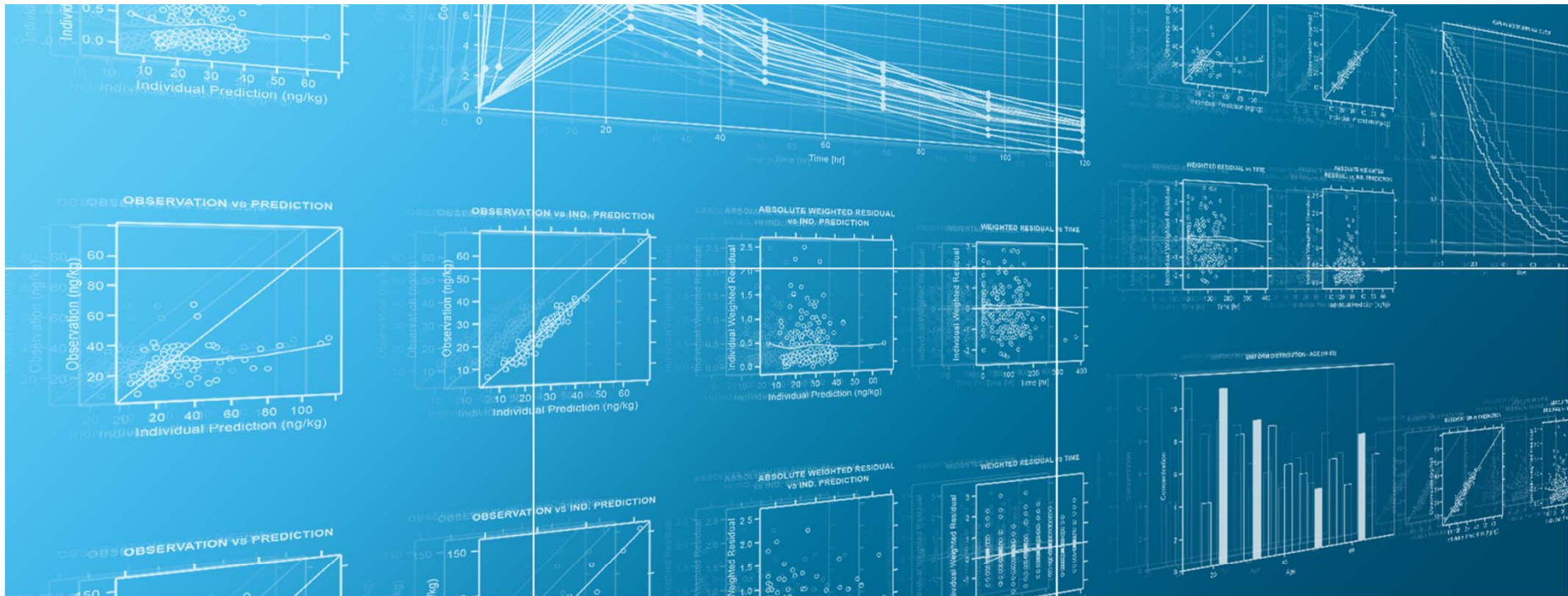


Keeping the Lights On nationalgrid



Chris Campbell, PhD

National Grid

- Owns English & Welsh electricity networks
- System Operator for UK grid



National Grid

- Manage flows of electricity to homes and businesses on a real time
- **Balance** the network, ensuring supply and demand are matched second by second
- Not generation

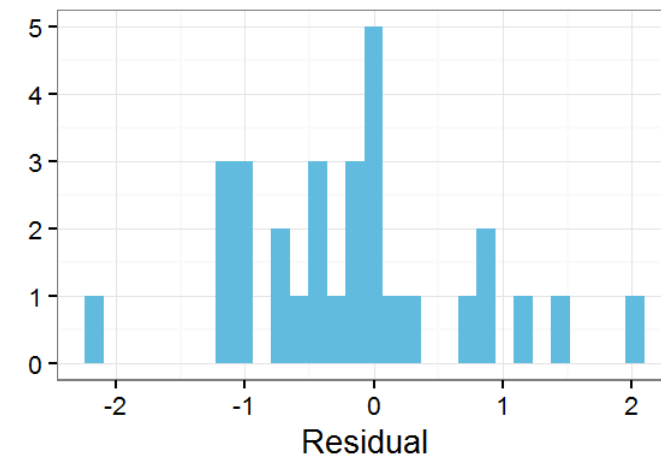
A vibrant market stall with baskets of fresh produce including tomatoes, oranges, and onions. The scene is filled with various fruits and vegetables, creating a colorful and lively atmosphere. The produce is displayed in wooden baskets and crates, with some items like tomatoes and oranges in the foreground being in sharp focus, while others in the background are blurred.

