

Causal Diagrams in R

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**Draw your causal assumptions
with causal directed acyclic
graphs (DAGs)**

The basic idea

- 1 Specify your causal question
- 2 Use domain knowledge
- 3 Write variables as nodes
- 4 Write causal pathways as arrows (edges)

ggdag

dagitty

ggplot2
ggraph

dagitty

powerful,
robust
algorithms

ggplot2
gggraph

dagitty

powerful,
robust
algorithms

ggplot2
gggraph

unlimited
flexibility

beautiful
plots

dagitty

ggplot2
ggraph

Data
structure:
tidy DAGs

```
graph BT; A[Data structure: tidy DAGs] --> B[dagitty]; A --> C[ggplot2 ggraph];
```

The diagram illustrates the relationship between the 'Data structure: tidy DAGs' concept and two R packages. Two arrows originate from the central text 'Data structure: tidy DAGs'. One arrow points upwards and to the left to the word 'dagitty'. The other arrow points upwards and to the right to the words 'ggplot2' and 'ggraph' stacked vertically.

Step 1: Specify your DAG

```
dagify(  
  cancer ~ smoking,  
  coffee ~ smoking  
)
```

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```
dagify(  
  cancer ~ smoking,  
  coffee ~ smoking  
)
```

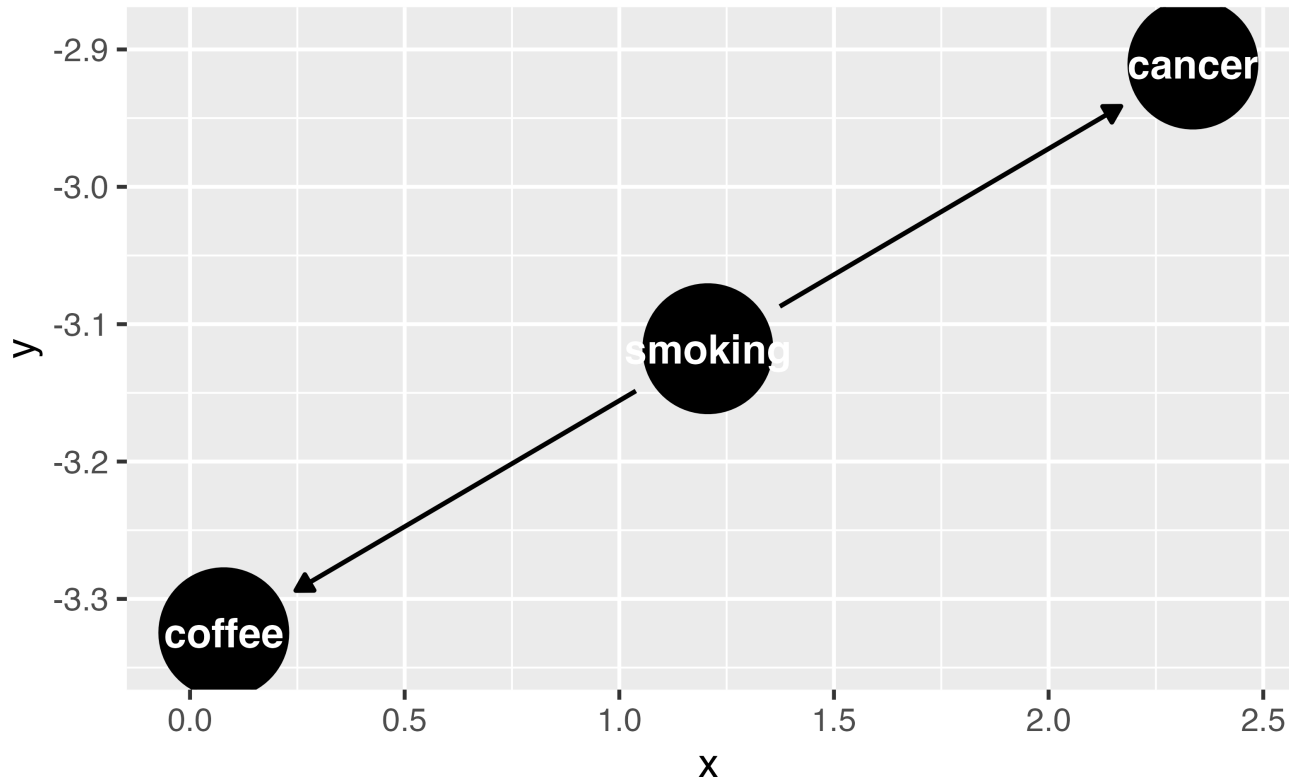
Step 1: Specify your DAG

