

Part I — Framing

Surfacing Influences

Online, with a lab for each exercise: thinking-in-diagrams.aryehnielsen.com

Influence maps Part I · Framing · Chapter 3 of 12 · the one chapter on influence maps

Which things affect an outcome, before you know how each changes it? An influence map shows the variables that bear on one outcome, and which bears on which, without saying which way each acts. A claim gets a direction only where its effect has been measured.

Signals you need this diagram

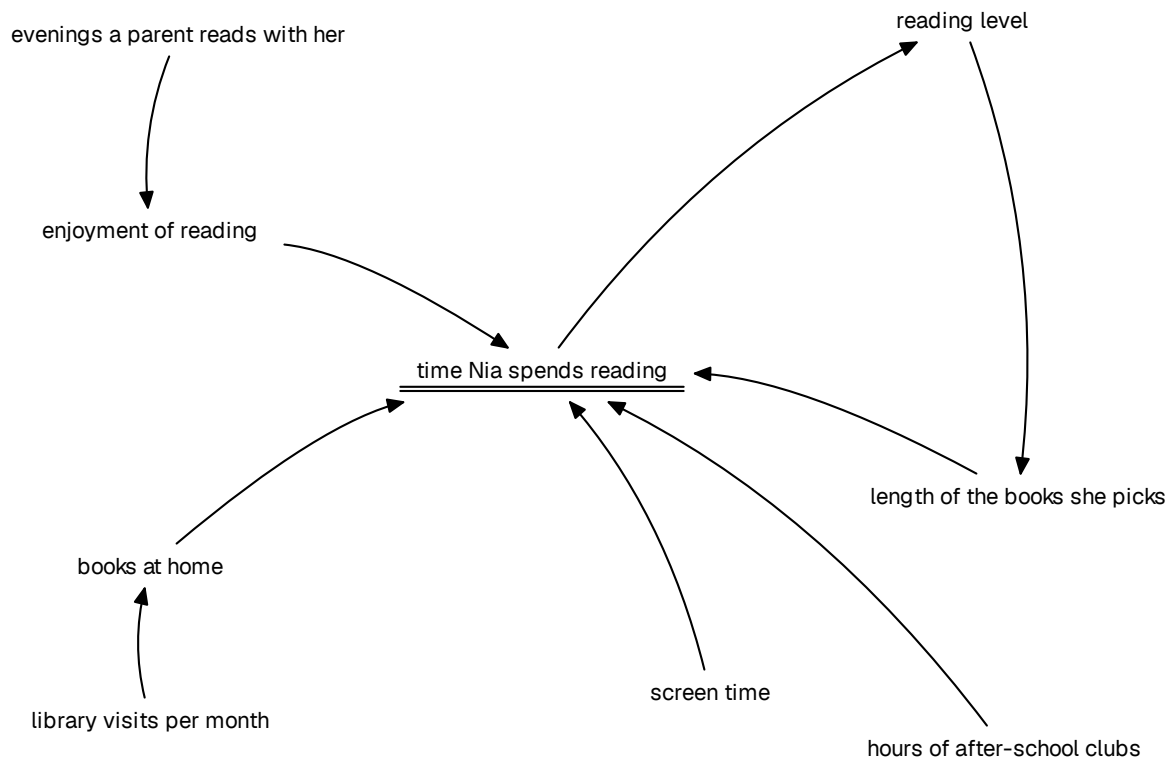
- Many things bear on one outcome, and nobody knows which way most of them act.
- A list of causes keeps growing, with no order to it.
- People argue over which way something pushes before anyone has counted it.
- Some effects have been measured and others only suspected, and a causal loop diagram would show them alike.

Nia's reading for pleasure

Nia is ten, and her parents would like her to read more for pleasure. Asked what bears on the time she spends reading, they list how well she reads, the length of the books she picks, how much she enjoys reading, the books at home, their visits to the library, her screen time, her after-school clubs, and the evenings one of them reads with her.

Her school's reading log holds the minutes she reads each day and each book she finishes; her teacher's assessments give her reading level each term. Over a year the two measured three effects: in terms when she logged more minutes, her level rose further; as her level rose, she picked longer books; and with a longer book on the go, she logged more minutes a day. Nothing records the rest of the list.

Her parents rank her enjoyment highest, her screen time and the length of her books next, and the books at home and her clubs lowest.



What the notation expresses

The central outcome

The **central outcome** is the one variable the map is drawn around: here, *time Nia spends reading*. Its name is double-underlined. A map has exactly one; a second outcome gets a map of its own.

Like every variable, it is a quantity that can rise or fall: *time Nia spends reading*, not *Nia reads*.

Influence claims

An **influence claim** says that one variable bears on another, without saying which way. More screen time might mean less reading or, with books on a tablet, more. It is drawn as a solid line with an arrowhead and no + or –, from the variable that bears to the one it bears on.

Two variables that bear on each other take two claims, one each way.

Direct and indirect influences

A **direct influence** is a claim ending at the central outcome: *screen time* → *time Nia spends reading*. An **indirect influence** ends at another variable and reaches the outcome through it: *library visits per month* reaches *time Nia spends reading* through *books at home*.

From every variable, a path of claims runs to the central outcome. A variable with no path there either gets the claim it lacks or comes off the map.

Clusters

A **cluster** holds two or more variables that share something, under a label naming what they share: *books to hand* holds *books at home* and *library visits per month*. It is drawn as four corner brackets, the label inside the top-left one. A variable belongs to the cluster whose brackets it sits within.

Clusters neither nest nor overlap, and the central outcome sits in none. With no continuous outline, a cluster can't be read as a boundary thinking-in-diagrams.aryehnielsen.com/framing/drawing-the-boundary/#the-boundary, which marks what a model explains.

Weight

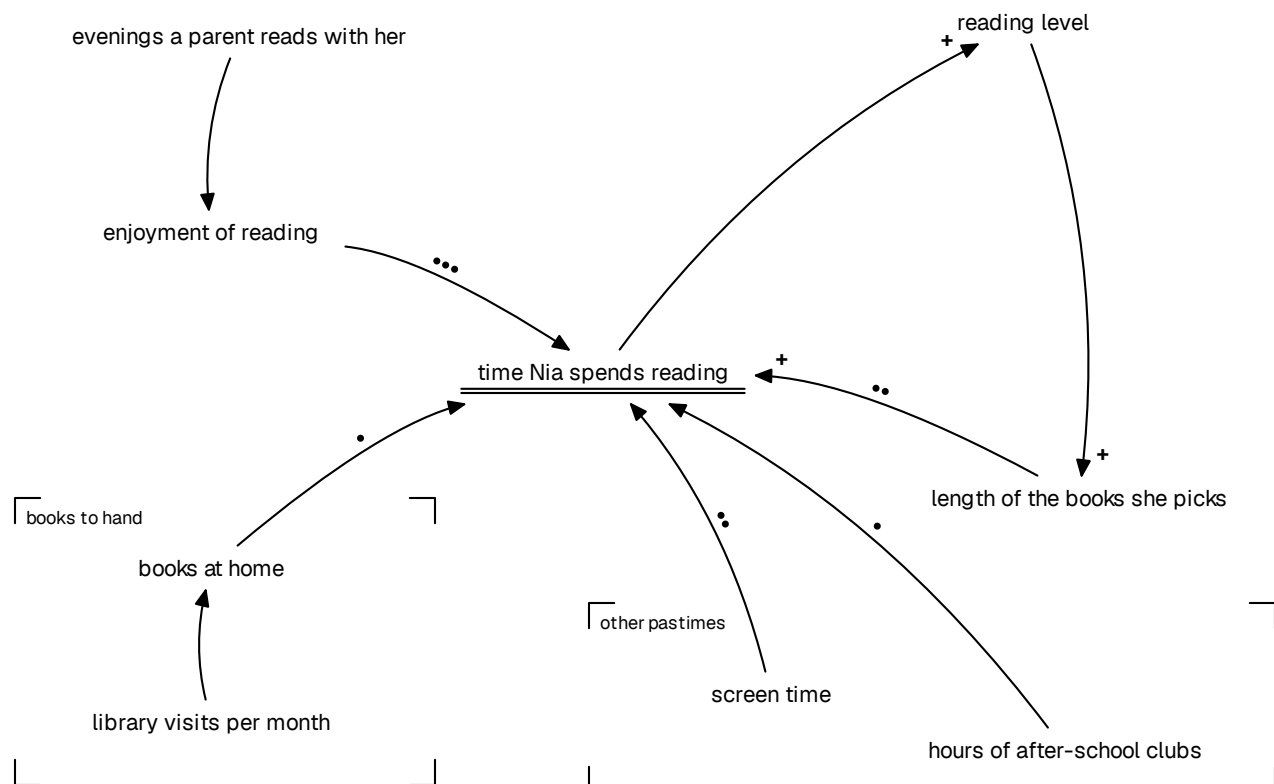
Weight is an influence's relative importance, where influences are ranked: one, two or three dots beside the middle of the claim's line. Nia's parents rank her enjoyment highest, so its claim carries three dots, and her clubs' claim one.

