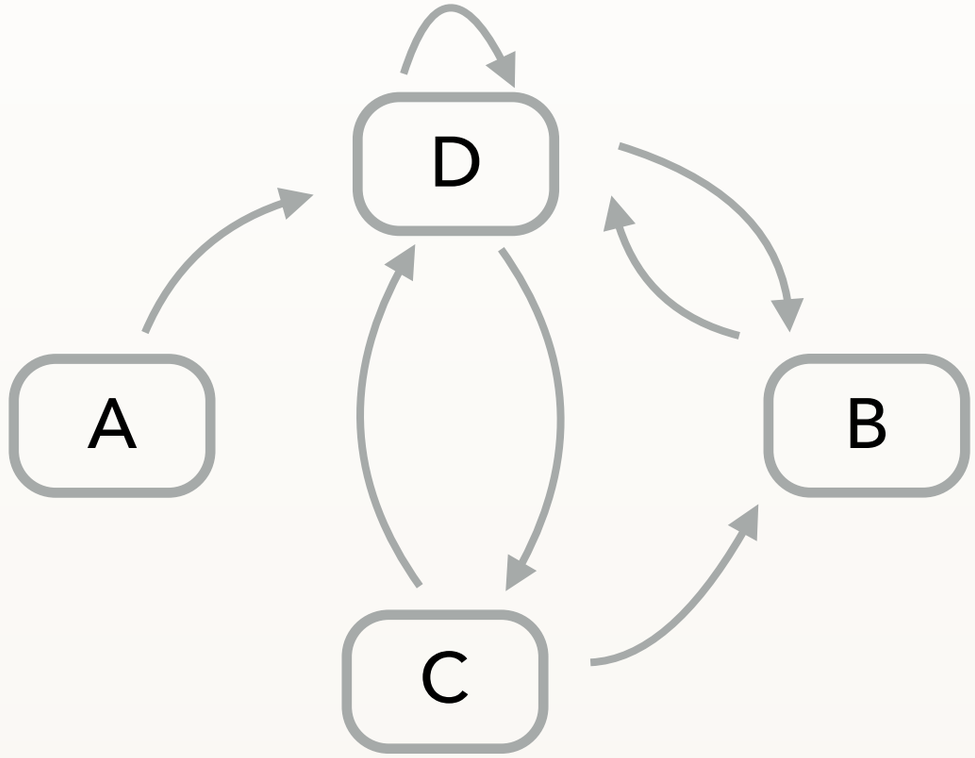
3. DAY-TO-DAY FOCUS

Repetitive day-to-day vs. Switching focus

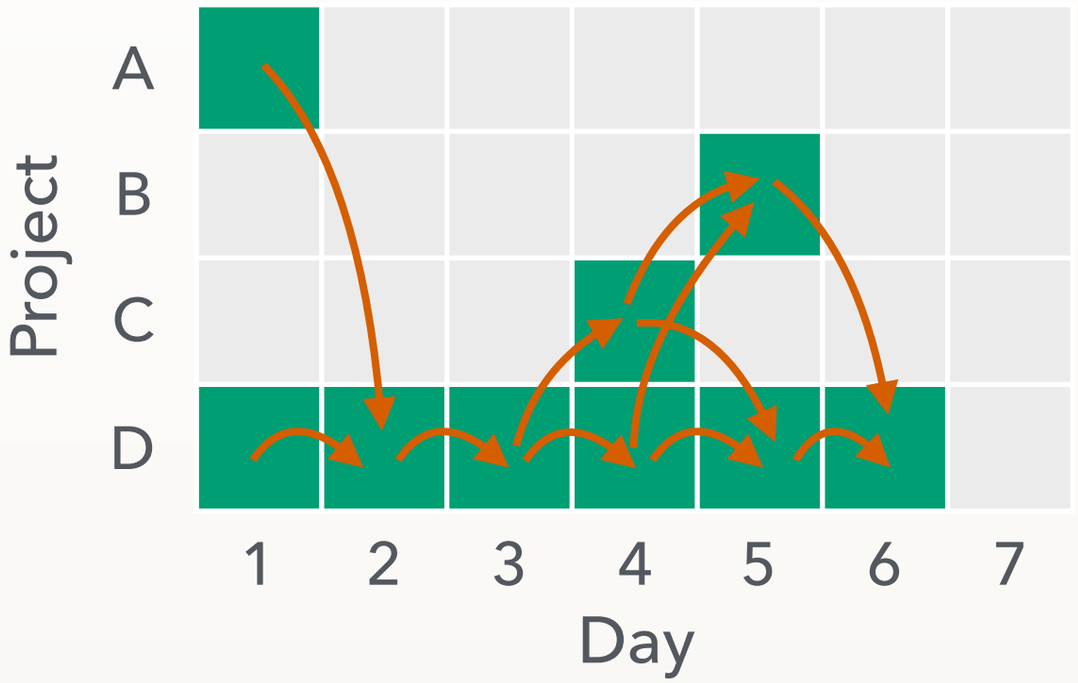


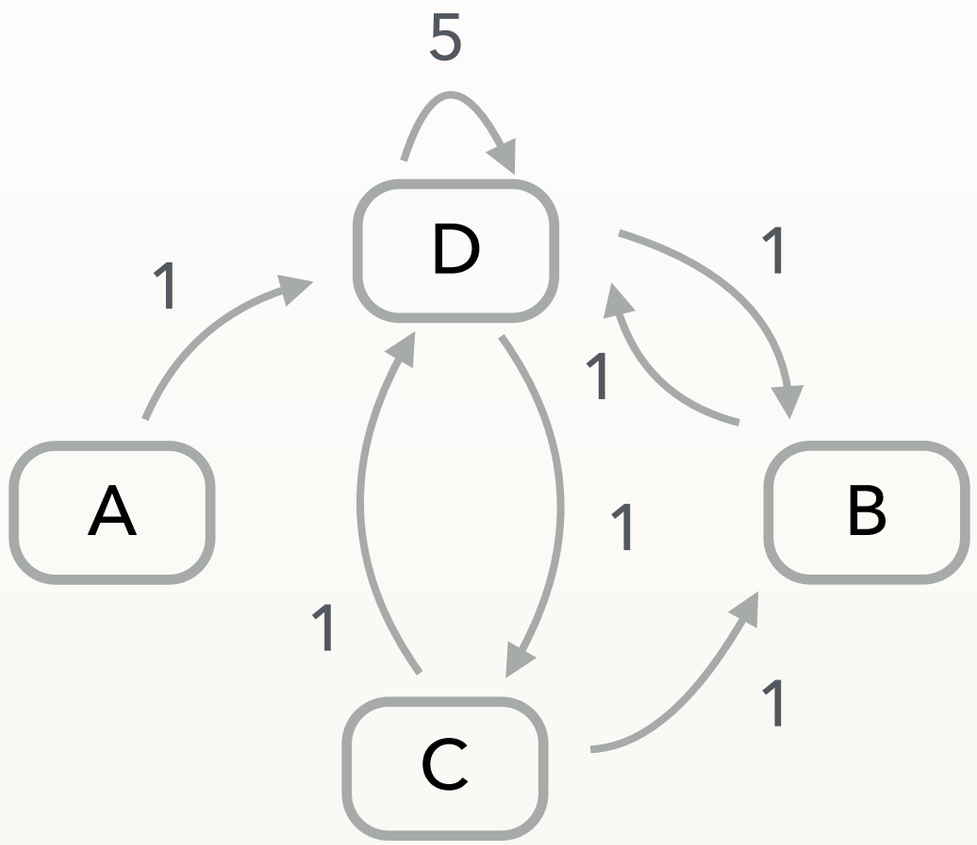


