

Collaborative Energy Debugging for Mobile Devices

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Mobile is Hot

- ... sometimes, literally:



ASK LIFEHACKER

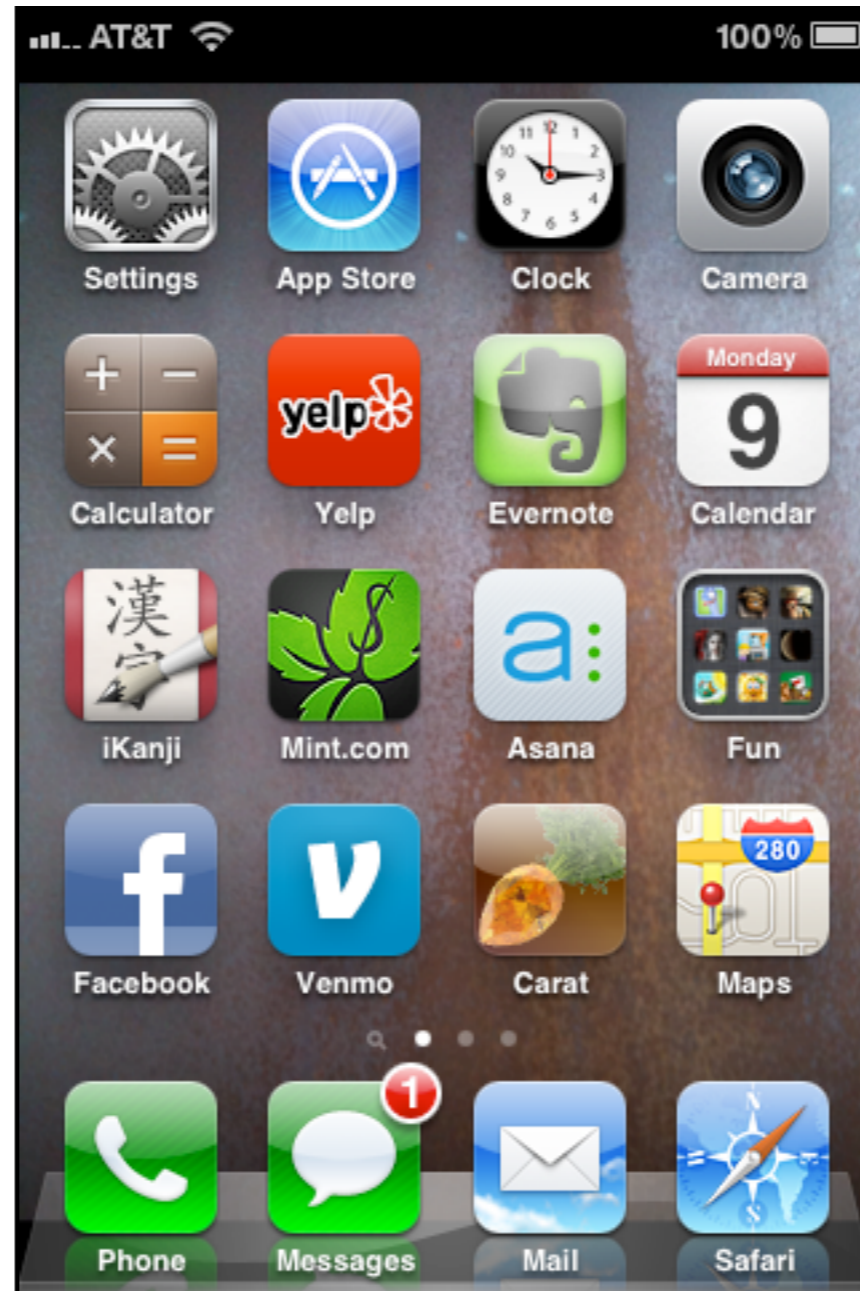
Why Is My Cellphone Burning a Hole in My Pocket?

Dear Lifehacker,
I'm loving my new smartphone, but sometimes it gets really hot in my pocket—like surface-of-the-sun hot. Is there something wrong with it? Why does it get so hot, and how can I make it stop?

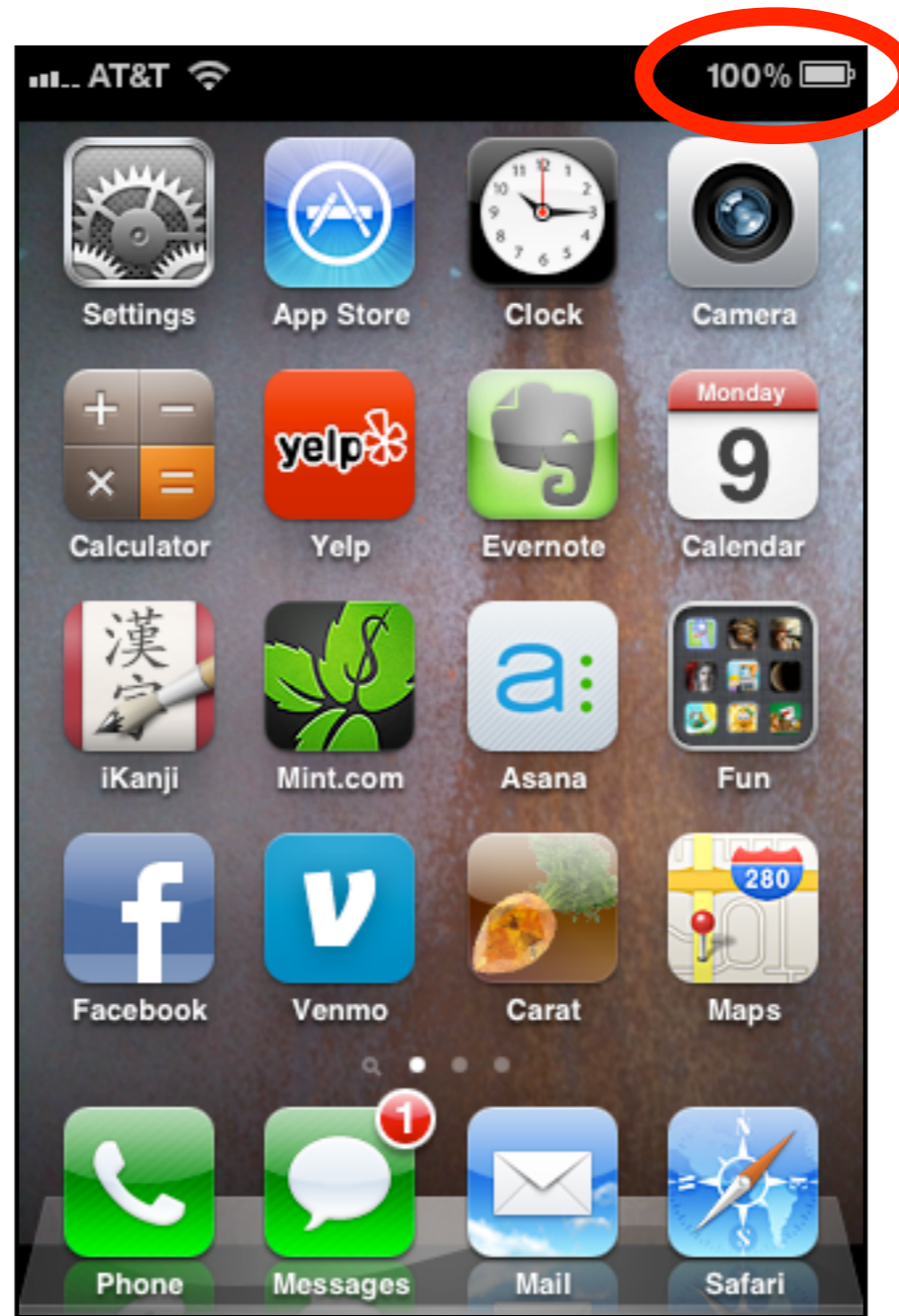
Sincerely,
Fearing Firey Phones

*Photo remixed from an original by
Shutterstock.*

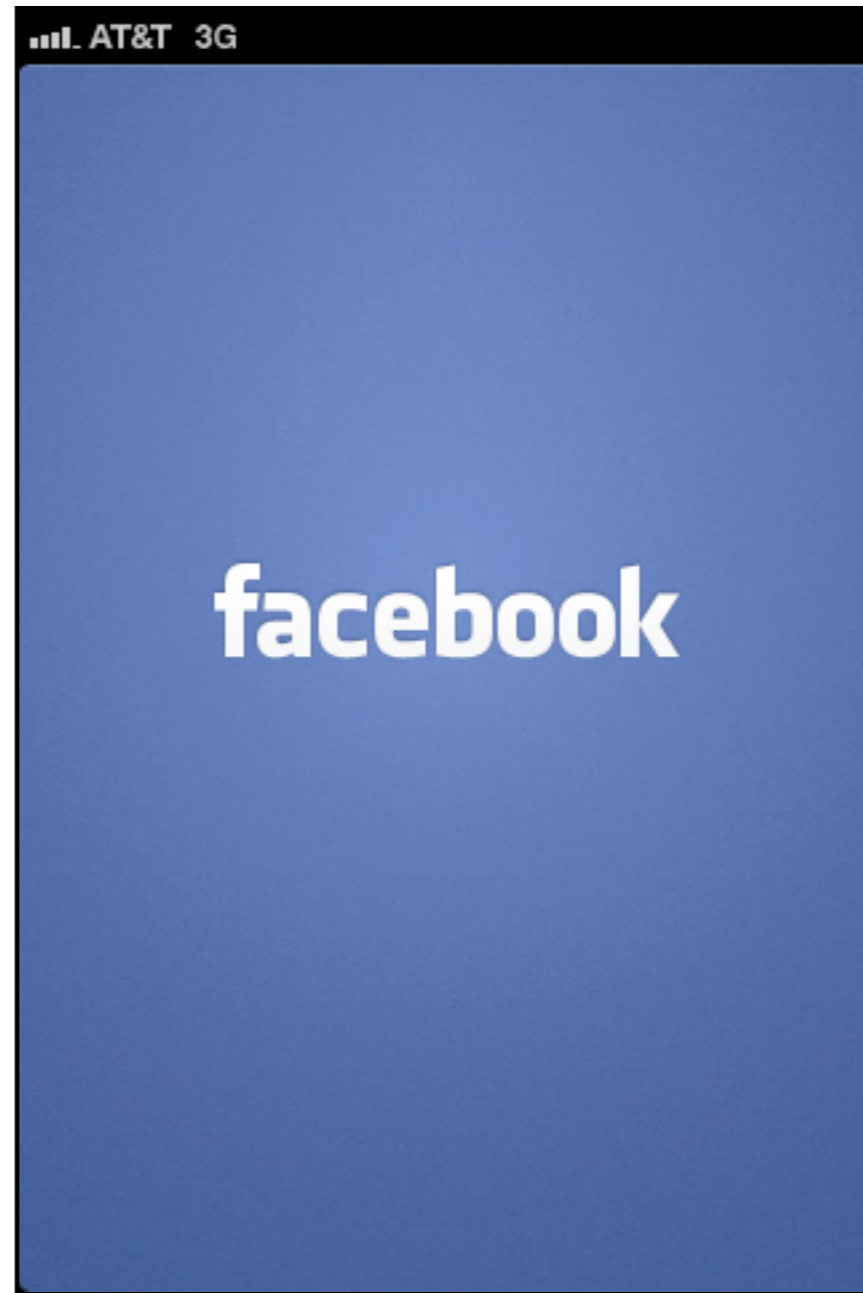
A Day in the Life



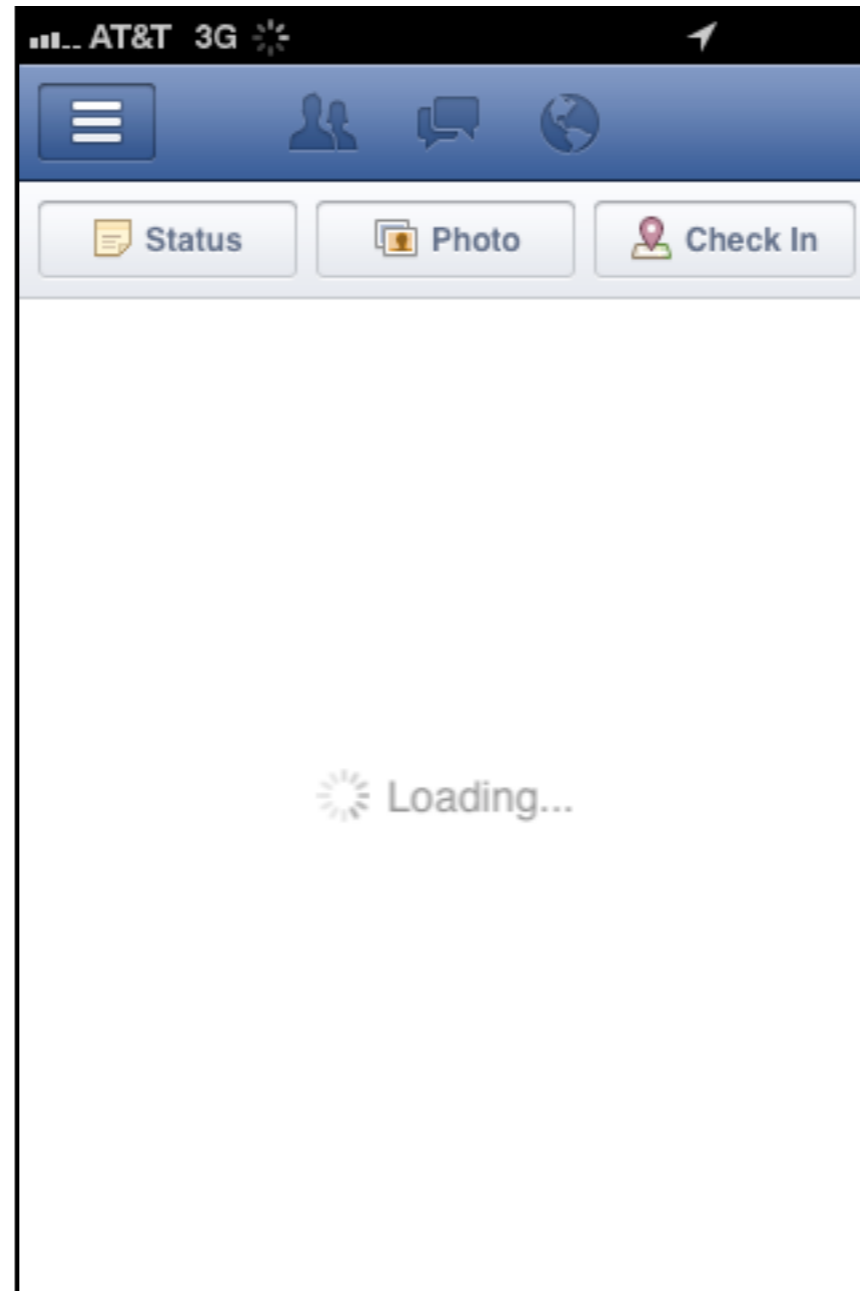
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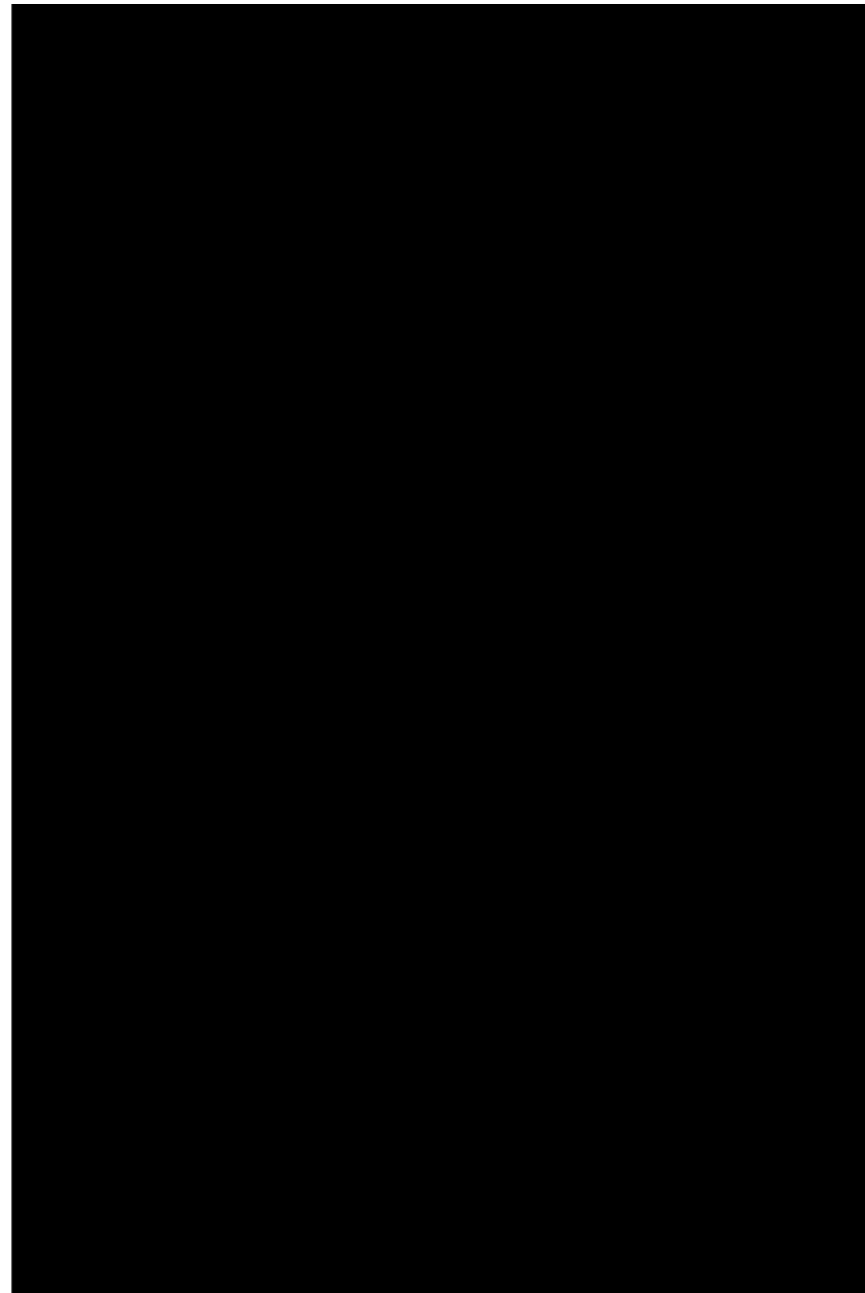
A Day in the Life



