

Combining Collaborative Filtering with Carbon Footprint Calculation

Joel Ross, Nitin Shantharam, Bill Tomlinson
Department of Informatics
University of California, Irvine

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Carbon Footprint

The total amount of carbon dioxide directly and indirectly caused by an activity or accumulated over the lifetime of a product.

Online Footprint Calculators

U.S. ENVIRONMENTAL PROTECTION AGENCY

Climate Change - Greenhouse Gas Emissions

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You are here: [EPA Home](#) » [Climate Change](#) » [Greenhouse Gas Emissions](#) » [Individual Emissions](#) » Household Emissions Calculator

Individual Emissions | **In the Home** | **On the Road** | Household Emissions Calculator

Household Emissions Calculator

Instructions | **1. Current Emissions** | 2. Reduce Emissions

1. The Basics | **2. Household Vehicles** | 3. Home Energy

Enter your household's energy use:

How much natural gas does your household use per month?
 dollars
 thousands of dollars
 therms
(\$70 is about \$14.14/therm)

How much electricity does your household use per month?
 dollars
 thousands of dollars
(\$70 is about \$10.6/kWh)

Does your household currently purchase green power? Yes No
Green power can often be bought through your local utility or through a green power marketer.

[What is Green Power?](#)

How much fuel oil does your household use per month?
 dollars
 thousands of dollars
(\$90 is about \$12/gallon)

Carbonfund.org
 REDUCE WHAT YOU CAN OFFSET WHAT YOU CAN'T

About | Education | Projects | Business | News | Carbon Calculators

Pre-industrial CO2 levels in the atmosphere: 280 PPM CO2 Levels Today: 385 PPM

A whopping 50,000 pounds a year
 That's the average American's total carbon footprint which includes the emissions from your home, car, air travel and everything you use. Be a leader in the fight against climate change: [calculate](#) your carbon footprint (or select a preset) and [offset](#) it today!

What You Get: [e-certificate](#), [bumper sticker](#), [window decal](#), [pen](#).

1 Select an activity to offset

2 Select a preset value OR use our Calculators

Flight Presets
 or use calculator

- 6,000 Miles: 2,500 lbs CO₂ - \$11.33
- 20,000 Miles: 8,350 lbs CO₂ - \$37.86
- 40,000 Miles: 16,700 lbs CO₂ - \$75.73
- 100,000 Miles: 41,750 lbs CO₂ - \$189.43

Flight Calculator

Departure:

Arrival:

Include Radiative Forcing
What's this?

Miles:

Tons CO₂:

Total Cost:

1320 Fenwick Lane, Suite 206 • Silver Spring, MD 20910 • (240) 247-0630

Carbonfund.org is the nation's leading nonprofit provider of carbon offsets and climate solutions. We make it a carbon footprint with carbon offsets that are verified to third-party carbon offsets.

Help fight global warming through our carbon offsets. More info on our carbon offsets, how offsets work, a

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The Nature Conservancy
 Protecting nature. Preserving life.

The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

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Carbon Footprint Calculator
 Climate Change and Global Warming

Carbon Offset Program

Carbon Footprint Calculator

Climate-Saving Tips

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Make a Donation

Adopt an Acre of Rainforest

how you can help

- donate online
- renew membership
- estate planning
- gift ideas
- volunteer
- activities
- shop
- magazine
- conservation science
- e-newsletter
- carbon calculator
- what's your impact?

Driving & Flying Calculator
 (calculating carbon footprint for my entire household) Tons of CO₂ eq/year

What Have You Done to Change Your Impact?

We drive the following vehicle(s):
 Mid-size (or 20-30) roughly 12000 miles per year [more info](#)
[add vehicle](#)

We generally check the air filter... [more info](#)
 Monthly Occasionally Rarely

We check the tire pressure... [more info](#)
 Monthly Occasionally Rarely

The total number of flights we have flown in the last year, counting each flight taken by each member in my household, is:
 long flights and short flights. [more info](#)

Driving & Flying Total: 9 Tons of CO₂ eq/year. That's 81% below avg.

Total Greenhouse Gas Emissions: 32 Tons of CO₂ eq/year. That's 40% below avg.

How is my carbon footprint calculated?