MULTITASKING DIMENSIONS

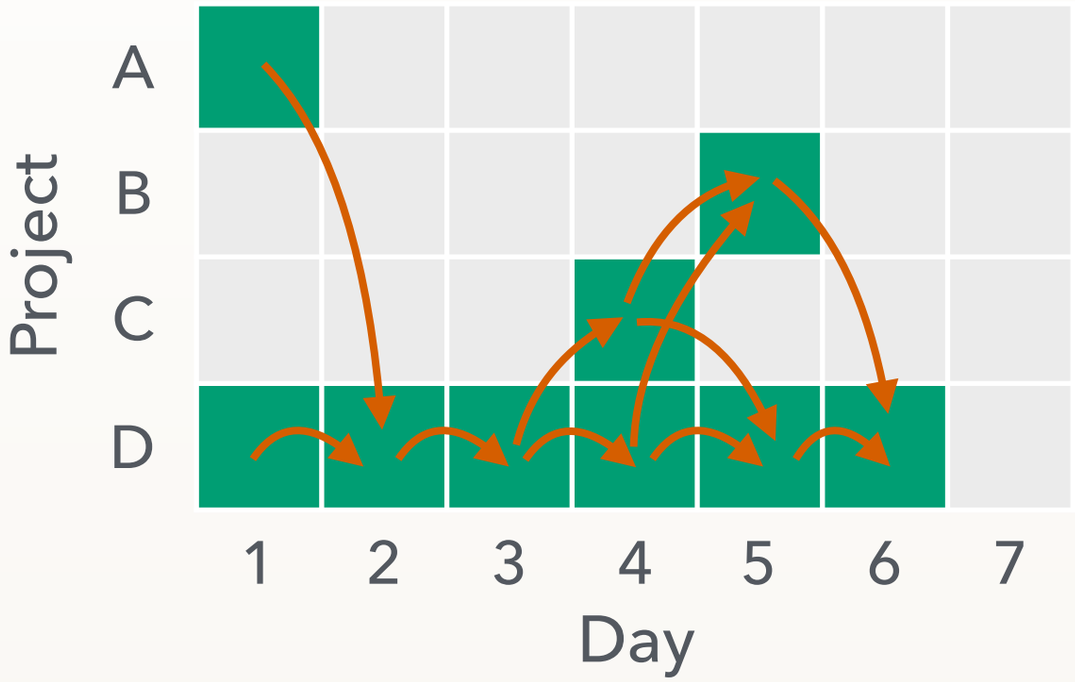
3. DAY-TO-DAY FOCUS

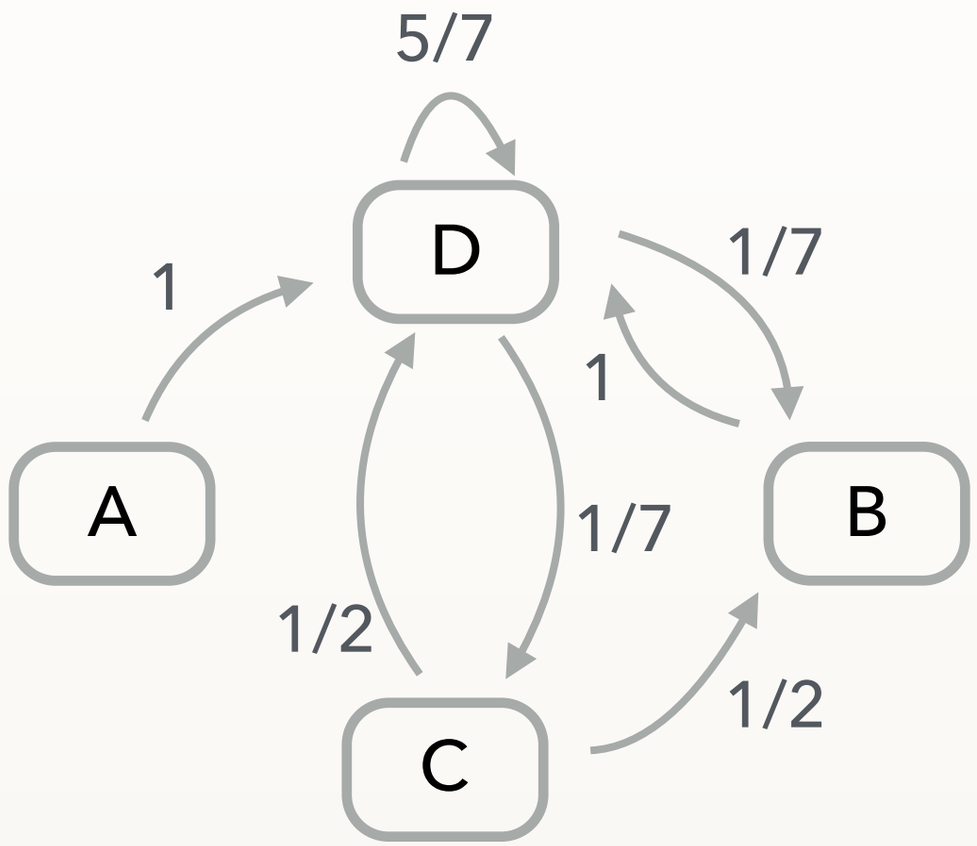
Repetitive day-to-day vs. Switching focus