A Day in the Life



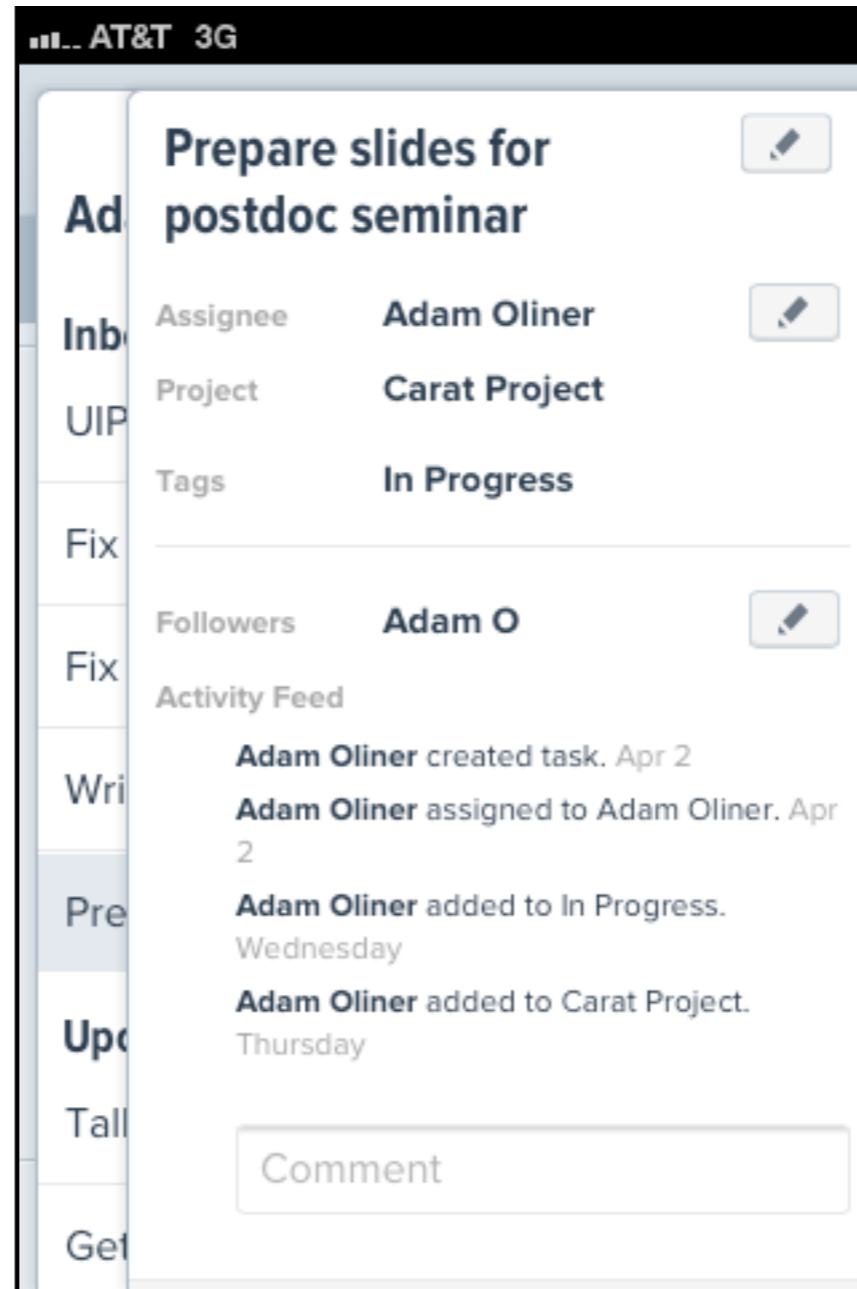
A Day in the Life



A Day in the Life



A Day in the Life



A Day in the Life



A Day in the Life



Users' Questions

- ***Why*** is my battery draining?
- Is that ***normal***?
- What can I ***do*** about it?

Today

1. Carat
2. Sampling to Diagnosis
3. Dealing with Uncertainty
4. Deployment

Prior Approaches

- Ad hoc
 - e.g., no-sleep bug
- Intrusive
- Generic
 - “Kill *all* background apps”
 - “Dim the screen”

Prior Approaches

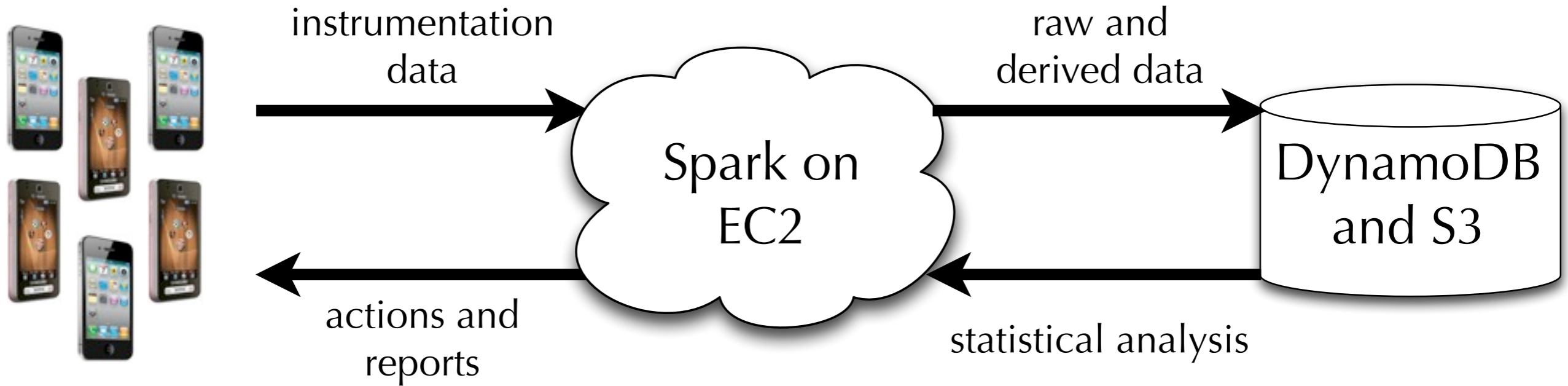
- Ad hoc
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- Generic
 - “Kill *all* background apps”
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the crowd

the cloud

big data

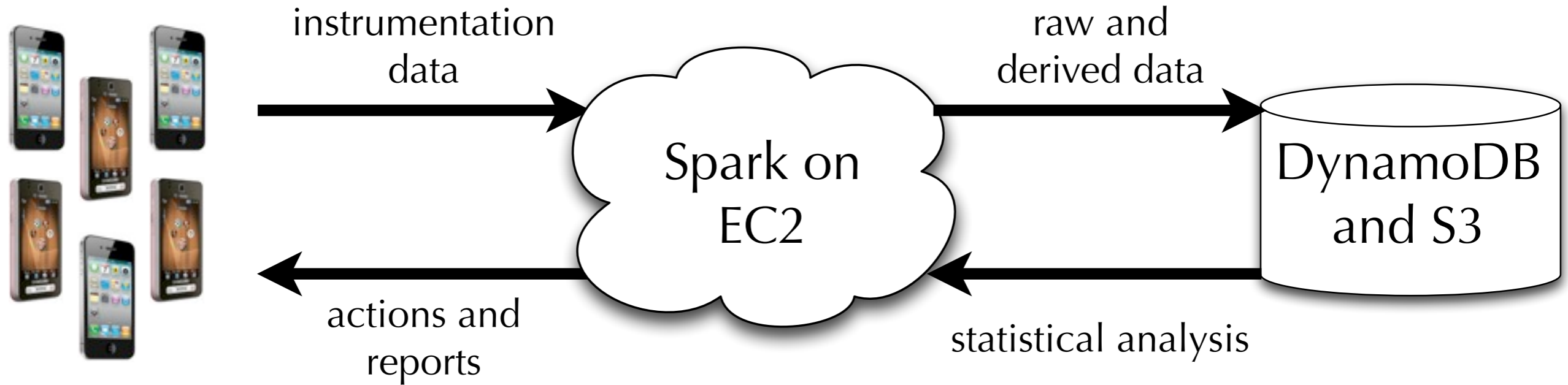


Our Approach

the crowd

the cloud

big data

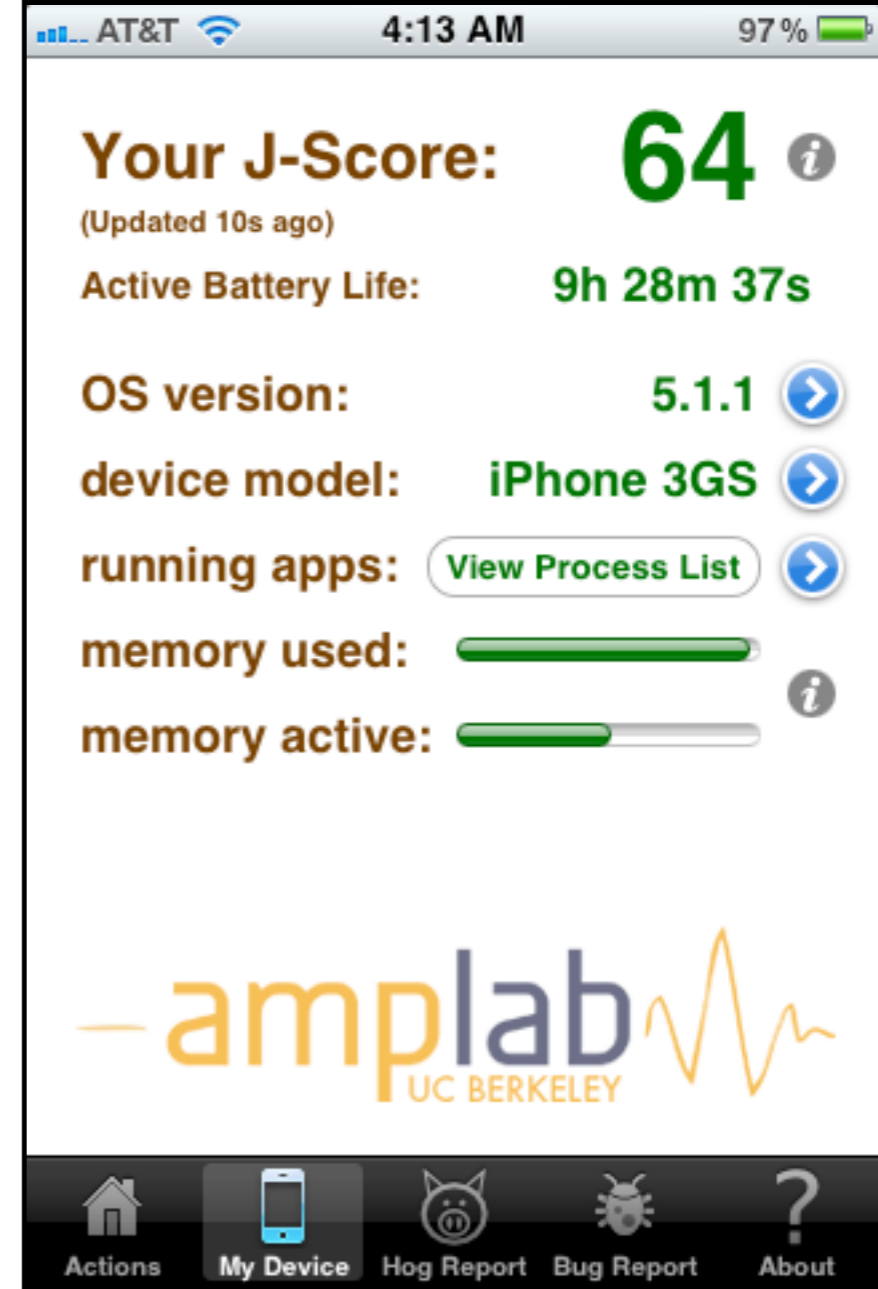
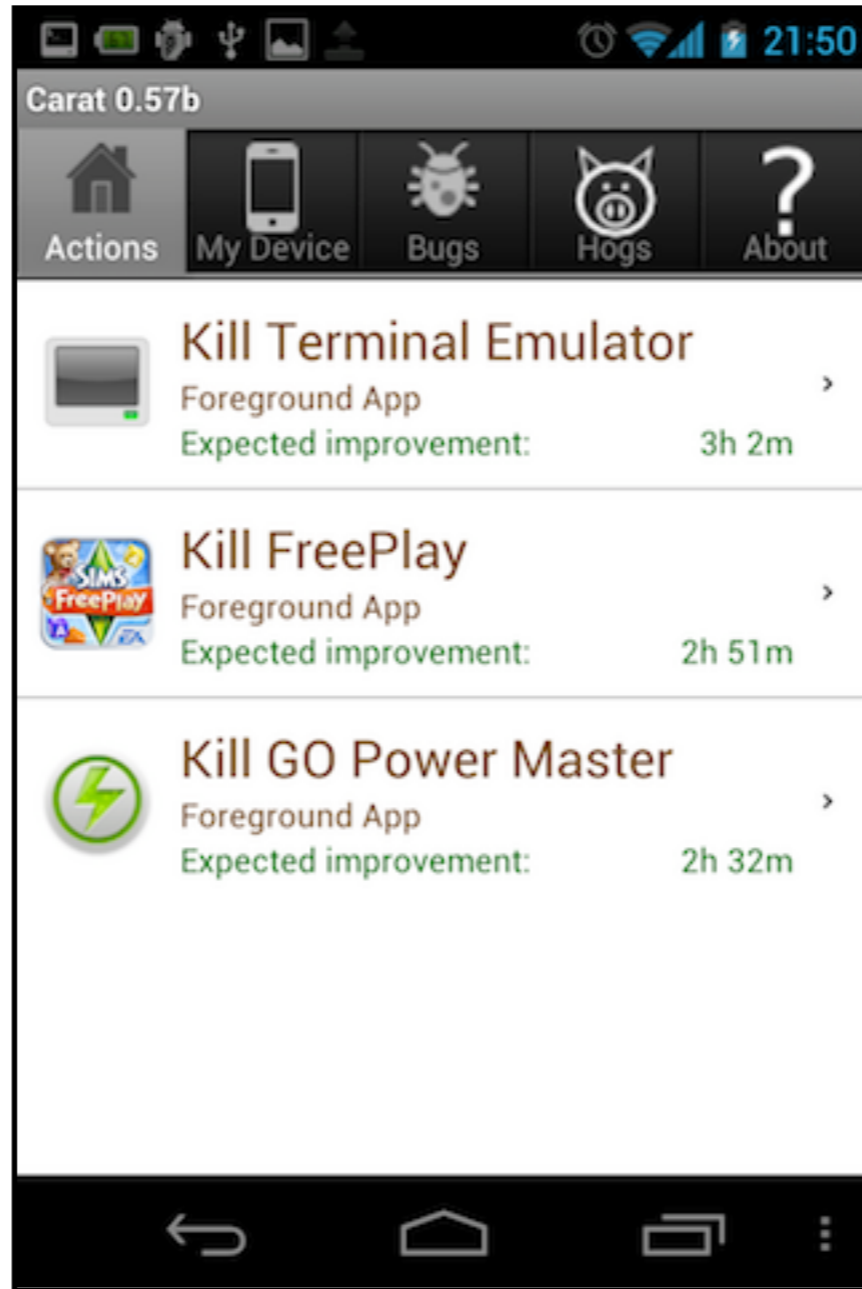