```
dagify(  
  cancer ~ smoking,  
  coffee ~ smoking  
)
```

Step 1: Specify your DAG

```
dagify(  
  cancer ~ smoking,  
  coffee ~ smoking  
) %>% ggdag()
```

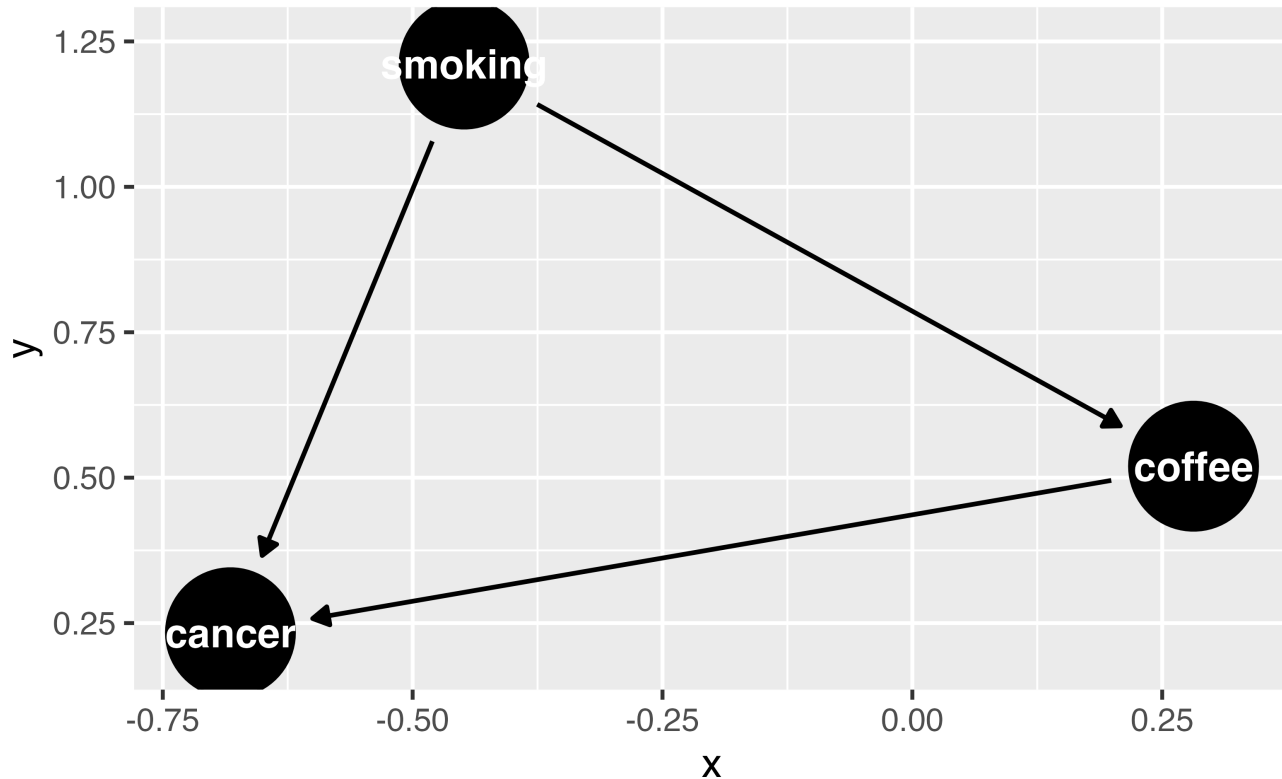
Step 1: Specify your DAG



Step 1: Specify your DAG