Limitations of Carbon Calculators

Interaction requires user **time**, **effort**, and **knowledge**

Leads to a **restricted scope**

Focus on the **individual** rather than the community

Encourages purchasing offsets, not **collective action**

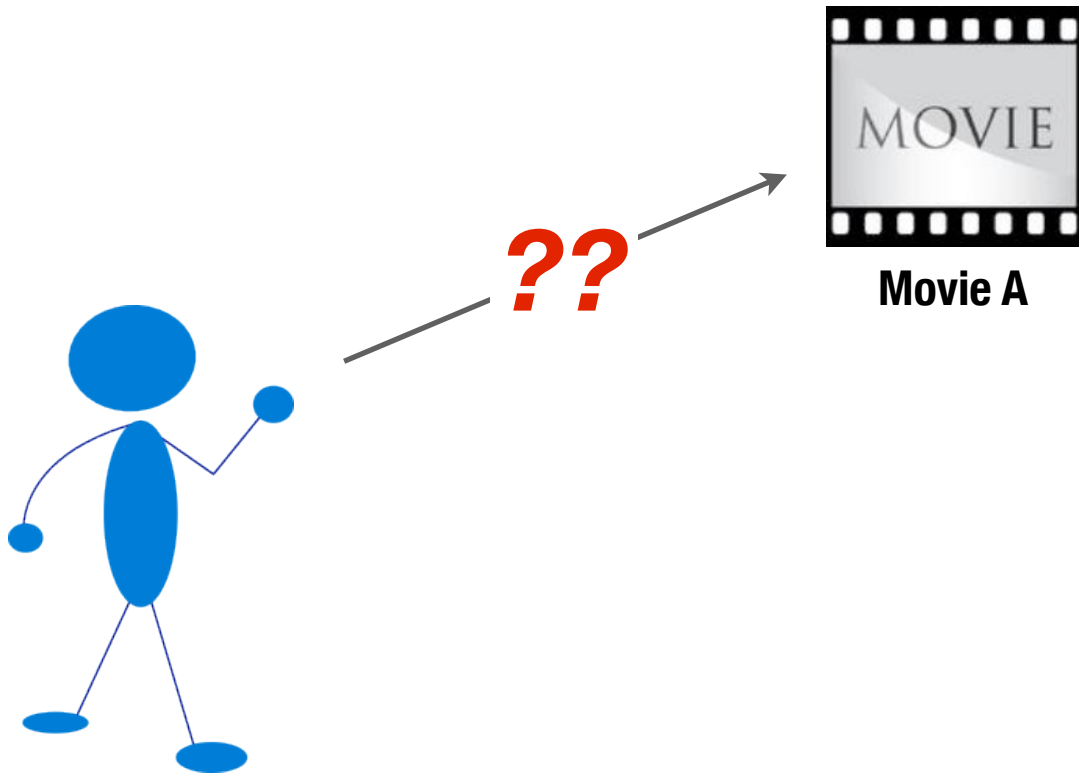
Collaborative Filtering

A Definition:

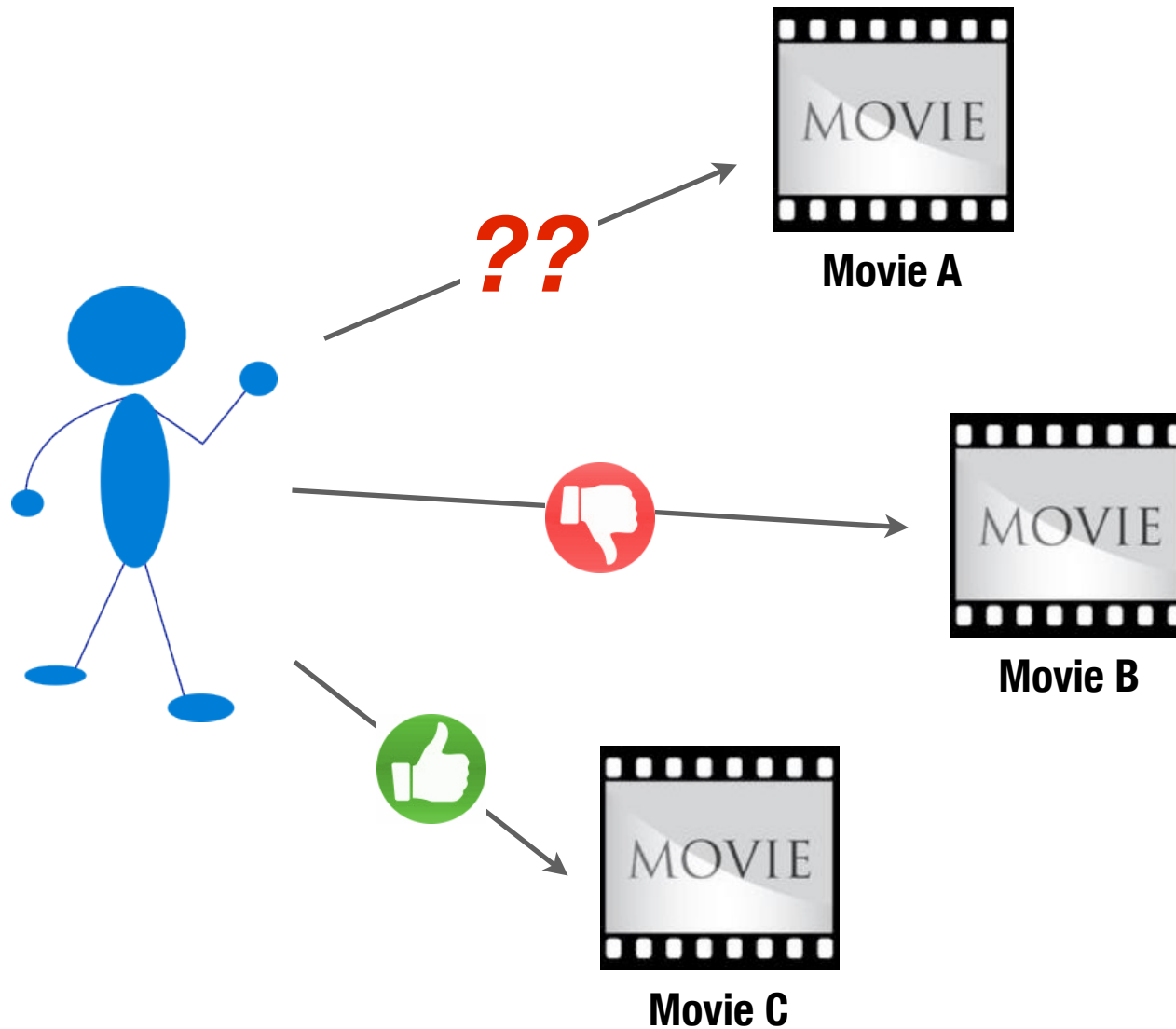
Collaborative Filtering is the process of filtering information for (or making predictions about) an unknown user based on information about a known group of users.

