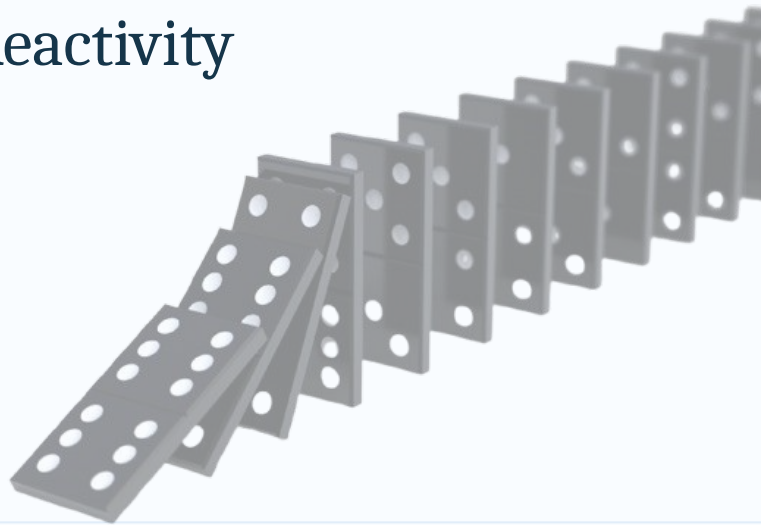
Why Is It Triggering Twice?

Understanding Shiny Reactivity



Douglas Mesquita

shiny::conf

09/04/2025

Overview

About me

- Master's and PhD in Statistics (UFMG)
- R/Shiny developer for 3 years
- Statistician/Data scientist 10+ years
- Open source contributor

github.com/DouglasMesquita

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www.require-r.com

Wait a Second!

What should you know before we start?

shiny::conf repo

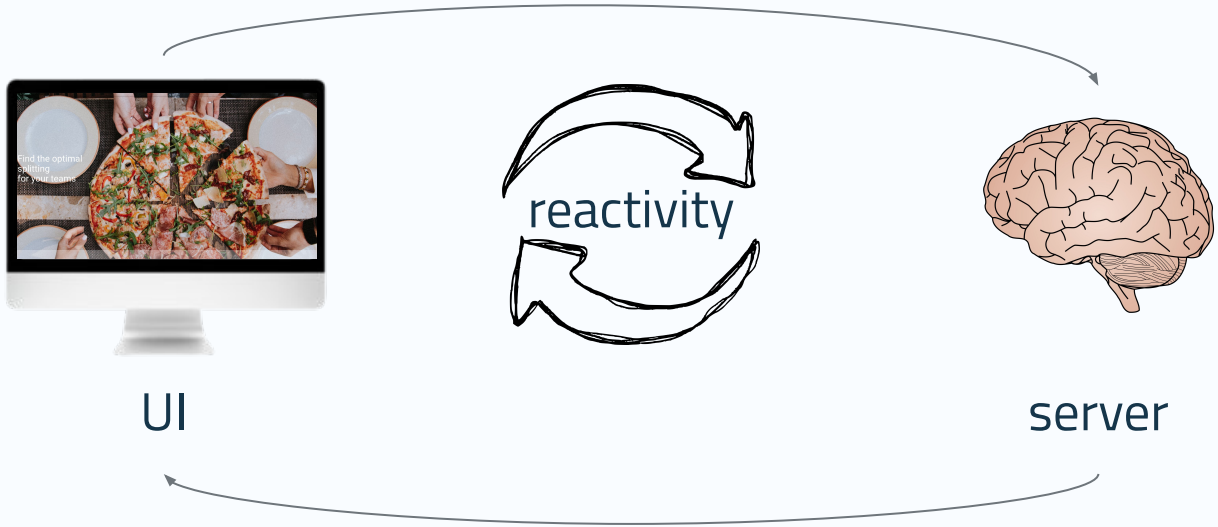
In this repo you will find all the examples I will be showing today as well as this presentation!

github.com/DouglasMesquita/shiny_conf_2025

Open the project and run *renv::restore()*

Always run the examples in the browser!!!

Where does reactivity happen?



Understanding Shiny Reactivity

Dependencies, invalidations, and execution flow

Reactivity

a() absolutePanel() actionButton() actionLink() addResourcePath() animationOptions() appendTab() as.shiny.appobj() basicPage() bindCache() bindEvent() bookmarkButton() bootstrapLib() bootstrapPage() br() browserViewer() brushedPoints() brushOpts() busyIndicatorOptions() callModule() captureStackTraces() checkboxGroupInput() checkboxInput() clickOpts() code() column() conditionalPanel() conditionStackTrace() conditionStackTrace<-() createRenderFunction() createWebDependency() dataTableOutput() dateInput() dateRangeInput() dblclickOpts() debounce() devmode() dialogViewer() diskCache() div() downloadButton() downloadHandler() downloadLink() em() enableBookmarking() eventReactive() exportTestValues() exprToFunction() ExtendedTask() fileInput() fillCol() fillPage() fillRow() fixedPage() fixedPanel() fixedRow() flowLayout() fluidPage() fluidRow() freezeReactiveVal() freezeReactiveValue() get_devmode_option() getCurrentOutputInfo() getCurrentTheme() getDefaultReactiveDomain() getQueryString() getShinyOption() getUrlHash() h1() h2() h3() h4() h5() h6() headerPanel() helpText() hideTab() hoverOpts() hr() HTML() htmlOutput() htmlTemplate() httpResponse() icon() imageOutput() img() in_devmode() includeCSS() includeHTML() includeMarkdown() includeScript() includeText() incProgress() inputPanel() insertTab() insertUI() installExprFunction() invalidateLater() is.key_missing() is.reactive() is.reactivevalues() is.shiny.appobj() is.singleton() isolate() isRunning() isTruthy() key_missing() loadSupport() mainPanel() makeReactiveBinding() markdown() markRenderFunction() maskReactiveContext() memoryCache() MockShinySession() modalButton() modalDialog() moduleServer() navbarMenu() navbarPage() navlistPanel() nearPoints() need() NS() ns.sep() numericInput() observe() observeEvent() onBookmark() onBookmarked() onFlush() onFlushed() onReactiveDomainEnded() onRestore() onRestored() onSessionEnded() onStop() onUnhandledError() outputOptions() p() pageWithSidebar() paneViewer() parseQueryString() passwordInput() plotOutput() plotPNG() pre() prependTab() printError() printStackTrace() Progress() quoToFunction() radioButtons() reactive() reactiveConsole() reactiveFileReader() reactivePoll() reactiveTimer() reactiveVal() reactiveValues() reactiveValuesToList() reactlog() reactlogAddMark() reactlogReset() reactlogShow() register_devmode_option() registerInputHandler() registerThemeDependency() removeInputHandler() removeModal() removeNotification() removeResourcePath() removeTab() removeUI() renderCachedPlot() renderDataTable() renderImage() renderPlot() renderPrint() renderTable() renderText() renderUI() repeatable() req() resourcePaths() restoreInput() runApp() runExample() runGadget() runGist() runGitHub() runTests() runUrl() safeError() selectInput() selectizeInput() serverInfo() setBookmarkExclude() setProgress() setSerializer() shinyApp() shinyAppDir() shinyAppFile() shinyAppTemplate() shinyOptions() shinyServer() shinyUI() showBookmarkUrlModal() showModal() showNotification() showTab() sidebarLayout() sidebarPanel() singleton() sizeGrowthRatio() sliderInput() snapshotExclude() snapshotPreprocessInput() snapshotPreprocessOutput() span() splitLayout() stopApp() strong() submitButton() suppressDependencies() tableOutput() tabPanel() tabPanelBody() tabsetPanel() tag() tagAppendAttributes() tagAppendChild() tagAppendChildren() tagGetAttribute() tagHasAttribute() tagList() tags() tagSetChildren() testServer() textAreaInput() textInput() textOutput() throttle() titlePanel() uiOutput() updateActionButton() updateActionLink() updateCheckboxGroupInput() updateCheckboxInput() updateDateInput() updateDateRangeInput() updateNavbarPage() updateNavlistPanel() updateNumericInput() updateQueryString() updateRadioButtons() updateSelectInput() updateSelectizeInput() updateSliderInput() updateTabsetPanel() updateTextAreaInput() updateTextInput() updateVarSelectInput() updateVarSelectizeInput() urlModal() useBusyIndicators() validate() validateCssUnit() varSelectInput() varSelectizeInput() verbatimTextOutput() verticalLayout() wellPanel() with_devmode() withLogErrors() withMathJax() withProgress() withReactiveDomain() withTags()

shiny@1.0.9

Reactivity

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shiny@1.0.9

Reactivity

actionButton() actionLink()

bindCache() bindEvent()

checkboxGroupInput() checkboxInput()