First collaborative approach for diagnosing energy problems.

Carat

- Mobile app for iOS and Android
- Personalized energy debugging
- Design point
 - Deployable on app stores
 - Maximally invasive





Carat



Carat Sampling



Carat Sampling



Carat Sampling



Carat Sampling



Computing Rates

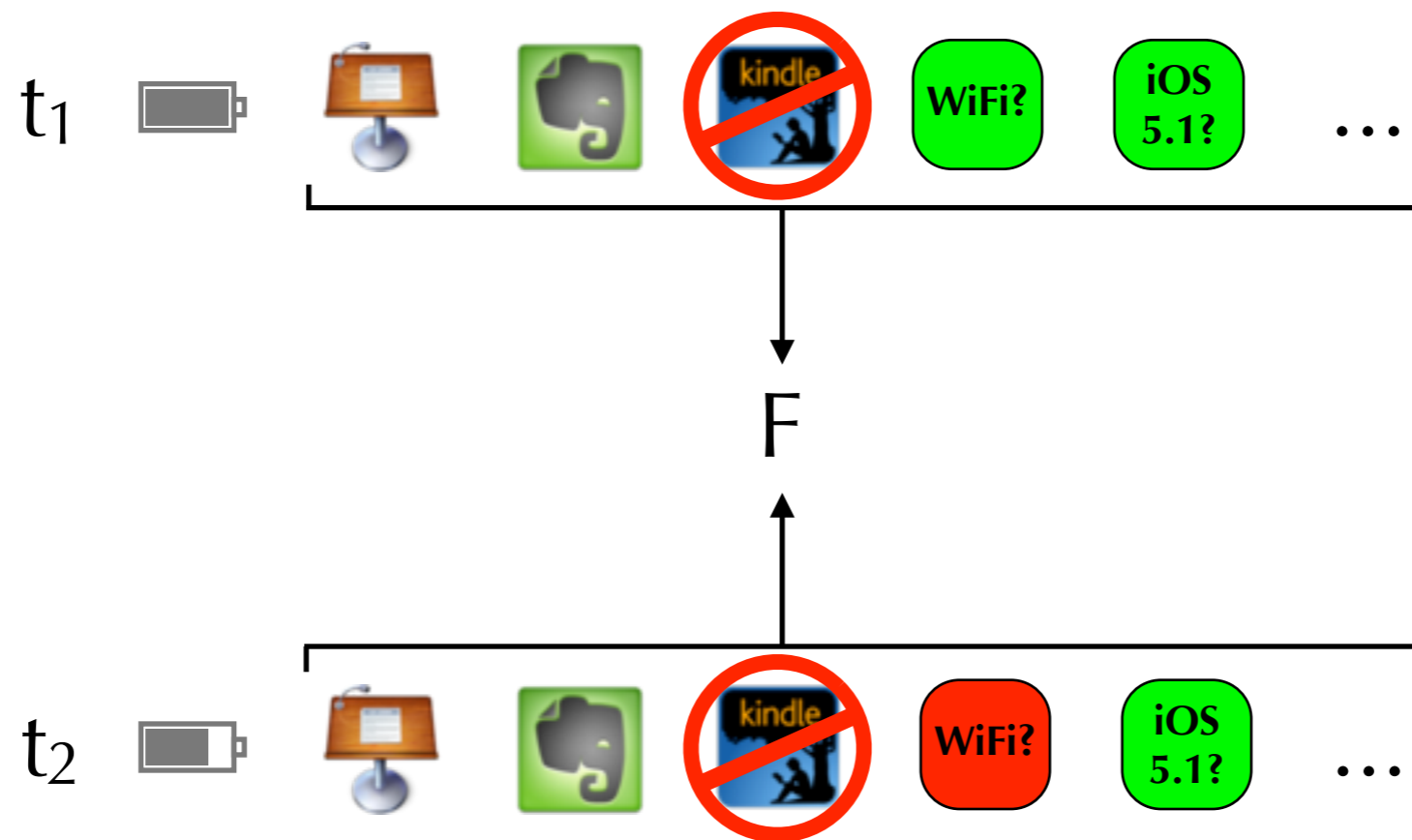


Computing Rates



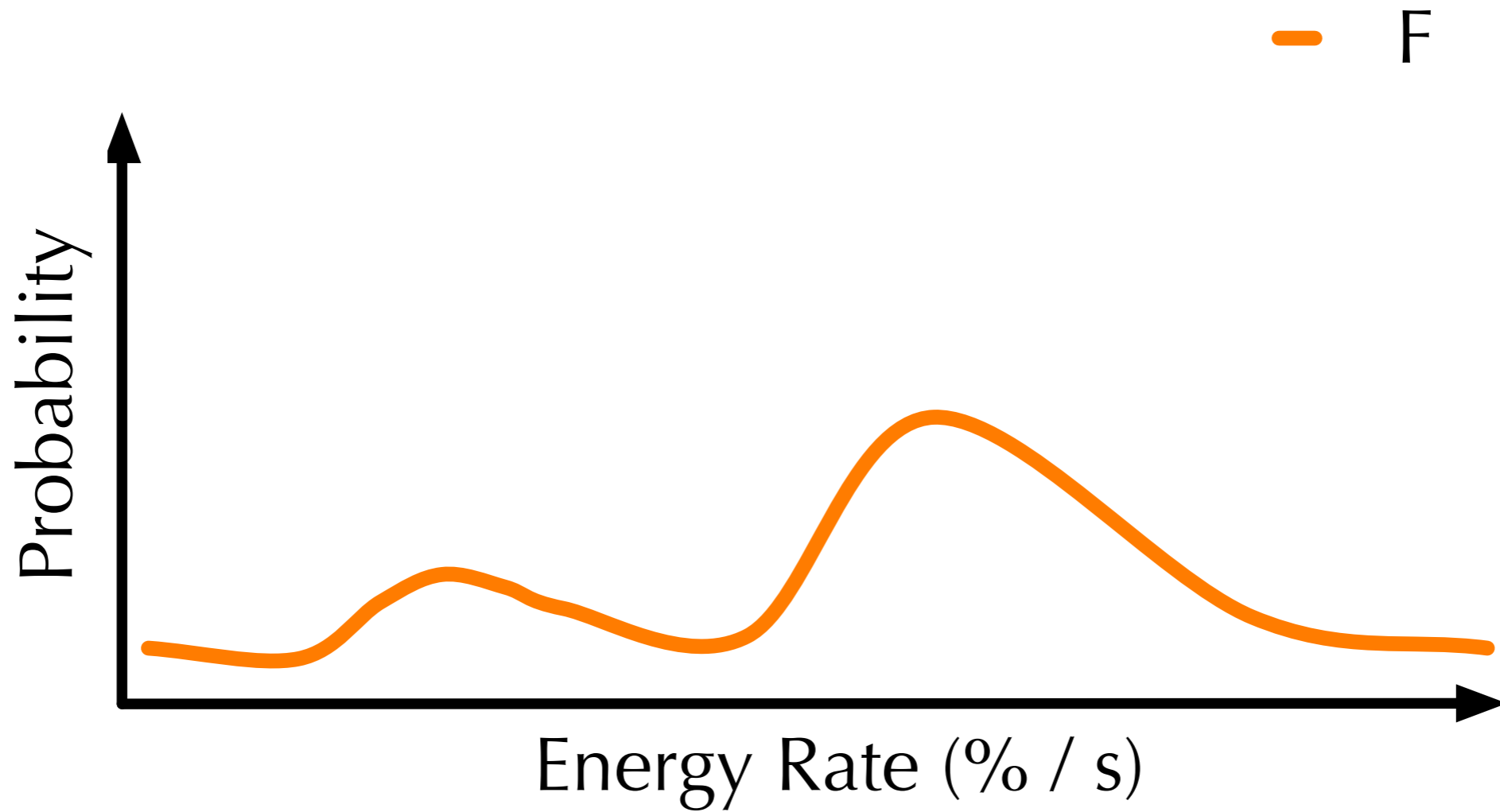
$$\frac{\Delta\%}{\Delta t} = \text{discharge rate (\%/s)}$$