Repetitive day-to-day vs. Switching focus





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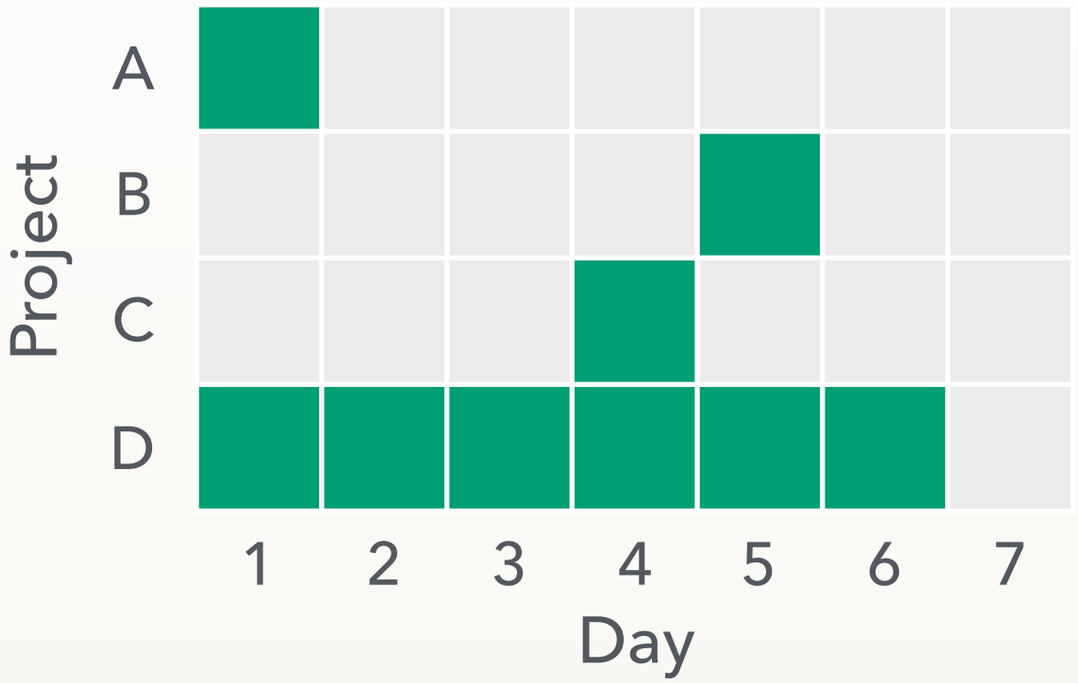
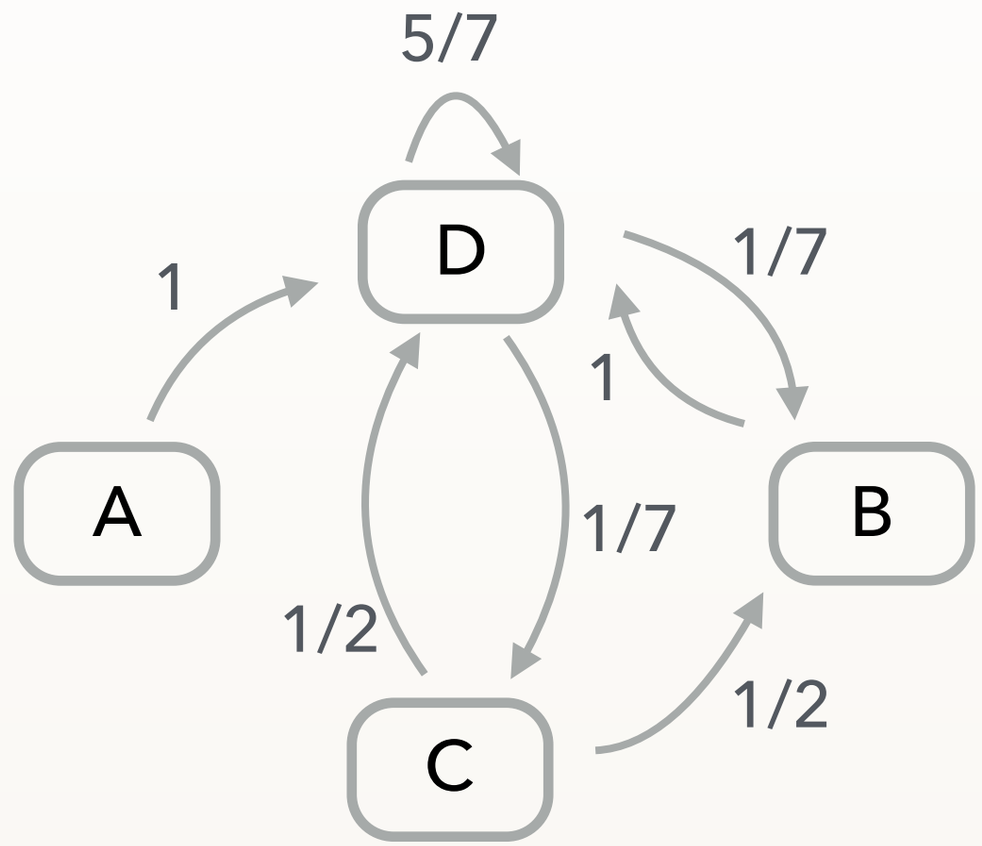