dataTableOutput() dateInput() dateRangeInput() debounce()

downloadButton() downloadHandler() downloadLink()

eventReactive() fileInput()

htmlOutput()

imageOutput()

invalidateLater()

isolate()

numericInput() observe() observeEvent()

passwordInput() plotOutput()

radioButtons() reactive()

reactiveFileReader() reactivePoll() reactiveTimer() reactiveVal() reactiveValues()

renderCachedPlot() renderDataTable() renderImage() renderPlot() renderPrint() renderTable() renderText() renderUI()

req()

selectInput() selectizeInput()

tableOutput()

textAreaInput() textInput() textOutput() throttle()

uiOutput()

validate()

varSelectInput() varSelectizeInput() verbatimTextOutput()

shiny@1.0.9

Reactivity

actionButton()
actionLink()
checkboxGroupInput()
checkboxInput()
dateInput()
dateRangeInput()
downloadButton()
downloadLink()
fileInput()
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passwordInput()
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selectInput()
selectizeInput()
textAreaInput()
textInput()
varSelectizeInput()
reactiveVal()
reactiveValues()

eventReactive()
reactive()
reactiveFileReader()
reactivePoll()
reactiveTimer()

bindCache()
bindEvent()
debounce()
invalidateLater()
isolate()
throttle()
req()
validate()

dataTableOutput()
downloadHandler()
htmlOutput()
imageOutput()
plotOutput()
tableOutput()
textOutput()
uiOutput()
verbatimTextOutput()
renderCachedPlot()
renderDataTable()
renderImage()
renderPlot()
renderPrint()
renderTable()
renderText()
renderUI()

observe()
observeEvent()

Reactivity

*Button()
*Link()
*Input()
radioButtons()
reactiveVal()
reactiveValues()

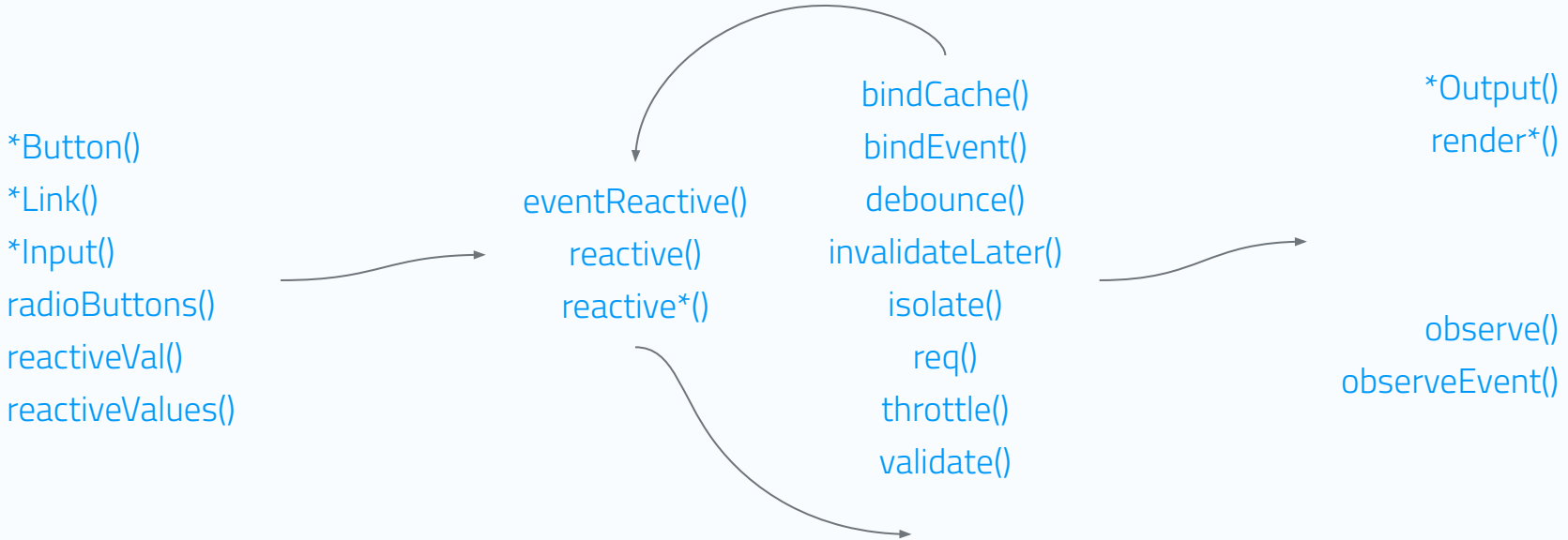
eventReactive()
reactive()
reactive*()

bindCache()
bindEvent()
debounce()
invalidateLater()
isolate()
req()
throttle()
validate()

*Output()
render*()

observe()
observeEvent()

Reactivity


*Button()
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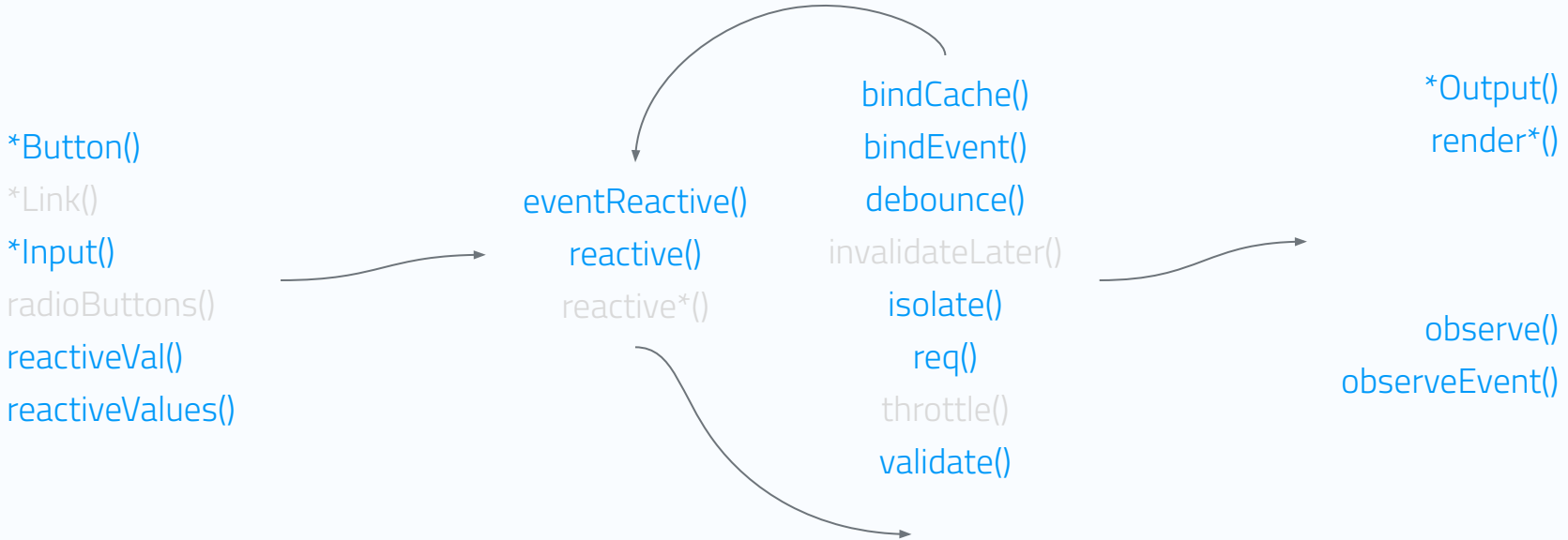
Reactivity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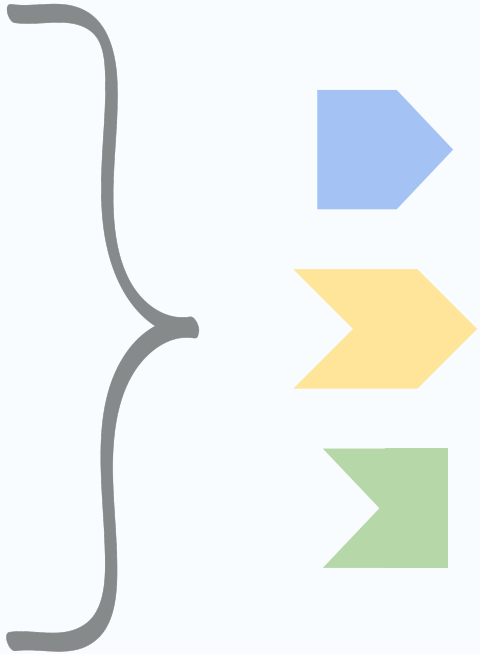


Reactivity

Sources

*Button()
*Input()
reactiveVal()
reactiveValues()

Conductors

eventReactive()
reactive()

---

bindCache()
debounce()
isolate()