Weight says how much, not which way or how sure. Every line is drawn alike: a thicker one means nothing.

Causal claims

A **causal claim** says which way a change runs, by its **polarity**: + when the two variables move in the same direction, – when they move in opposite directions. Giving an influence claim a polarity is an **upgrade**; the claim keeps its ends and its weight. Taking the polarity off makes it an influence claim again.

Upgrade a claim where you can say how you know its direction. The reading log and the assessments measured three effects, each +, so those three claims are upgraded. Enjoyment, weighted highest, stays an influence claim: nothing measured it.



CHECK YOUR UNDERSTANDING

A bakery's till records show that it sells more loaves on market days, and fewer in the weeks after each rise in the price of a loaf. The owner believes her new window display brings in customers, but nobody has counted them. On a map around loaves sold per day, which influence claims can be upgraded?

- a Market days per week, with a +, and the price of a loaf, with a –; the window display stays an influence claim
- b All three: the owner knows her shop
- c Only the window display, with a +: the owner put it there to bring customers in
- d None: an influence map holds no causal claims

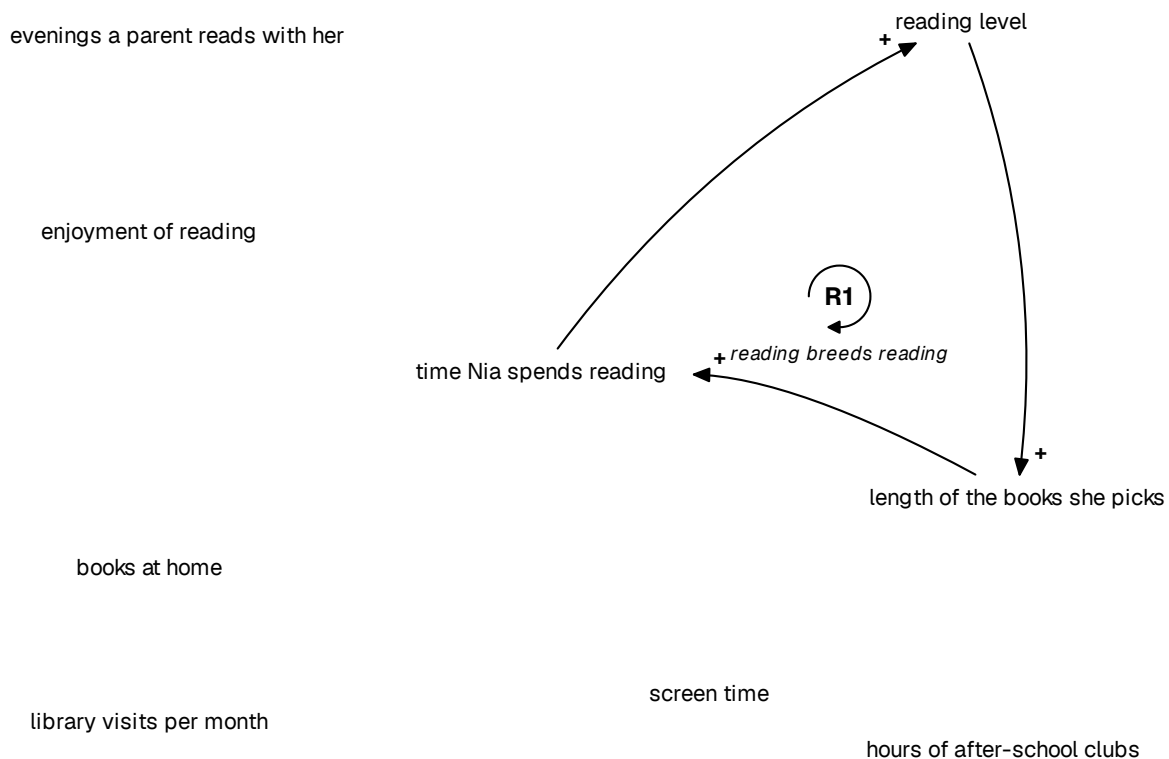
Feedback: Answers, chapter 3

Conversion to a causal loop diagram

A **conversion** carries an influence map into a new causal loop diagram. The variables and the causal claims carry over; the influence claims, weights, clusters and the central outcome's double underline are left behind. An influence claim isn't carried over without a polarity: in a causal loop diagram, an effect without one is unfinished.

Nia's three causal claims close a path: more minutes, a higher level, longer books, more minutes. Declared in the causal loop diagram, the path is a loop. It has no – effects, so by the parity rule

thinking-in-diagrams.aryehnielsen.com/feedback/loops-that-amplify-loops-that-correct/#the-parity-rule it is a reinforcing loop: a change in any of the three comes back around in the same direction.



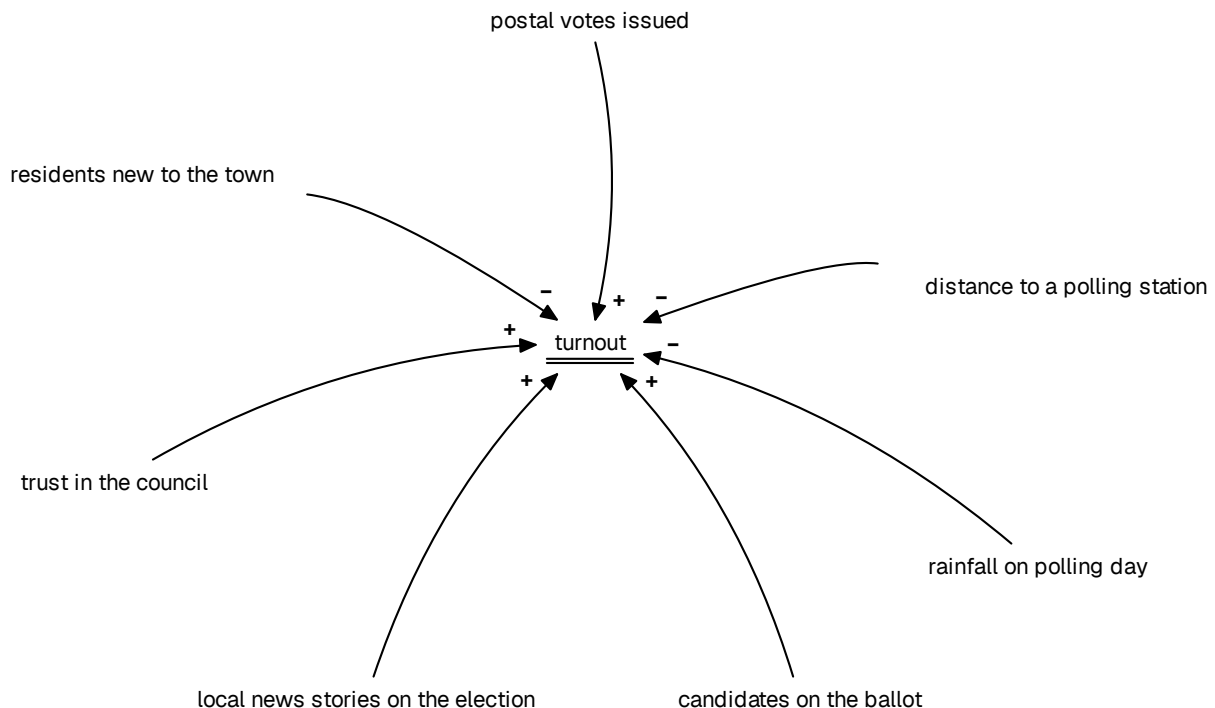
What stays informal

With a few influences, each acting on the outcome and none on another, a list of variables does what the map would. With one influence in question, a sentence does: *Nia's parents think screen time cuts into her reading.*

The map shows no amounts and no timing: not how many minutes screen time takes, nor when.

The bad diagram

What's wrong with this map of turnout in a town's local election?