Primarily used in **recommender systems** (e.g., Netflix, Amazon)

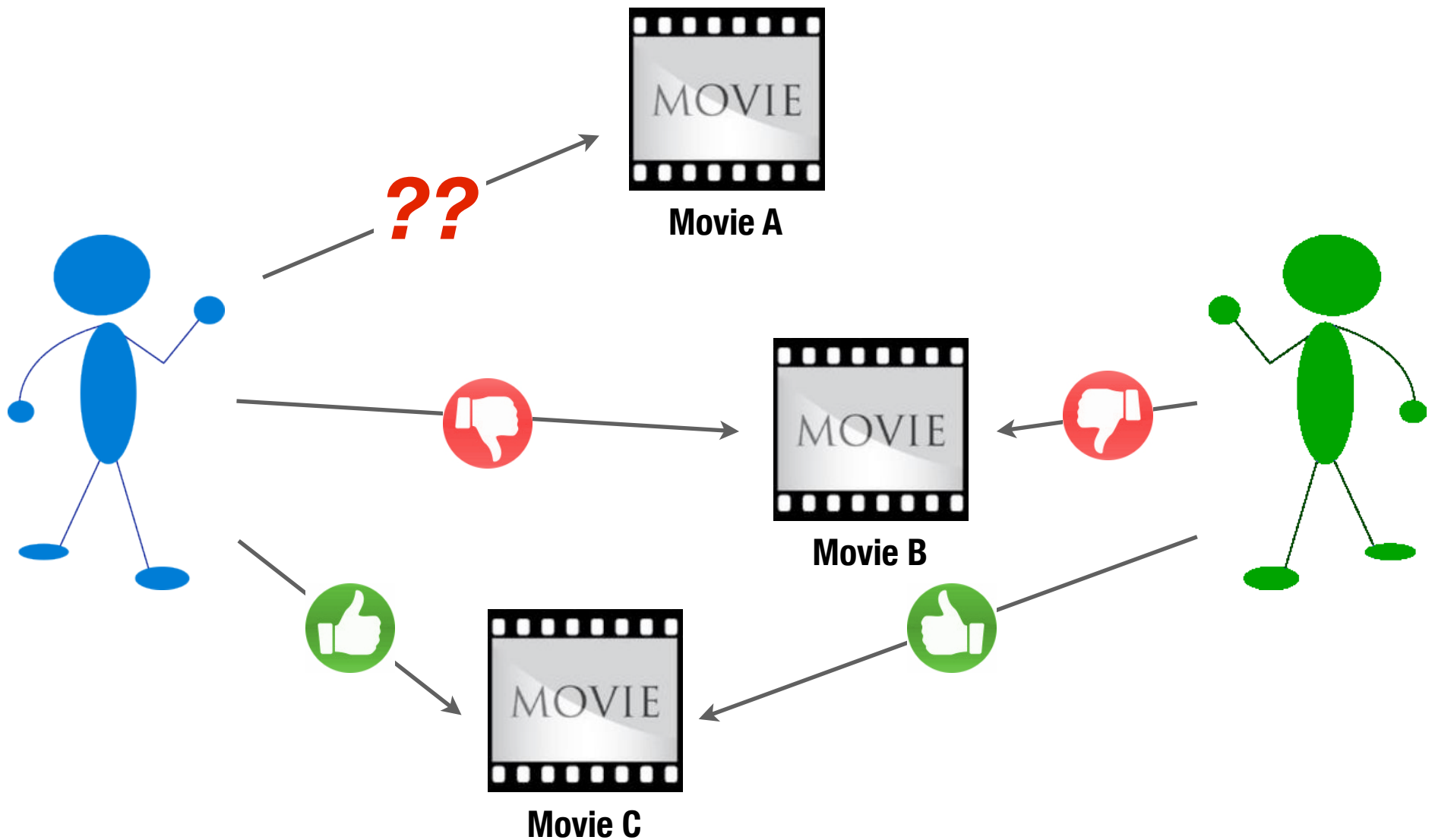
How does Collaborative Filtering Work?