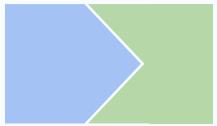
Endpoints

render*()
*Output()
observe()
observeEvent()

---

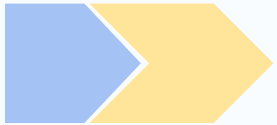
req()

Reactivity



Sources can affect Endpoints directly

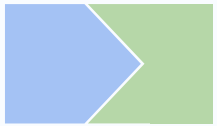
Conductors can affect Endpoints directly



Sources can affect Conductors

Conductors can affect other Conductors

Reactivity



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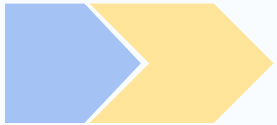
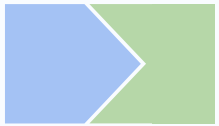


Sources can affect Conductors

Conductors can affect other Conductors

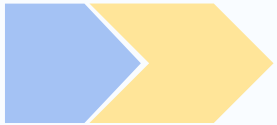
You can connect as many Reactive Components as you want

Reactivity



Sources can affect Endpoints directly

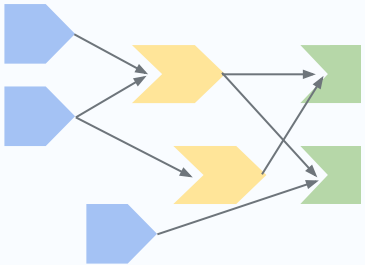
Conductors can affect Endpoints directly



Sources can affect Conductors

Conductors can affect other Conductors

You can connect as many Reactive Components as you want



Reactive components can have many-to-many connections

We are good to go

Let’s understand what our client wants…

Client meeting

We would like a very simple application...

It will take age, weight, gender, activity, and activity duration as inputs and return the estimated number of calories. No worries - we will provide the formula! Also, we don't need anything fancy. Plain text is just fine!

Calorie burn

$$\text{Calories} = \frac{\text{Duration (min)} * (\text{MET} * \text{Age factor} * \text{Gender factor}) * \text{Weight (kg)} * 3.5}{200}$$

$$\text{MET} = \begin{cases} \text{if Volleyball then } 3.0 \\ \text{if Walking then } 3.8 \\ \text{if Cycling then } 6.8 \\ \text{if Football then } 7.0 \\ \text{if Tennis then } 7.3 \\ \text{if Running then } 8.0 \\ \text{if Swimming then } 9.8 \end{cases}$$

$$\text{Age factor} = \begin{cases} \text{if age} \in [18, 30) \text{ then } 1.00 \\ \text{if age} \in [30, 40) \text{ then } 0.98 \\ \text{if age} \in [40, 50) \text{ then } 0.96 \\ \text{if age} \in [50, 60) \text{ then } 0.94 \\ \text{if age} \in [60, 70) \text{ then } 0.92 \\ \text{if age} \geq 70 \text{ then } 0.90 \end{cases}$$

$$\text{Gender factor} = \begin{cases} \text{if men then } 1.1 \\ \text{if women then } 0.9 \end{cases}$$

The values used are for illustrative purposes only

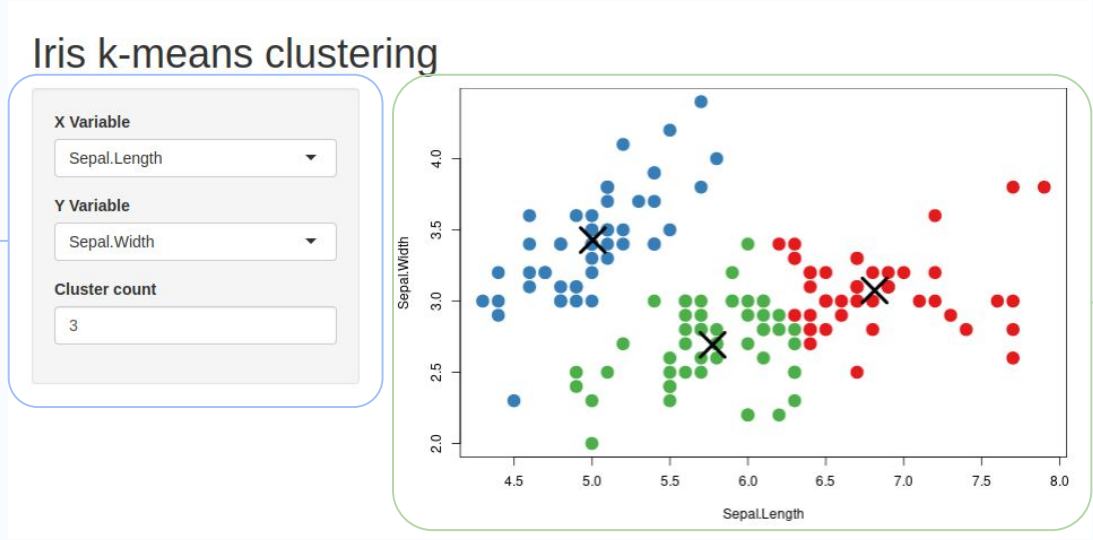
Core Reactive Elements

An overview of reactive values,observers, and render functions in Shiny.

Inputs and Outputs

*Input()

*Output()



reactive

reactive() is a worker that performs its task every time it is requested!

It is updated every time **any** reactive dependencies are triggered

It does not start any task unless requested

It does not have to complete the entire task on its own

It can deliver unfinished work if requested

reactive

eventReactive() only updates when a specific event occurs!

It is updated every time **specific** reactive dependencies are triggered

It does not start any task unless requested

It does not have to complete the entire task on its own

It can deliver unfinished work if requested

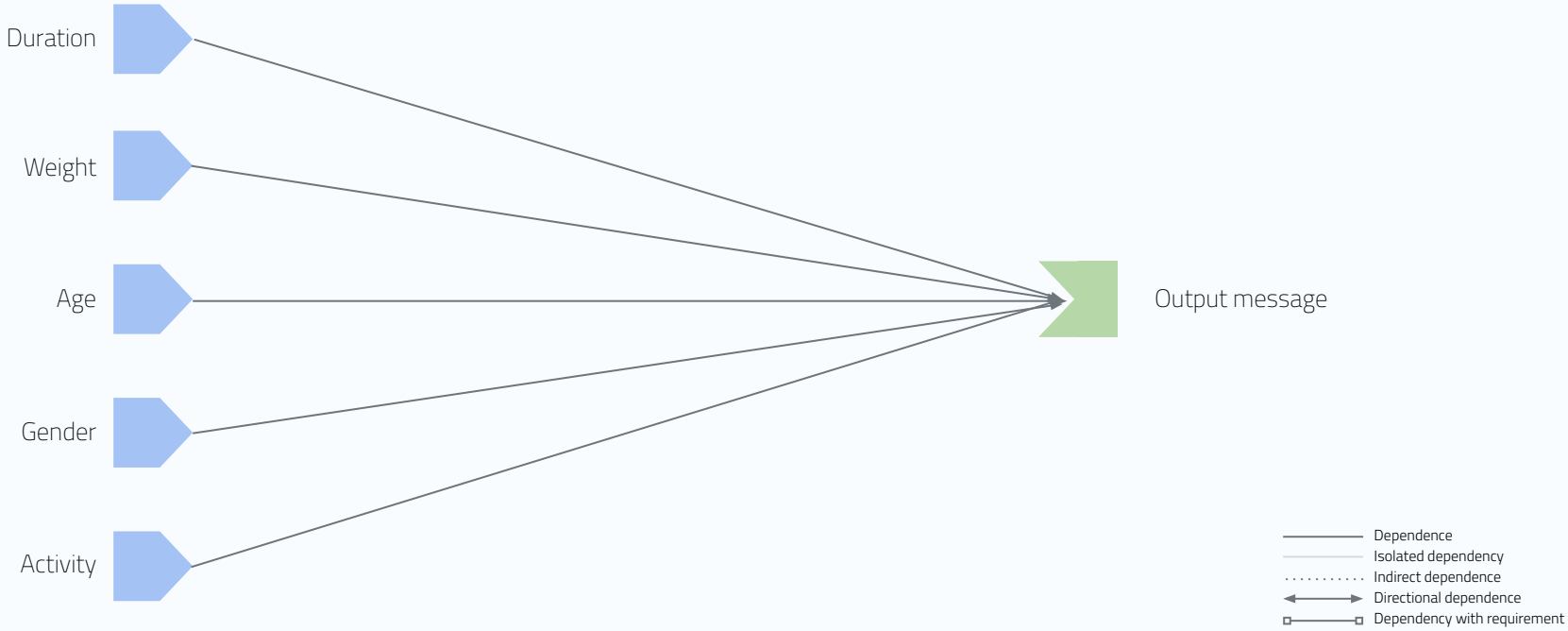
reactive

You can create a production line!