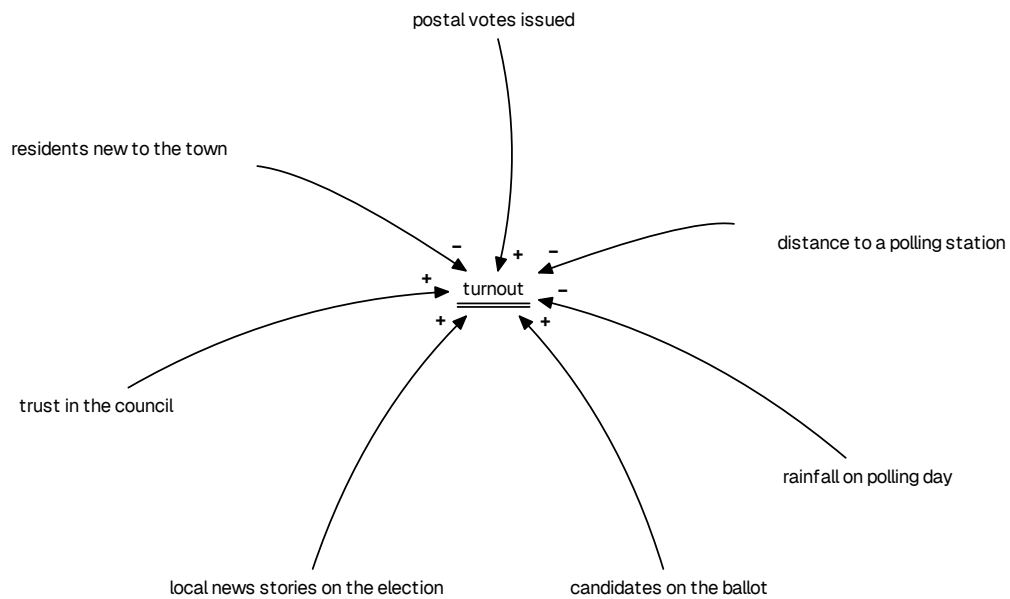
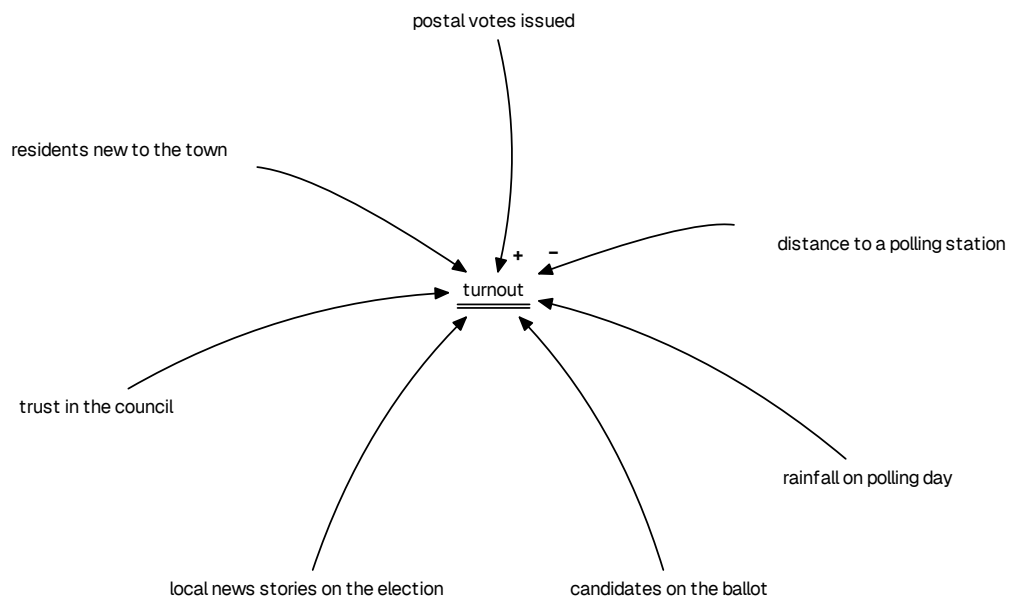


Every claim carries a + or -. The council's ward records measured only two effects: more postal votes issued, higher turnout; a longer distance to a polling station, lower turnout. The other five polarities, on rainfall, candidates, news stories, trust in the council and newcomers, are guesses drawn as findings. Converted, the map would carry all seven into a causal loop diagram.

The lab's checks test structure, not evidence: they report this map only under a brief requiring at least one influence claim.

The corrected diagram

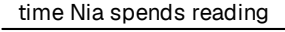
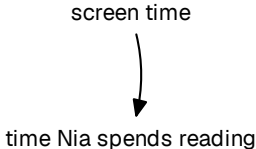
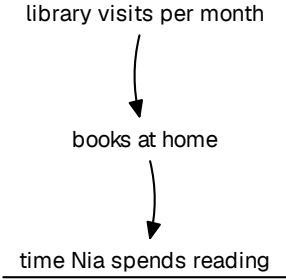
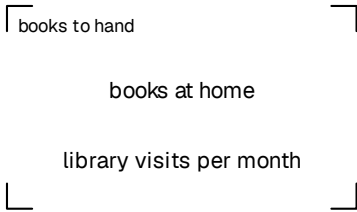
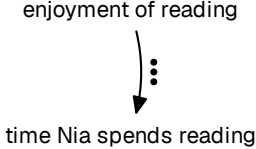
Corrected, the two measured claims keep their polarities and the other five are influence claims: the same variables and the same claims, with five fewer polarities.

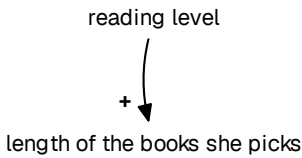
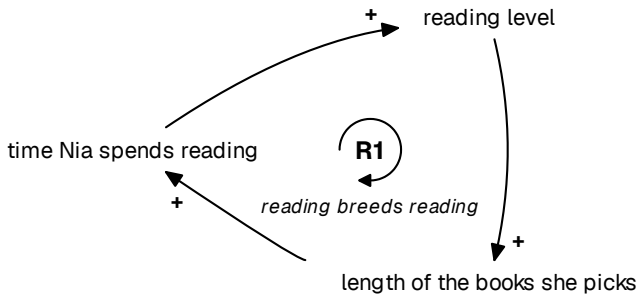
Bad diagram**Corrected diagram**

Labels unchanged. Claims: 5 returned to influence claims.

A count of turnout on wet and dry polling days, ward by ward, would let a third claim be upgraded.

Notation moves

Notation move	When	What it shows	Example
Mark the central outcome	You can name the one quantity in question	What the map is drawn around	<i>time Nia spends reading</i>
			
Draw an influence claim	One variable bears on another, its direction unmeasured	That it bears, not which way	<i>screen time</i> → <i>time Nia spends reading</i>
			
Draw an indirect influence	A variable acts on the outcome through another	The path by which it reaches the outcome	<i>library visits per month</i> → <i>books at home</i> → <i>time Nia spends reading</i>
			
Draw a cluster and label it	Several variables share something	What they share	<i>books to hand</i>
			
Give a claim a weight	Influences are ranked	Relative importance	three dots on <i>enjoyment of reading</i>
			

Notation move	When	What it shows	Example
Upgrade a claim with + or -	Something measured the effect	Which way the change runs	<i>reading level</i> → <i>length of the books she picks</i> , +
			
Convert to a causal loop diagram	Causal claims close a path	The loop, to declare and read there	R1 <i>reading breeds reading</i>
			