```
dagify(  
  cancer ~ smoking + coffee,  
  coffee ~ smoking  
) %>% ggdag()
```

Step 1: Specify your DAG



Your Turn 1 (02-dags-exercises.Rmd)

Specify a DAG with `dagify()`. Write your assumption that smoking causes cancer as a formula.

We're going to assume that coffee does not cause cancer, so there's no formula for that. But we still need to declare our causal question. Specify "coffee" as the exposure and "cancer" as the outcome (both in quotations marks).

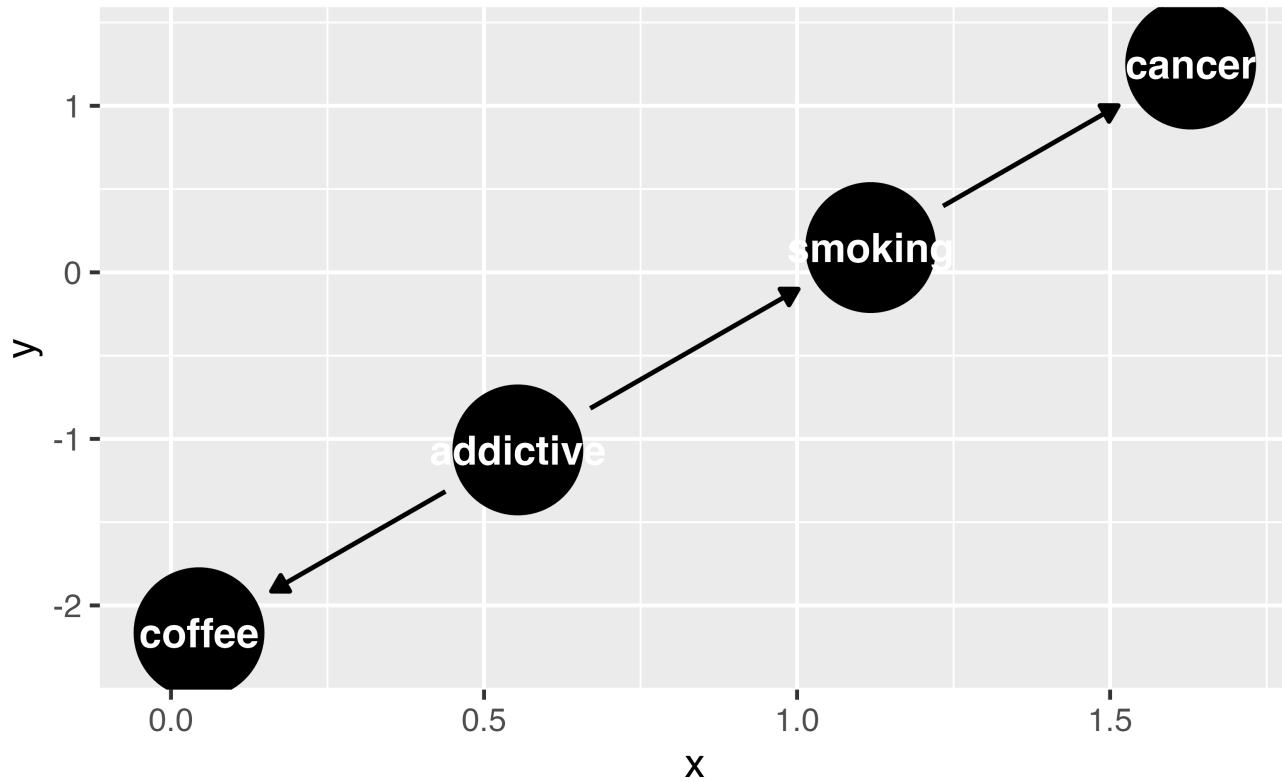
Plot the DAG using `ggdag()`

05:00

Your Turn 1 (02-dags-exercises.Rmd)