Each reactive/eventReactive perform a very specific task

They interact with each other sequentially

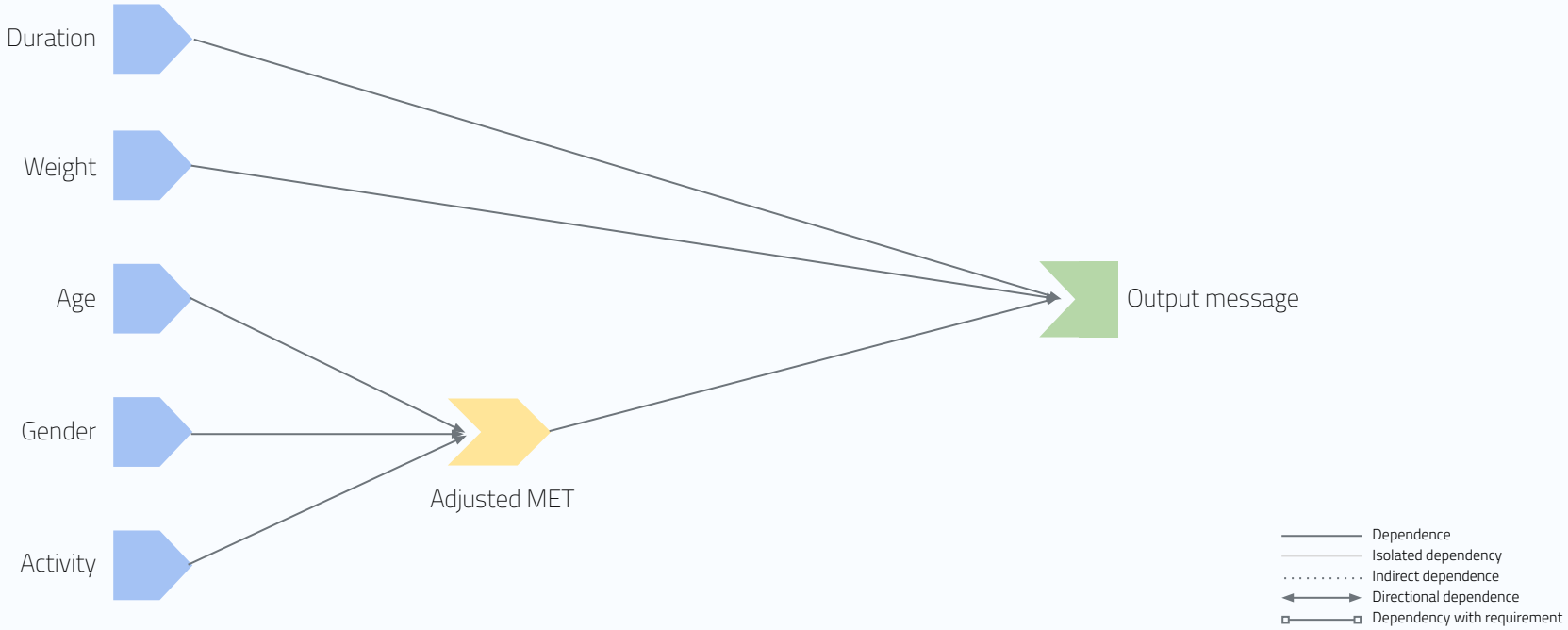
Calorie burn - 1st version



Calorie burn

```
runApp(appDir = "examples/01", launch.browser = TRUE)
```

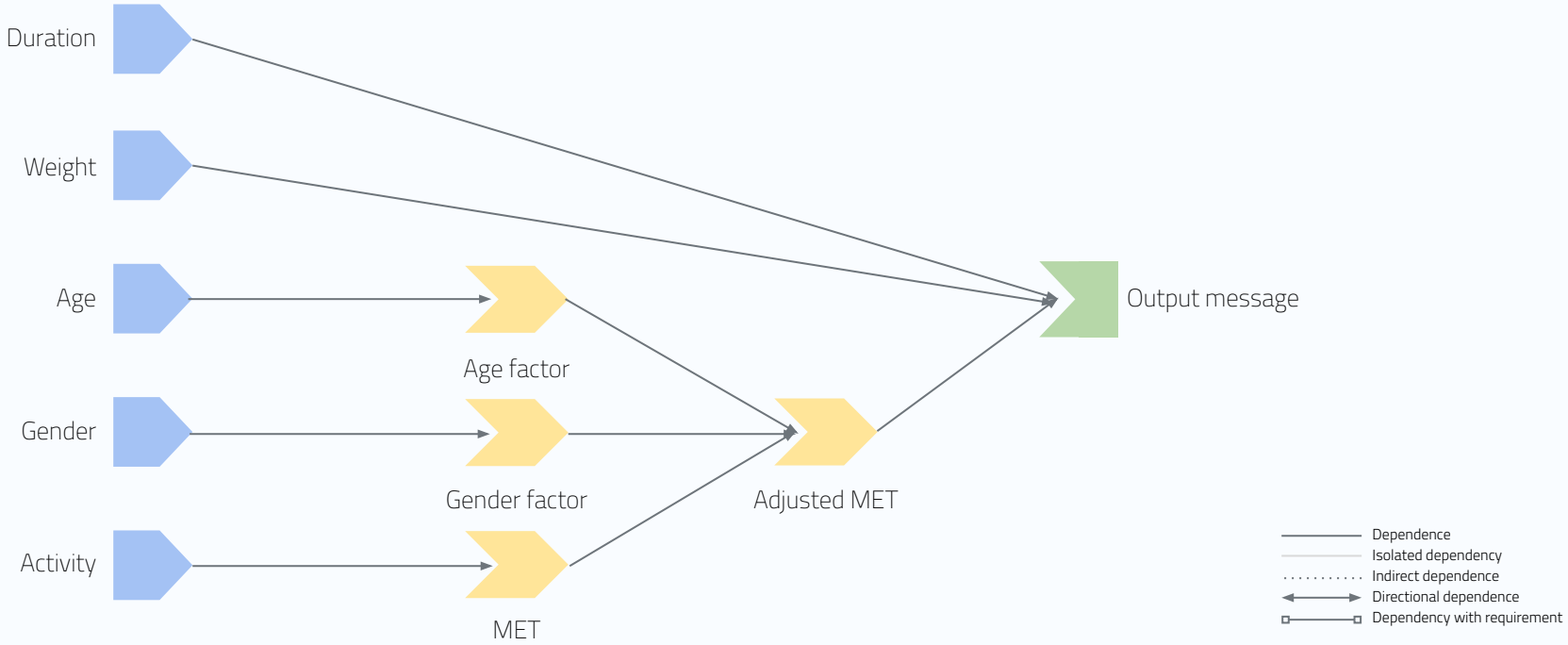
Calorie burn - 2nd version



Calorie burn

```
runApp(appDir = "examples/02", launch.browser = TRUE)
```

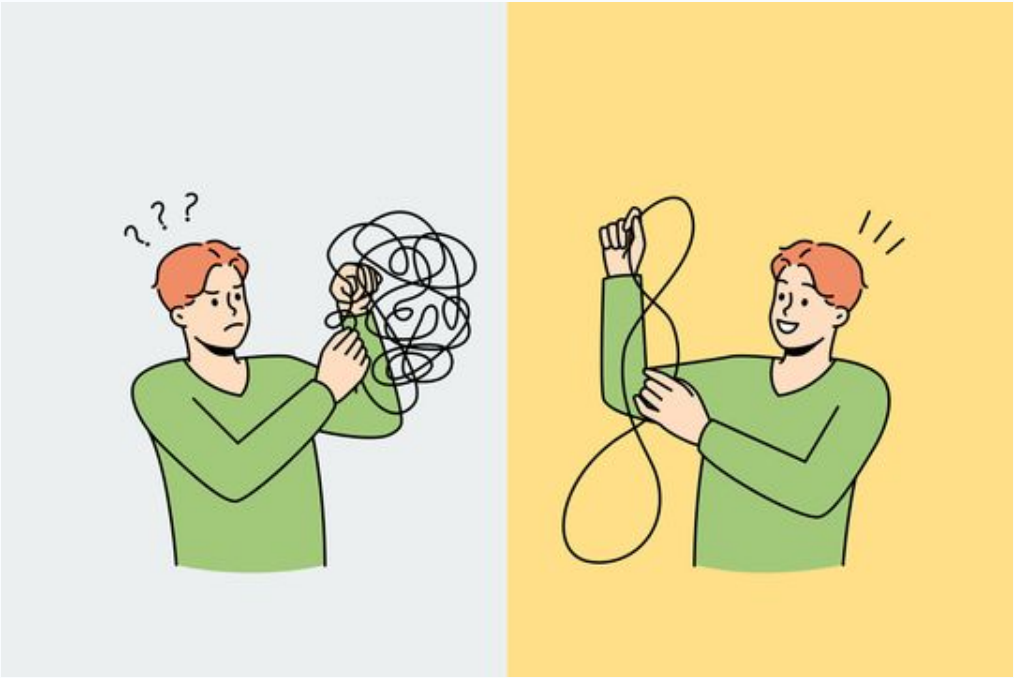
Calorie burn - 3rd version



Calorie burn

```
runApp(appDir = "examples/03", launch.browser = TRUE)
```

Calorie burn - In practice



Why was that triggering twice?