Computing Rates

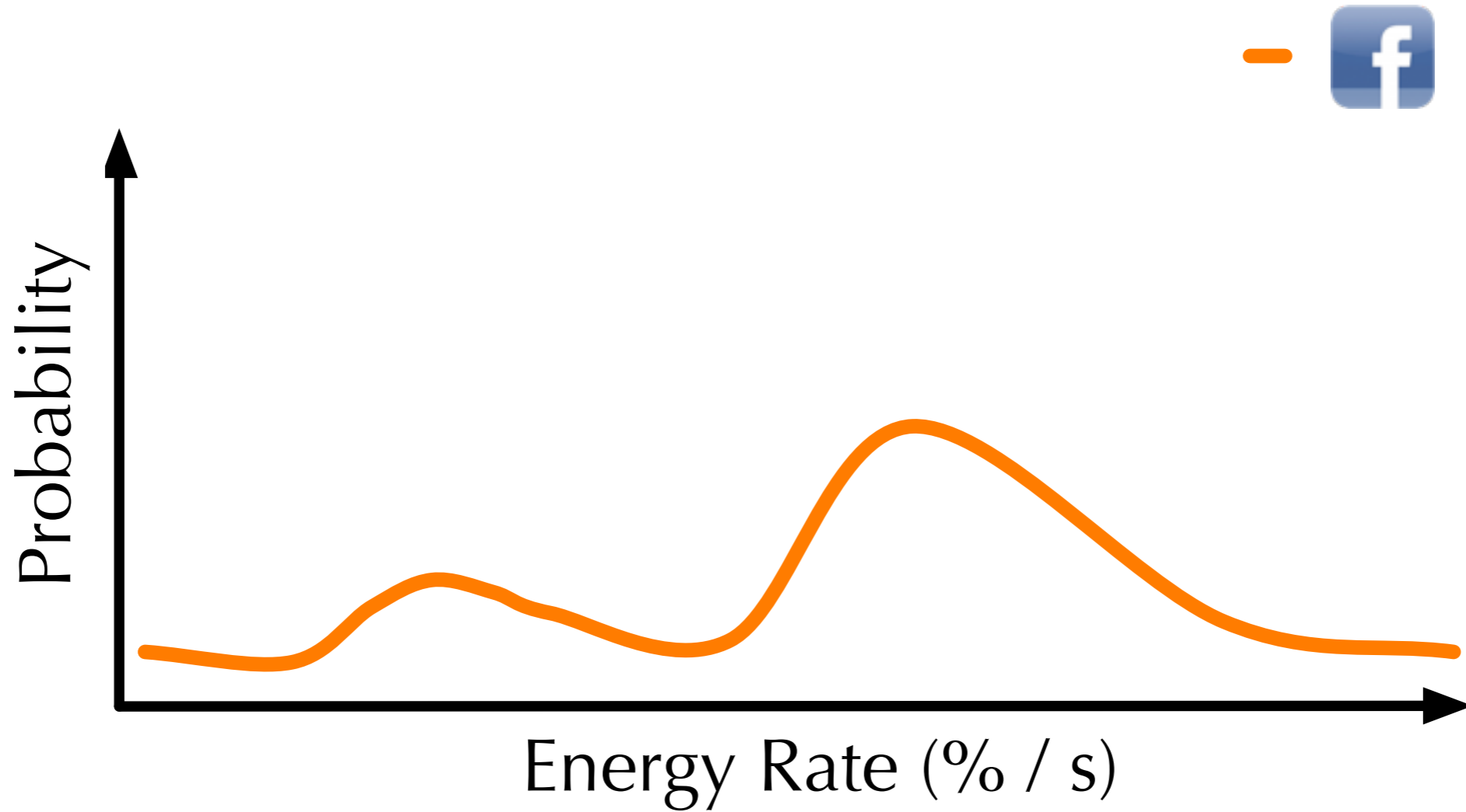


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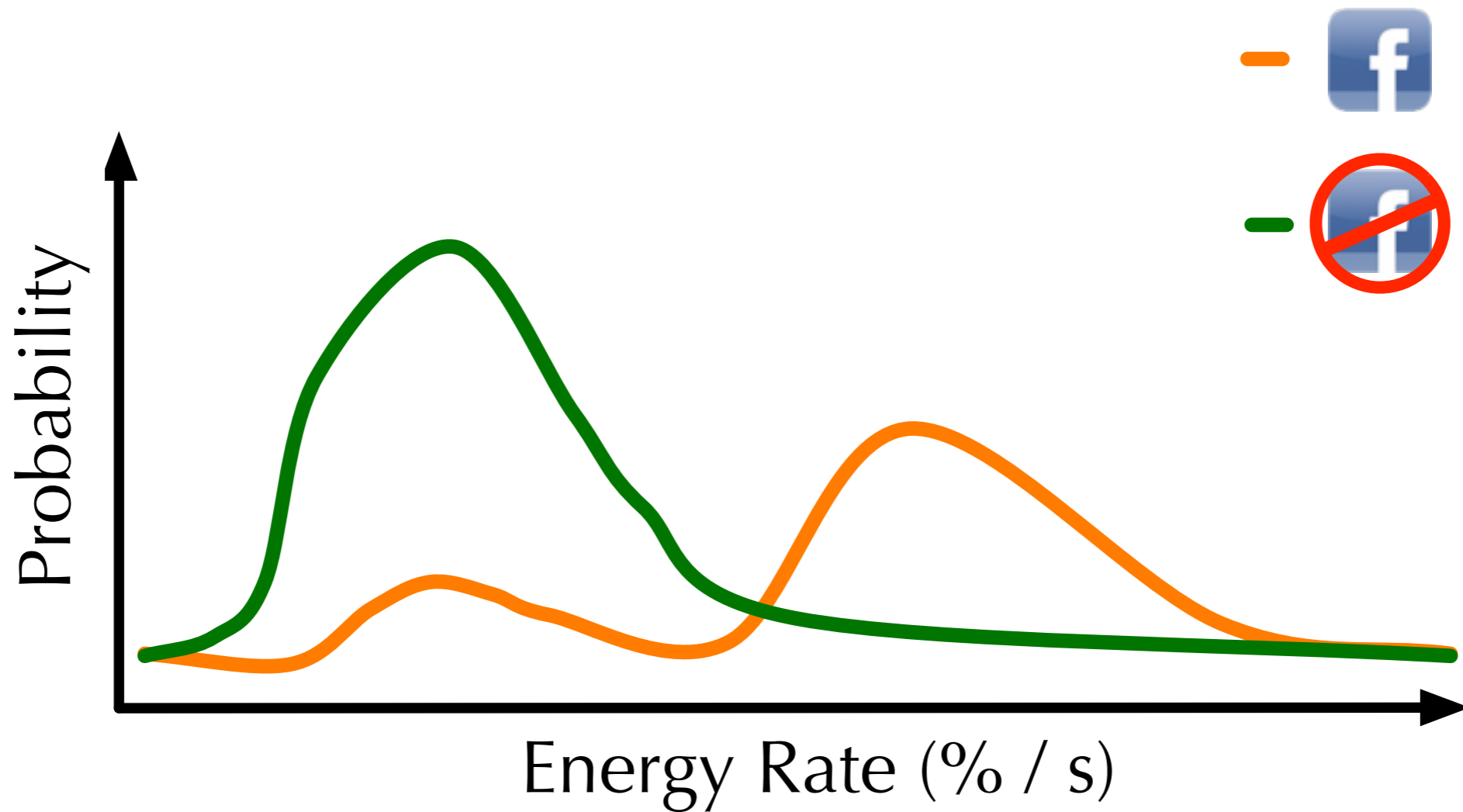
Computing Rates