Markov entropy:

$$S_{\text{Switch}} = -\sum_{i=1}^{N}\left[p_i \sum_{j\in\pi_i} p(j|i)\log_2 p(j|i)\right]$$

How predictable is my focus tomorrow if today I work on project j?

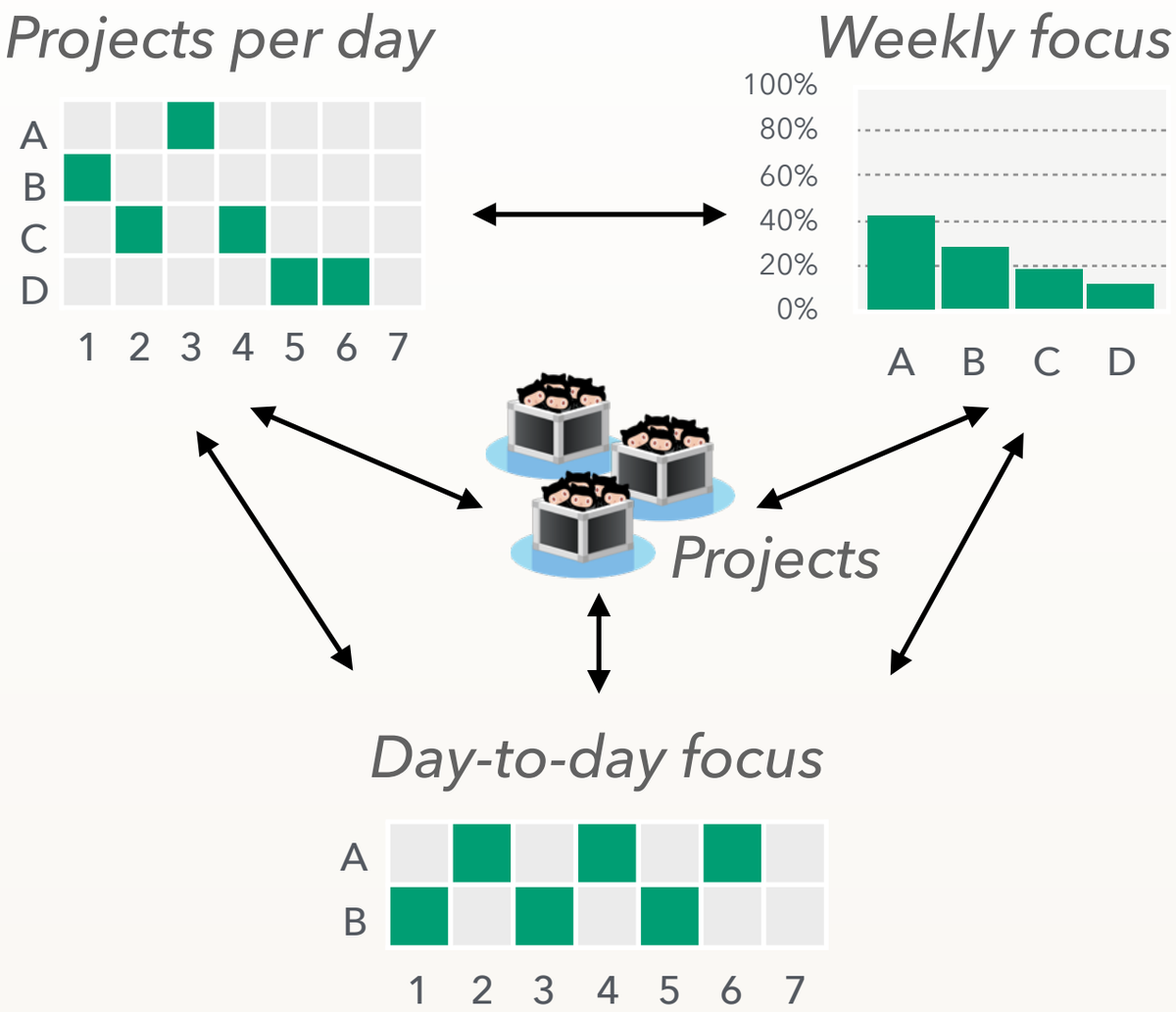
LINEAR MIXED-EFFECTS REGRESSION

Response:
LOC added / week

Controls:

