Lecture 3:
Goal-oriented interaction

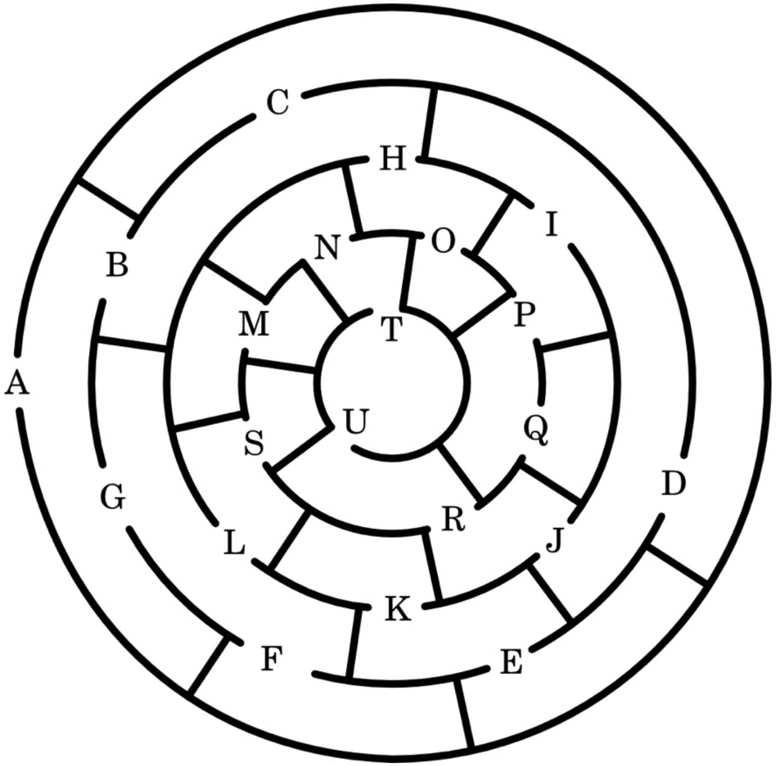
Using cognitive theories of planning, learning and understanding to understand user behaviour, and what they find hard.

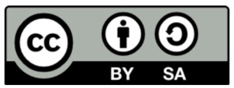
Overview of the course

- Theory driven approaches to HCI
- Design of visual displays
- **Goal-oriented interaction**
- Designing smart systems (guest lecturer)
- Designing efficient systems
- Designing meaningful systems (guest lecturer)
- Evaluating interactive system designs
- Designing complex systems

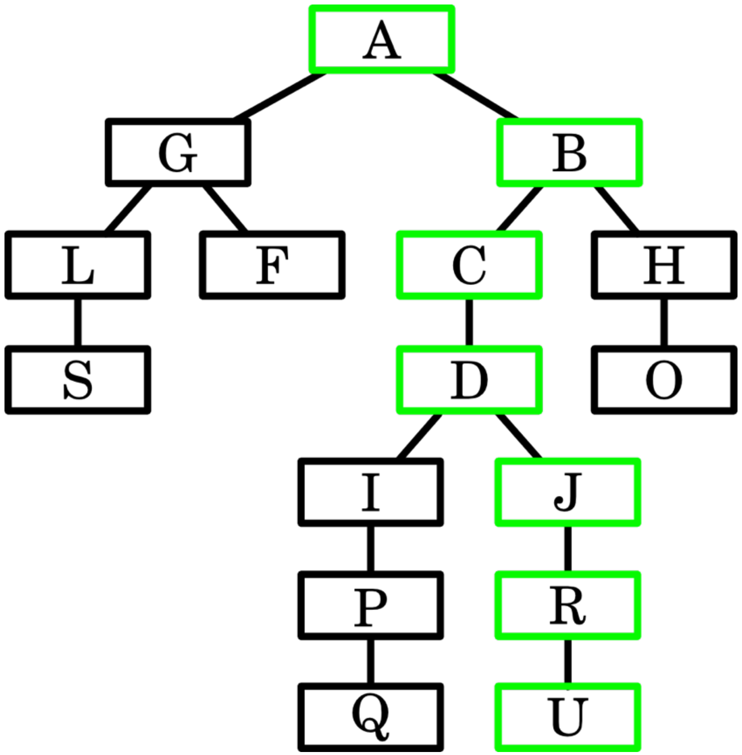
A *Metatheory* (in first-wave HCI): User interaction can be modelled as search

Reminder from Prolog course: problem solving using graph search





Turn the problem into a graph



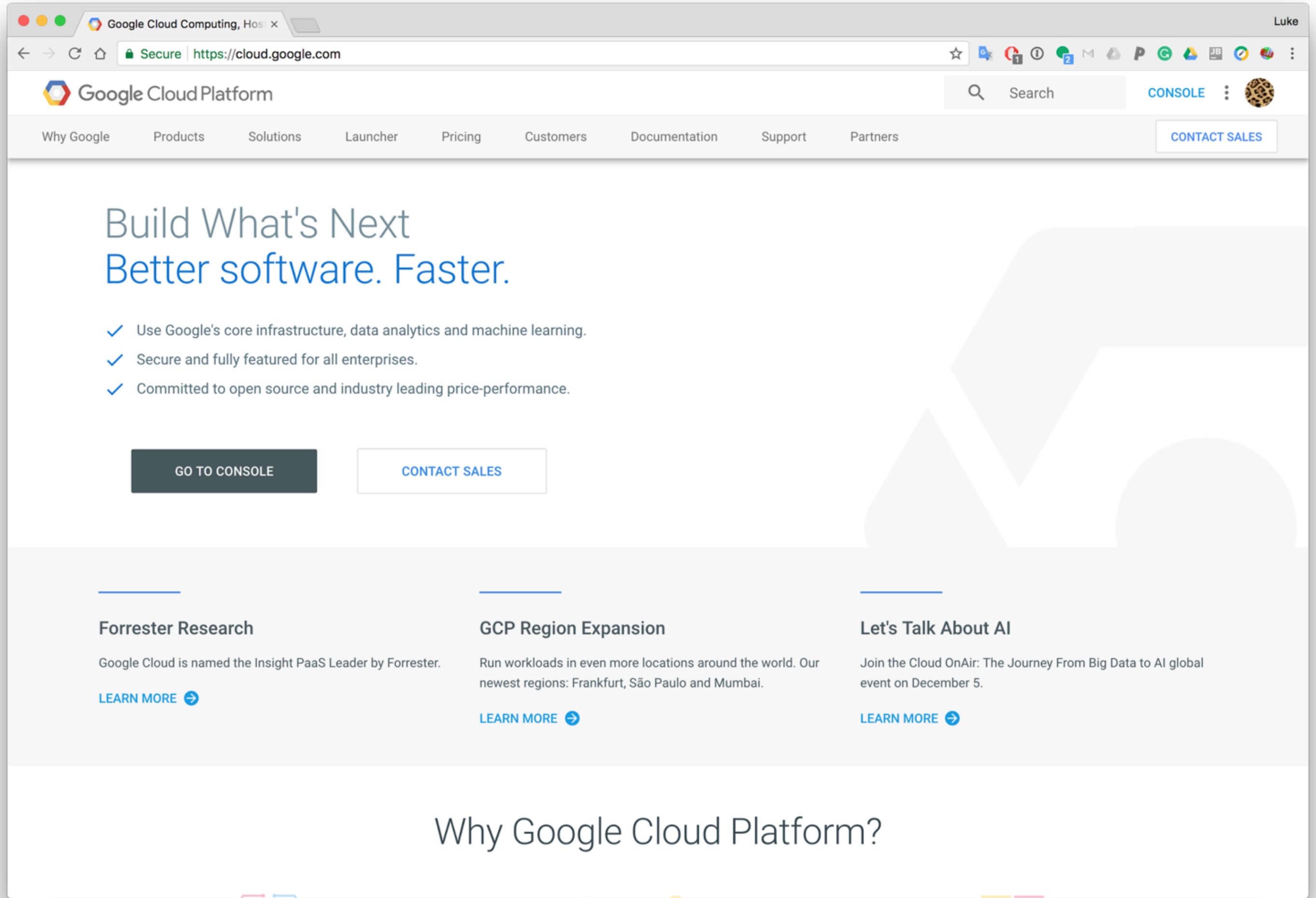
Encode as Prolog facts to solve

```
route(a,g).
route(g,l).
route(l,s).
...
travel(A,A).
travel(A,C) :- route(A,B),travel(B,C).

solve :- start(A),finish(B), travel(A,B).
```

```
start(a).
finish(u).
```