A simpler case: we didn't carefully consider the app flow!

Tips:

- Try to visualize the flow - if the app is large, focus only on the feature you're working on
- Try to create meaningful reactives with a single, well-defined purpose
- Be aware about the elements that are triggering your reactives

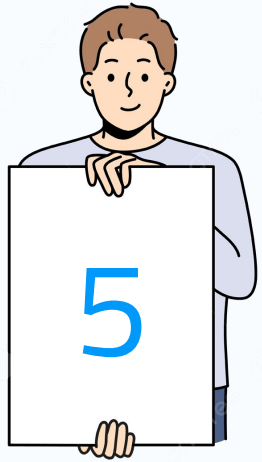
Client meeting

It's working very well!

Do you see any other areas where we could further improve performance? Some users are a bit frustrated.

reactiveVal

reactiveVal() is a holder for a variable that you can update manually

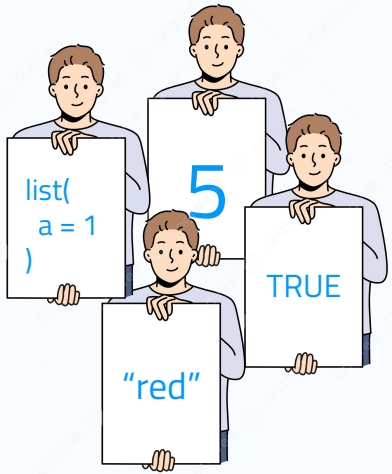


When the value is updated, it will keep the reactive chain flow

Only triggers reactive dependencies if the stored value changes

reactiveValues

reactiveValues() is a set of holders that you can update manually



You can observe elements independently

When one of the value is updated, it will keep the reactive chain flow

Only triggers reactive dependencies if the stored value changes

observe

observe() performs side effects when its reactive dependencies change

Runs when **any** of its reactive dependencies change

Used for side effects (e.g., updating variables, printing logs, ...)

Does not return a value

observeEvent

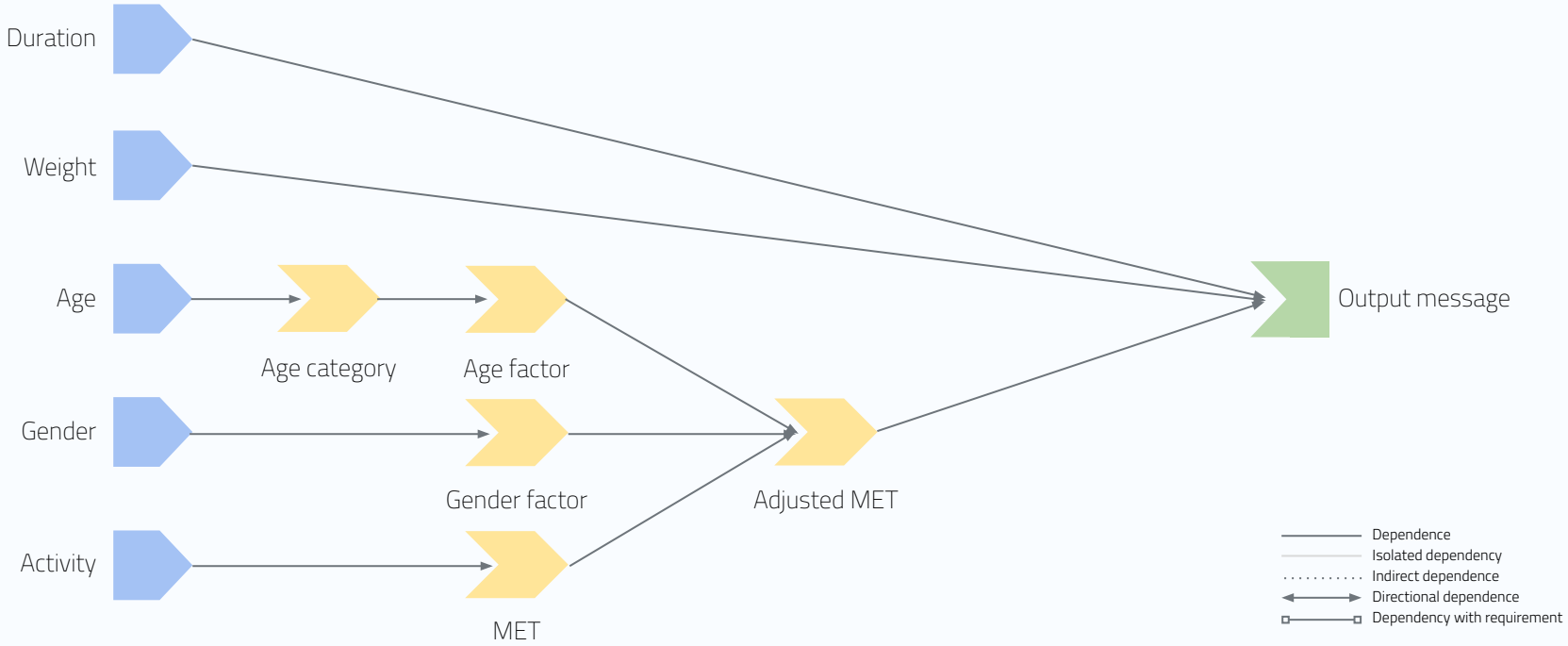
observeEvent() performs side effects only when specific event occurs

Runs when **specific** reactive dependencies change

Used for side effects (e.g., updating variables, printing logs, ...)