```
coffee_cancer_dag <- dagify(  
  cancer ~ smoking,  
  smoking ~ addictive,  
  coffee ~ addictive,  
  exposure = "coffee",  
  outcome = "cancer",  
  labels = c(  
    "coffee" = "Coffee",  
    "cancer" = "Lung Cancer",  
    "smoking" = "Smoking",  
    "addictive" = "Addictive \nBehavior"  
  )  
)
```

```
ggdag(coffee_cancer_dag)
```



Causal effects and backdoor paths

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Ok, correlation \neq causation. But why not?

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We want to know if $x \rightarrow y$...

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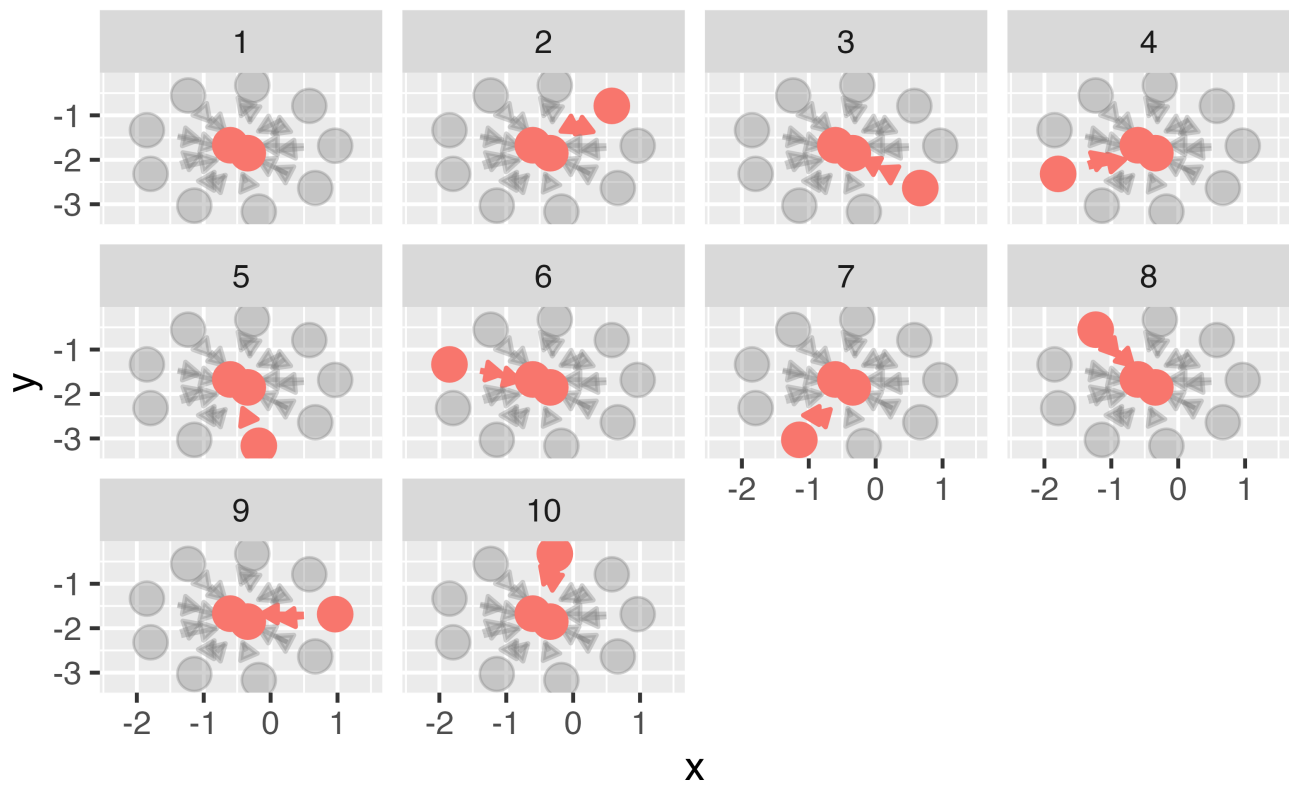
We want to know if $x \rightarrow y$...

But other paths also cause associations

ggdag_paths()

Identify "backdoor" paths