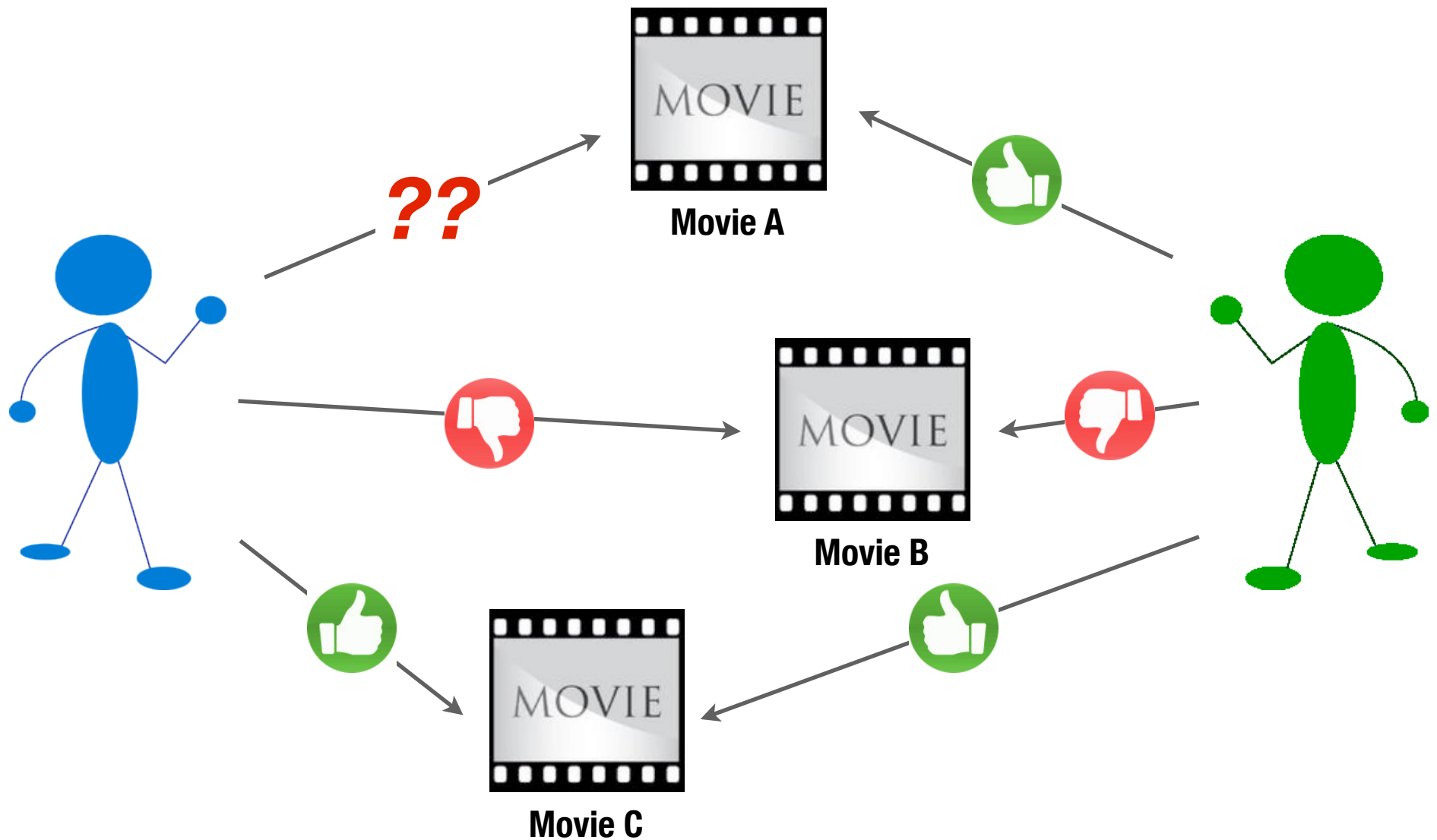
How does Collaborative Filtering Work?