HCI example of a **User Goal**:
“How much did my use of Google Cloud Platform cost me last month?”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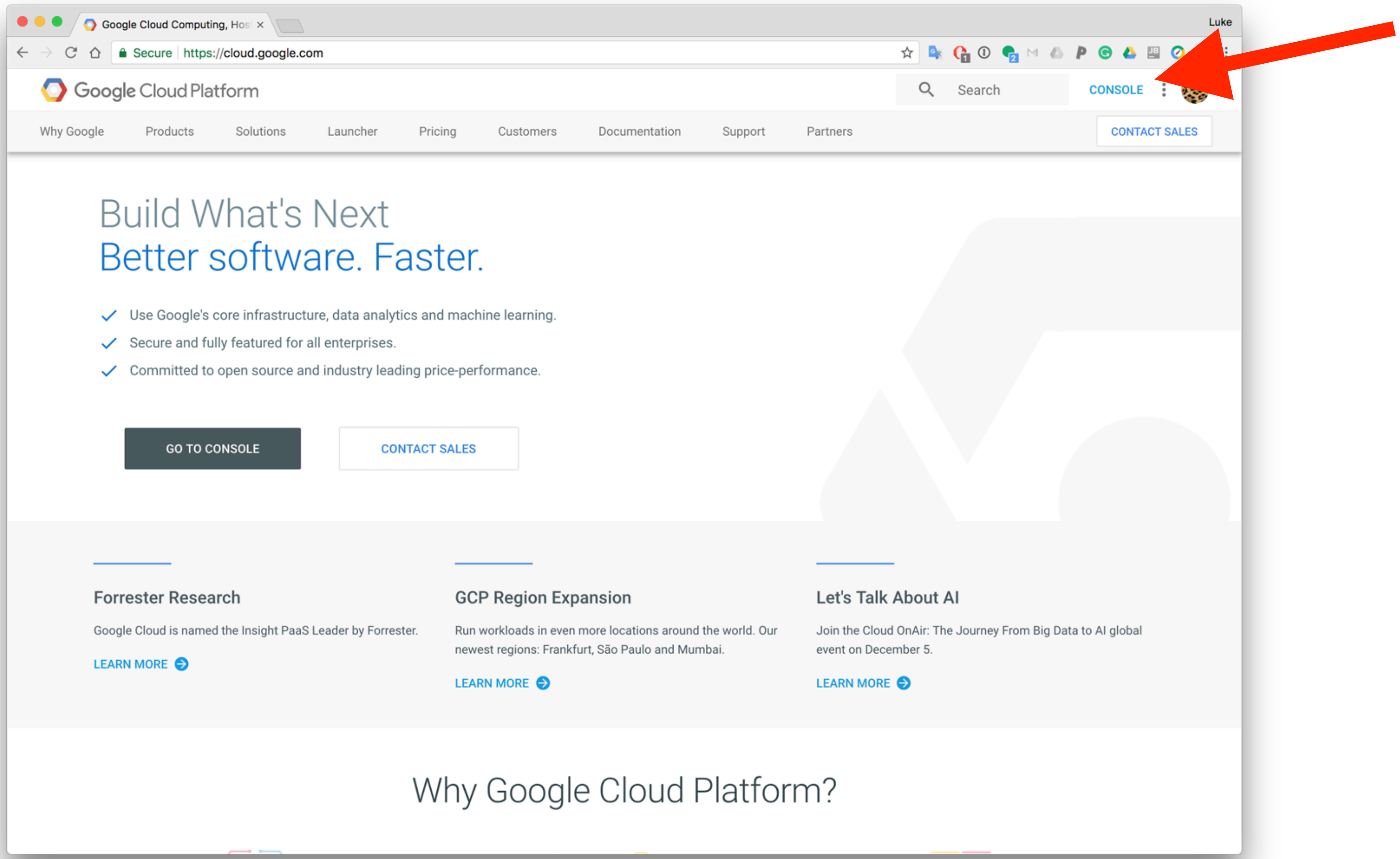
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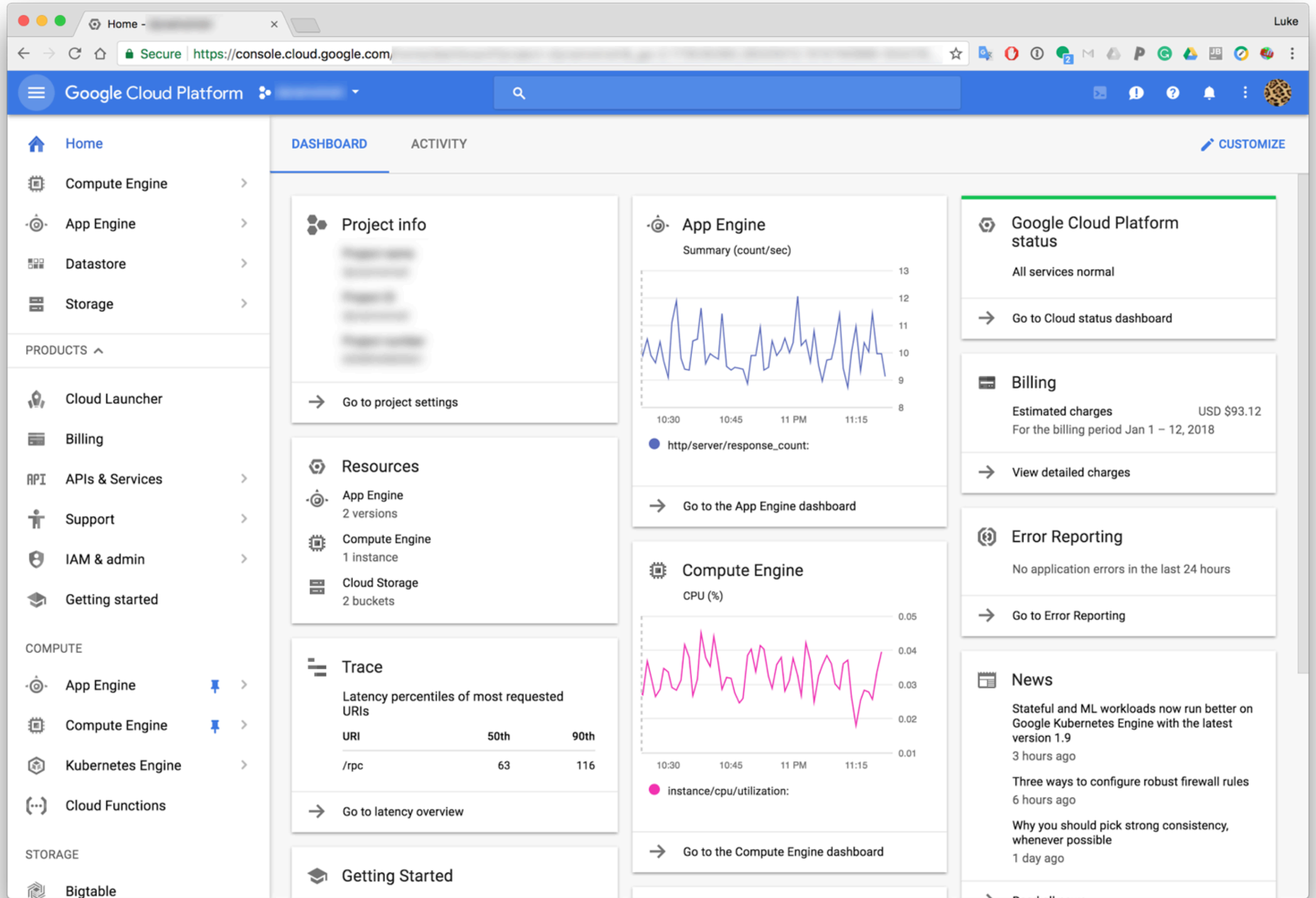
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Compute Engine
Kubernetes Engine
Cloud Functions
STORAGE
Bigtable
DASHBOARD
ACTIVITY
CUSTOMIZE
Project info
Go to project settings
Resources
App Engine
2 versions
Compute Engine
1 instance
Cloud Storage
2 buckets
Trace
Latency percentiles of most requested URIs
URI 50th 90th
/rpc 63 116
Go to latency overview
Getting Started
App Engine
Summary (count/sec)
http/server/response_count:
Go to the App Engine dashboard
Compute Engine
CPU (%)
instance/cpu/utilization:
Go to the Compute Engine dashboard
Google Cloud Platform status
All services normal
Go to Cloud status dashboard
Billing
Estimated charges USD $93.12
For the billing period Jan 1 – 12, 2018
View detailed charges