```
ggdag_paths(smk_wt_dag)
```



Your Turn 2

**Call `tidy_dagitty()` on `coffee_cancer_dag` to create a tidy DAG, then pass the results to `dag_paths()`.
What's different about these data?**

Plot the open paths with `ggdag_paths()`. (Just give it `coffee_cancer_dag` rather than using `dag_paths()`; the quick plot function will do that for you.)

Remember, since we assume there is **no causal path from coffee to lung cancer, any open paths must be confounding pathways.**

05:00

Your Turn 2

```
coffee_cancer_dag %>%  
  tidy_dagitty() %>%  
  dag_paths()
```

```
## # A DAG with 4 nodes and 3 edges
```

```
## #
```

```
## # Exposure: coffee
```

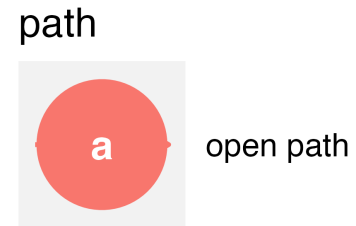
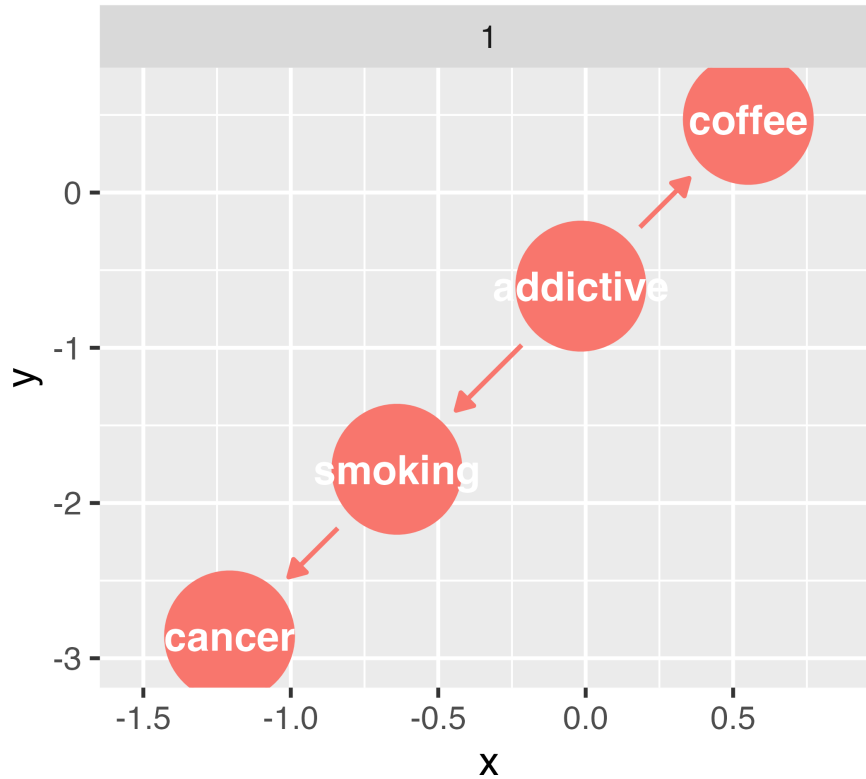
```
## # Outcome: cancer
```

```
## #
```

```
## # A tibble: 5 × 11
```

```
##   set   name      x      y direction to      xend  yend  
##   <chr> <chr>    <dbl> <dbl> <fct>    <chr> <dbl> <dbl>  
## 1 1      addictive -2.49  1.51  ->      coff... -3.45  0.772  
## 2 1      addictive -2.49  1.51  ->      smok... -1.42  2.32  
## 3 1      cancer    -0.456 3.06  <NA>      <NA>   NA     NA  
## 4 1      coffee    -3.45  0.772 <NA>      <NA>   NA     NA  
## 5 1      smoking   -1.42  2.32  ->      canc... -0.456 3.06  
## # ... with 3 more variables: circular <lgl>, label <chr>,  
## #   path <chr>
```