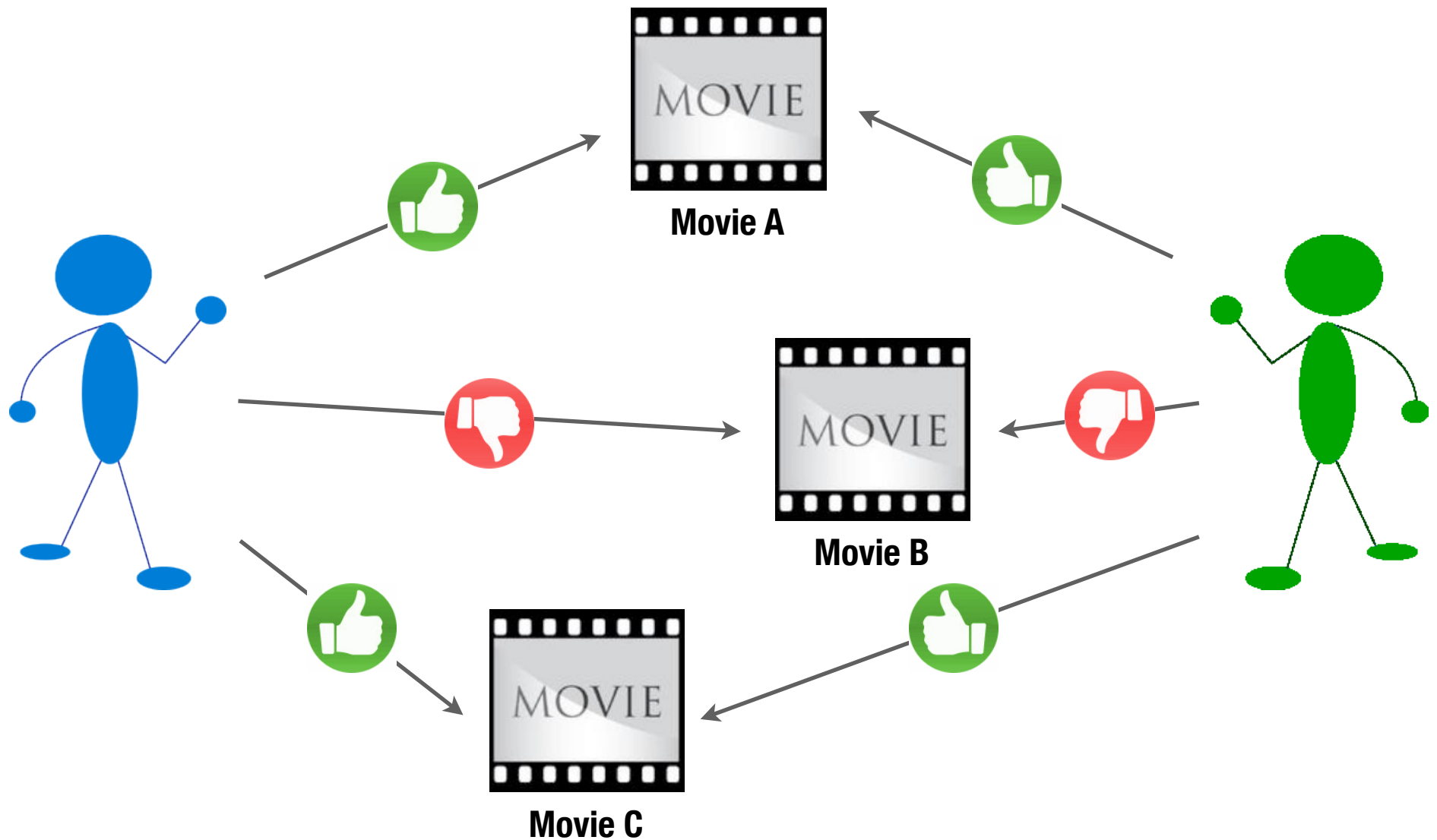
How does Collaborative Filtering Work?



How does Collaborative Filtering Work?



How does Collaborative Filtering Work?





Your household's **carbon footprint** is its total yearly greenhouse gas emissions, such as from driving your car and heating your home.

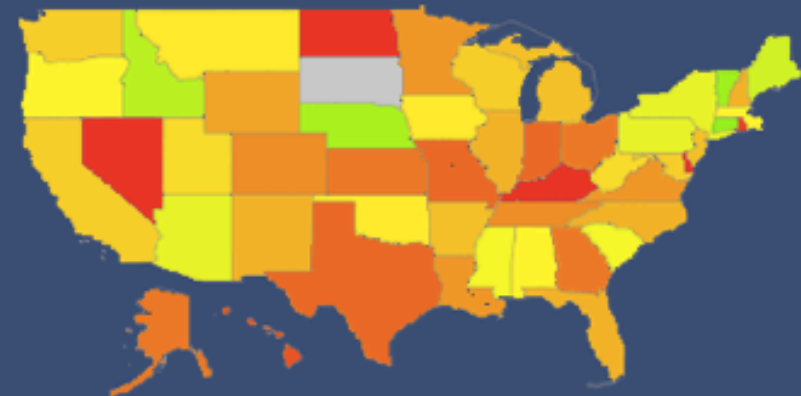
Enter an address to view its carbon footprint ([privacy policy](#))

my address, my city, my state

VIEW CARBON FOOTPRINT

Create an account

Better Carbon estimates your carbon footprint based on the footprint of your local community.