Error Reporting
No application errors in the last 24 hours
Go to Error Reporting
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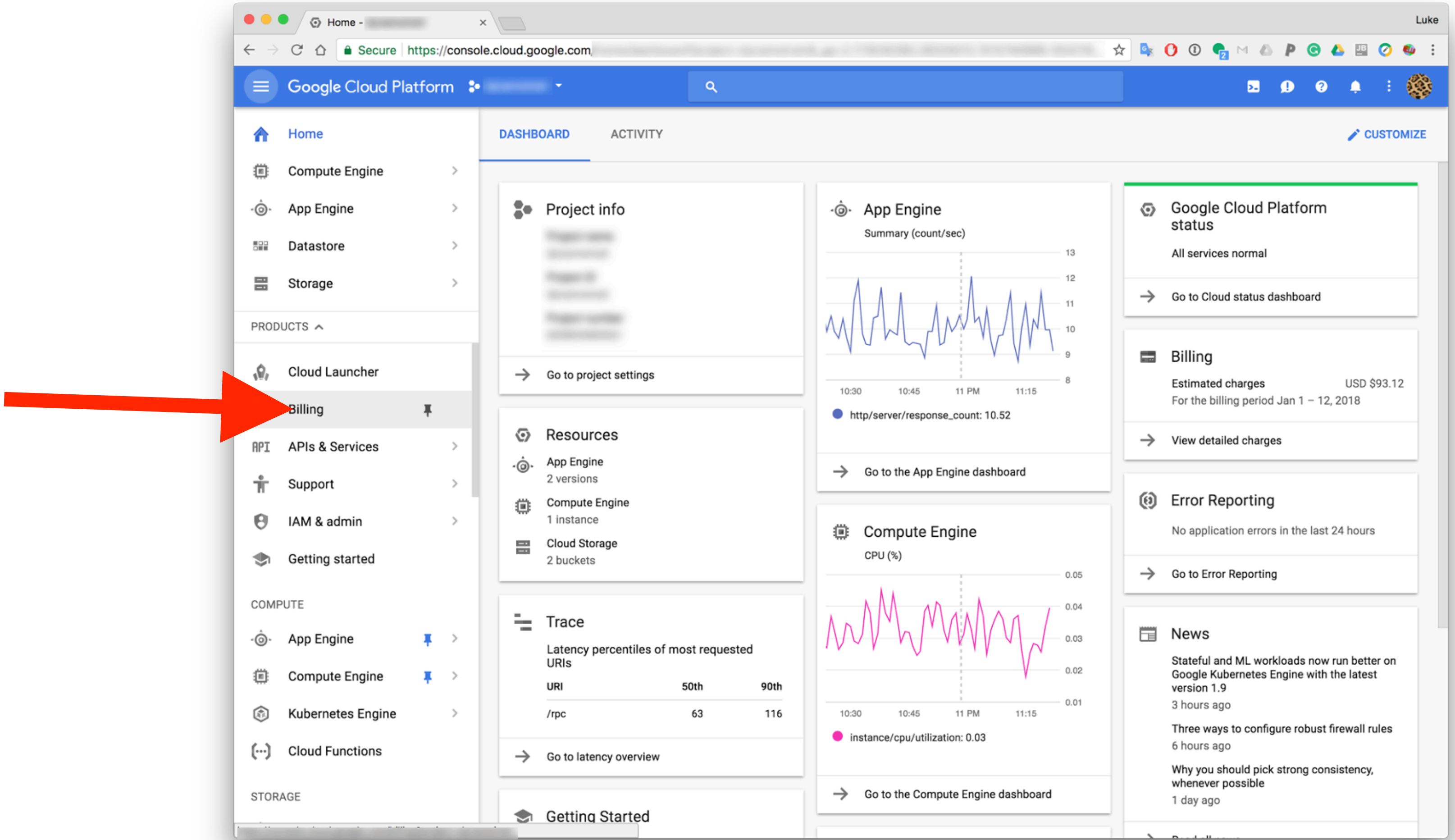
Three ways to configure robust firewall rules
6 hours ago
Why you should pick strong consistency, whenever possible
1 day ago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App Engine
Compute Engine
Kubernetes Engine
Cloud Functions
STORAGE
DASHBOARD
ACTIVITY
CUSTOMIZE
Project info
Go to project settings
Resources
App Engine
2 versions
Compute Engine
1 instance
Cloud Storage
2 buckets
Trace
Latency percentiles of most requested URIs
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Getting Started
App Engine
Summary (count/sec)
http/server/response_count: 10.52
Go to the App Engine dashboard
Compute Engine
CPU (%)
instance/cpu/utilization: 0.03
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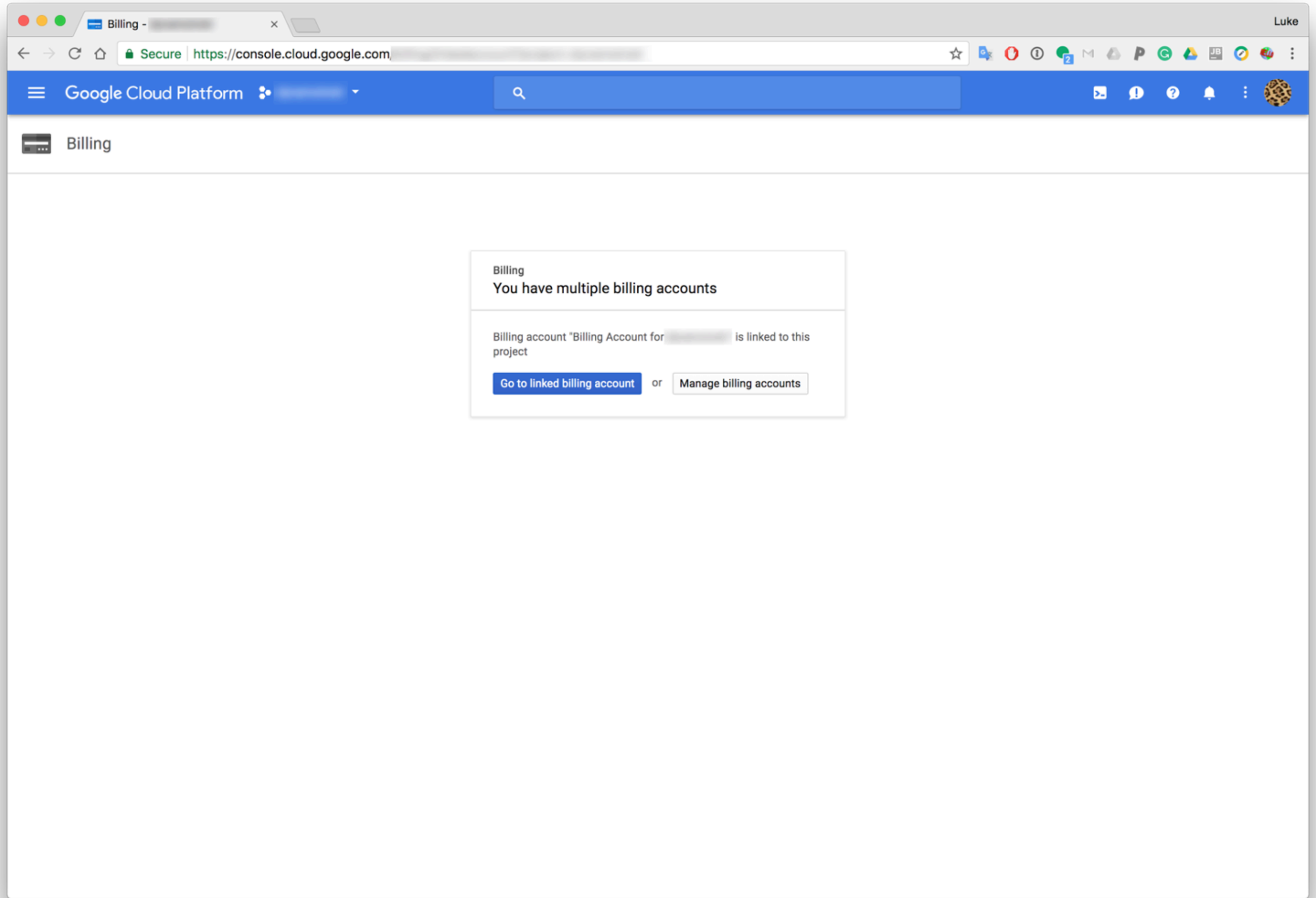
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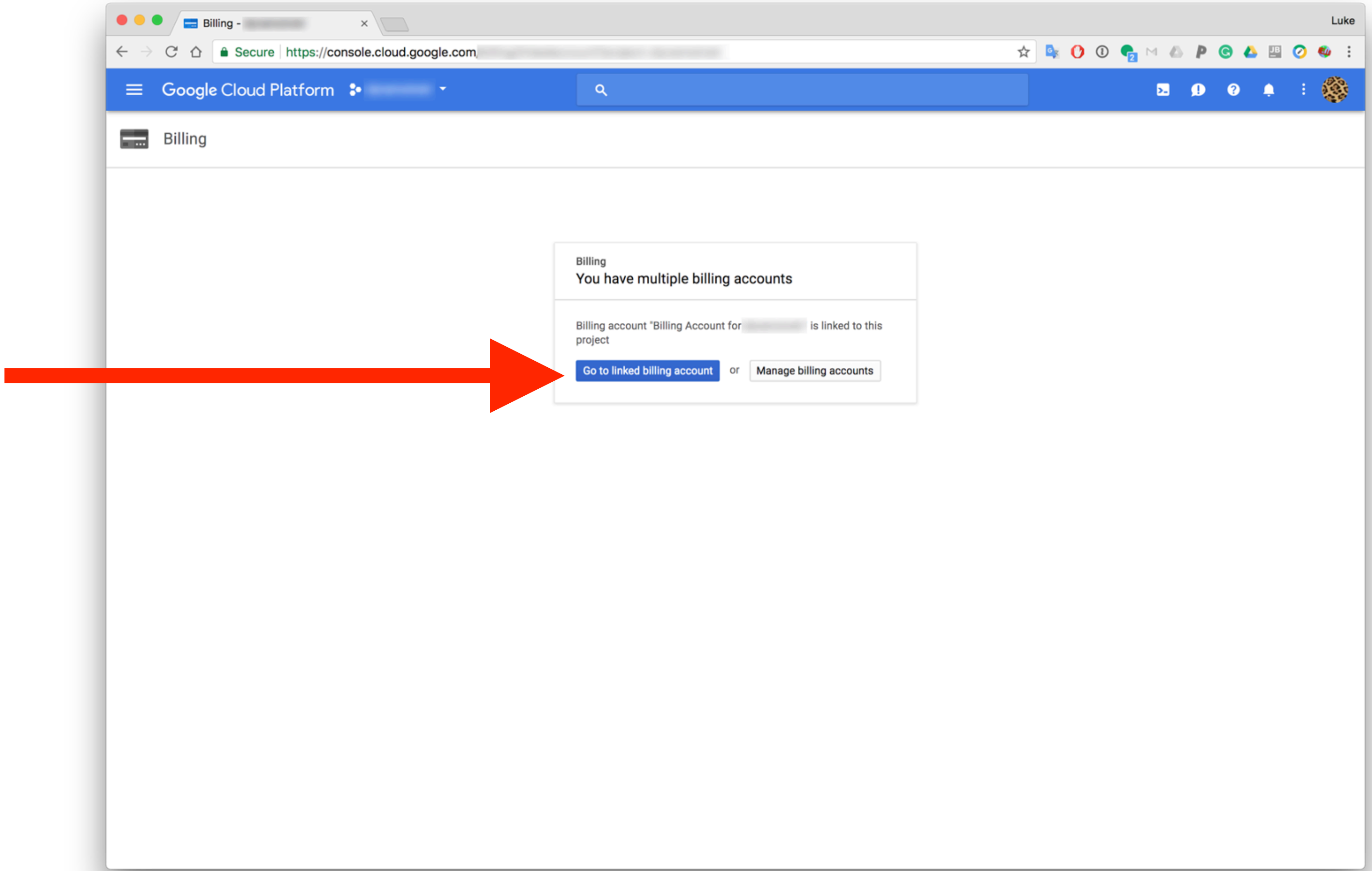