- time
- total projects
- programming languages

Predictors:



Longitudinal data

- 1,200 developers
- 5+ years each: multiple weeks of observation

Random effect: developer

- developer-to-developer variability in the response

Random slope: time | developer

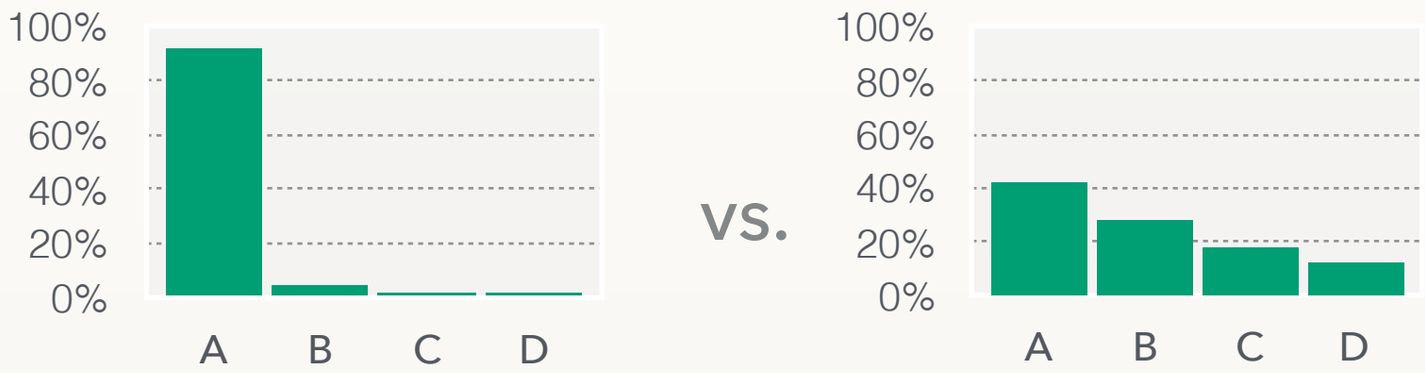
- developers more productive initially may be less strongly affected by time passing

MULTITASKERS DO MORE; SCHEDULING MATTERS

Higher LOC added

Projects per day

Weekly focus

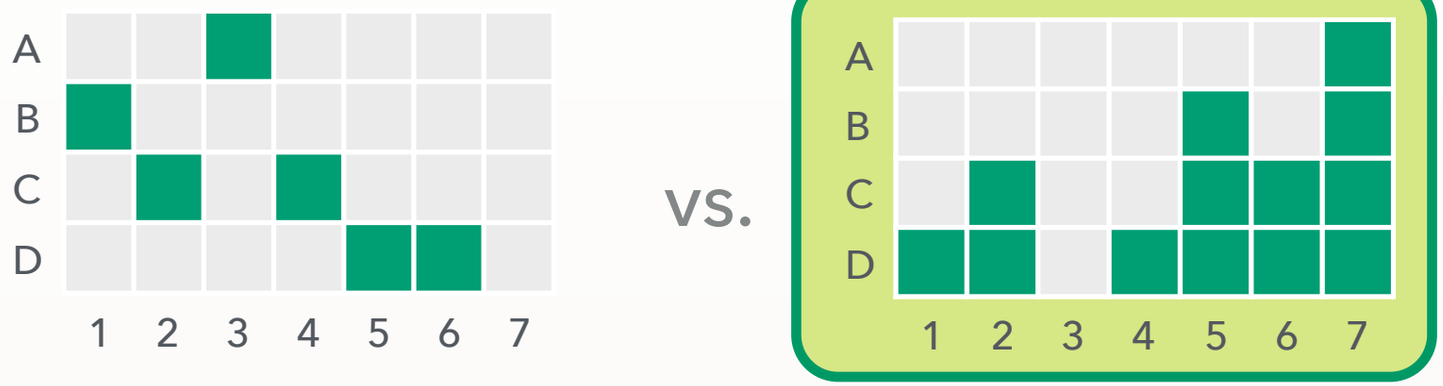


Day-to-day focus (repeatability)