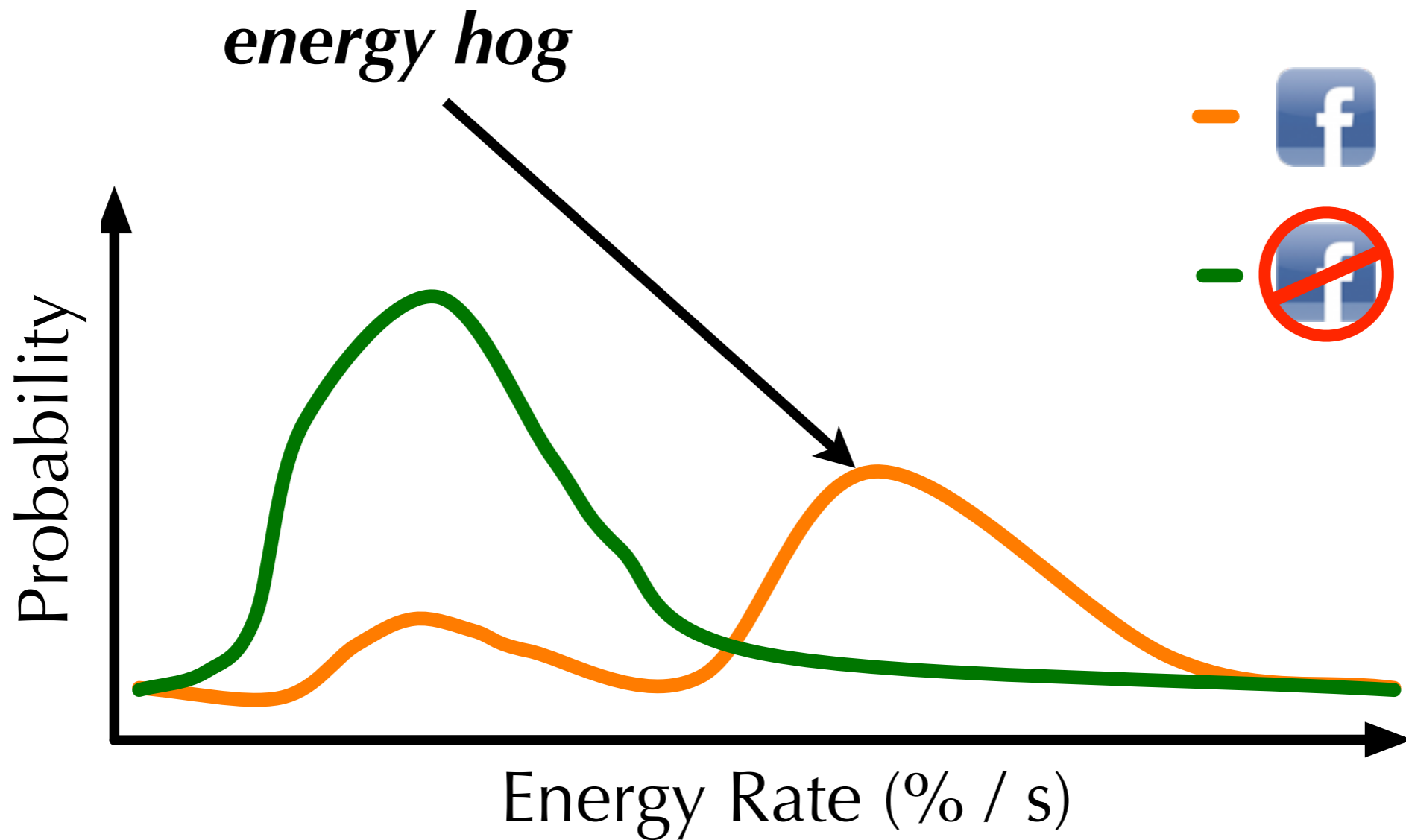
Energy Anomalies



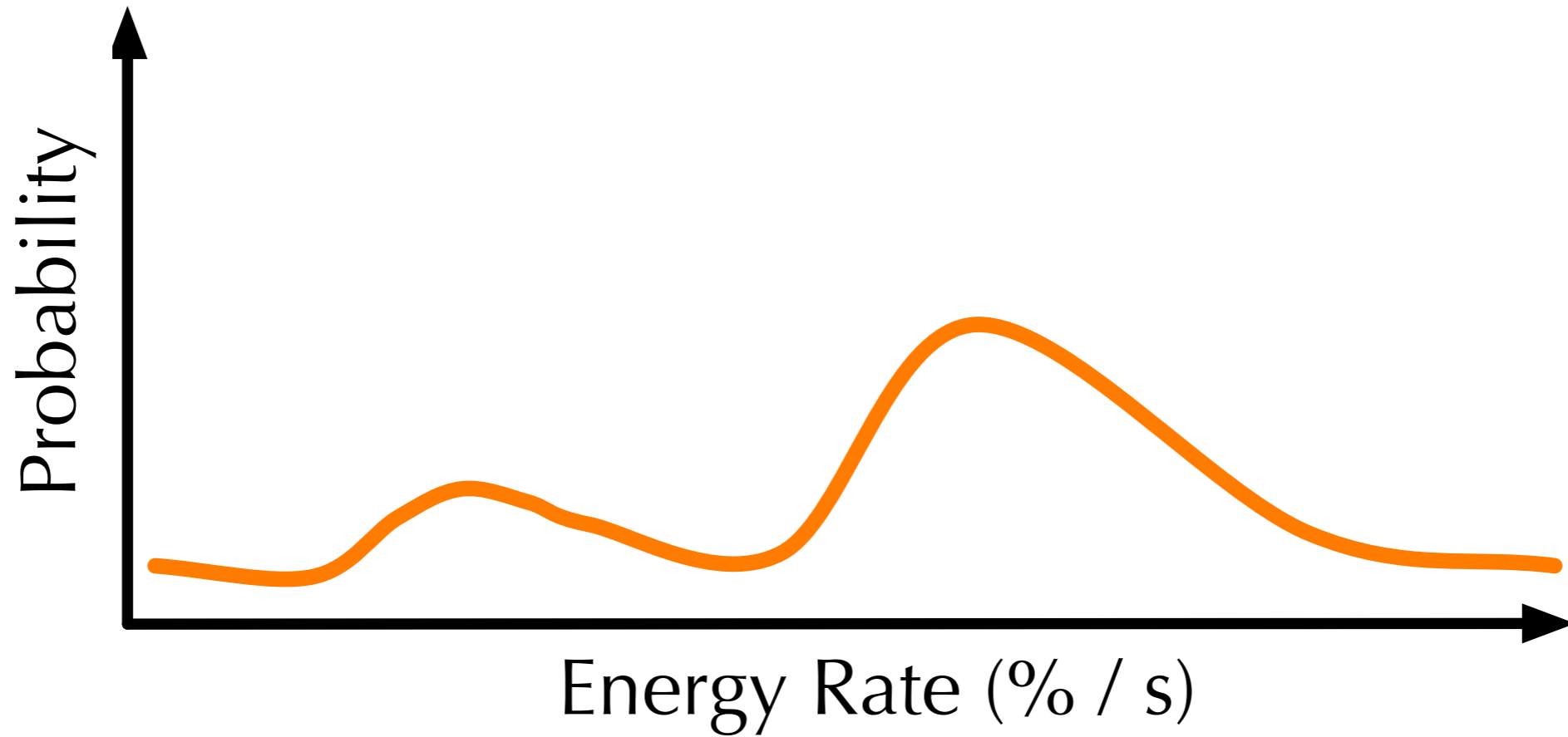
Energy Anomalies



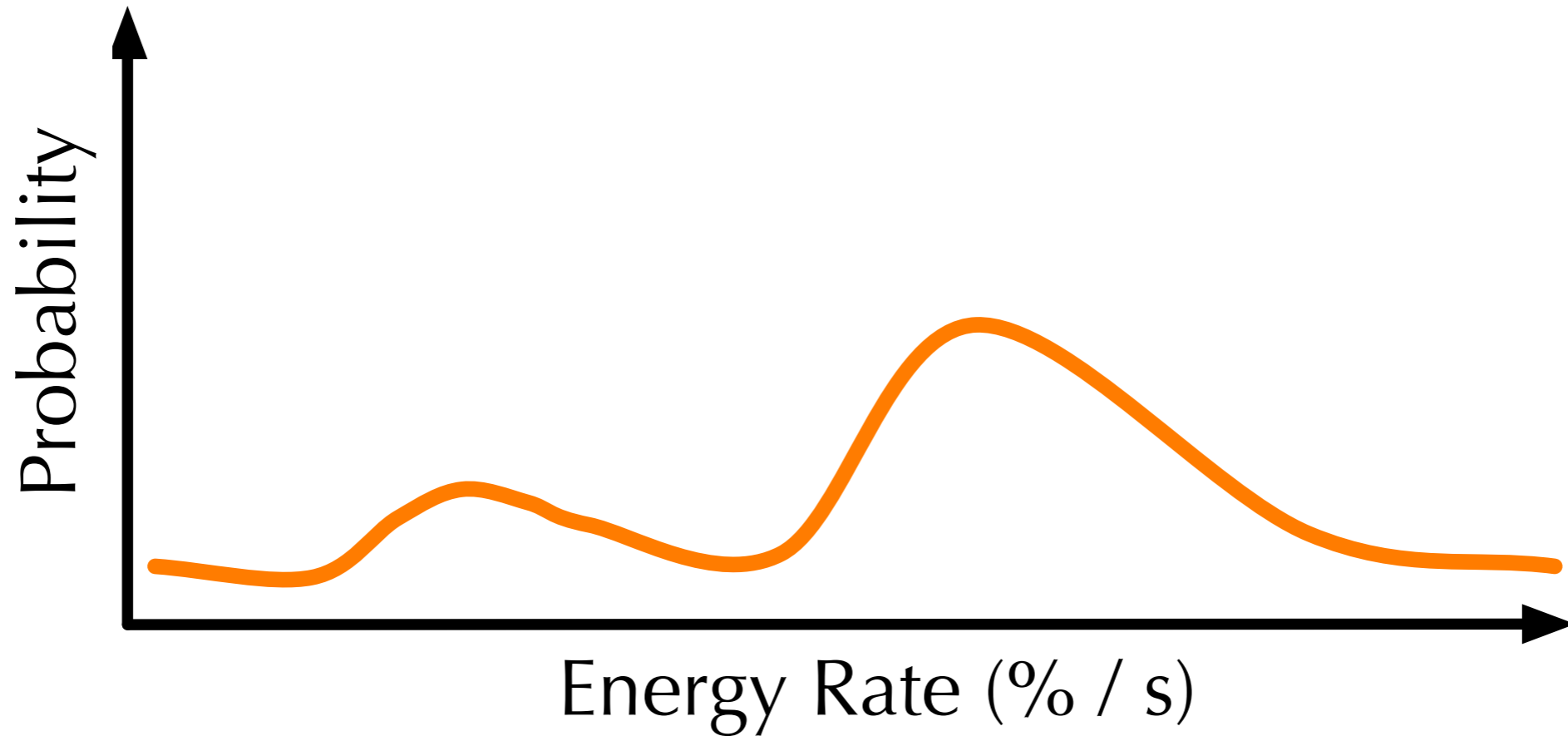
Energy Anomalies



Energy Anomalies

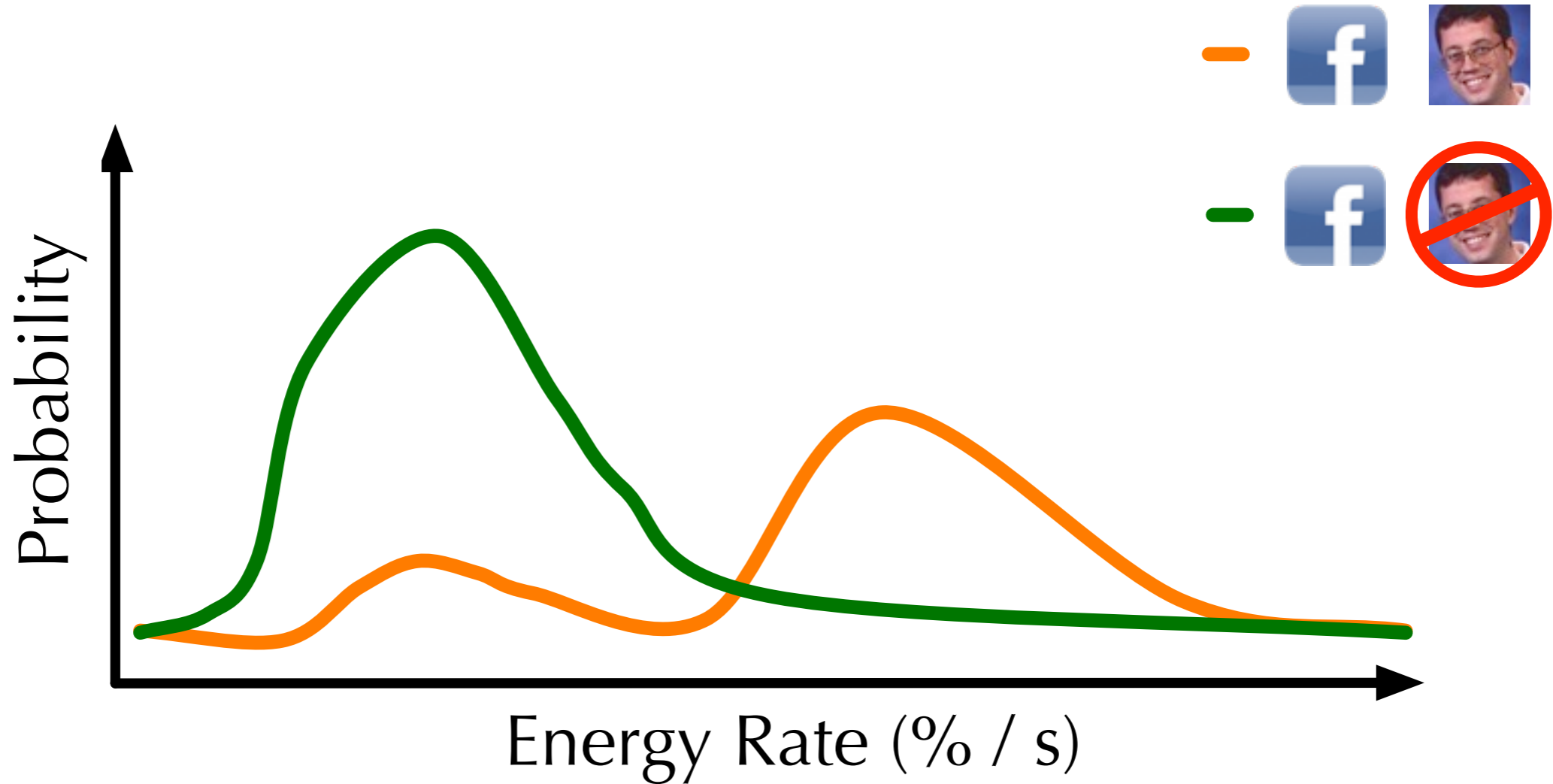


Energy Anomalies



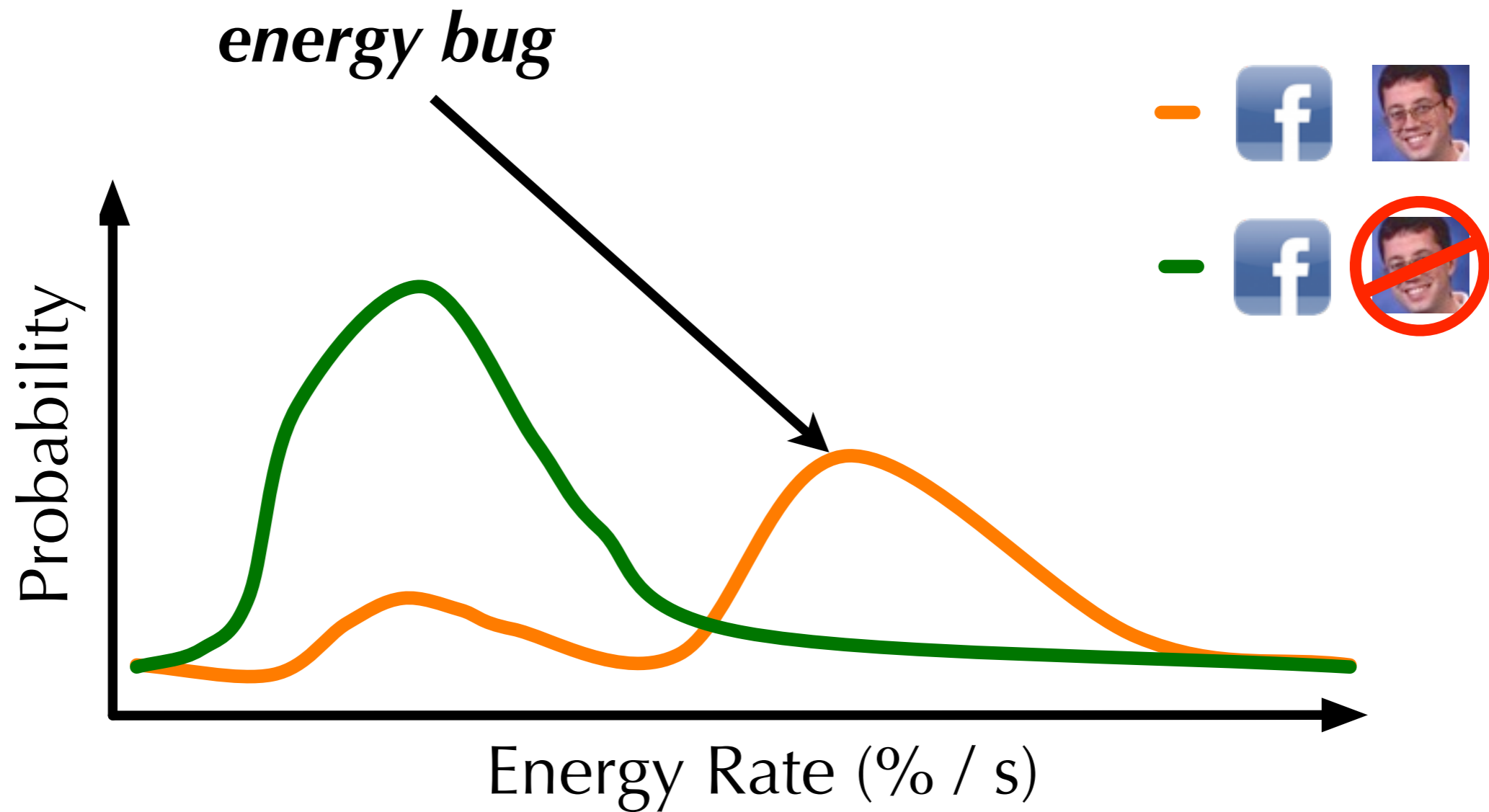
Without the crowd, there is no way to know whether this use is normal.

(Given  is not a Hog.)



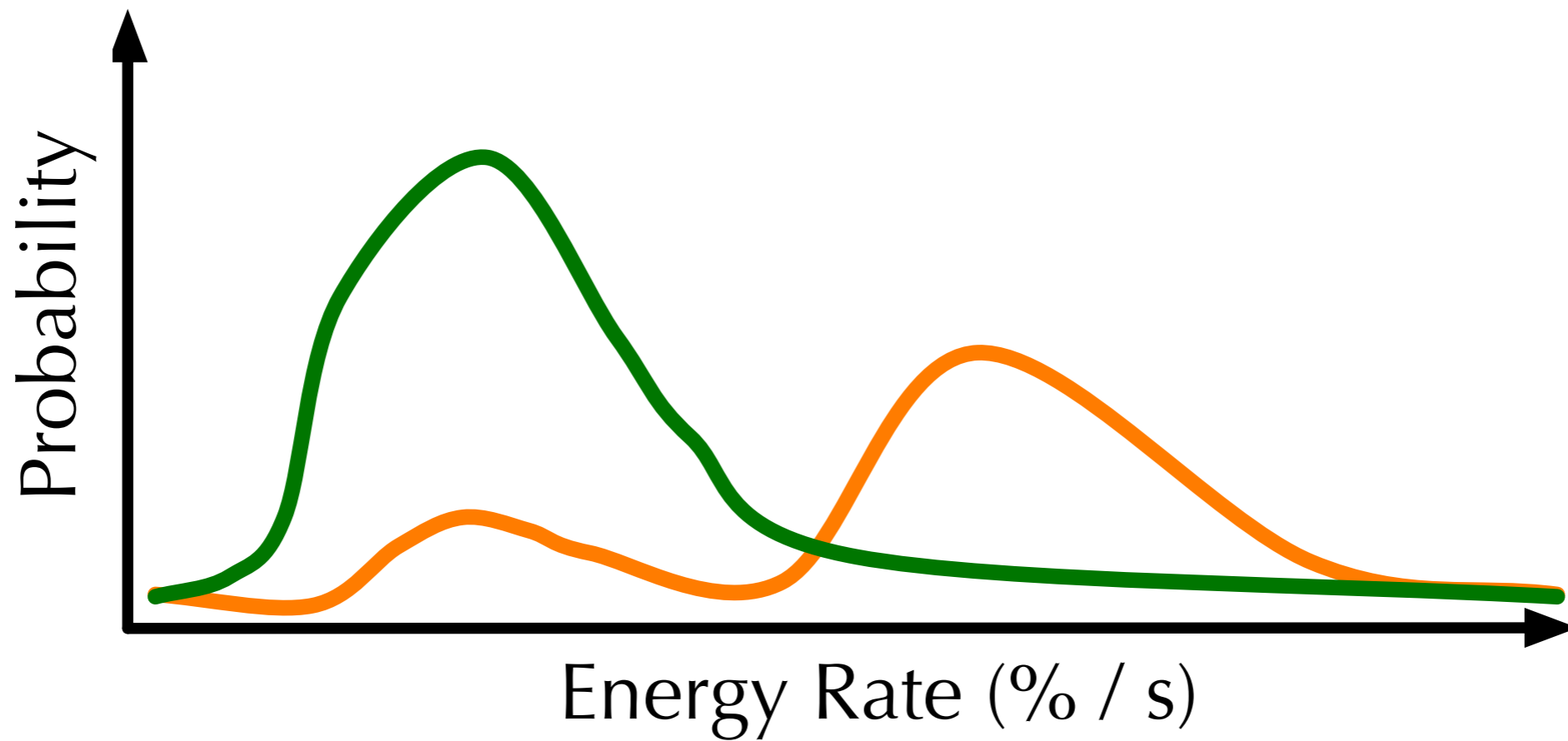
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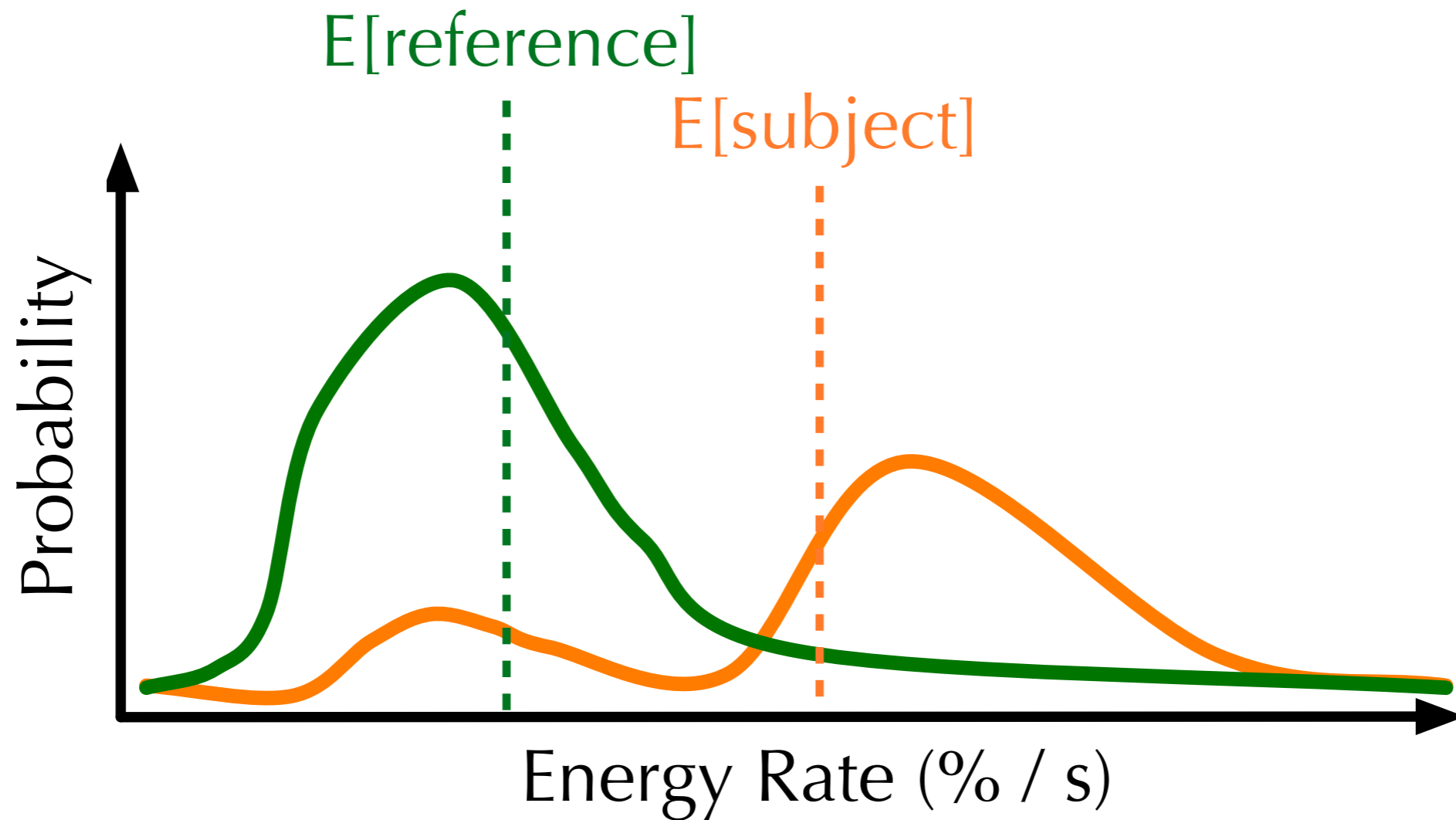


Energy Anomalies

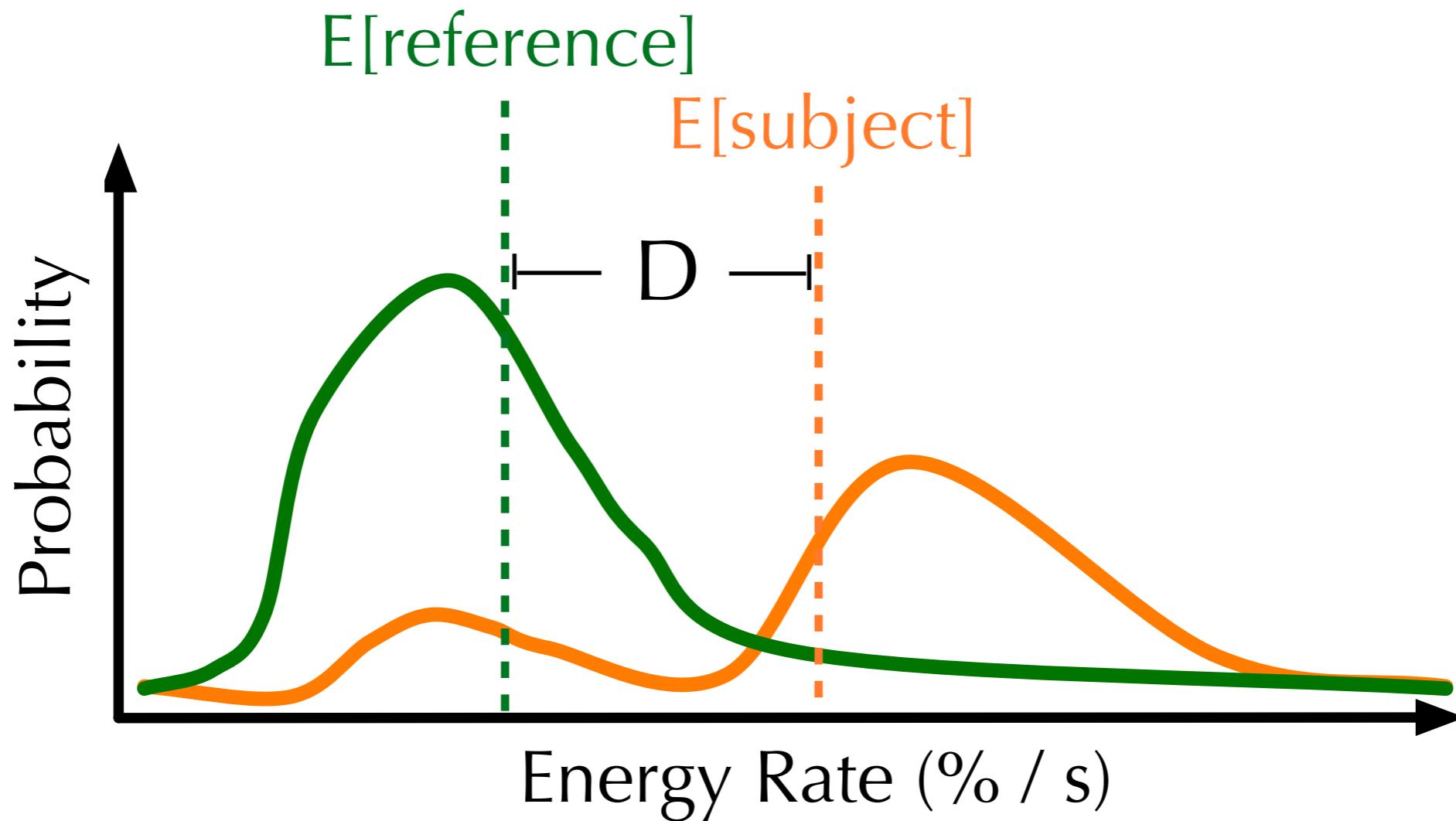
Distance



Distance



Distance



Trigger	Measured %	Actual %
BatteryLevelChanged	x	x
else	x	(x-5, x]