Google Cloud Platform
Billing
Billing
You have multiple billing accounts
Billing account "Billing Account for is linked to this project
Go to linked billing account
or
Manage billing accounts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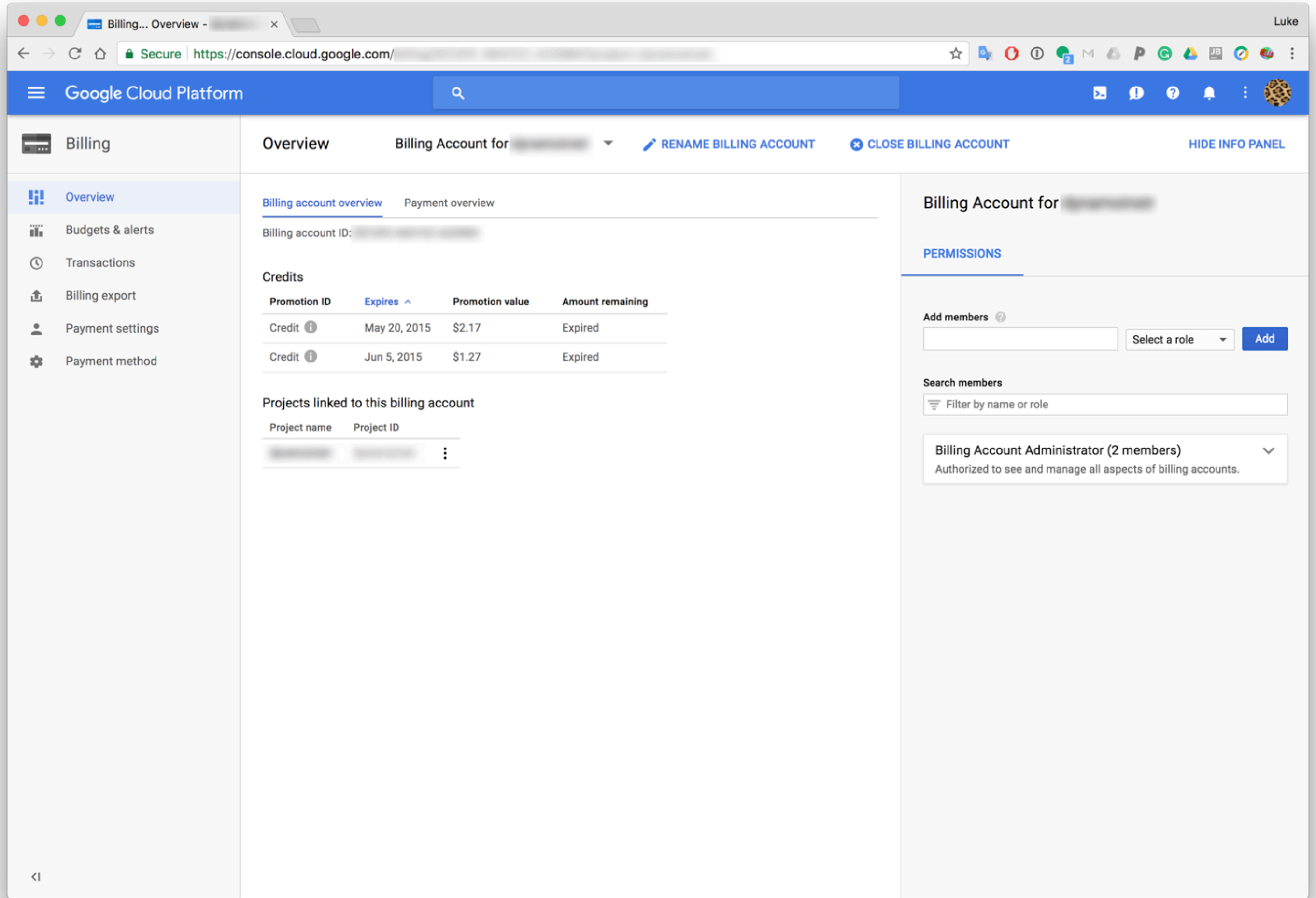
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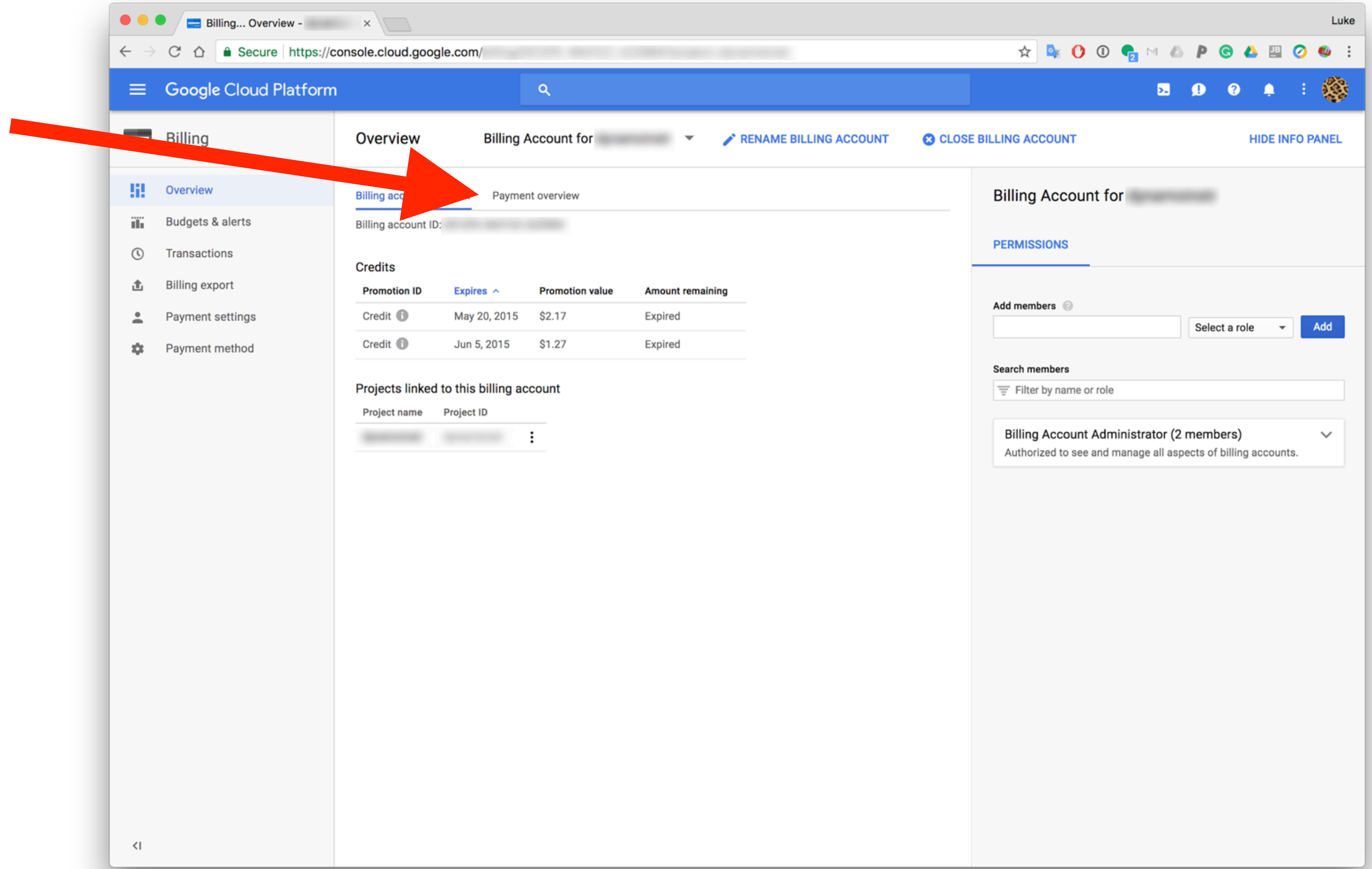
Overview
Budgets & alerts
Transactions
Billing export
Payment settings
Payment method
Overview
Billing Account for
RENAME BILLING ACCOUNT
CLOSE BILLING ACCOUNT
HIDE INFO PANEL
Billing account overview
Payment overview
Billing account ID:
Credits
Promotion ID
Expires
Promotion value
Amount remaining
Credit May 20, 2015 $2.17 Expired
Credit Jun 5, 2015 $1.27 Expired
Projects linked to this billing account
Project name
Project ID
Billing Account for
PERMISSIONS
Add members
Select a role
Add
Search members
Filter by name or role
Billing Account Administrator (2 members)
Authorized to see and manage all aspects of billing accounts.