Check your understanding

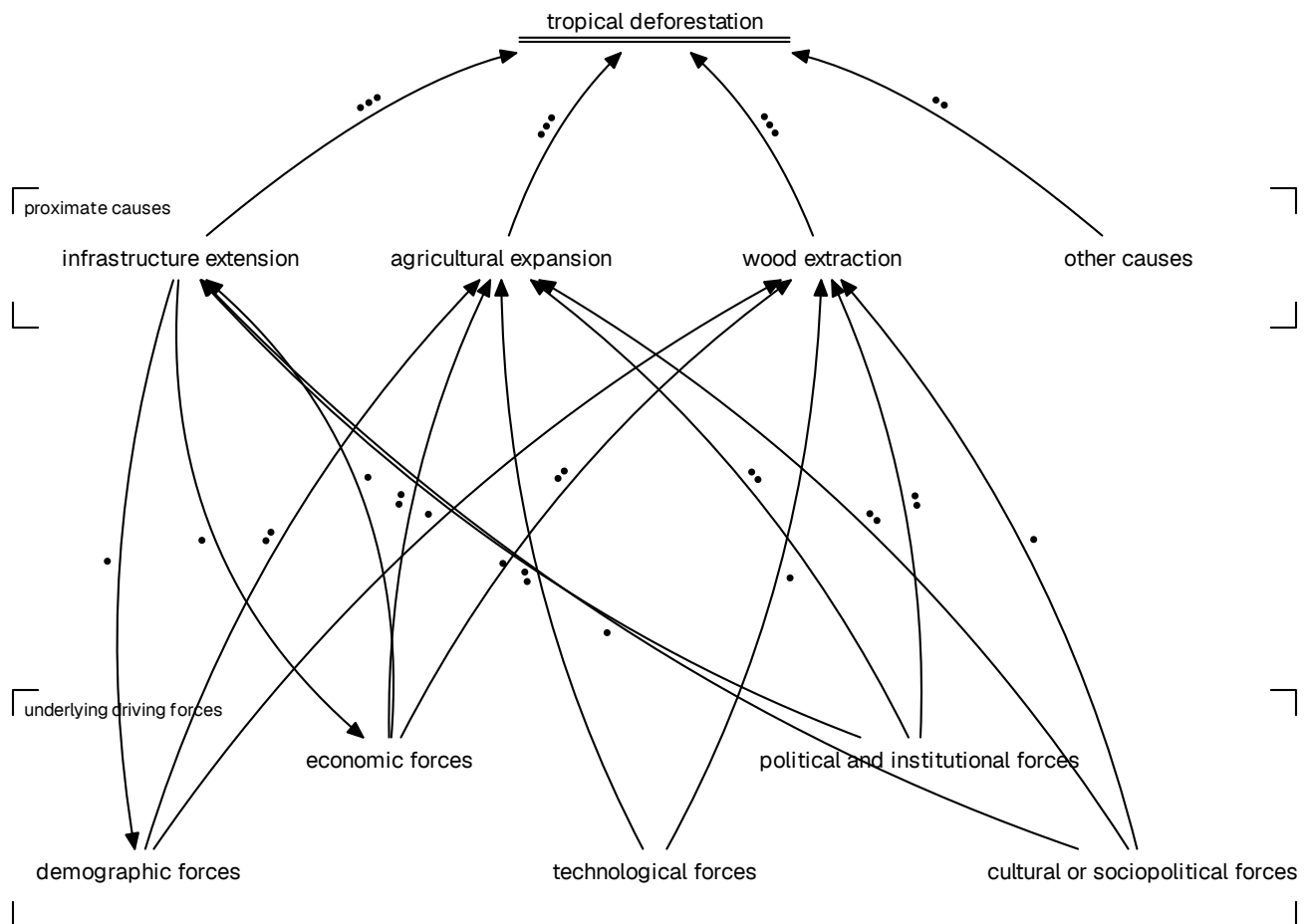
CHECK YOUR UNDERSTANDING

An influence map of an allotment has the central outcome crop yield. Water per week → crop yield and crop yield → seed saved are causal claims, each +. Seed saved → crop yield and compost spread → crop yield are influence claims. Converted to a causal loop diagram, what loop can be declared there?

- a None
- b One reinforcing loop: crop yield → seed saved → crop yield
- c Two: one through seed saved and one through compost spread

Feedback: Answers, chapter 3

Causes of tropical deforestation, redrawn



Redrawn from Helmut J. Geist and Eric F. Lambin, "Proximate Causes and Underlying Driving Forces of Tropical Deforestation", *BioScience* 52(2), 143–150 (2002) academic.oup.com/bioscience/article/52/2/143-150/341135, Figure 2. © 2002 American Institute of Biological Sciences; its structure and short labels only.

Tropical deforestation, named in the figure's title, added as the central outcome, with a claim from each of the four proximate causes; the two tiers drawn as clusters, the five underlying names ending in forces, as the source names their tier, and the last proximate cause named other causes; each line's width, the share of the 152 cases, drawn as one dot (under a third), two or three (over two thirds); the two dashed lines labeled Feedback drawn solid; the lines within each tier, the colors and the percentages left out.

QUESTION 1 OF 3

The source's figure has no box for deforestation. Why does the redrawing add tropical deforestation, double-underlined?

- a It is the quantity in question, named in the figure's title, and every path of claims ends there.
- b It marks the result of agricultural expansion, the cause found most often.
- c Every influence map has a variable that no claim leaves.

QUESTION 2 OF 3

Which variables share a cluster with wood extraction?

- a Economic forces and political and institutional forces, which bear on it in the most cases.
- b Tropical deforestation, which it bears on directly.
- c Infrastructure extension, agricultural expansion and other causes.

QUESTION 3 OF 3

Which claim could be upgraded with a polarity, from what the source's authors report?

- a Agricultural expansion → tropical deforestation, whose three dots mark it found in 96% of the cases.
- b None: an influence map's claims carry no polarity.
- c Infrastructure extension → economic forces, +, one of the source's two dashed lines labeled Feedback.

Feedback: Answers, chapter 3

Exercises

Passing the checks means meeting the brief, not being right.

IM 01 Cycling to work through the winter

A central outcome and its direct influences

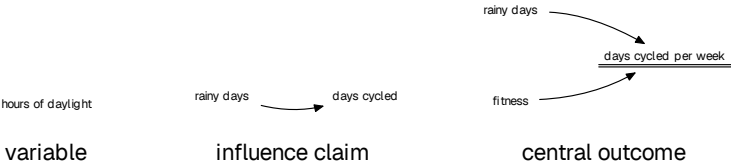
Reasoning ●○○○○ 1 of 5 Polish ●○○○○ 1 of 5

Tomás rides nine kilometres to work and takes the bus on the days he doesn't. From October he counts the days he rides each week. The hours of daylight fall through the autumn, and the rainy days per week rise. The council is putting street lights along his route, so the length of lit route grows month by month. His office has two showers, and on busy mornings fewer are free when he arrives. His fitness, built up over the summer, makes the ride quicker. The bus fare went up in September. Nobody has measured how much any of these moves the days he rides.

The brief

- ☐ Draw at least four direct influences on days cycled per week.
- ☐ Draw no indirect influences: each influence claim ends at days cycled per week.
- ☐ Each variable is a quantity that can rise or fall: hours of daylight, not the dark.

Your palette



Draw here

A large grid of dots for drawing the influence map.

IM 02 World food prices

Influences that reach the central outcome through another variable

Reasoning ●○○○○ 1 of 5 Polish ●●○○○ 2 of 5

The FAO food price index tracks what the world pays for cereals, vegetable oils, dairy, meat and sugar. The size of the world's grain harvest sets how much is on sale, and the area in drought across growing regions cuts the harvest. Farmers spread less fertilizer when its cost climbs, and the grain harvest falls with it. Fertilizer is made and shipped with fossil fuels, so its cost follows the oil price, which also sets what it costs to move and process food. A dear barrel makes ethanol and biodiesel pay, and biofuel demand takes maize and vegetable oil off the food market. When a harvest fails, some governments ban grain exports, and the more grain under export bans, the fewer cargoes importers can bid for. The area in drought and fertilizer cost act on the index only through the grain harvest; the oil price acts on it straight and through fertilizer cost and biofuel demand.

The brief

- ☐ Draw at least four direct influences on the world food price index.
- ☐ Draw at least three indirect influences.
- ☐ Each indirect influence reaches the index through the variable it acts on.

Your palette



Draw here

A large grid of dots for drawing an influence map.

IM 03 An amateur football team's season

Clusters, each labeled for what its variables share

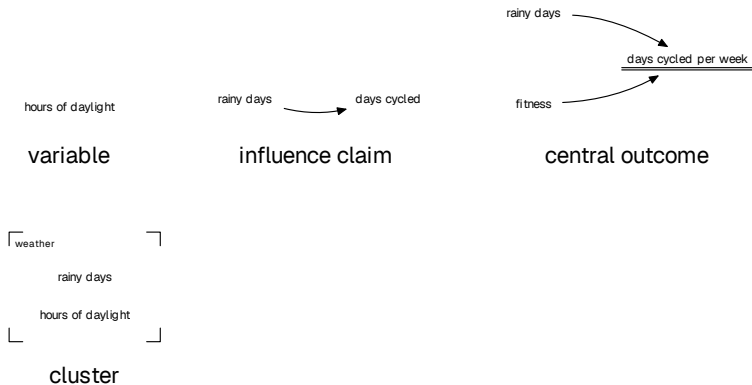
Reasoning ●●○○○ 2 of 5 Polish ●●○○○ 2 of 5

The Rovers, an amateur team, play on Sunday mornings in a county league, and their season is counted in league points. The squad size was twenty-two in September; players leaving for work or university cut it through the winter. Training attendance on Wednesday nights runs from eight to eighteen, and the players who come keep their match fitness. The players injured each week, mostly with pulled hamstrings, are fewer when match fitness is high. The coach spends half of each session on how the back four hold their line, and the training time on tactics shows in clean sheets. Team morale shows in how hard the players run in the last twenty minutes of a match, and players with low morale leave. The players at post-match socials in the clubhouse keep the team's morale up. Nobody at the club has measured how much any of these moves the points.

The brief

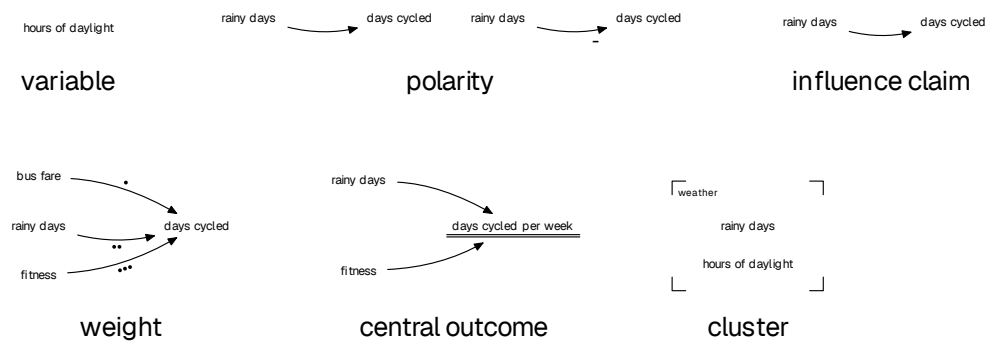
- ☐ Draw at least three clusters.
- ☐ Put every variable but league points in a cluster.
- ☐ Draw at least three direct influences on league points.
- ☐ Each cluster's label names what its variables share.