High Low
Average Carbon Footprint by State

Documentation

- What is a "carbon footprint"?
- FAQ
- Site documentation
- About the team

Make a difference

- How to reduce your carbon footprint
- Make a pledge on PledgeBank

Better Carbon is a research project by Social Code Group at the University of California, Irvine.

[Social Code Group University of California, Irvine Calit2](#)

feedback



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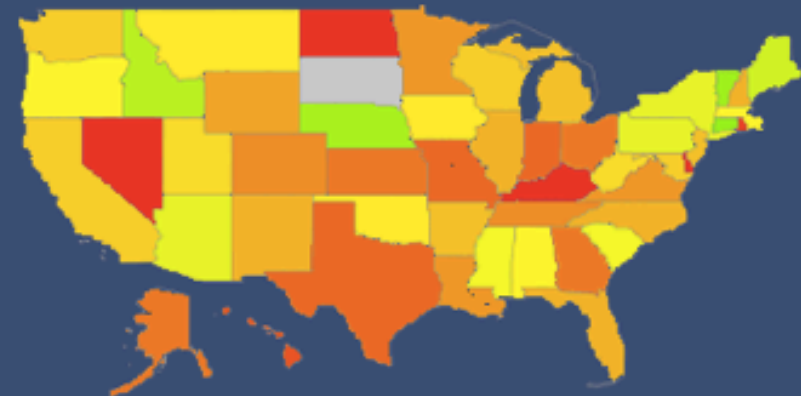
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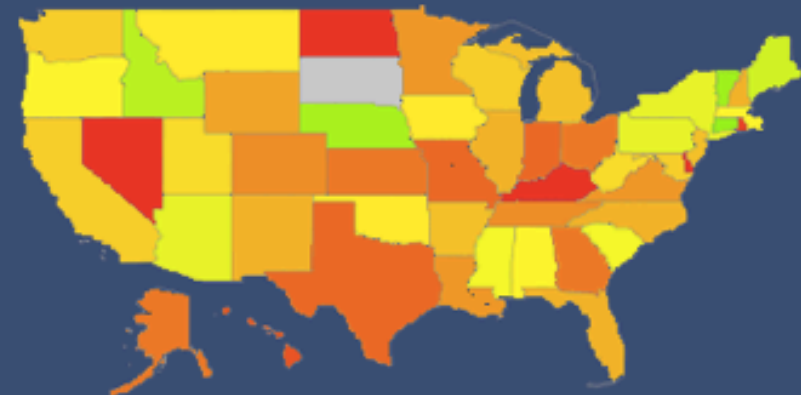
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18.55

tons CO₂/year

[\(How was this calculated?\)](#)

To get a more **accurate estimate** and improve the estimate of your entire community, click to **personalize your carbon profile**.

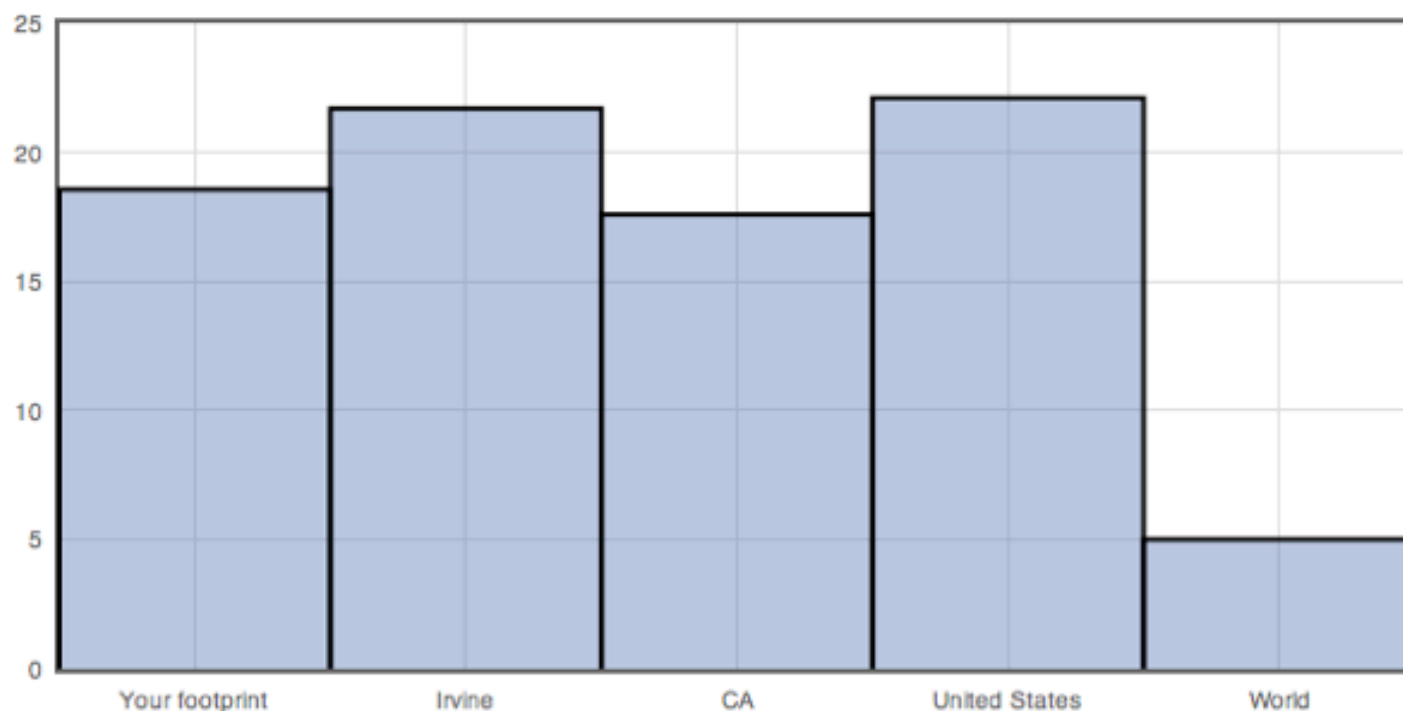
[Personalize Profile](#)