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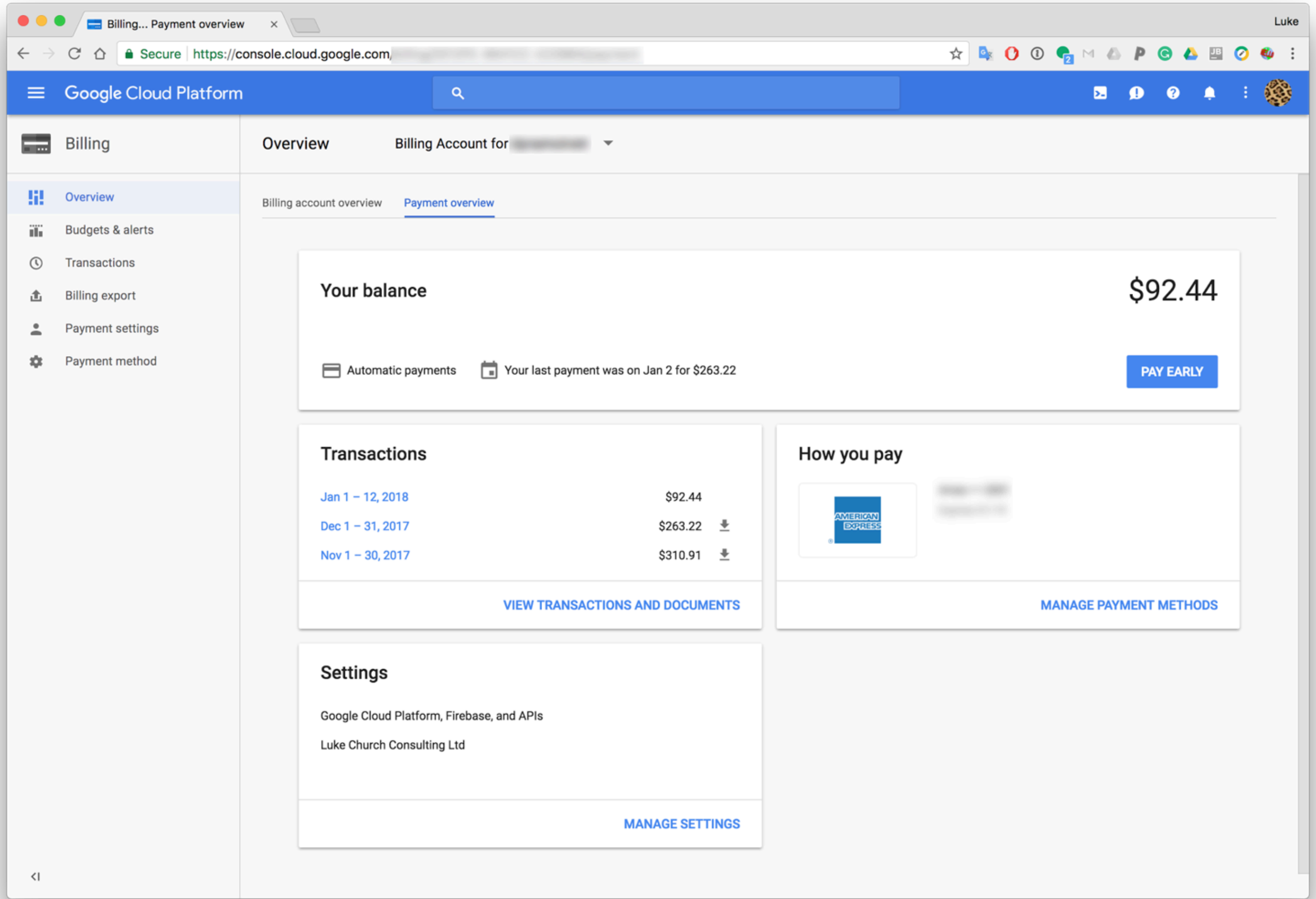
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Payment overview
Your balance
$92.44
Automatic payments
Your last payment was on Jan 2 for $263.22
PAY EARLY
Transactions
Jan 1 – 12, 2018
$92.44
Dec 1 – 31, 2017
$263.22
Nov 1 – 30, 2017
$310.91
VIEW TRANSACTIONS AND DOCUMENTS