Measurement Uncertainty


Trigger	Measured %	Actual %
BatteryLevelChanged	x	x
else	x	(x-5, x]



85% → 85%

Measurement Uncertainty

Trigger	Measured %	Actual %
BatteryLevelChanged	x	x
else	x	(x-5, x]

 85% → 85%

 85% → (80%,85%]

Measurement Uncertainty

Trigger	Measured %	Actual %
BatteryLevelChanged	x	x
else	x	(x-5, x]

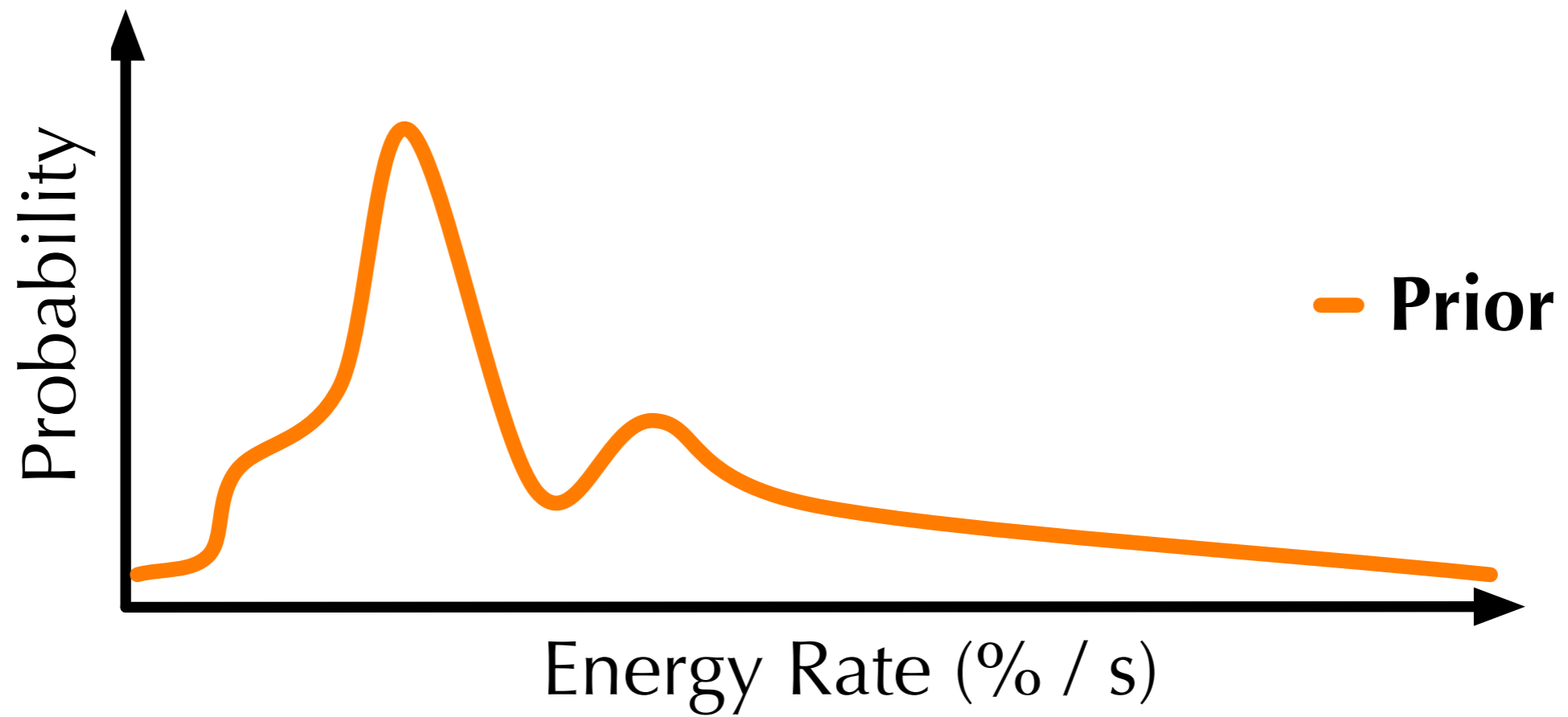


85% → 85% **Prior**

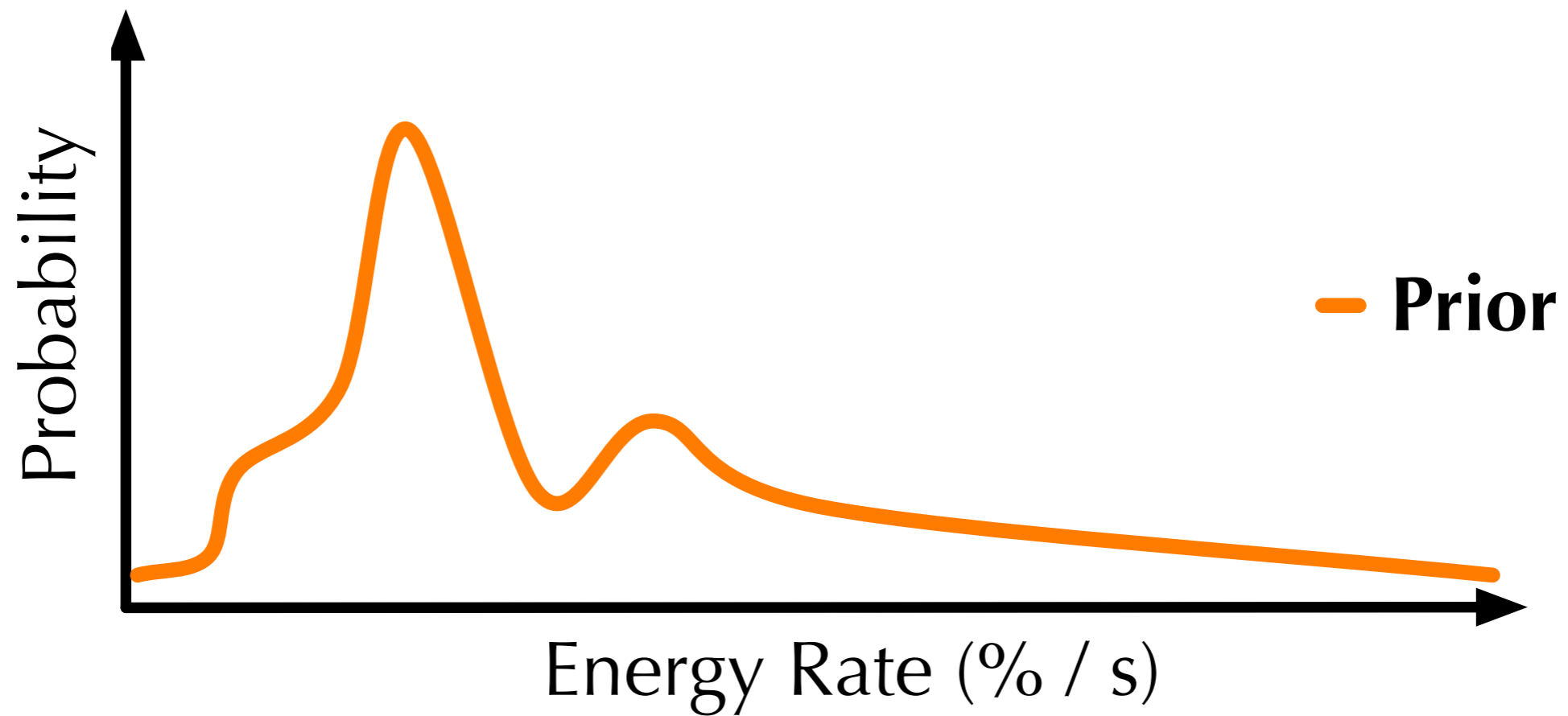
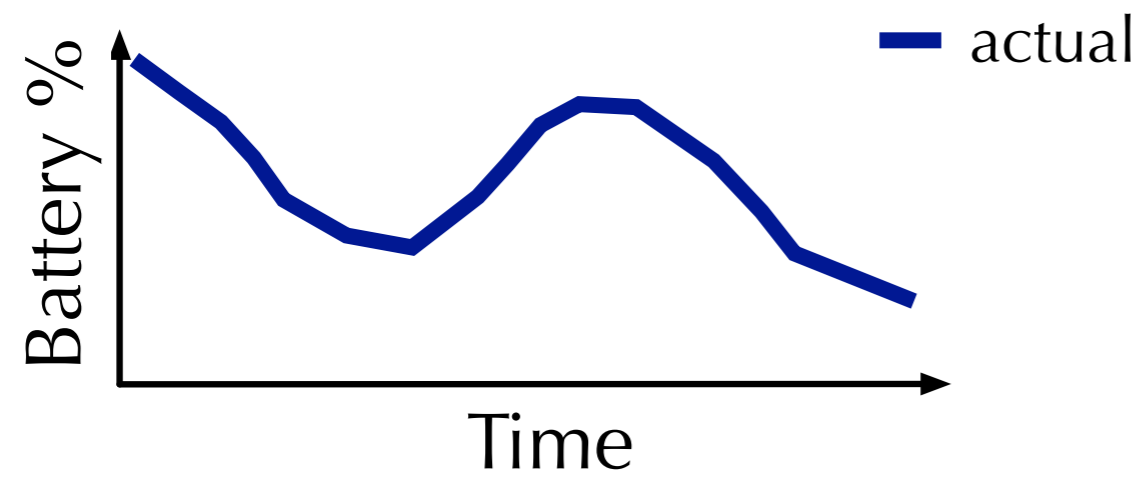


85% → (80%, 85%]

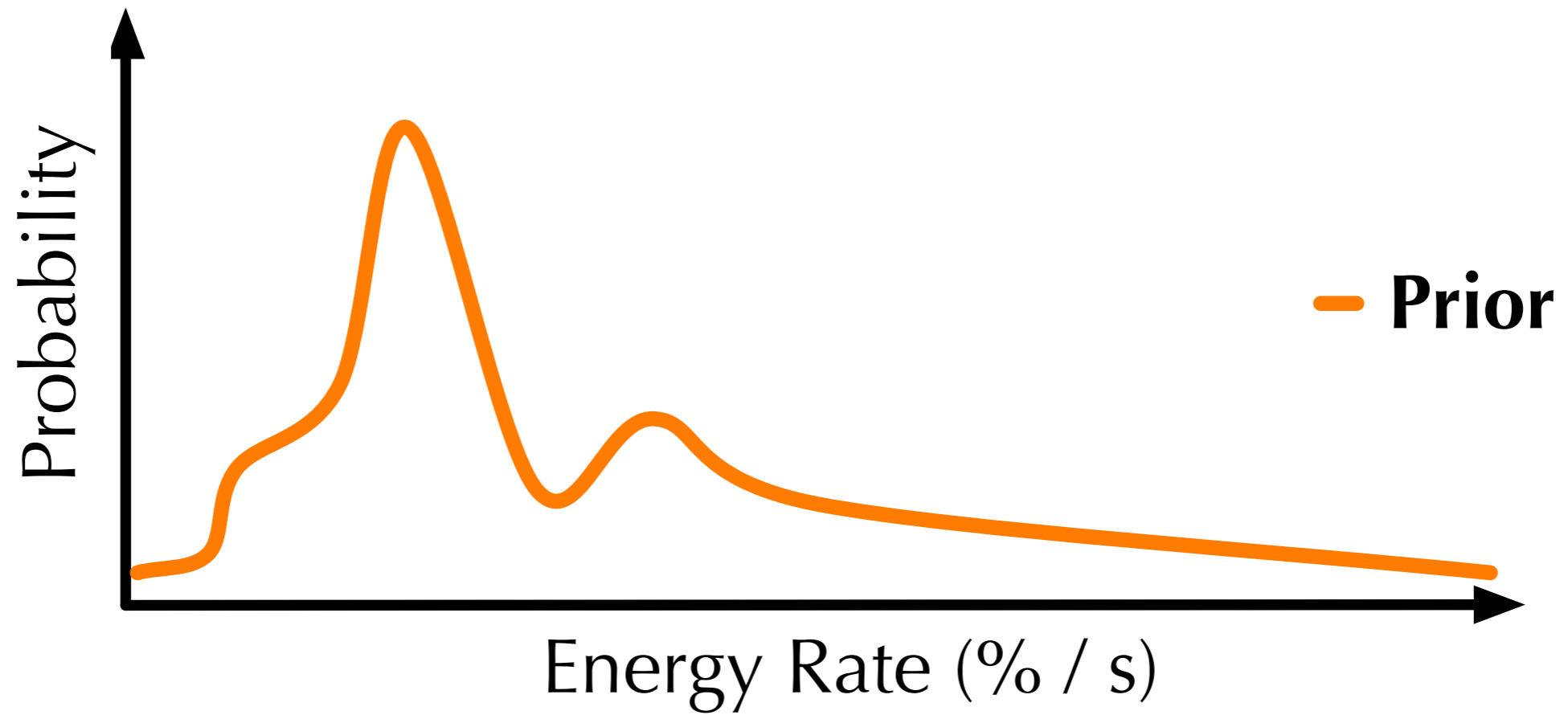
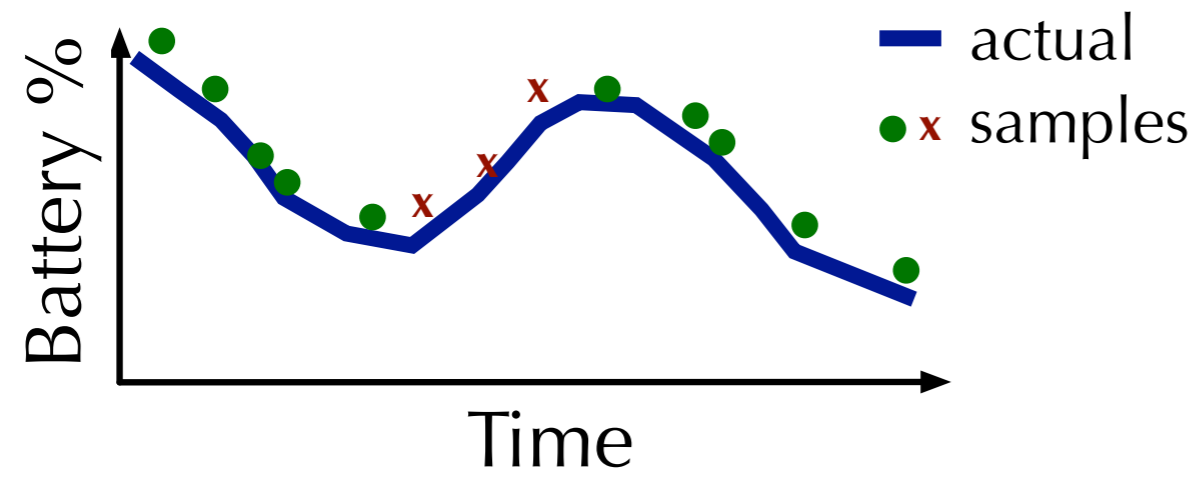
Measurement Uncertainty