Does not return a value

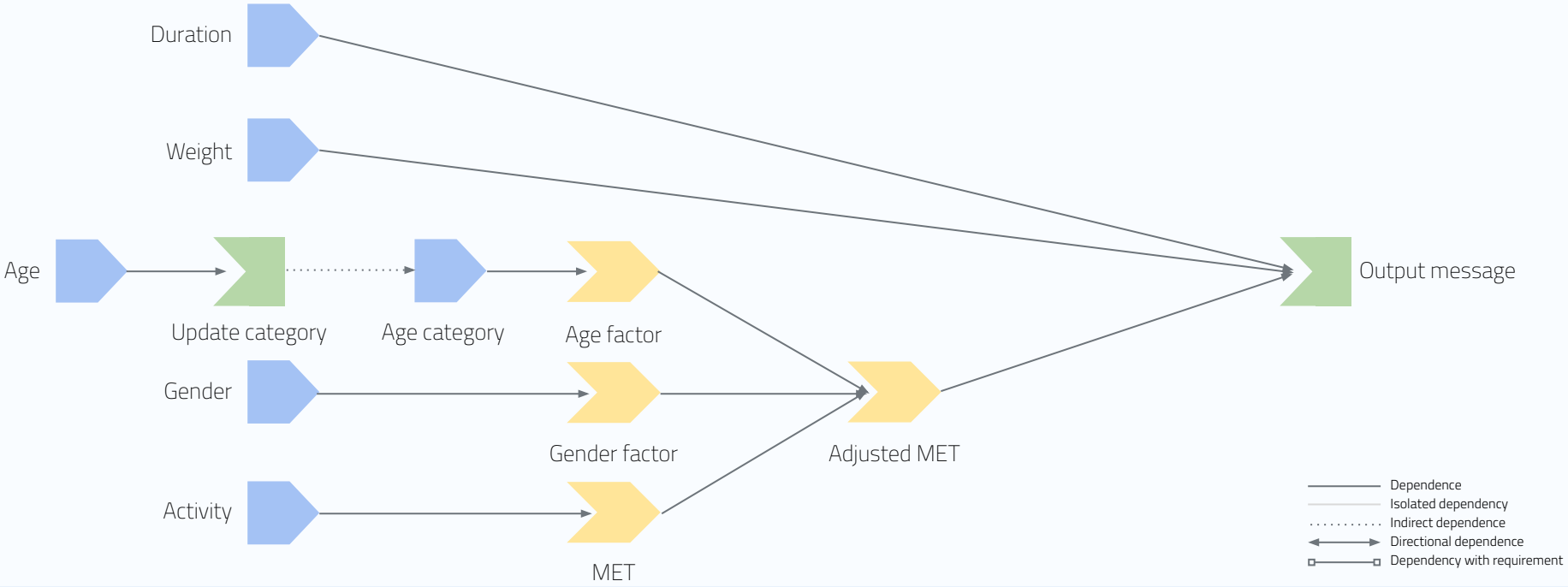
Calorie burn - 4th version



Calorie burn

```
runApp(appDir = "examples/04", launch.browser = TRUE)
```

Calorie burn - 5th version



Calorie burn

```
runApp(appDir = "examples/05", launch.browser = TRUE)
```

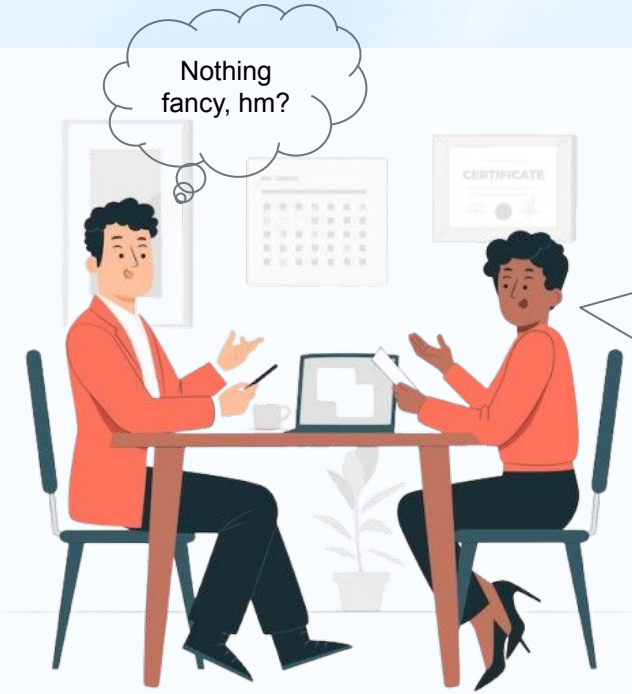
Why was that triggering twice?

Even if the result doesn't change, a reactive expression will still be invalidated and recomputed when its dependencies change, whereas a reactiveVal only triggers reactivity when its stored value actually changes

Tips:

- Try to identify reactives with a limited number of outputs and replace them with *reactiveValues*
- Prefer using *observeEvent* and *eventReactive* for better control over reactive dependencies

Client meeting



That's amazing!

We really love it and are using it more and more. We did receive some feedback from our users, though... They would like a way to store their choices for weight, age, gender, activity, and duration since these values don't change often.

Unexpected Triggers

How to Prevent Unnecessary Reactivity Updates

isolate

isolate() prevents certain reactive elements from triggering an expression

isolate() can be used inside observers and reactives to prevent an expression from being invalidated by reactive changes

observeEvent/eventReactive arguments

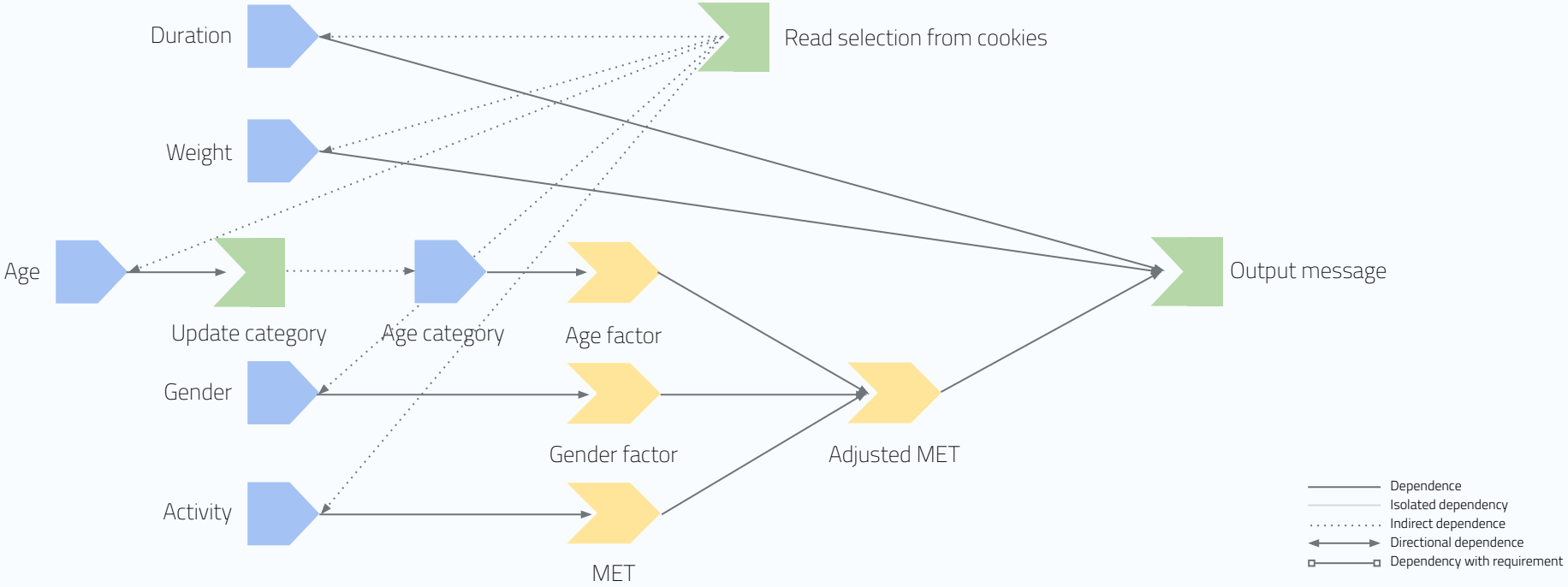
once, *ignoreNULL* and *ignoreInit* are useful friends

once: Ensures that the expression is only evaluated once

ignoreNULL: Controls whether NULL values should be ignored or not

ignoreInit: Prevents the initial value of a reactive from triggering

Calorie burn - 6th version



Calorie burn

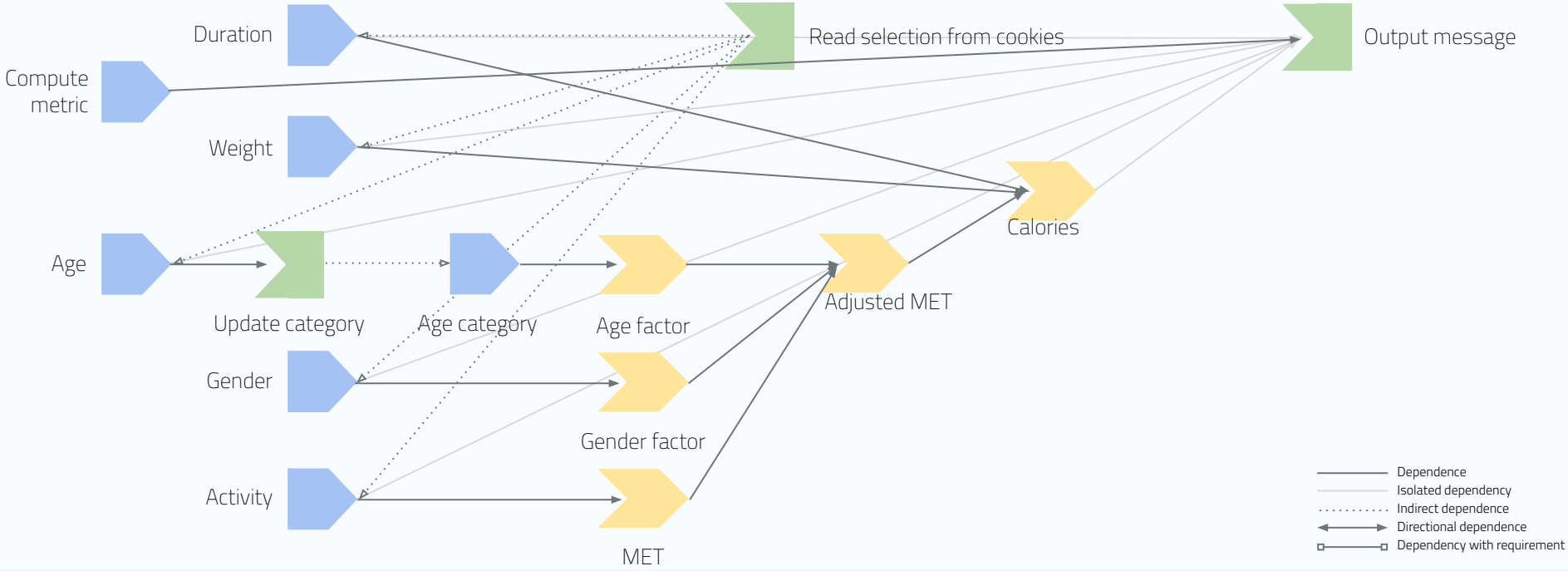
```
runApp(appDir = "examples/06", launch.browser = TRUE)
```

Client meeting

By the way...