```
coffee_cancer_dag %>%  
  ggdag_paths()
```



Closing backdoor paths

Closing backdoor paths

We need to account for these open, non-causal paths

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Randomization

Closing backdoor paths

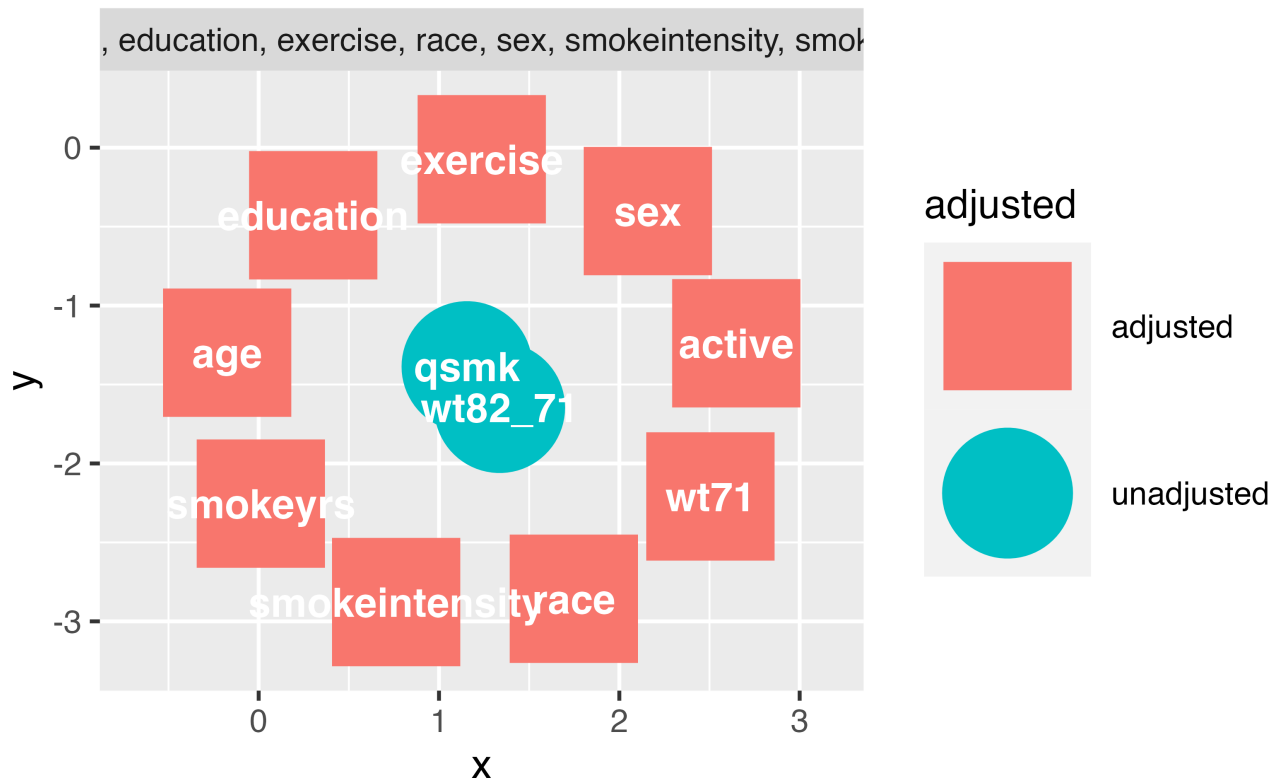
We need to account for these open, non-causal paths

Randomization

Stratification, adjustment, weighting, matching, etc.

Identifying adjustment sets