Your palette



Draw here

Grid area for drawing the influence map.

IM 04 Algal blooms in a lake**Your palette**

IM 04 Algal blooms in a lake

Weight, and upgrading only the influences that were measured

Reasoning ●●○○○ 2 of 5 Polish ●●●○○ 3 of 5

Lake Esk supplies drinking water to three towns, and most Augusts its surface turns green with algae. The lake authority counts the weeks of algal bloom each summer. Over ten years it has measured three things that rise and fall with them: phosphorus in farm runoff, sewage overflows per year from the towns' treatment works, and summer water temperature. Farm runoff carries about two-thirds of the phosphorus that reaches the lake, and sewage overflows most of the rest; the three warmest summers had the longest blooms. Fertilizer spread on the fields around the lake feeds the runoff, and heavy rainstorms, a few each summer, wash it into the streams. Anglers blame the shrinking area of reed beds along the shore, and boat operators blame the number of summer visitors. The authority has measured neither.

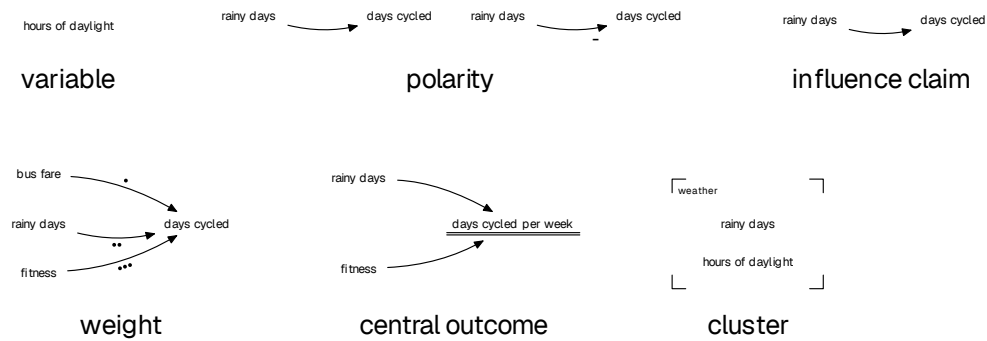
The brief

- ☐ Give each direct influence on weeks of algal bloom each summer a weight.
- ☐ Upgrade exactly three influences, giving each a + or -.
- ☐ Leave at least two influences without a + or -.
- ☐ Each causal claim is one the authority measured; every other claim stays an influence claim.

Your palette

On the page before this sheet.

Draw here

IM 05 An open-source project's contributors**Your palette**

IM 05 An open-source project's contributors

Upgrades that close a path of causal claims, read as a causal loop diagram

Reasoning ●●●○○ 3 of 5 Polish ●●●○○ 3 of 5

Ledger is an open-source library that reads spreadsheet files, and its maintainers count its active contributors each month. Six years of the project's records show three things. Releases made while more contributors are active carry more fixes. More fixes per release bring more users, as the package registry counts them. More users bring more active contributors, since most first contributions come from someone who hit a bug in their own work. The three run in a circle: active contributors, fixes per release, users, and back to active contributors. The maintainers believe newcomers stay when their first change is reviewed within a week, when the documentation pages explain how the code is laid out, and when issues are labeled for newcomers. Donations, about four thousand dollars a year, pay a maintainer for a few hours each week, most of them spent on review. None of these has been measured.

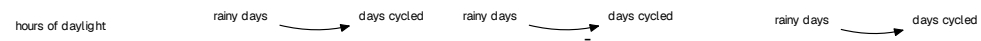
The brief

- ☐ Upgrade the influences the project's records show until they close a path of causal claims.
- ☐ Keep at least two influence claims.
- ☐ Draw at least two clusters.
- ☐ Every causal claim is one the project's records show.

Your palette

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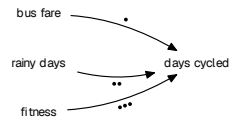
Draw here

CS 03 Kelsham Primary School: what decides where a child starts**Your palette**

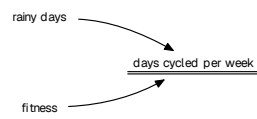
variable

polarity

influence claim



weight



central outcome



cluster

On the page before this sheet.

Draw here

Sources

- The Open University, *Diagramming for development 2: exploring interrelationships* www.open.edu/openlearn/digital-computing/diagramming-development-2-exploring-interrelationships/content-section-3.1 (OpenLearn), §3.1, *Influence diagram*, on influence diagrams: a snapshot of what can influence a situation, two influences that run both ways drawn as two lines, and stronger influences drawn thicker.
- Geoff Coyle, *Qualitative Modelling in System Dynamics, or What Are the Wise Limits of Quantification?* proceedings.systemdynamics.org/1999/PAPERS/KEYNOTE1.PDF, keynote to the System Dynamics Society's conference (Wellington, 1999), on influence diagrams drawn and studied without simulation, and what they are used for: a problem on one page, loops found in the diagram, and a basis for a quantified model.
- John D. Sterman, *Business Dynamics: Systems Thinking and Modeling for a Complex World* (Irwin/McGraw-Hill, 2000), chapter 5, on polarity in causal loop diagrams, with §5.2.1, *Causation versus Correlation*.
- George P. Richardson, "Problems with Causal-Loop Diagrams" doi.org/10.1002/sdr.4260020207, *System Dynamics Review* 2, no. 2 (1986), on what polarity does and doesn't mean.

Answers

Chapter 3 · Surfacing Influences

A bakery's till records show that it sells more loaves on market days, and fewer in the weeks after each rise in the price of a loaf. The owner believes her new window display brings in customers, but nobody has counted them. On a map around loaves sold per day, which influence claims can be upgraded?

- a** Market days per week, with a +, and the price of a loaf, with a –; the window display stays an influence claim
Yes. The till records measured those two effects and which way each runs: more market days, more loaves; a higher price, fewer. Nothing has measured the display's, so its claim says only that it bears on sales.
- b** All three: the owner knows her shop
Not quite. Knowing the shop is grounds for drawing an influence claim from the display. A polarity says which way the change runs, and only a record or a count shows that.
- c** Only the window display, with a +: the owner put it there to bring customers in
Not quite. Why the owner put the display there says what she expects, not what happened. The display's claim is the one left unmeasured; the other two have the till records behind them.
- d** None: an influence map holds no causal claims
Not quite. An influence map holds both kinds. Upgrading a claim gives it a polarity and makes it a causal claim; the map stays an influence map.

An influence map of an allotment has the central outcome crop yield. Water per week → crop yield and crop yield → seed saved are causal claims, each +. Seed saved → crop yield and compost spread → crop yield are influence claims. Converted to a causal loop diagram, what loop can be declared there?

- a** None
Yes. Only the causal claims carry over. Seed saved → crop yield is an influence claim, so it is left behind, and the path from crop yield to seed saved doesn't return. Upgrading that claim, if a record shows which way it runs, would close the path.
- b** One reinforcing loop: crop yield → seed saved → crop yield
Not quite. That path closes only through an influence claim. The conversion leaves influence claims behind rather than carrying them without a polarity, so in the causal loop diagram the path is open.
- c** Two: one through seed saved and one through compost spread
Not quite. Nothing runs from crop yield back to compost spread, so no path closes there. The path through seed saved closes only by an influence claim, which the conversion leaves behind.

QUESTION 1 OF 3

The source's figure has no box for deforestation. Why does the redrawing add tropical deforestation, double-underlined?

- a It is the quantity in question, named in the figure's title, and every path of claims ends there.
Yes. The figure's title reads Causative pattern of tropical deforestation. Drawn, it is the one variable the map is drawn around, reached from every underlying driving force through the four proximate causes.
- b It marks the result of agricultural expansion, the cause found most often.
Not quite. Agricultural expansion was found in 96% of the cases, and it is one of four claims ending at deforestation. The central outcome is what the map is drawn around, not the cause found most often.
- c Every influence map has a variable that no claim leaves.
Not quite. A central outcome is chosen as the quantity in question, not for having no claim leave it.