How you pay
AMERICAN EXPRESS
MANAGE PAYMENT METHODS
Settings
Google Cloud Platform, Firebase, and APIs
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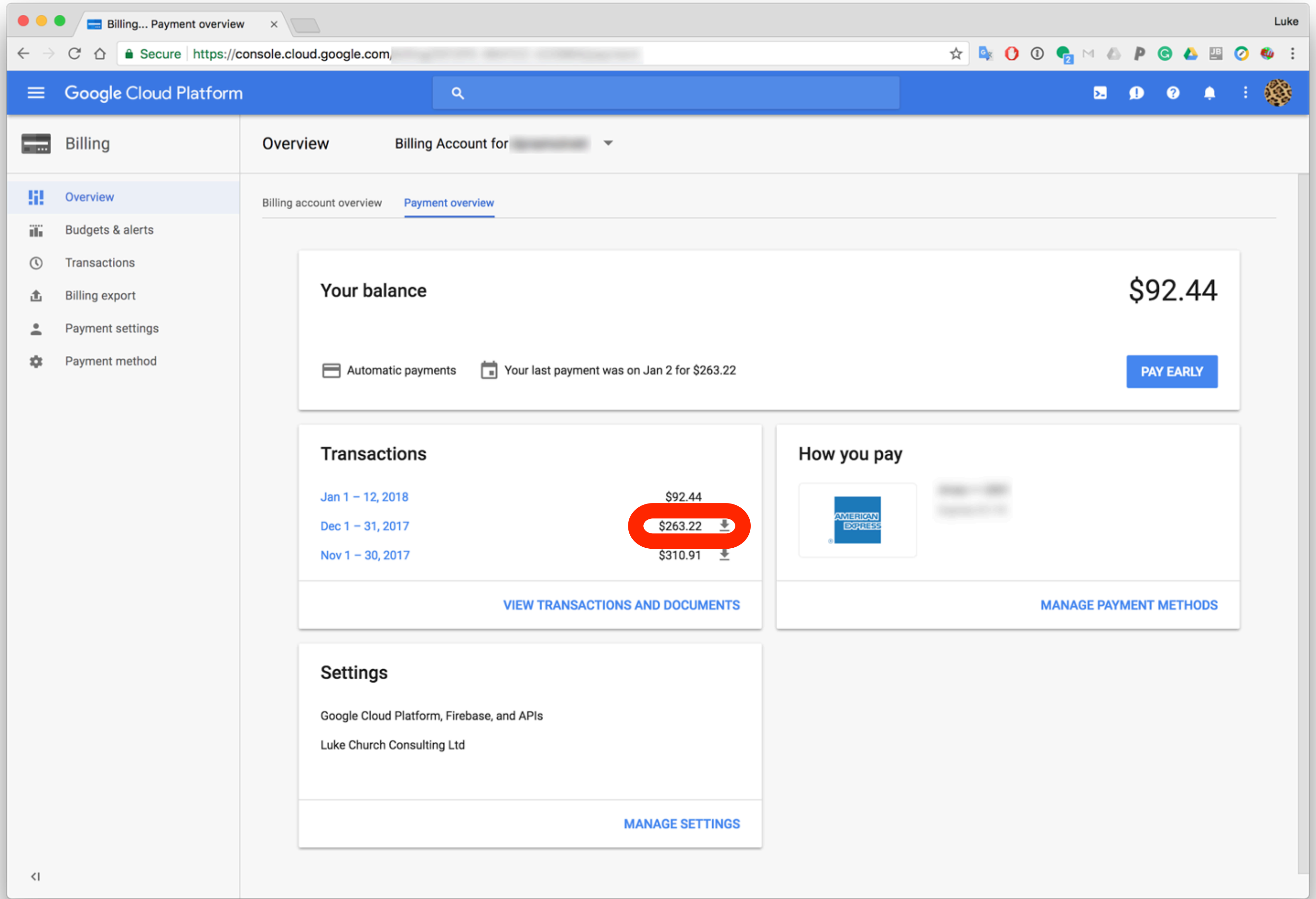
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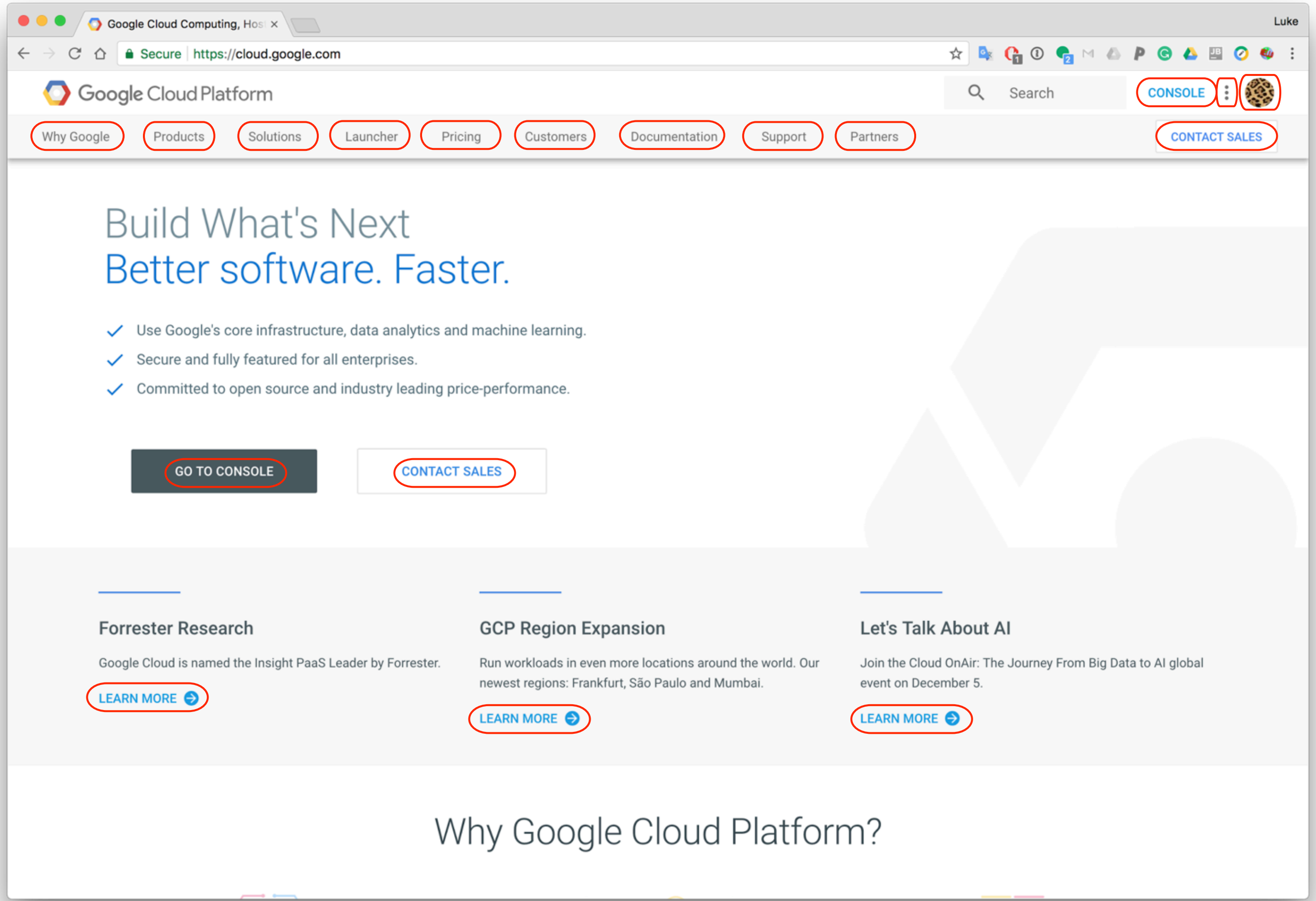
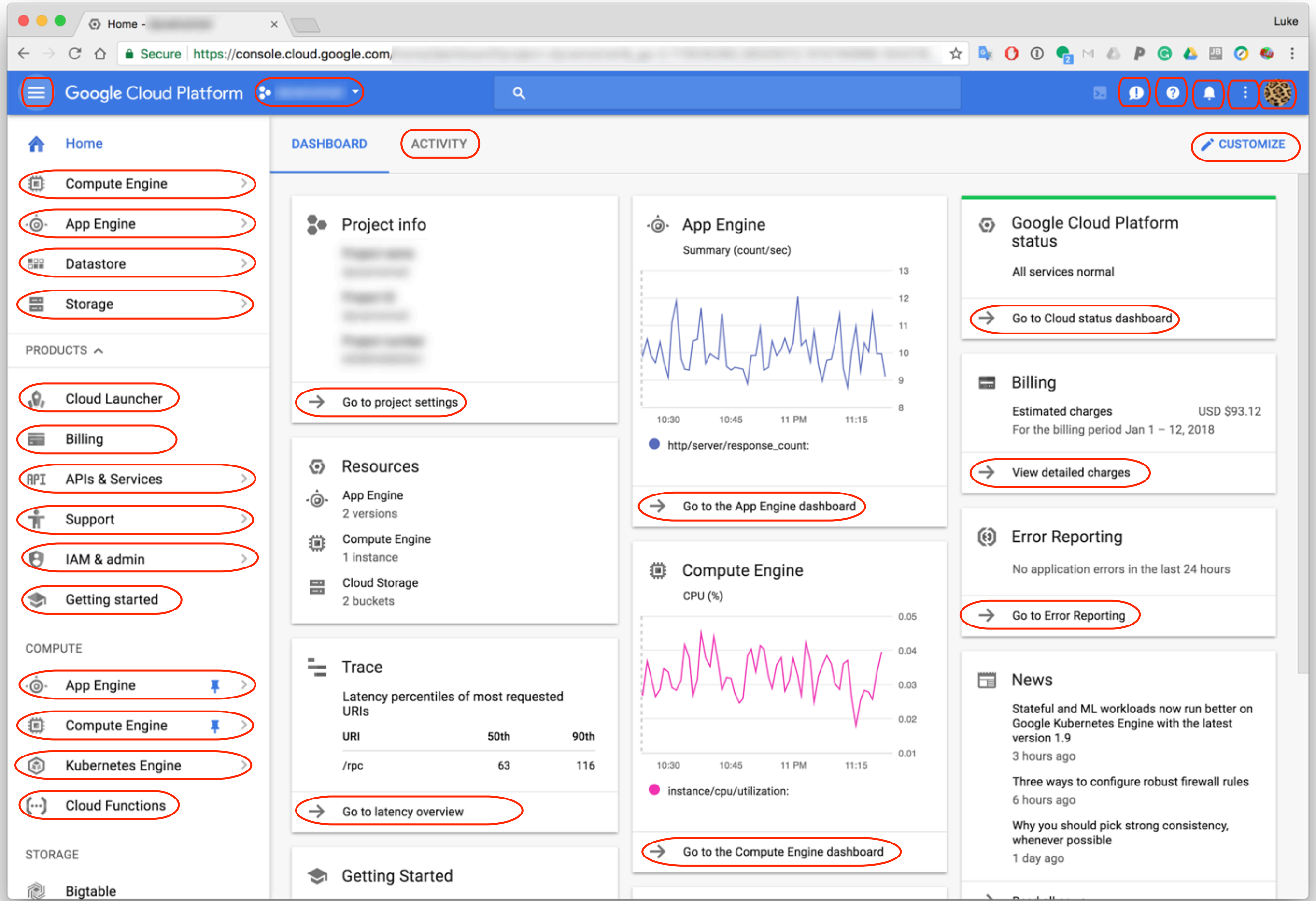
What search algorithm is being used here?