MULTITASKERS DO MORE; SCHEDULING MATTERS

Higher LOC added

Projects per day



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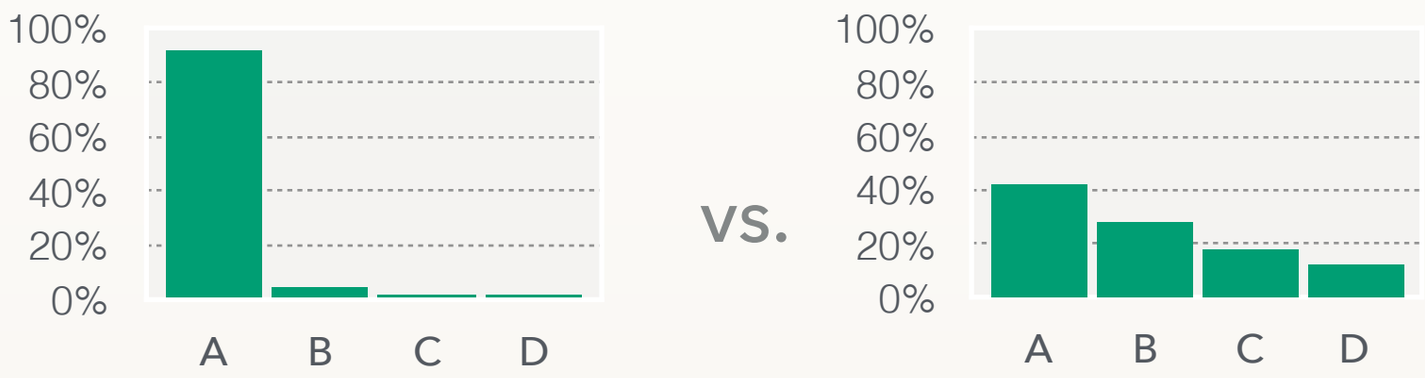

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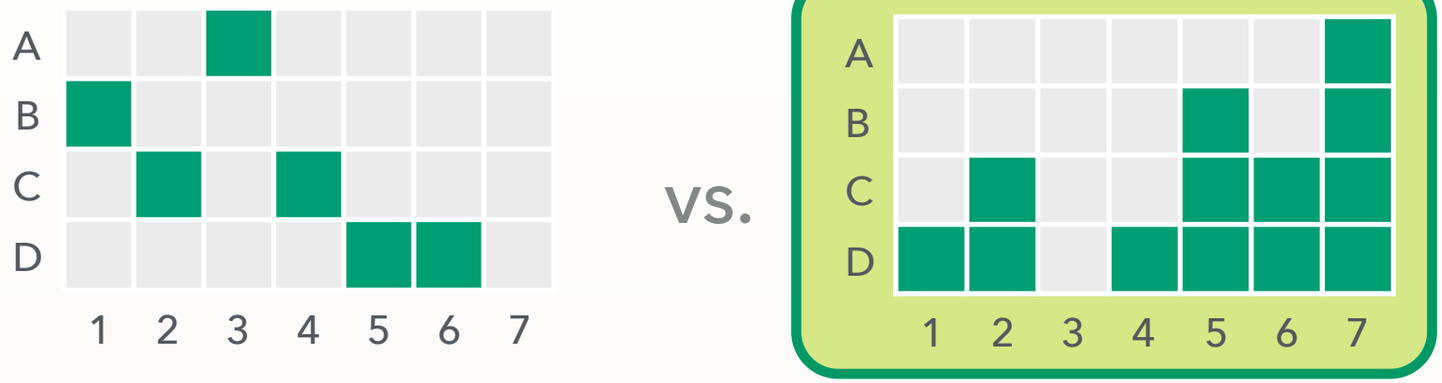
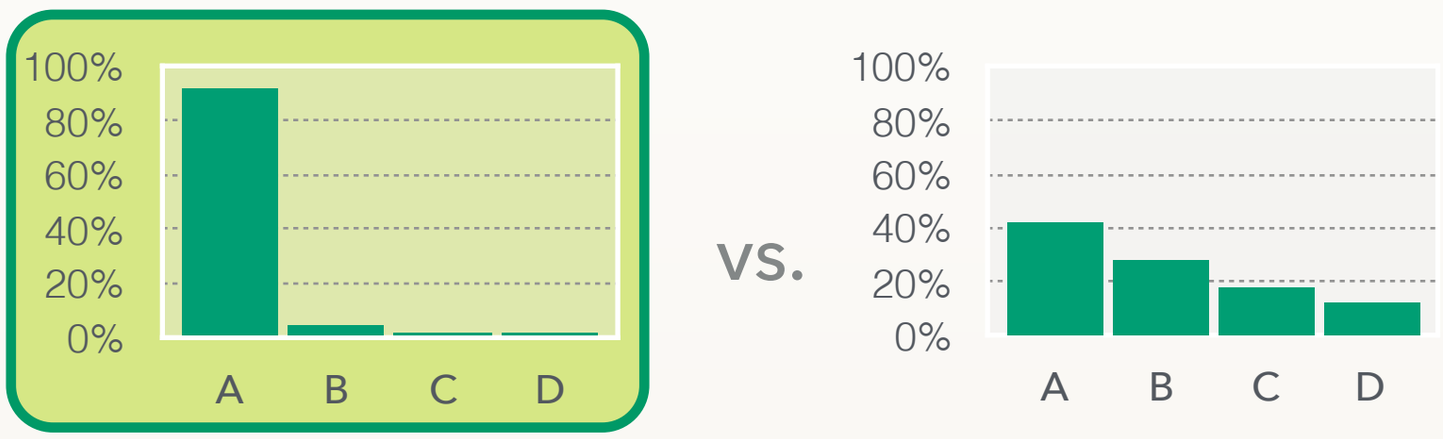