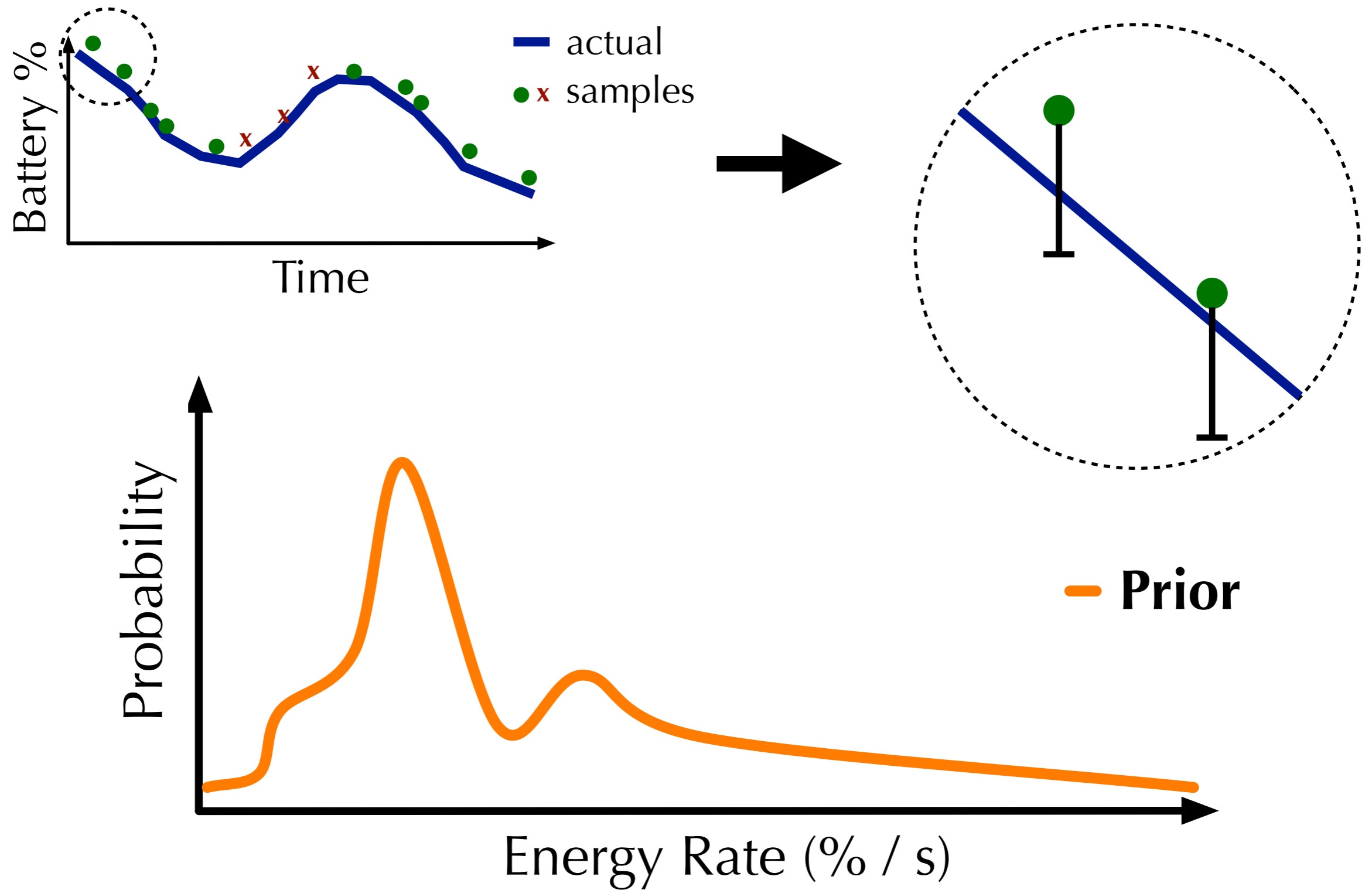
Measurement Uncertainty



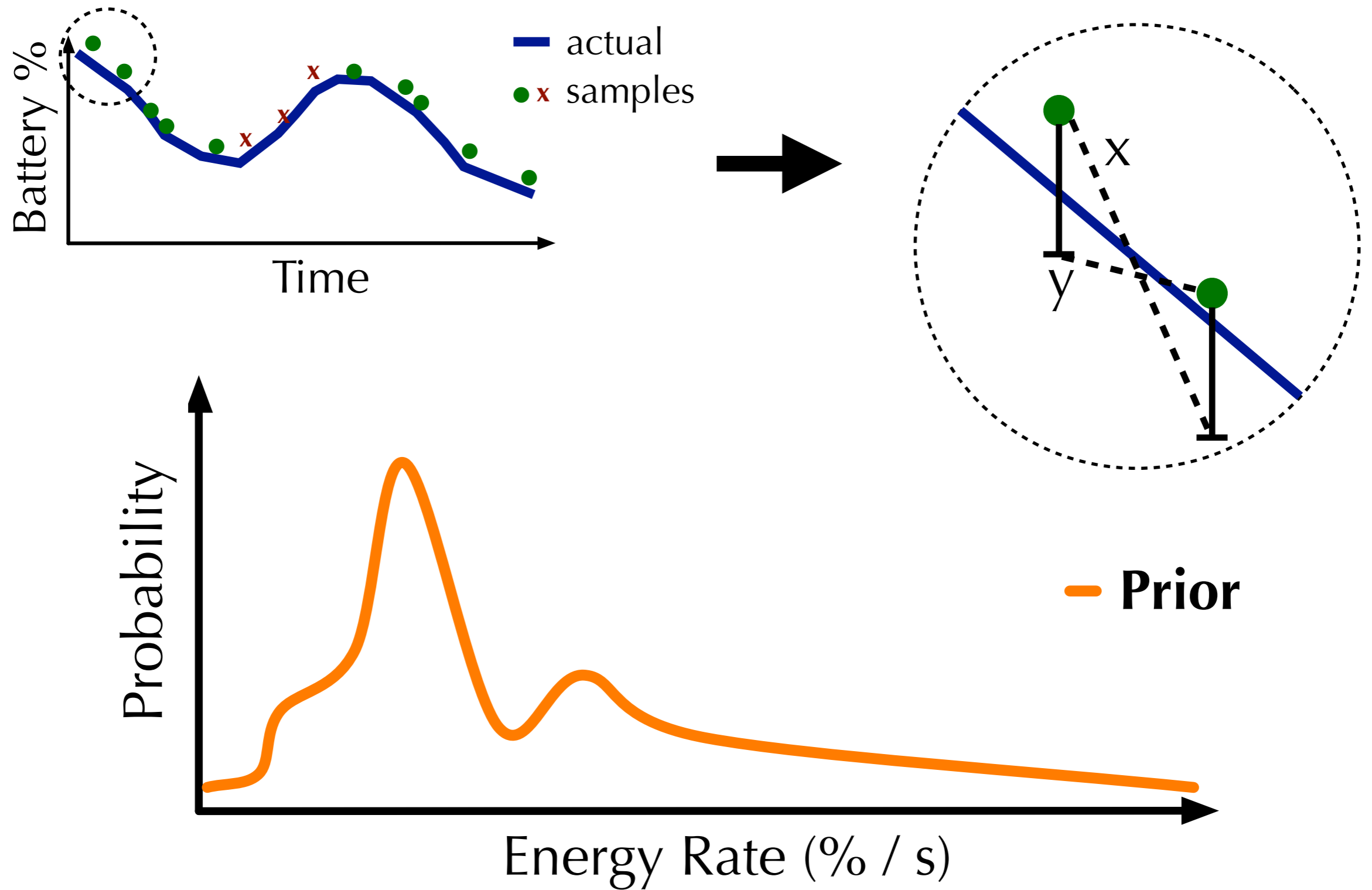
Measurement Uncertainty



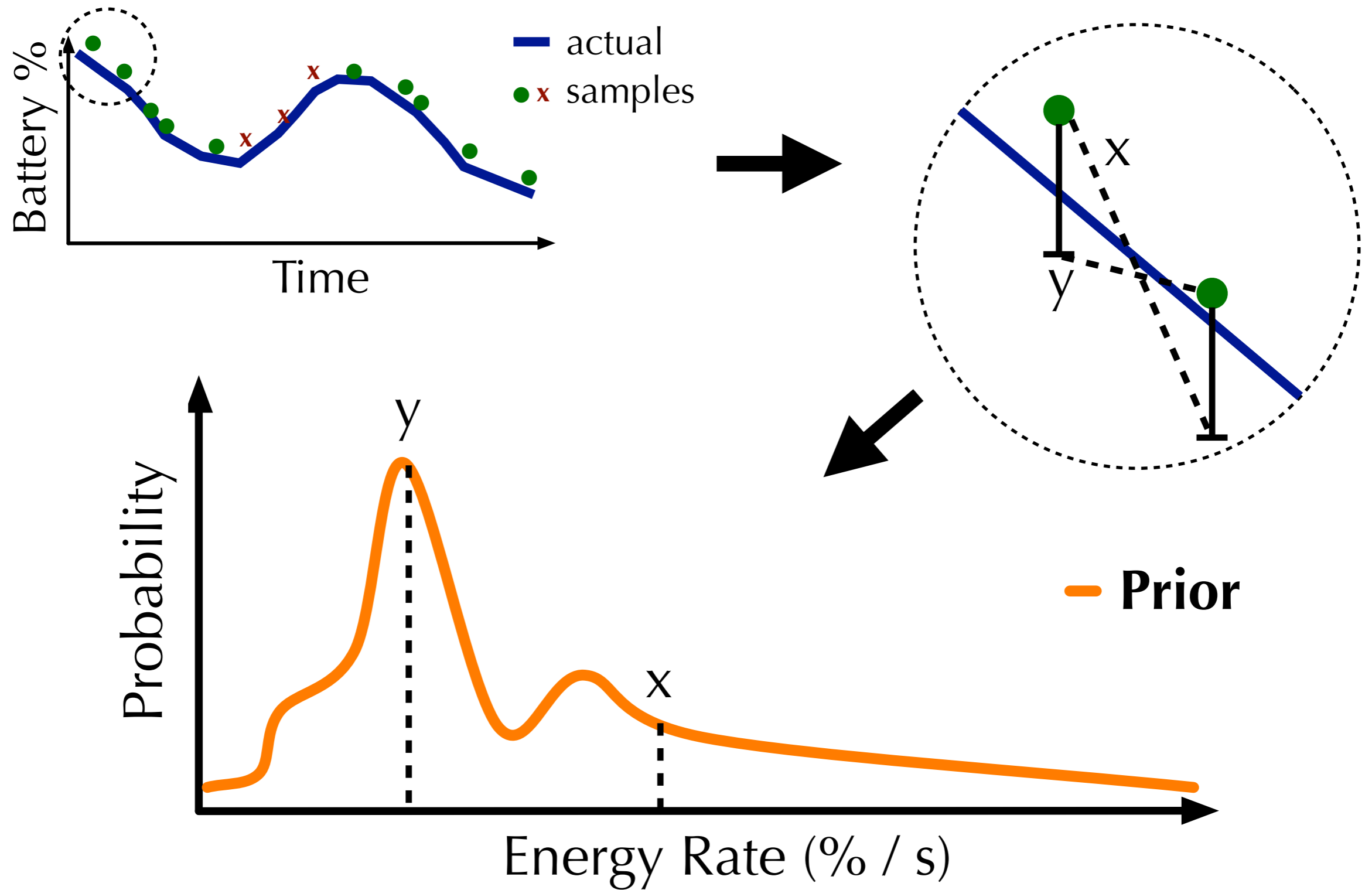
Measurement Uncertainty



Measurement Uncertainty



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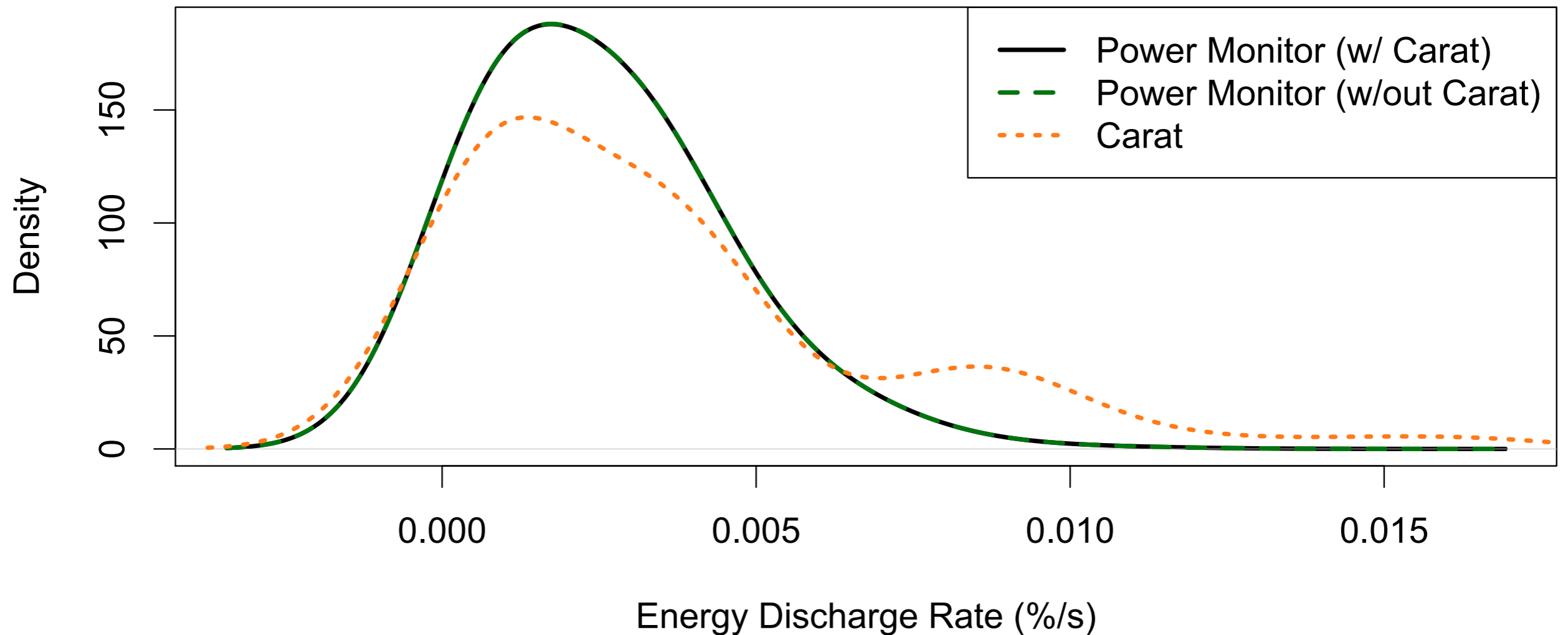
Ground Truth