Breadth first/Depth first?

Click targets



Click targets

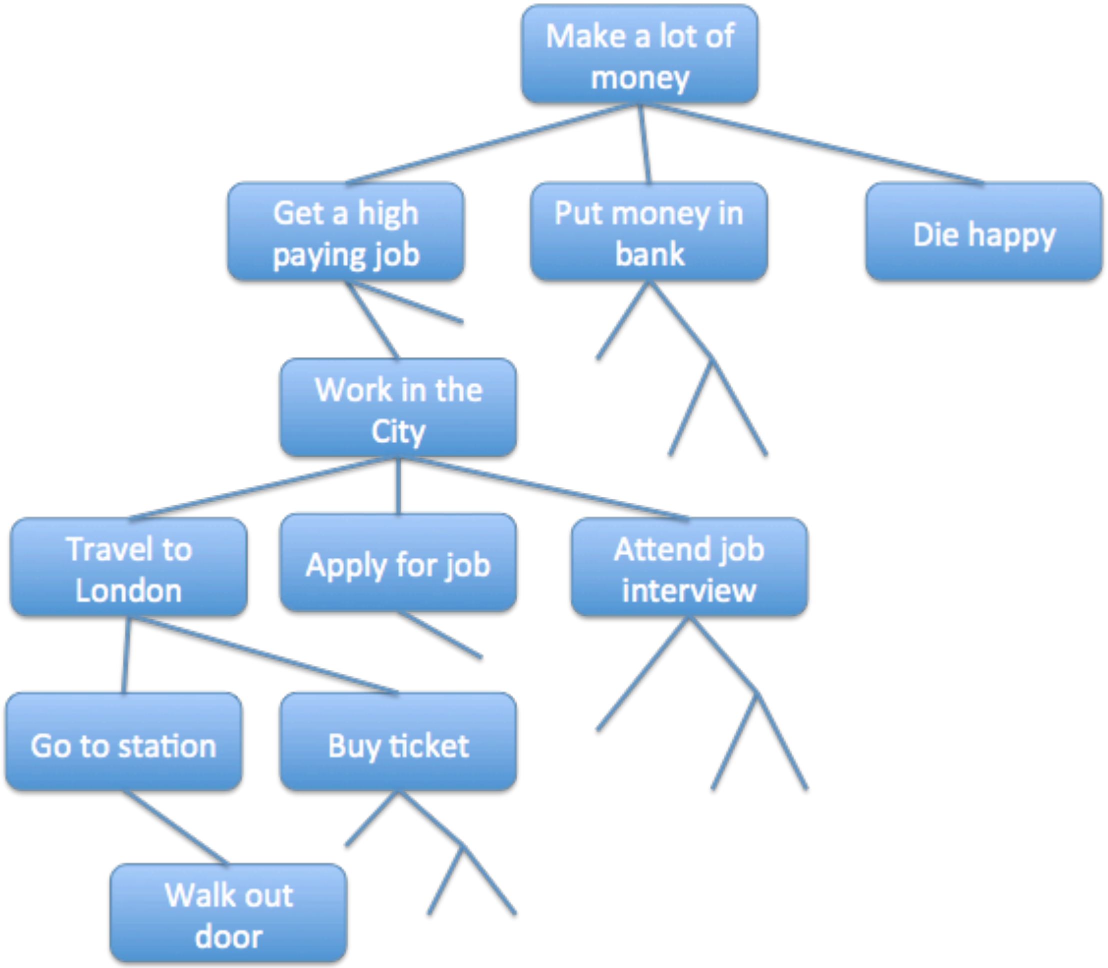


Human problems as AI search

Alan’s ultimate goal: Make a lot of money

Some nodes in the search tree that must be arranged in order:

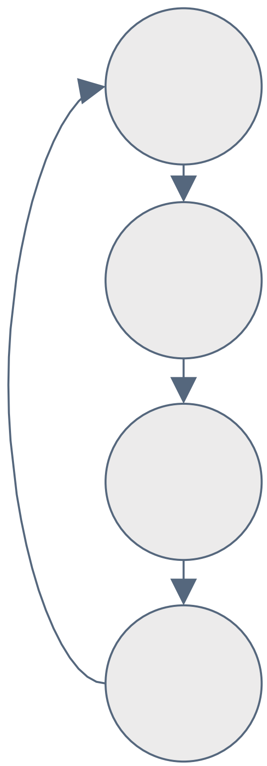
- Get a high paying job
- Save the money
- Work in the City
- Attend a job interview
- Apply for a job
- Travel to London
- Buy a train ticket
- Go to the station ...



Make a lot of money
Get a high paying job
Put money in bank
Die happy
Work in the City
Travel to London
Apply for job
Attend job interview
Go to station
Buy ticket
Walk out door

Reminder from Part 1a:
Cognitive Walkthrough

[Simplified] Cognitive Walkthrough



Goal

Availability

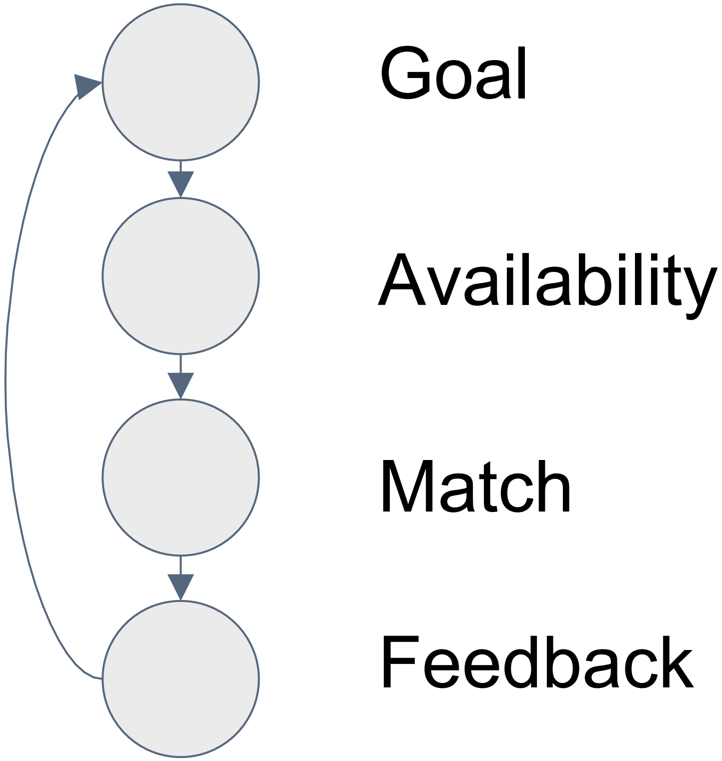
Match

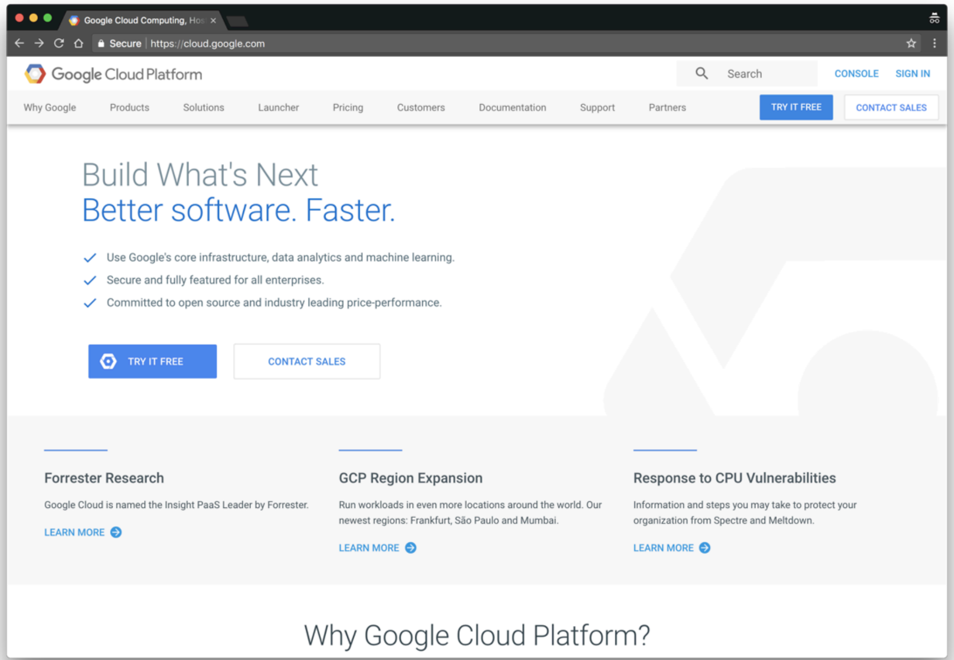
Feedback

See: https://www.colorado.edu/ics/sites/default/files/attached-files/93-07.pdf

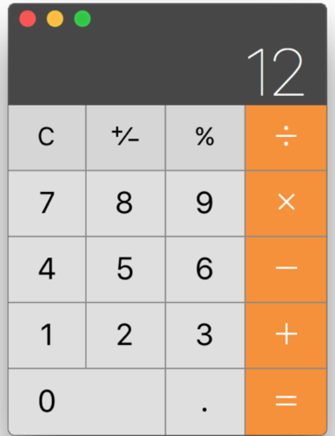
For a detailed description

Finding your bill?