More within-day multitasking

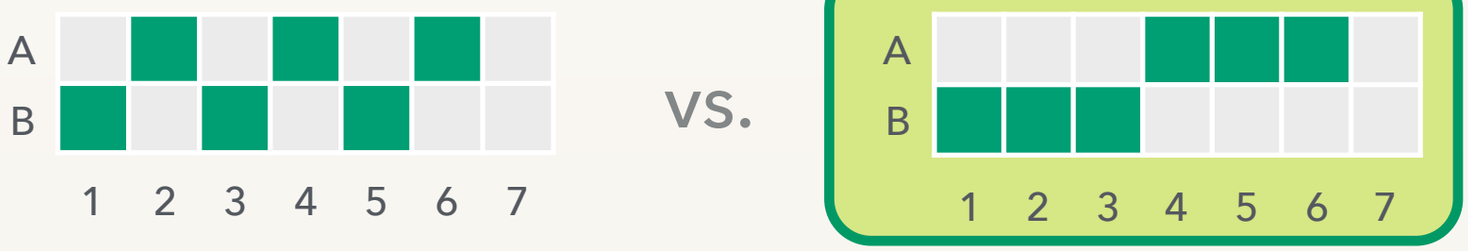
Weekly focus



Higher focus

More repetitive day-to-day work

Day-to-day focus (repeatability)



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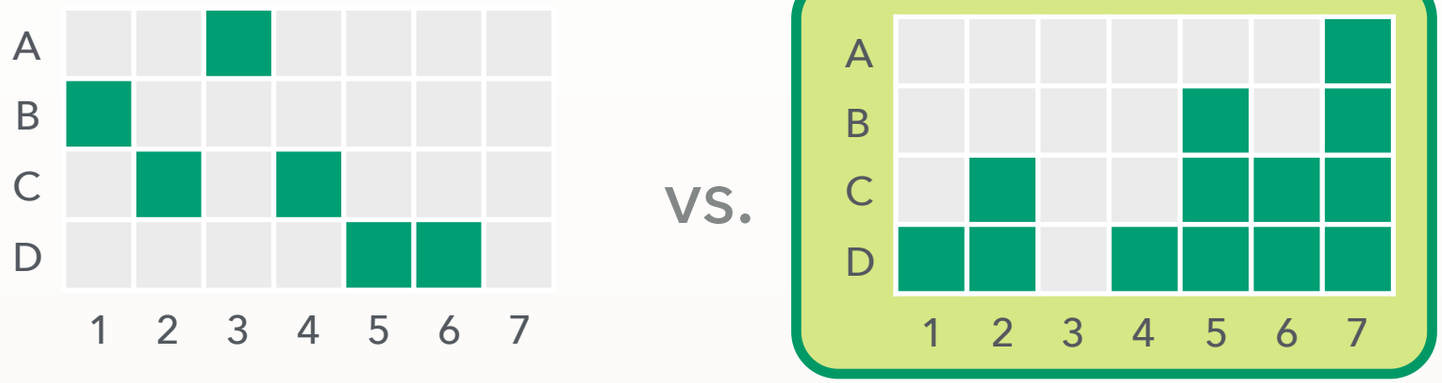

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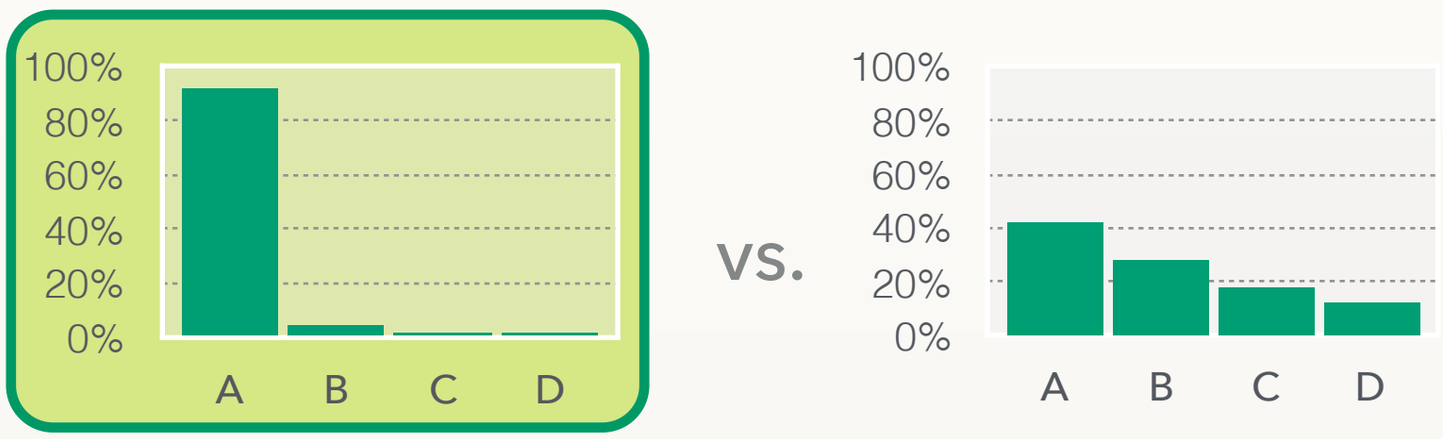

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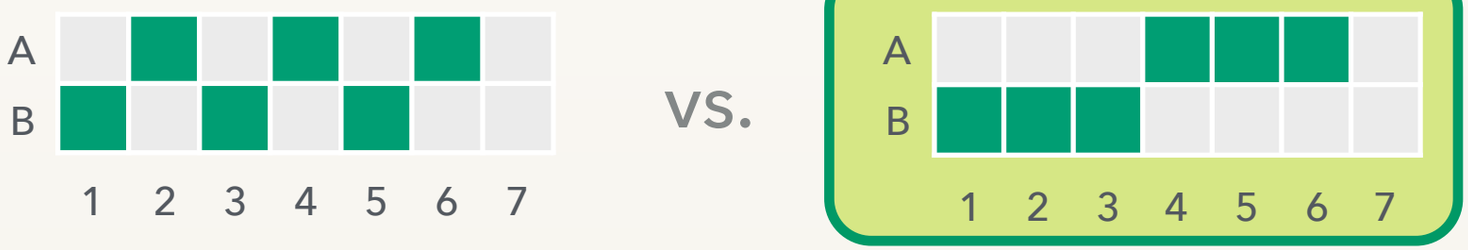


<u>Interaction effects</u>:

No scheduling is productive over 5 projects/week

MULTITASKERS DO MORE; SCHEDULING MATTERS

Higher LOC added

Theory: How does multitasking affect performance?