QUESTION 2 OF 3

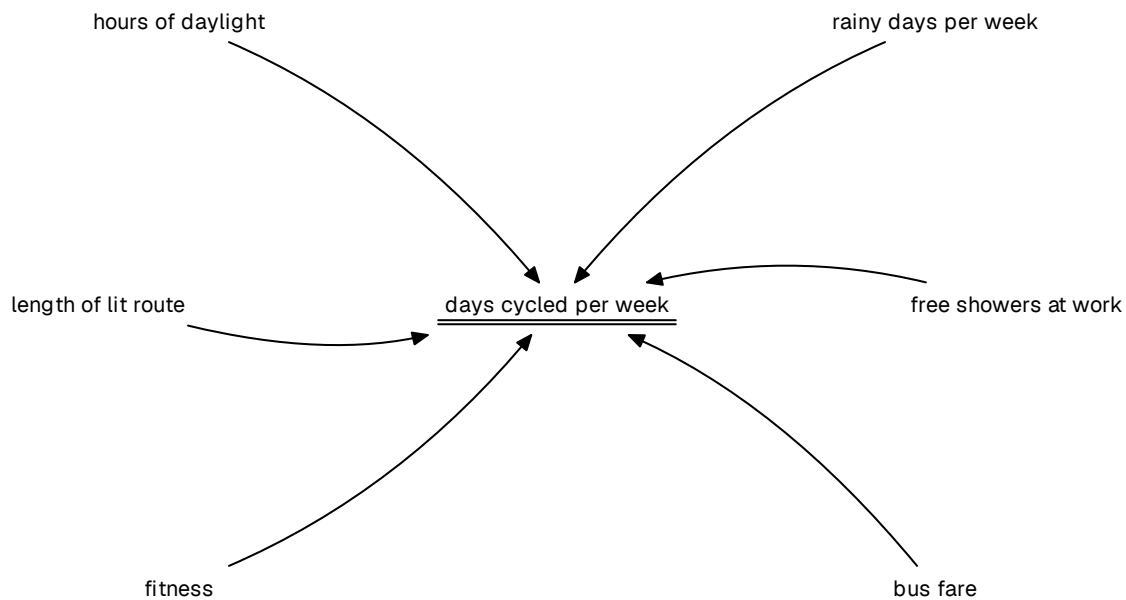
Which variables share a cluster with wood extraction?

- a Economic forces and political and institutional forces, which bear on it in the most cases.
Not quite. Those two bear on wood extraction from the other cluster, underlying driving forces. A cluster holds variables that share something, not variables joined by claims.
- b Tropical deforestation, which it bears on directly.
Not quite. The central outcome sits in no cluster.
- c Infrastructure extension, agricultural expansion and other causes.
Yes. The four are the source's proximate causes, which clear the forest directly; its five underlying driving forces reach deforestation only through them.

QUESTION 3 OF 3

Which claim could be upgraded with a polarity, from what the source's authors report?

- a Agricultural expansion → tropical deforestation, whose three dots mark it found in 96% of the cases.
Not quite. The dots here count the cases in which the two were found together, not which way a change runs, nor how strongly. An upgrade takes a direction someone can say how they know.
- b None: an influence map's claims carry no polarity.
Not quite. A claim is upgraded where someone can say how they know its direction, as the reading log let Nia's parents say for three of theirs.
- c Infrastructure extension → economic forces, +, one of the source's two dashed lines labeled Feedback.
Yes. The authors report that new roads and settlements feed the growth of wood and food markets, which amplify deforestation: more infrastructure extension, more economic forces at work. Its dashes mark feedback in the source; no line in an influence map is dashed, so it is solid here.

IM 01 Cycling to work through the winter

This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Days cycled per week, double-underlined as the central outcome, with six variables acting on it straight: hours of daylight, rainy days per week, length of lit route, free showers at work, fitness and bus fare. Every influence is an influence claim with no + or –.

Why it works

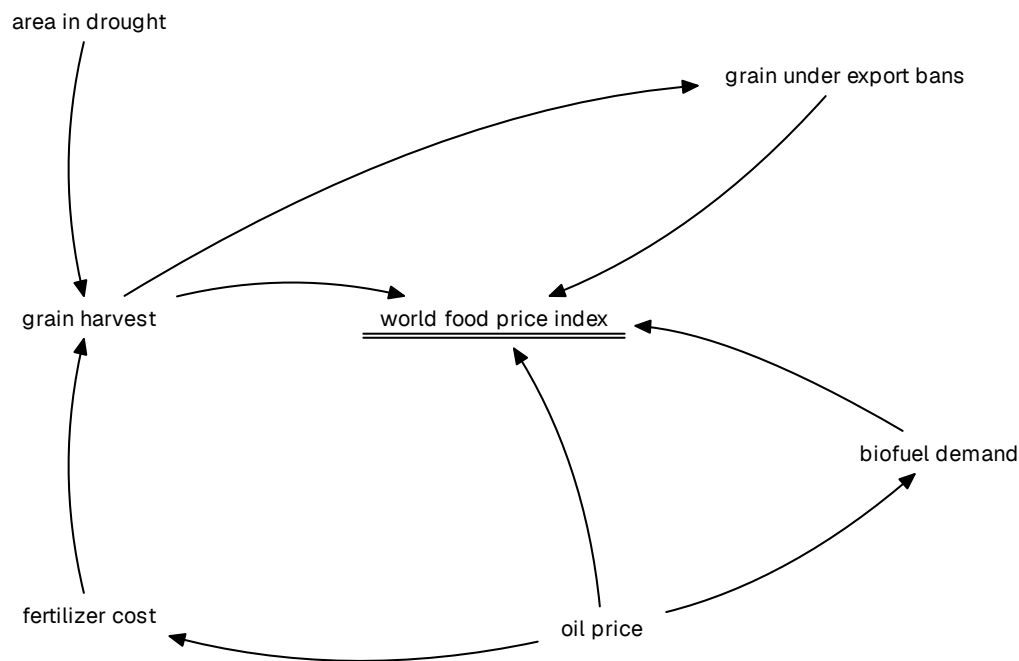
- One central outcome, the number Tomás counts
- Six direct influences and no indirect ones
- No polarity: nothing in the situation was measured
- Each variable a quantity: free showers at work, not the showers

Step by step

1. Days cycled per week, double-underlined as the central outcome, alone before any influence claim, since every claim in the brief ends at it.
2. Hours of daylight and rainy days per week, each with an influence claim on days cycled per week: the two the autumn moves, one falling and one rising.
3. Length of lit route and free showers at work, each with an influence claim: the route and the office, which change with the council's work and the morning's rush.
4. Fitness and bus fare, each with an influence claim: what Tomás brings to the ride and what the other way to work costs.

What another defensible answer might vary

Another defensible answer might leave out the bus fare, draw morning temperature as a seventh variable, or name rainy days per week as hours of rain. What stays the same is one central outcome, each variable a quantity, and every influence claim drawn straight to it with no + or –.

IM 02 World food prices

This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

The world food price index as the central outcome, with four direct influences: grain harvest, oil price, biofuel demand and grain under export bans. Area in drought and fertilizer cost reach the index through the grain harvest, the oil price also acts on fertilizer cost and biofuel demand, and the grain harvest acts on grain under export bans. Every influence is an influence claim with no + or –.

Why it works

- One central outcome: the world food price index
- Four direct influences, each ending at the index
- Five indirect influences, each drawn to the variable it acts on
- The oil price on three paths: straight, through fertilizer cost and through biofuel demand
- Every variable has a path to the index