The cost of thinking:
Heuristics and Biases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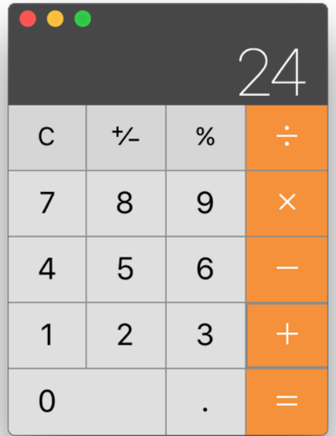
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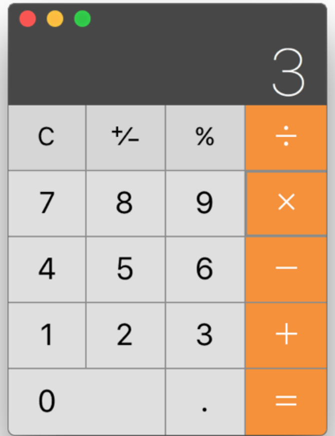
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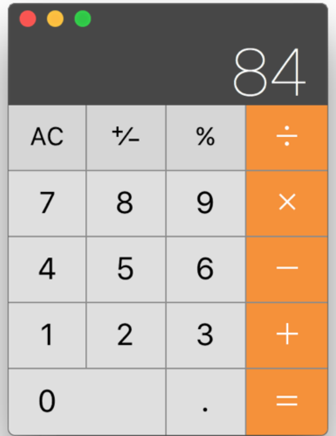
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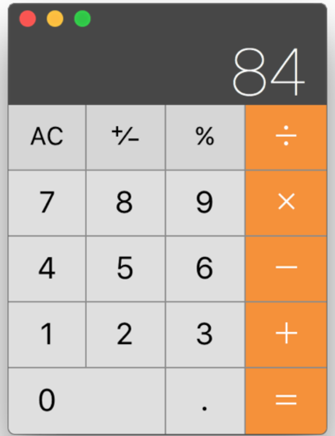
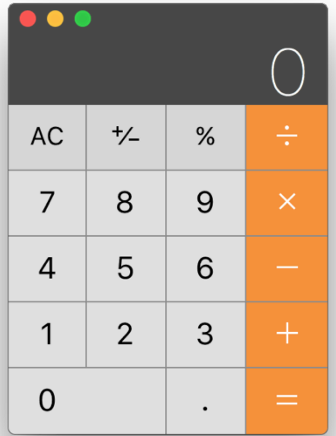
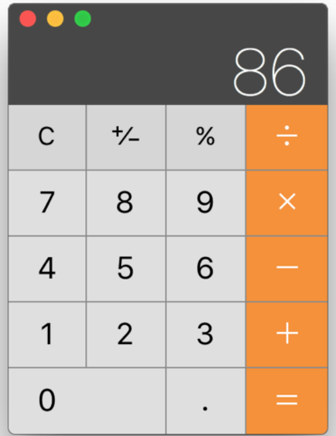






= AC + 2

“eh?”

(Example from Richard Young)

How many times should the calculator user press AC?

Classical theories of metareasoning

- Optimal search
  - Find the best possible solution within stated constraints on resources
- Bounded rationality
  - Computation is one of the constraints
- Satisficing
  - Find a satisfactory solution within computation constraints

Neuro-economic models of reasoning

- Behavioural economics, popularly known as "Nudge"
- Original basis in "prospect theory" (Kahneman & Tversky)
  - General theory of decision making
  - Construct a utility model, based on outcome of possible actions
  - Weight estimated values by likelihood
  - Choose action with optimal utility
  - May include future value discounting
- In practice, the optimisation is more likely to involve satisficing, due to reasoning with bounded rationality constraints
  - In Kahneman's terms "thinking fast and slow"

Bounded rationality in humans

- Apply *heuristics* rather than searching for optimal plan
  - Availability heuristic - reason based on examples easily to hand
  - Affect heuristic – base decision on emotion rather than calculating cost / benefit
  - Representativeness heuristic - judge probability based on resemblance
- Apply *biases* to ensure estimation error within tolerable bounds
  - Loss aversion - losses hurt more than gains feel good
  - Expectation bias - researchers (even in HCI) find results they expected
  - Bandwagon effect - do what other people do
- And many others!

Behavioural economics in programming

- “Attention Investment theory” of abstraction use
  - Automation requires abstract specification
    - e.g. defining a regular expression for search and replace
  - Benefit of automation is saving time and concentration in future
  - But abstract specification (programming) takes time and concentration!
    - And powerful abstractions (programs) can go wrong powerfully
  - User may prefer repetitive manual operations - safe and incremental
- So utility function will compare future saving of attention from programming vs costs of concentrating on a risky strategy
  - Biases such as loss aversion will apply
  - Bounded rationality will apply, since deciding what to do takes even more concentration

The limitations of goal based HCI

It assumes the user doesn't make mistakes

- Would need a cognitive model of why error occurred
  - Information loss due to cognitive limitations
  - Incorrect mental model
  - Misleading design
- Need description of user journey that accounts for problem identification, diagnosis, debugging, testing, iteration etc

It assumes the user has the right goal

- Persuasive design is a field of HCI that addresses goal formation
- Applications:
  - Reduce energy consumption
  - Promote exercise
  - Manage diet and nutrition
  - Smoking cessation
- May include “nudge” to account for biases
  - But paternalistic / patronising

It assumes the user knows what the goal is

- Not true when the purpose is an experience (third wave HCI)
- Not true in “exploratory design”

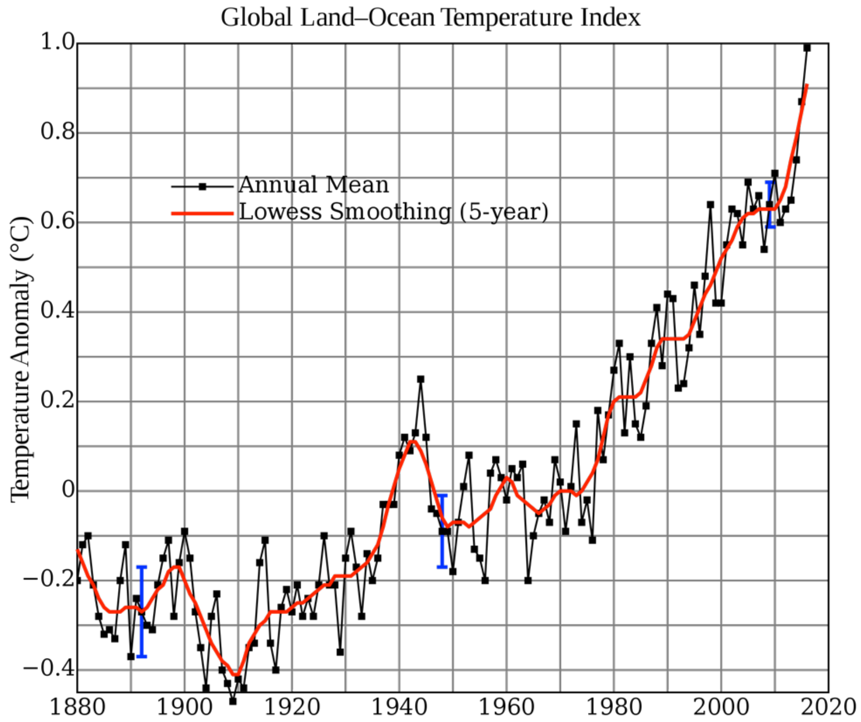
- More attention to this later in the course
- Some problems can’t be decomposed into actions
- Sometimes actions have side effects

Wicked problems

Including material provided by
Steven Tanimoto

A Wicked Problem:

Slowing climate change



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More Wicked Problems

- Stopping the spread of antibiotic-resistant diseases
- Halting nuclear proliferation
- Ending homelessness in Cambridge
- Avoiding species extinction
- Colonizing Mars

Rittel-Webber Characteristics 1-5 of 10

1. There is no definitive formulation of a wicked problem
2. Wicked problems have no stopping rule
3. Solutions to wicked problems are not true-or-false, but good-or-bad
4. There is no immediate and no ultimate test of a solution to a wicked problem
5. Every solution to a wicked problem is a “one-shot operation”; because there is no opportunity to learn by trial-and-error, every attempt counts significantly

Rittel-Webber Characteristics 6-10 of 10

6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan
7. Every wicked problem is essentially unique
8. Every wicked problem can be considered to be a symptom of another problem
9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution
10. The planner has no right to be wrong

Discuss with your supervisor:
"How might you design software to help solve wicked problems?"