```
ggdag_adjustment_set(smkn_wt_dag)
```

Your Turn 3

Now that we know the open, confounding pathways (sometimes called "backdoor paths"), we need to know how to close them! First, we'll ask {ggdag} for adjustment sets, then we would need to do something in our analysis to account for at least one adjustment set (e.g. multivariable regression, weighting, or matching for the adjustment sets).

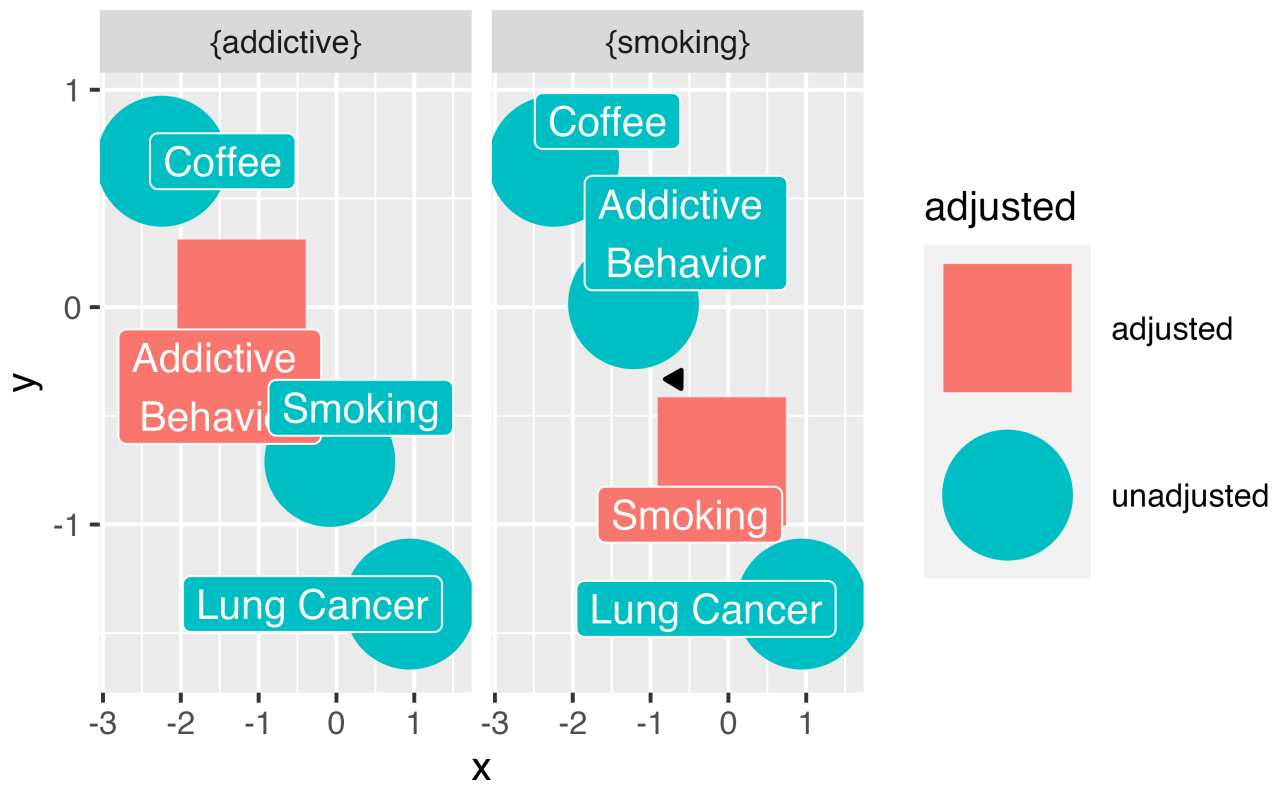
Use `ggdag_adjustment_set()` to visualize the adjustment sets. Add the arguments `use_labels = "label"` and `text = FALSE`.

Write an R formula for each adjustment set, as you might if you were fitting a model in `lm()` or `glm()`

05:00

Your Turn 3

```
ggdag_adjustment_set(  
  coffee_cancer_dag,  
  use_labels = "label",  
  text = FALSE  
)
```



Your Turn 3

cancer ~ coffee + addictive

cancer ~ coffee + smoking

Choosing what variables to include

Adjustment sets and domain knowledge

Conduct sensitivity analysis if you don't have something important

Common trip ups

Using prediction metrics

The 10% rule

Predictors of the outcome, predictors of the exposure

Selection bias and colliders (more later!)

Resources: ggdag vignettes

An Introduction to ggdag

An Introduction to Directed Acyclic
Graphs

Common Structures of Bias