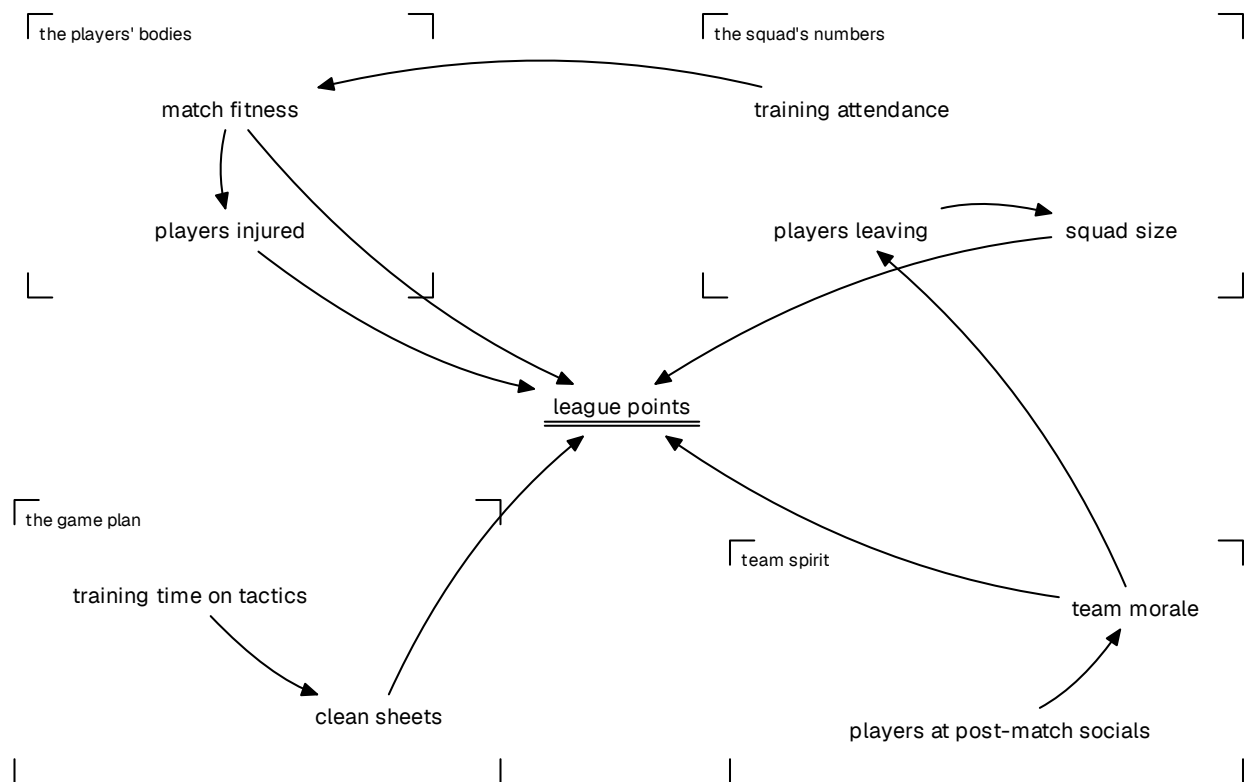
Step by step

1. The world food price index, double-underlined as the central outcome, alone before any influence claim, since every path in the drawing ends at it.
2. Grain harvest, oil price, biofuel demand and grain under export bans, each with an influence claim on the index, before anything indirect: a variable acting through another comes after it.
3. Area in drought and fertilizer cost, each with an influence claim on the grain harvest, the variable both act through.
4. Three influence claims among variables already drawn: the oil price on fertilizer cost and on biofuel demand, and the grain harvest on grain under export bans.

What another defensible answer might vary

Another defensible answer might draw fertilizer cost straight to the index as a cost of farming, add grain stocks between the harvest and the index, or leave out the influence claim from the grain harvest to grain under export bans. What stays the same is one central outcome, and the area in drought reaching it only through the grain harvest.

IM 03 An amateur football team's season



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

League points as the central outcome, in no cluster, with four clusters around it: the players' bodies (match fitness, players injured), the squad's numbers (training attendance, players leaving, squad size), the game plan (training time on tactics, clean sheets) and team spirit (team morale, players at post-match socials). Match fitness, players injured, squad size, clean sheets and team morale act on league points straight; the other four reach it through one of them. Every influence is an influence claim with no + or –.

Why it works

- One central outcome, league points, outside every cluster
- Four clusters, each labeled for what its variables share
- Every other variable in one cluster, and two or more in each
- Five direct influences and six indirect ones
- No polarity: nobody at the club measured any of them

Step by step

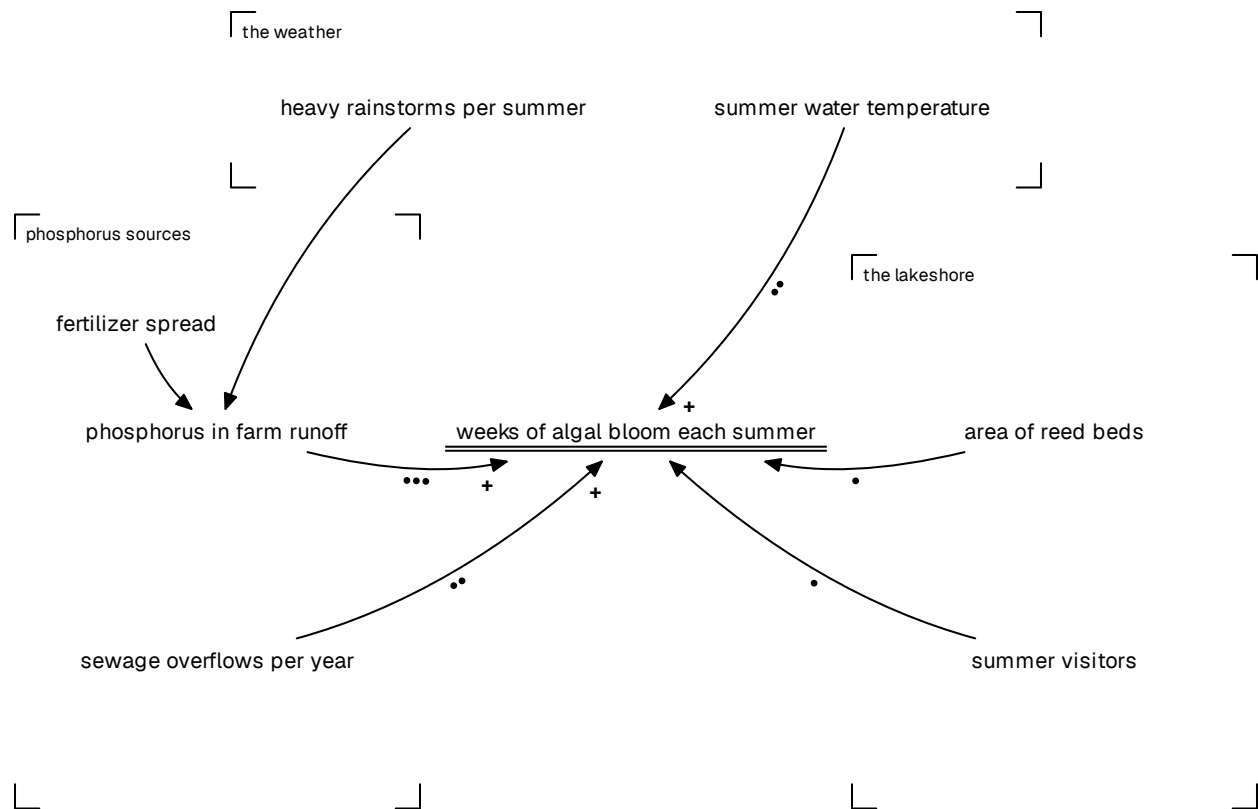
1. League points, double-underlined as the central outcome, alone before any influence claim, as the score every other variable reaches.
2. Match fitness, players injured, squad size, clean sheets and team morale, each with an influence claim on league points: the five that act on it straight.
3. Training attendance, training time on tactics and players at post-match socials, each with an influence claim on the direct influence it acts through: match fitness, clean sheets and team morale.

4. Players leaving, with an influence claim into it from team morale and one from it to squad size, and the claim from match fitness to players injured: the last claims, each between variables drawn.
5. The four clusters, the players' bodies, the squad's numbers, the game plan and team spirit, drawn last because each goes round variables already in place.

What another defensible answer might vary

Another defensible answer might put training attendance with the players' bodies, label the squad's numbers as who is available, or label the game plan as defending. What stays the same is league points outside every cluster, and each cluster holding two or more variables that share what its label names.

IM 04 Algal blooms in a lake



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Weeks of algal bloom each summer as the central outcome, with five direct influences, each weighted. Each of the three the authority measured is a causal claim with a +: phosphorus in farm runoff (weight 3), sewage overflows per year (weight 2) and summer water temperature (weight 2). The area of reed beds and summer visitors, blamed but not measured, each stays an influence claim of weight 1. Fertilizer spread and heavy rainstorms reach the blooms through farm runoff. Three clusters hold every variable but the central outcome: phosphorus sources, the weather and the lakeshore.

Why it works

- A causal claim with a + for each of the three the authority measured, and for nothing else
- The reed beds and the visitors each kept as an influence claim: blamed, not measured
- A weight on every direct influence, the most on farm runoff, which carries two-thirds of the phosphorus
- Three clusters, the central outcome in none

Step by step

1. Weeks of algal bloom each summer, double-underlined as the central outcome, alone before any claim.
2. Area of reed beds and summer visitors, each an influence claim of weight 1 on the blooms: the anglers' and the boat operators' blame.
3. Phosphorus in farm runoff, sewage overflows per year and summer water temperature, each drawn upgraded, a causal claim with a +, weighted 3, 2 and 2: ten years of the authority's counts rise and fall with the blooms.
4. Fertilizer spread and heavy rainstorms per summer, each with an influence claim on phosphorus in farm runoff, after it, since they reach the blooms only through the runoff.