Overview

Details

Recommendations

Your carbon footprint is determined based on the footprints of nearby and similar people. The footprint calculated for your community helps estimate your own emissions.



Carbon Profile

[Cancel](#)[Save](#)

Car & Public Travel (5.57 tons)

	Your Household		Irvine (Avg)
Number of miles driven per year	<input type="text" value="7176.65"/>	(estimated)	6816.85
Miles per gallon	<input type="text" value="23.92"/>	(estimated)	25.00
Vehicle fuel type	<input type="text" value="Gasoline"/>	(estimated)	(no data)
Vehicle size	<input type="text" value="Mid-sized car"/>	(estimated)	1.50
Miles traveled via public transportation per month	<input type="text" value="131.45"/>	(estimated)	63.39

Air Travel (4.24 tons)

	Your Household		Irvine (Avg)
Number of short trips (<400mi) per year. (Round trips are 2 flights)	<input type="text" value="1.41"/>	(estimated)	5.67
Number of medium trips (400-1500mi) per year. (Round trips are 2 flights)	<input type="text" value="1.78"/>	(estimated)	5.33
Number of long trips (1500-3000mi) per year. (Round trips are 2 flights)	<input type="text" value="1.39"/>	(estimated)	4.25
Number of extended trips (>3000mi) per year. (Round trips are 2 flights)	<input type="text" value="0.78"/>	(estimated)	1.50

Home Energy (7.51 tons)

	Your Household		Irvine (Avg)
\$ spent on electricity per month	<input type="text" value="90.65"/>	(estimated)	23.00
\$ spent on natural gas per month	<input type="text" value="26.65"/>	(estimated)	8.00
\$ spent on other fuel per month	<input type="text" value="5.23"/>	(estimated)	0.00
\$ spent on water and sewage per month	<input type="text" value="41.96"/>	(estimated)	20.00
Square feet of household	<input type="text" value="1443.87"/>	(estimated)	1233.71

Food (0.72 tons)

Your Household

Irvine (Avg)

Carbon Profile

[Cancel](#)[Save](#)

Car & Public Travel (5.57 tons)

	Your Household		Irvine (Avg)
Number of miles driven per year	<input type="text" value="7176.65"/>	(estimated)	6816.85
Miles per gallon	<input type="text" value="23.92"/>	(estimated)	25.00
Vehicle fuel type	<input type="text" value="Gasoline"/>	(estimated)	(no data)
Vehicle size	<input type="text" value="Mid-sized car"/>	(estimated)	1.50
Miles traveled via public transportation per month	<input type="text" value="131.45"/>	(estimated)	63.39

Air Travel (4.24 tons)

	Your Household		Irvine (Avg)
Number of short trips (<400mi) per year. (Round trips are 2 flights)	<input type="text" value="1.41"/>	(estimated)	5.67
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Number of extended trips (>3000mi) per year. (Round trips are 2 flights)	<input type="text" value="0.78"/>	(estimated)	1.50

Home Energy (7.51 tons)

	Your Household		Irvine (Avg)
\$ spent on electricity per month	<input type="text" value="90.65"/>	(estimated)	23.00
\$ spent on natural gas per month	<input type="text" value="26.65"/>	(estimated)	8.00
\$ spent on other fuel per month	<input type="text" value="5.23"/>	(estimated)	0.00
\$ spent on water and sewage per month	<input type="text" value="41.96"/>	(estimated)	20.00
Square feet of household	<input type="text" value="1443.87"/>	(estimated)	1233.71

Food (0.72 tons)

Your Household

Irvine (Avg)

Carbon Profile

[Cancel](#)

[Save](#)

Car & Public Travel (8.06 tons)