Could we improve the output message? We'd like to have all the information used to generate the result presented in a single sentence.

Calorie burn - 7th version



Calorie burn

```
runApp(appDir = "examples/07", launch.browser = TRUE)
```

Why was that triggering twice?

We need to carefully manage the triggers of each reactive context and be aware that, unless we use specific options, observers will always be triggered.

Tips:

- Use *once* when you need to ensure an observer or reactive expression executes only once
- Use *ignoreInit* to prevent execution on initialization, ensuring the first value is ignored
- Use *ignoreNULL = FALSE* when you need to trigger a reaction even when the input is NULL
- Use *isolate()* to access reactive values without establishing a reactive dependency

Client meeting

We are getting there!

This new button is nice, but we'd prefer a more reactive experience like before. Ideally, the calculations should update automatically as soon as the user changes the inputs.

Controlling Execution

Managing Dependencies and Avoiding Unwanted Triggers

req

req() stops reactive execution when specified conditions are not met.

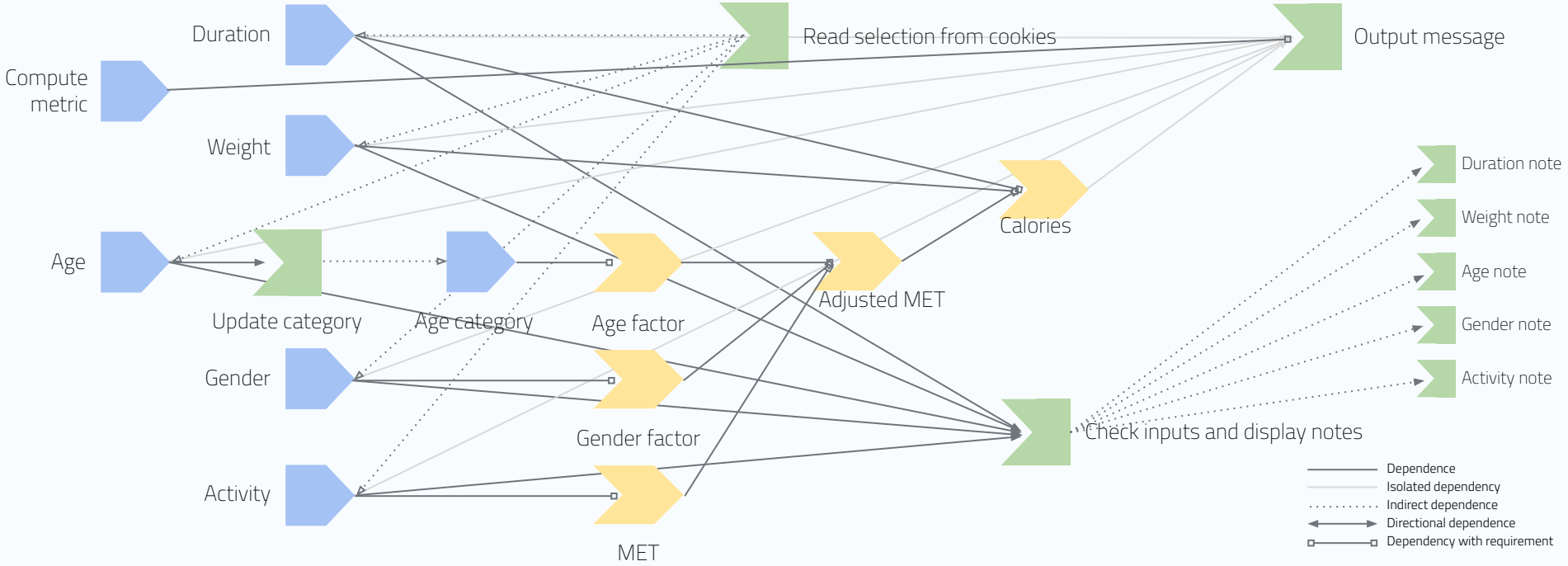
req() can be used inside observers and reactive expressions to prevent execution when certain conditions are not met.

debounce

debounce() postpones the execution of a reactive context

You can debounce any reactive expression by specifying the duration to wait for new changes before executing the reactive context