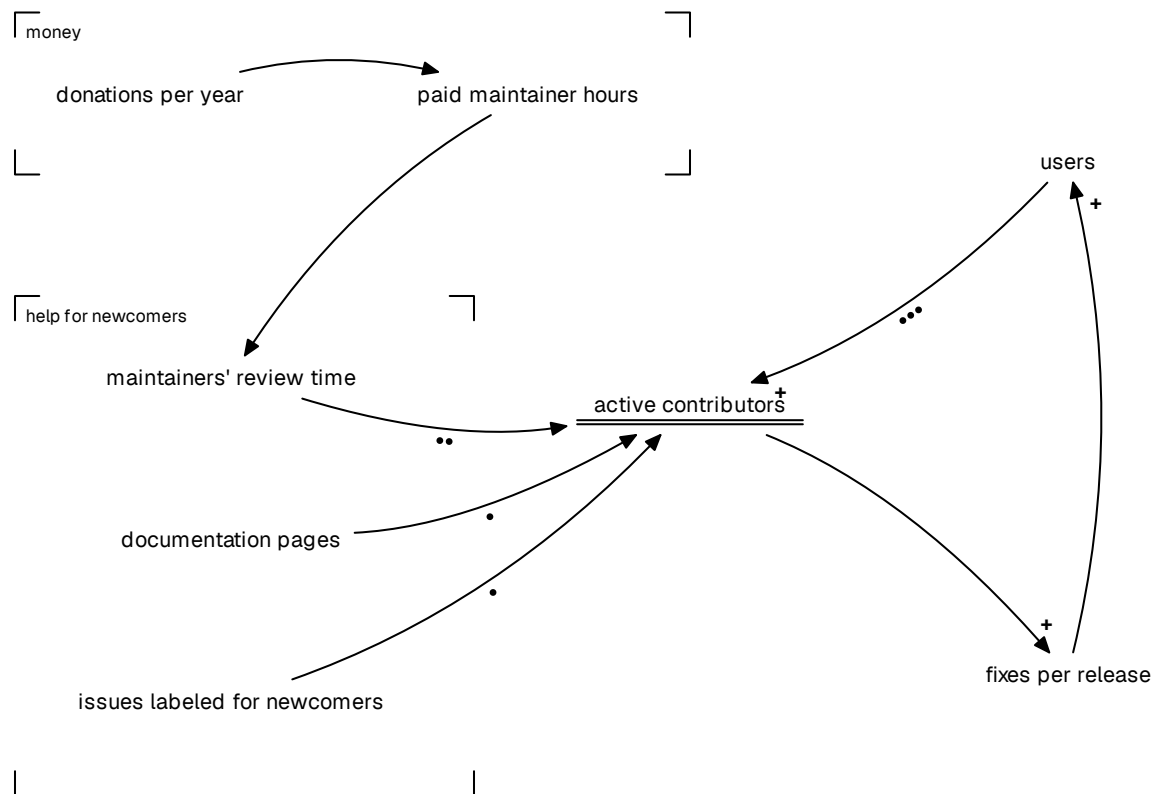
5. The three clusters, phosphorus sources, the weather and the lakeshore, drawn last around variables already in place.

What another defensible answer might vary

Another defensible answer might give summer water temperature a weight of 3 or sewage overflows a weight of 1, draw heavy rainstorms to sewage overflows as well, or name phosphorus sources as what reaches the water.

What stays the same is a causal claim for each of the three the authority measured, and every other claim an influence claim.

IM 05 An open-source project's contributors



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Active contributors as the central outcome. The three claims the records show are causal claims, each with a +, and they close a path: active contributors → fixes per release → users → active contributors. Maintainers' review time, documentation pages and issues labeled for newcomers each act on active contributors as an influence claim, in a cluster, help for newcomers; donations per year reach review time through paid maintainer hours, the two in a cluster, money. Every direct influence has a weight, 3 on users. The conversion to a causal loop diagram carries the eight variables and the three causal claims, and leaves behind five influence claims, two clusters, four weights and the central outcome's mark.

Why it works

- A causal claim with a + for each of the three the records show, and for nothing else
- One closed path of causal claims, active contributors → fixes per release → users → active contributors, with no – claims: reinforcing by the parity rule
- Review time, documentation, newcomer issues and donations each kept as an influence claim: believed, not measured
- Two clusters, the central outcome in neither, and a weight on every direct influence

Step by step

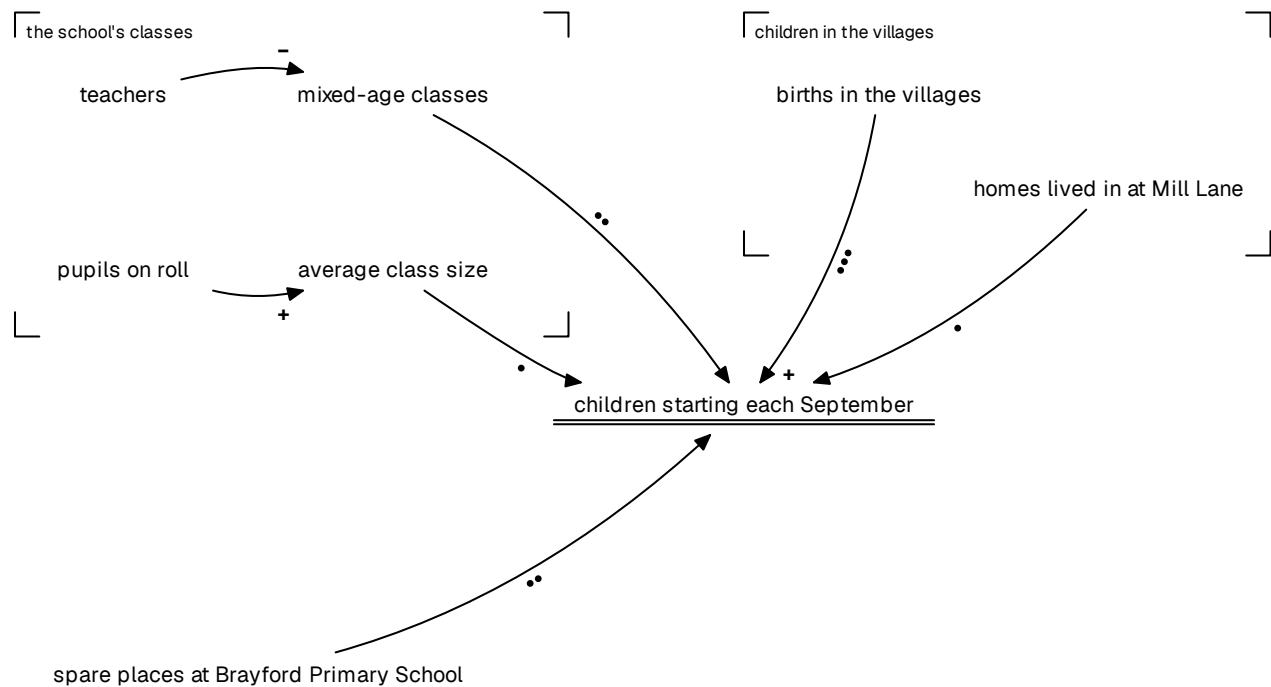
1. Active contributors, double-underlined as the central outcome, the number the maintainers count each month, alone before any claim.
2. Maintainers' review time, documentation pages and issues labeled for newcomers, each an influence claim on active contributors, weighted 2, 1 and 1: what the maintainers believe keeps newcomers.

3. Donations per year and paid maintainer hours, with influence claims from donations to the hours and from the hours to review time, the review the money pays for.
4. Fixes per release and users, with three causal claims, each a +, running from active contributors through fixes and users and back, weight 3 on the last: the upgrades, drawn once every influence claim is in place.
5. The two clusters, money and help for newcomers, drawn last around variables already in place.

What another defensible answer might vary

Another defensible answer might make users the central outcome, draw paid maintainer hours to fixes per release as well, or put fixes per release and users in a third cluster. What stays the same is a causal claim with a + for each of the three the records show, closing one path, and every other claim an influence claim.

CS 03 Kelsham Primary School: what decides where a child starts



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Children starting each September as the central outcome, with five direct influences, each weighted. Births in the villages, counted against the starters four years later, is a causal claim with a +, weight 3. Mixed-age classes and average class size, the parents' reasons, spare places at Brayford Primary School and homes lived in at Mill Lane each stay an influence claim: told, said or forecast, never counted against the starters. Teachers reach the starters through mixed-age classes, with a –, and pupils on roll through average class size, with a +: two causal claims the school has counted. A count of each September's starters beside the mixed-age classes, the class sizes or Brayford's spare places would upgrade that claim. Two clusters: the school's classes and children in the villages.

Why it works

- A causal claim for each of the three changes someone counted, and for nothing else
- Births weighted 3: every September's starters have followed them
- The parents' two reasons, Brayford's places and the new homes each kept as an influence claim
- Teachers and pupils on roll reach the starters only through the parents' reasons, so the outcome still rests on influence claims
- Two clusters, the central outcome and spare places at Brayford Primary School in neither

Step by step

1. Children starting each September, double-underlined as the central outcome, alone before any claim: the number Tom Hale asks about.

2. Mixed-age classes, average class size, spare places at Brayford Primary School and homes lived in at Mill Lane, each an influence claim on the starters, weighted 2, 1, 2 and 1: what parents tell, what Helen Marsh says and what David Brennan forecasts.
3. Births in the villages, with a causal claim with a + on the starters, weight 3, drawn after the influence claims as the one upgrade among the direct influences: the county council counts both.
4. Teachers and pupils on roll, with a causal claim with a – on mixed-age classes and one with a + on average class size, each reaching the starters through a parent's reason: the school counts both.
5. The two clusters, the school's classes and children in the villages, drawn last around variables already in place.

What another defensible answer might vary

Another defensible answer might weight the parents' reasons 3 and the births 2, draw pupils on roll as a variable the starters change, or put spare places at Brayford Primary School in a third cluster with a variable such as the bus journey's minutes. What stays the same is a causal claim for each of the three counted changes, and every other claim an influence claim.