PROS

- **Fill downtime**

  Switch focus between projects to utilize tim more efficiently

  (Adler and Benbunan-Fich, 2012)

- **Cross-fertilisation**

  Easier to work on other projects if knowledge is transferrable

  (Lindbeck and Snower, 2000)

CONS

- **Cognitive switching cost**

  Depends on interruption duration, complexity, moment

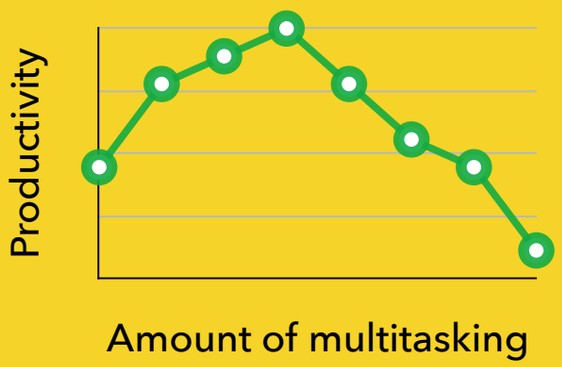
  (Altmann and Trafton, 2002) Borst, Taatgen, van Rijn, 2015)

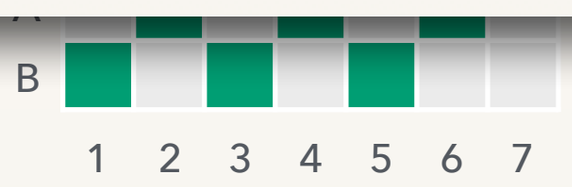
- **"Project overload"**

  Mental congestion when too much multitasking

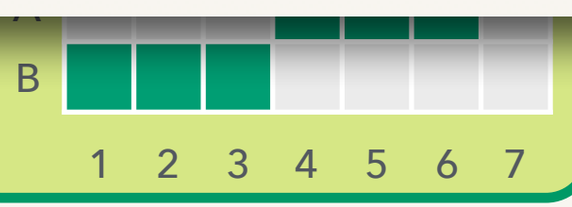
  (Zika-Viktorsson, Sundstrom, Engwall, 2006)

In theory:





VS.



More within-day multitasking

Higher focus

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Interaction effects:

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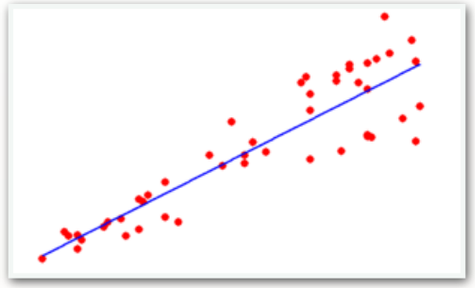
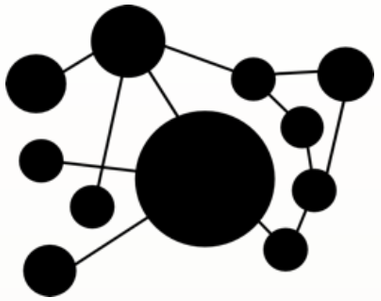
TOOLKIT FOR SOCIAL SOFTWARE ENGINEERING RESEARCHERS

THEORY

QUALITATIVE METHODS



STATISTICS



NETWORK SCIENCE

EXAMPLE 1: PULL REQUEST EVALUATION TIME

MODELS

M2: M1 + process-related factors + continuous integration

✓ R^2 = 58.7%

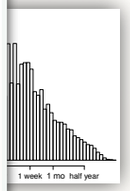
Title & description
- n_tokens

Priority
- time_to_first _response

Continuous Integration
- response time

Management
- workload
- availability

Social tagging
- @mention
- #issue



1 2 3 4 5 6 7
Day

THEORY: HOW DOES MULTITASKING AFFECT PERFORMANCE?

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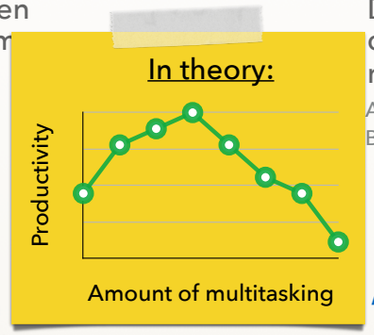

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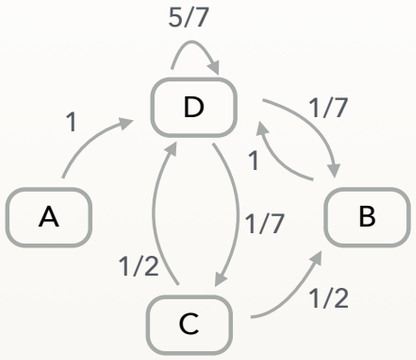
3. DAY-TO-DAY FOCUS

vs. Switching focus



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