	Your Household		Irvine (Avg)
Number of miles driven per year	<input type="text" value="8177.29"/>	(estimated)	6816.85
Miles per gallon	<input type="text" value="17.00"/>	(estimated)	25.00
Vehicle fuel type	<input type="text" value="Gasoline"/>	(estimated)	(no data)
Vehicle size	<input type="text" value="Mid-sized car"/>	(estimated)	1.50
Miles traveled via public transportation per month	<input type="text" value="130.35"/>	(estimated)	63.39

Air Travel (3.77 tons)

	Your Household		Irvine (Avg)
Number of short trips (<400mi) per year. (Round trips are 2 flights)	<input type="text" value="1.48"/>	(estimated)	5.67
Number of medium trips (400-1500mi) per year. (Round trips are 2 flights)	<input type="text" value="1.21"/>	(estimated)	5.33
Number of long trips (1500-3000mi) per year. (Round trips are 2 flights)	<input type="text" value="1.46"/>	(estimated)	4.25
Number of extended trips (>3000mi) per year. (Round trips are 2 flights)	<input type="text" value="0.65"/>	(estimated)	1.50

Home Energy (7.75 tons)

	Your Household		Irvine (Avg)
\$ spent on electricity per month	<input type="text" value="92.12"/>	(estimated)	23.00
\$ spent on natural gas per month	<input type="text" value="29.52"/>	(estimated)	8.00
\$ spent on other fuel per month	<input type="text" value="4.22"/>	(estimated)	0.00
\$ spent on water and sewage per month	<input type="text" value="42.95"/>	(estimated)	20.00
Square feet of household	<input type="text" value="1446.43"/>	(estimated)	1233.71

Food (0.70 tons)

Your Household

Irvine (Avg)

Algorithm Details

User similarity determined through **cosine similarity**

Normalize each variable $0 \leq x \leq 1$

Construct an ordered vector [miles_driven, num_flights, electricity_used, food_costs, ...]

Determine cosine of vector angle
$$\text{similarity} = \cos(\theta) = \frac{A \cdot B}{\|A\| \|B\|}$$

Estimate is a simple **average weighted** by similarity:

$$A_i = \frac{\sum (Sim_{i,j})(A_j)}{\sum Sim_{i,j}}$$

Calculator Accuracy

Tested with **397 users** recruited through Mechanical Turk.

Mean Absolute Error (MAE):

The average amount that estimates deviate from the true value.

U.S. Average as estimate	Population Average as estimate	Cosine Similarity estimate
Avg. MAE: 0.145 (14.5% error)	Avg. MAE: 0.083 (8.3% error)	Avg. MAE: 0.078 (7.8% error)

Evaluating the Interaction

100 users compared Better Carbon to other major calculators

75%: Better Carbon as quick or quicker

62%: Better Carbon as easy or easier

30%: Better Carbon perceived as accurate as others

56%: Better Carbon created a **stronger link between users and their communities**

"I liked the statements from my locality at the end of the Better Carbon - that brought it home."

Limitations of Better Carbon

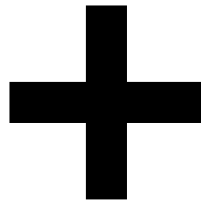
Still provides an **estimate** based on self-reported data

Reducing an estimate is not the same as reducing impact

Faster and easier... a problem?

There may be benefits to manually working through a calculator

Future Work



The screenshot shows the 'Better Carbon' website interface. At the top, there is a dark blue header with the 'BETTER CARBON' logo (including a footprint icon) and the word 'Beta'. To the right of the logo are links for 'Welcome to Better Carbon!', 'Create an account', 'Sign In', and a Facebook 'Login' button.

The main content area is white. On the left, there is a vertical red 'feedback' button. The main text reads: 'Your household's **carbon footprint** is its total yearly greenhouse gas emissions, such as from driving your car and heating your home.' Below this is a text input field with the placeholder 'my address, my city, my state' and a 'VIEW CARBON FOOTPRINT' button.

On the right, there is a green 'Create an account' button and a dark blue box containing the text: 'Better Carbon estimates your carbon footprint based on the footprint of your local community.' Below this text is a map of the United States color-coded by state, with a legend at the bottom showing a gradient from red (High) to green (Low) for 'Average Carbon Footprint by State'.

At the bottom of the page, there is a footer with the text: 'Better Carbon is a research project by Social Code Group at the University of California, Irvine. [Social Code Group University of California, Irvine Cali12](#)'

Summary: Better Carbon

Better Carbon (*bettercarbon.com*)

Uses **collaborative filtering** for carbon footprint calculation

Generates estimates with **better-than-average accuracy**

Is **extendable**; includes more factors without more user effort

Provides a stronger **social basis** for carbon footprints

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Better Carbon (*bettercarbon.com*)

Uses **collaborative filtering** for carbon footprint calculation

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Acknowledgments

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Contact Information

Joel Ross

Informatics, UC Irvine

jwross@uci.edu

ics.uci.edu/~jwross