- Sampling cost and accuracy
- iPhone 4S + Monsoon Power Monitor



Ground Truth

- Good accuracy with low overhead



Ground Truth

- Discharge rate estimation
 - 0.00088 %/sec error
 - Samples: 9 vs. 28,800,000
- Overhead
 - Less than Weather app
 - ~3.5% of the battery less

Initial Deployment

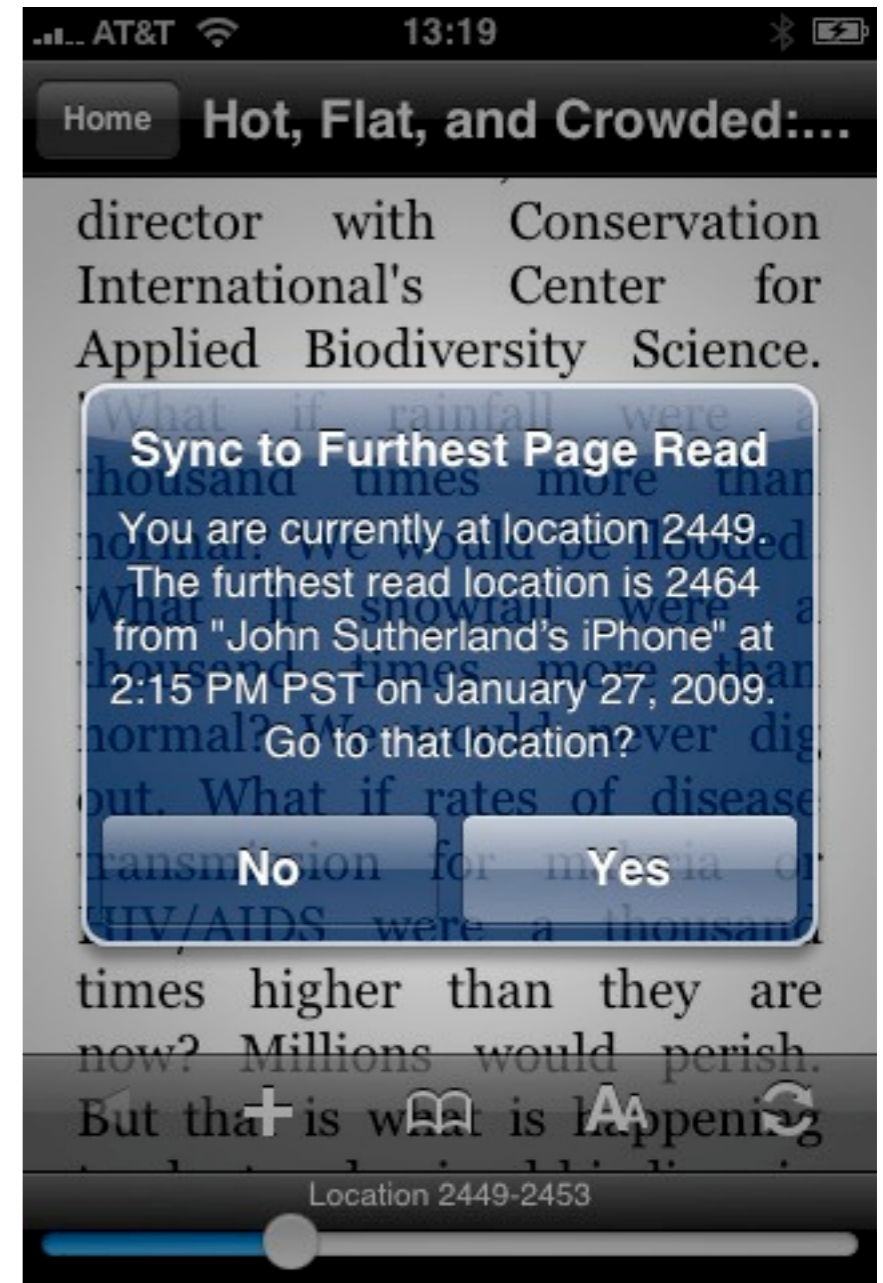
- TestFlight and Zuhium
- App Store and Play Store
- 883 devices
- 180k samples

Initial Results

- Found 644 apps exhibiting energy bugs
 - e.g., Facebook, Kindle, Flipboard
 - Corroborated with forum posts, news articles, and data correlations
- Injected three bugs in Wikipedia
 - Detected all of them

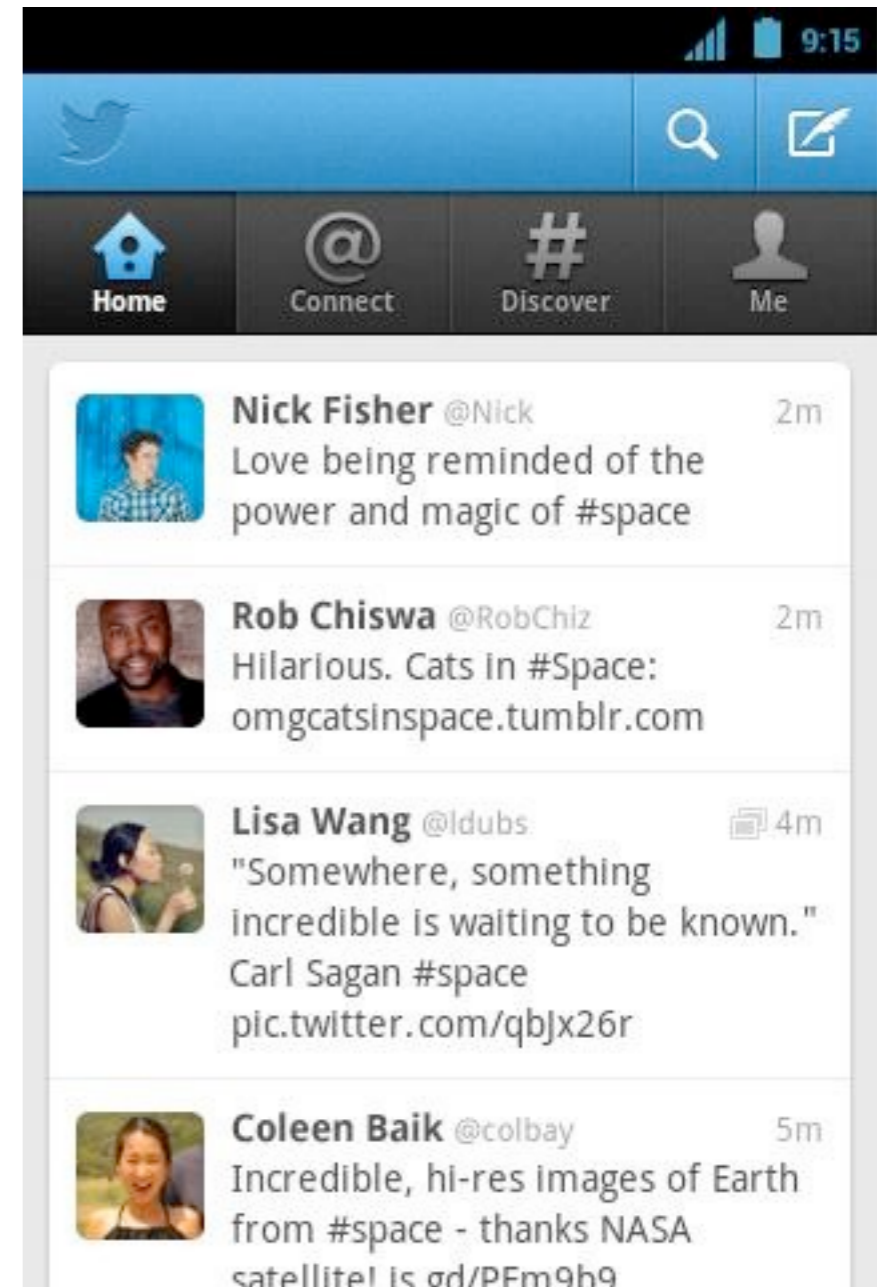
Kindle Bug (iOS)

- E-book reader
- Bug on 3.9% of clients
- Forum: WhisperSync
- Confirmed by our data
- Turn on WiFi
→ 36m improvement



Twitter Bug (Android)

- Microblogging app
- Bug on 14.9% of clients
- Data implicates OS
- WiFi also helps
- Upgrade to ICS 4.0.4
→ 94m improvement



Comment

36

Like

1k

Tweet

in

Share

309

+1

171

Carat: The Brilliant App That Increases Your Battery Life By Showing What Other Apps To Kill



JOSH CONSTINE

Thursday, June 14th, 2012

36 Comments



"Kill Pandora – Expected Battery Life Improvement: 1 hour 50 minutes" This is what you'll learn from **Carat**, an incredibly useful free **new iOS** and **Android app** that's the first to give you personalized mobile battery life-saving recommendations.

Carat quietly takes measurements from you device, does some math, combines it with other people's anonymized data, and sends back tips on if you should update your OS, kill or restart apps, and how many more minutes of tablet or phone fiddling you'll gain.

As battery tech is expected to improve slowly, some say increasing life just 5% a year, and as we get faster processors, more powerful apps, and brighter screens, everyone could use a Carat in their pocket.

Suddenly...

t By o Kill

36 Comments

Life Improvement: 1 hour
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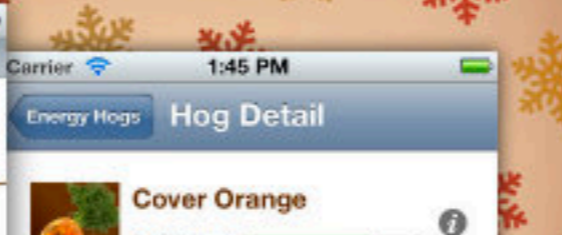
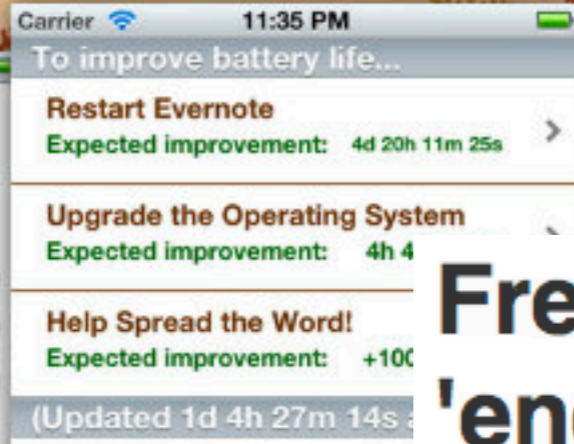
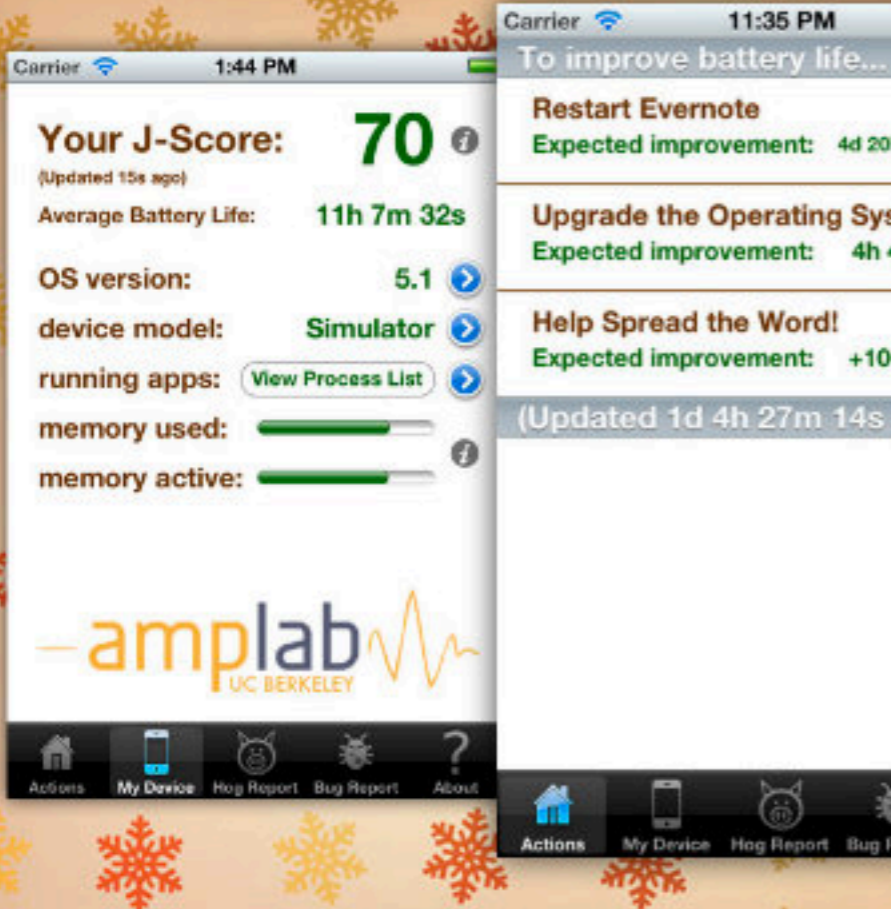
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Free Carat app finds 'energy hogs,' 'energy bugs' on iOS or Android devices

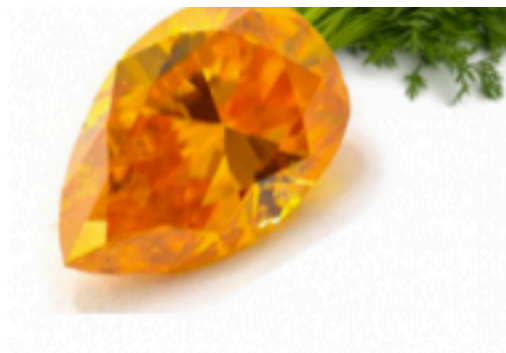
ANDROID | JUNE 14, 2012 | BY: MICHAEL SANTO

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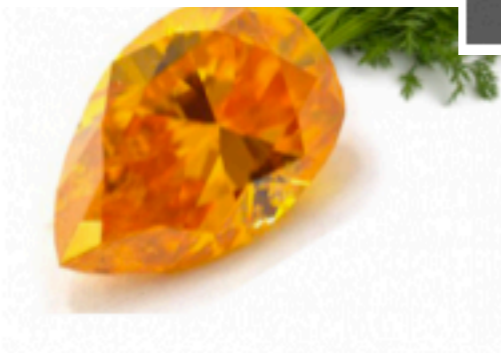
Carat



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Carat: Extend Your Phone's Battery Life

LESLIE HORN JUNE 19, 2012 2:00 PM



Carat



Su

Carat: Extend Your Phone's Battery Life

LESLIE HORN JUNE 19, 2012 2:00 PM



Topic: iPhone

iOS and Android app helps you get more from your battery

Summary: Carat has been developed by a team of scientists from the UC Berkeley electrical engineering and computer science department's Algorithms, Machines, and People Laboratory (AMP Lab).



By [Adrian Kingsley-Hughes](#) for [Hardware 2.0](#) | June 15, 2012 -- Updated 10:21 GMT (03:21 PDT)

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Carat: Extend Your Phone's Battery Life

LESLIE HORN JUNE 19, 2012 2:00 PM



Carat went viral. In 24 hours, there were dozens of articles and we had more than 100,000 users.

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Carat Today

- 360,000 devices
- 20M samples
- Deploy to the crowd; debug in the cloud
 - Platform for collaborative debugging
 - Statistics as a service

carat.cs.berkeley.edu

Fin

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