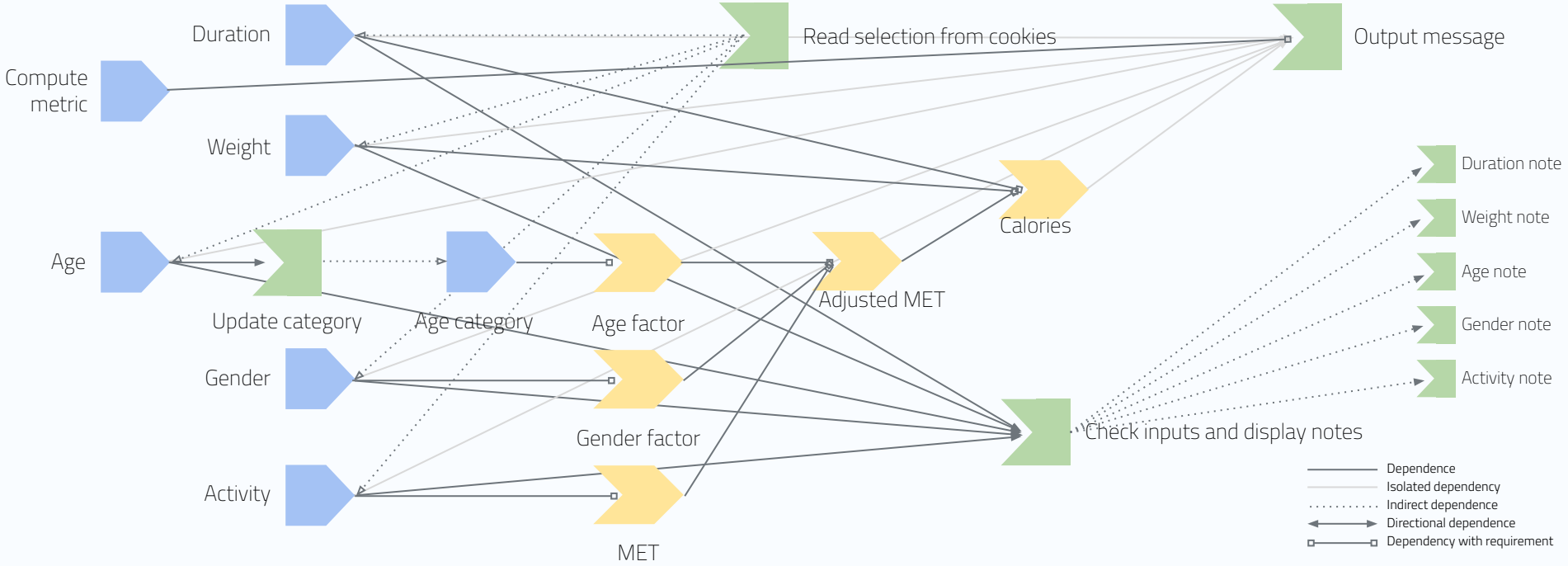
Calorie burn - 8th version



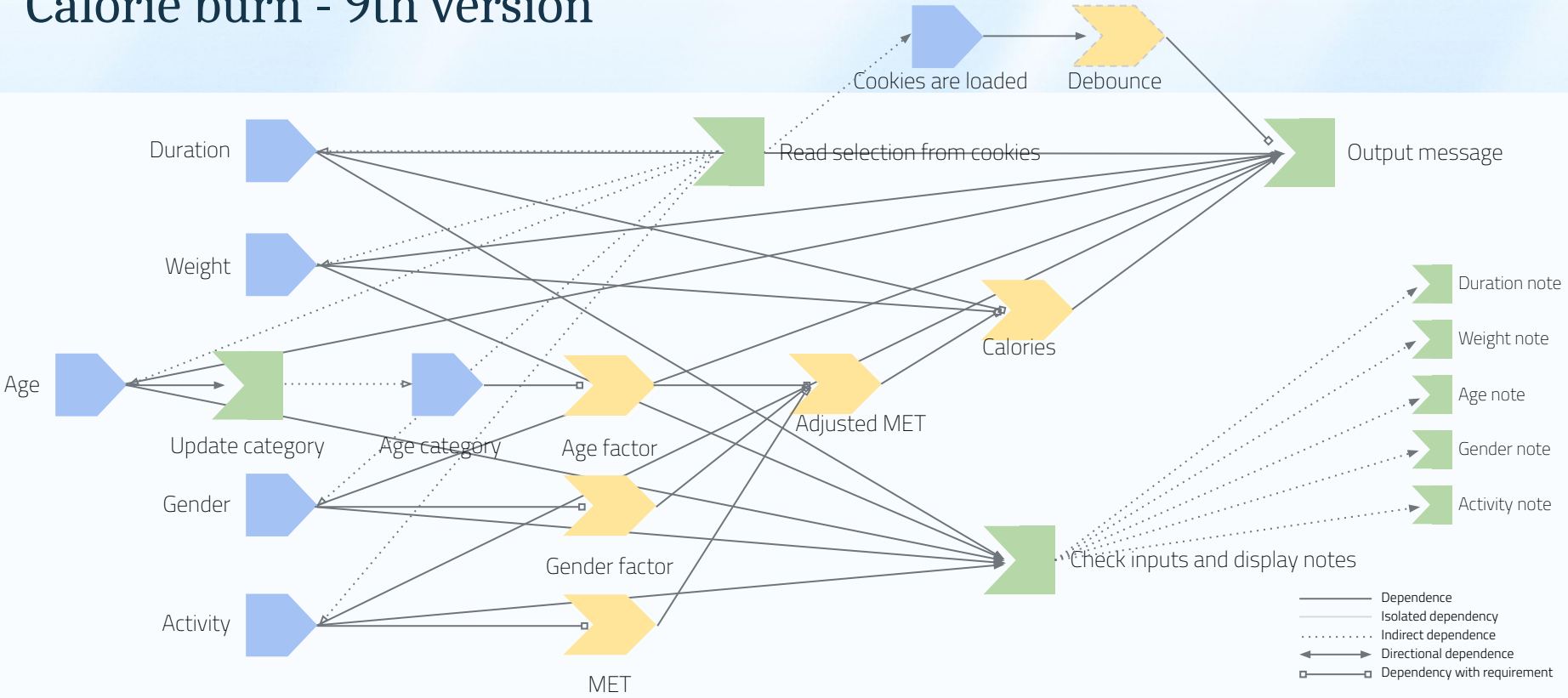
Calorie burn

```
runApp(appDir = "examples/08", launch.browser = TRUE)
```

Calorie burn - 8th version (to compare)



Calorie burn - 9th version



Calorie burn

```
runApp(appDir = "examples/09", launch.browser = TRUE)
```

Why was that triggering twice?

Inputs in Shiny are updated after the current reactive chain completes, ensuring that UI changes are applied in a synchronized and consistent manner.

Tips:

- Pay attention to where you are using reactive elements (e.g., functions)
- Use meaningful initial values for your inputs
- Use *req()* to prevent premature reactivity
- Use *debounce()* to wait for the reactive chain to settle (or for the user to finish selecting values)

Optimizing Reactivity

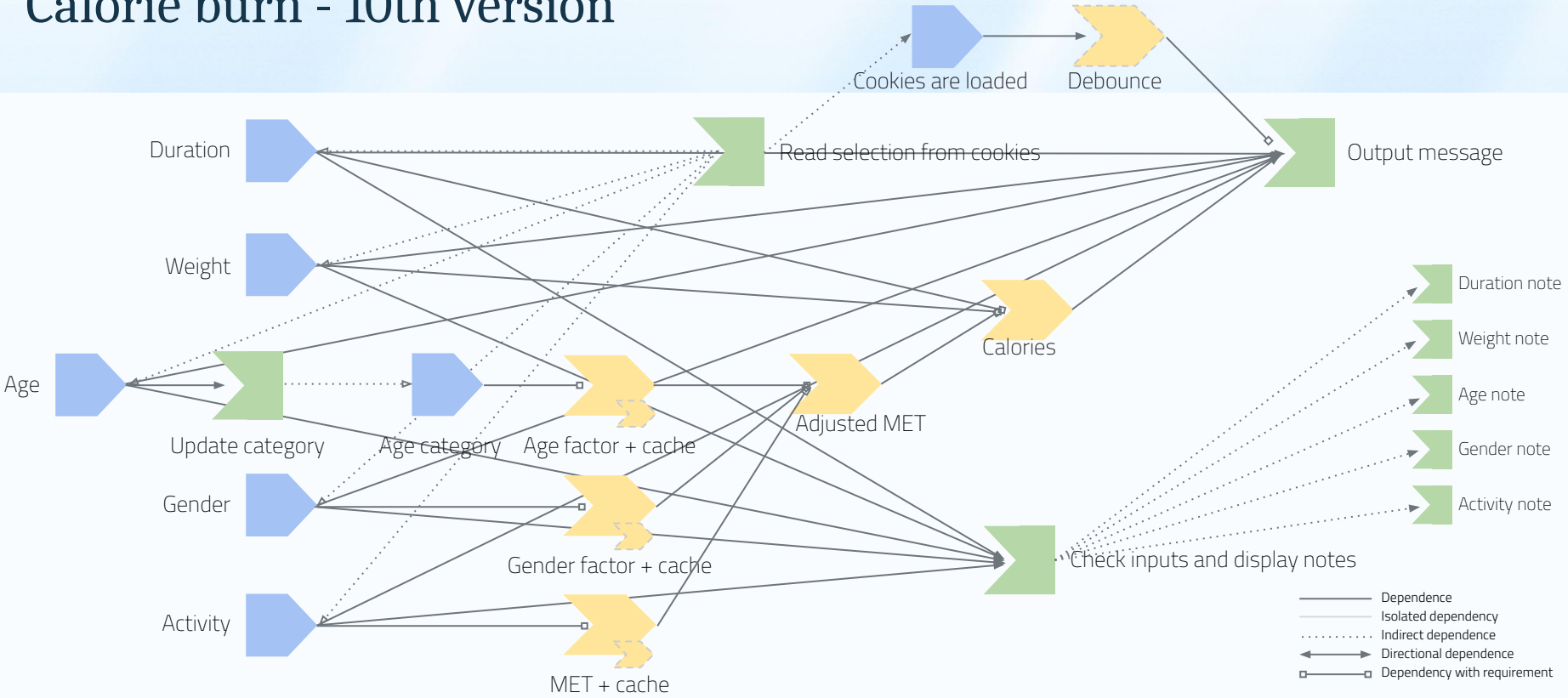
Improving Performance and Reducing Unwanted Updates

bindCache

bindCache() helps store previously computed results

It avoids redundant recalculations and can improve app performance.

Calorie burn - 10th version



Calorie burn

```
runApp(appDir = "examples/10", launch.browser = TRUE)
```

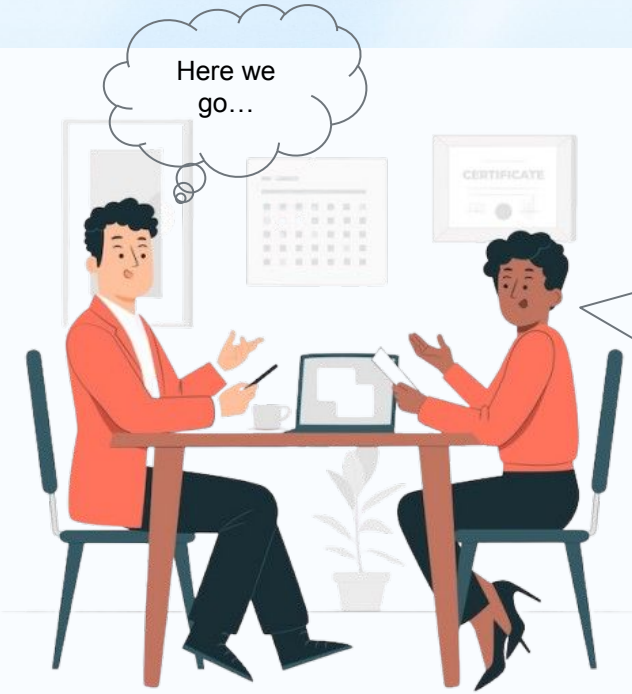
Why was that triggering twice?

Reactives don’t remember previous values on their own; they only react to changes in input.

Tips:

- Use bindCache() when the results in a reactive don’t change often

Client meeting



THANK YOU!

The app is performing better than ever. You did a great job! However, the UI doesn't look very good at all…

Best Practices - Summary

Key Tips for Improving Shiny App Performance

Why was that triggering twice?

- Try to visualize the flow and create meaningful reactives with a clear, single purpose
- Be aware that *reactive()* and *reactiveVal()* behave differently
- Prefer using *eventReactive()* and *observeEvent()* when appropriate
- Use *once*, *ignoreInit*, and *ignoreNULL* to properly control the app flow
- Use *isolate()* to access a reactive object without adding a dependency
- Be mindful that using reactive elements inside functions can lead to unintended reactivity
- Use *req()* to prevent unnecessary reactivity
- Use *debounce()* to delay reactivity
- Use *bindCache()* to improve performance when the results of a reactive don't change frequently

Thank you :)

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