Electricity Market

- Generation provided by electricity market
- Policies and framework support the market

Supply/Demand

- Unexpected issues on network
- Demand higher than forecast (residual error)





Supply/Demand

- Request **margin** (spare capacity above demand)

Strategic Pricing Code Review

- Policy to reimburse flexible energy suppliers
- Data driven capacity requests based on supply forecasting
- R analysis prototype



Challenges

- Frequent forecasts
- Multiple data sources feed into Oracle database (demand, availability, wind)
- Consumed live



Solutions

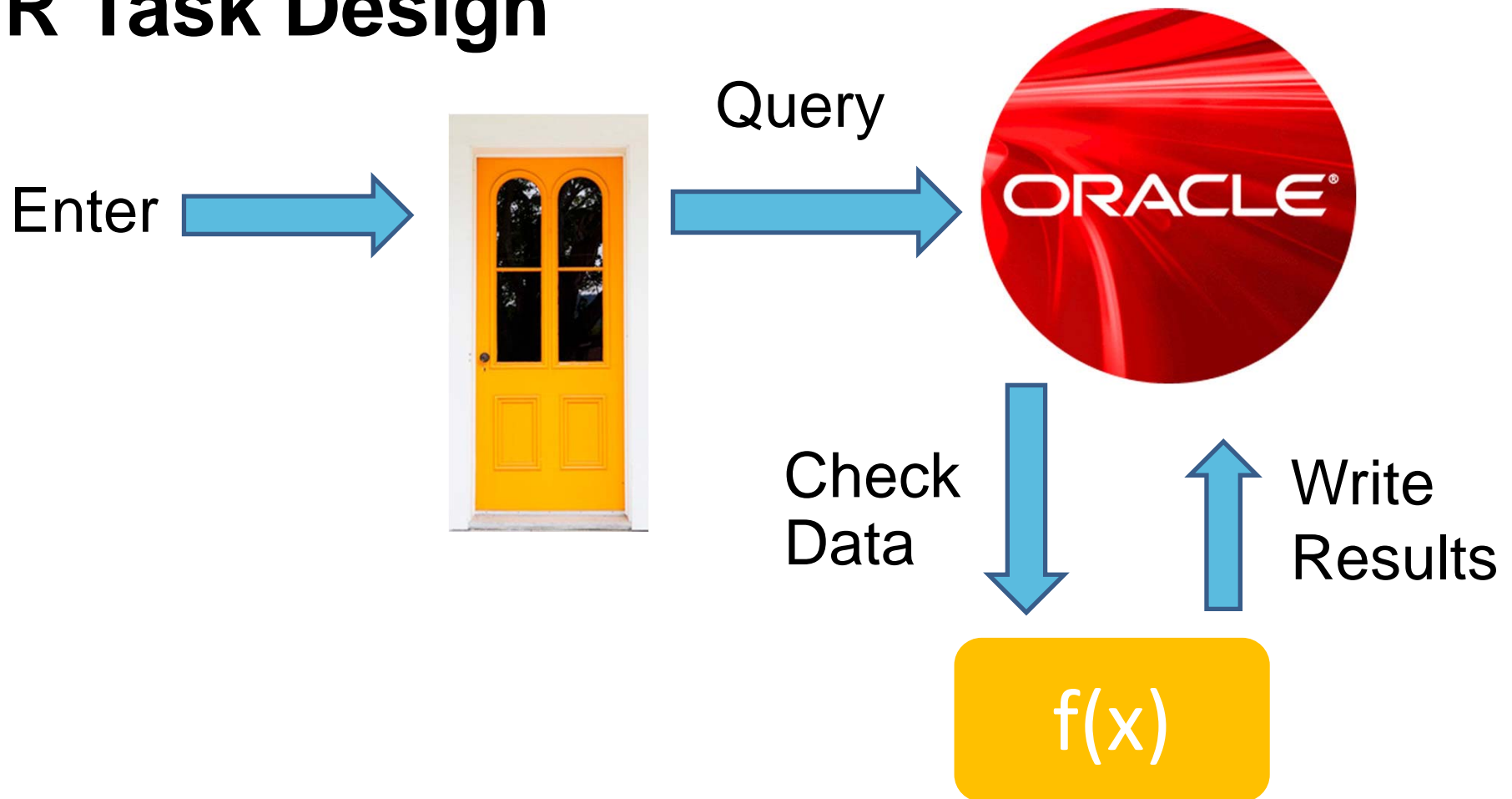
nationalgrid



MANGOSOLUTIONS

data analysis that delivers

R Task Design



Live Analysis

- Automated execution
- **cron**



Check Data - S4 Classes

- Specify structure – data required for analysis
- Validate contents – apply business rules

S4 Classes

```
setClass(Class = "DemandData",  
  slots = c(  
    Timestamp = "POSIXct",  
    Demand = "numeric"),  
  prototype = prototype(  
    Timestamp = as.POSIXct(NA),  
    Demand = NA_real_))
```



S4 Classes

```
demand <- new(Class = "DemandData",
              Timestamp = Sys.time() + 1:3 * 1800)
demand
# An object of class "DemandData"
# Slot "Timestamp":
# [1] "2016-05-17 20:21:49 BST"
# ...
# Slot "Demand":
# [1] NA
```




S4 Classes

```
slot(object = demand,  
      name = "Demand") <- 1:3
```

```
demand
```

```
# An object of class "DemandData"
```

```
# Slot "Timestamp":
```

```
# [1] "2016-05-17 20:21:49 BST"
```

```
# ...
```

```
# Slot "Demand":
```

```
# [1] 1 2 3
```



Check Data

```
validDemand <- function(object) {  
  dmd <- slot(object = object,  
    name = "Demand")  
  if (any(dmd < 0)) {  
    stop("Demand less than zero")  
  }  
}  
  
setValidity(Class = "DemandData",  
  method = validDemand)
```



Check Data

```
validObject(demand)
```

```
# [1] TRUE
```


High Integrity Reporting

- Data check fails
- Write informative message to file



High Integrity Reporting

- Analysis consumed by downstream processes – capacity pricing
- Reporting allows R code to run unmonitored – data error rapidly traceable

Summary

- Analysts with domain-specific expertise generate analytic code
- S4 Class allows data definition and validation
- R Code deployed into high integrity system