The **esperr** R package

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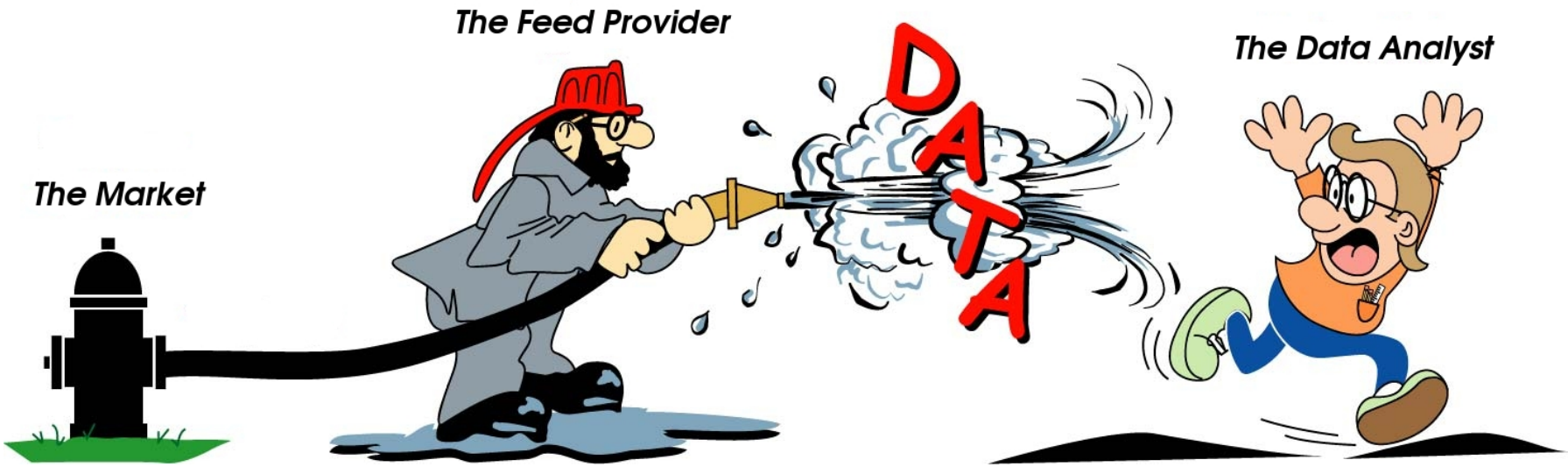
Outline

Stock Market Feeds

- Stock ticker information (price, volume, etc.) for a set of companies (MSFT, GOOG, etc.)
- Received asynchronously
- High frequency
- Combination of information for multiple companies at a high frequency results in high volume

Like Drinking from a Firehose



Can't we do this in R?

```
while (1)
{
  tickInfo <- GetTickInfo(stockSymbols)
  analysisResults <- TickAnalysis(tickInfo)
  MakeTrades(analysisResults)
}
```

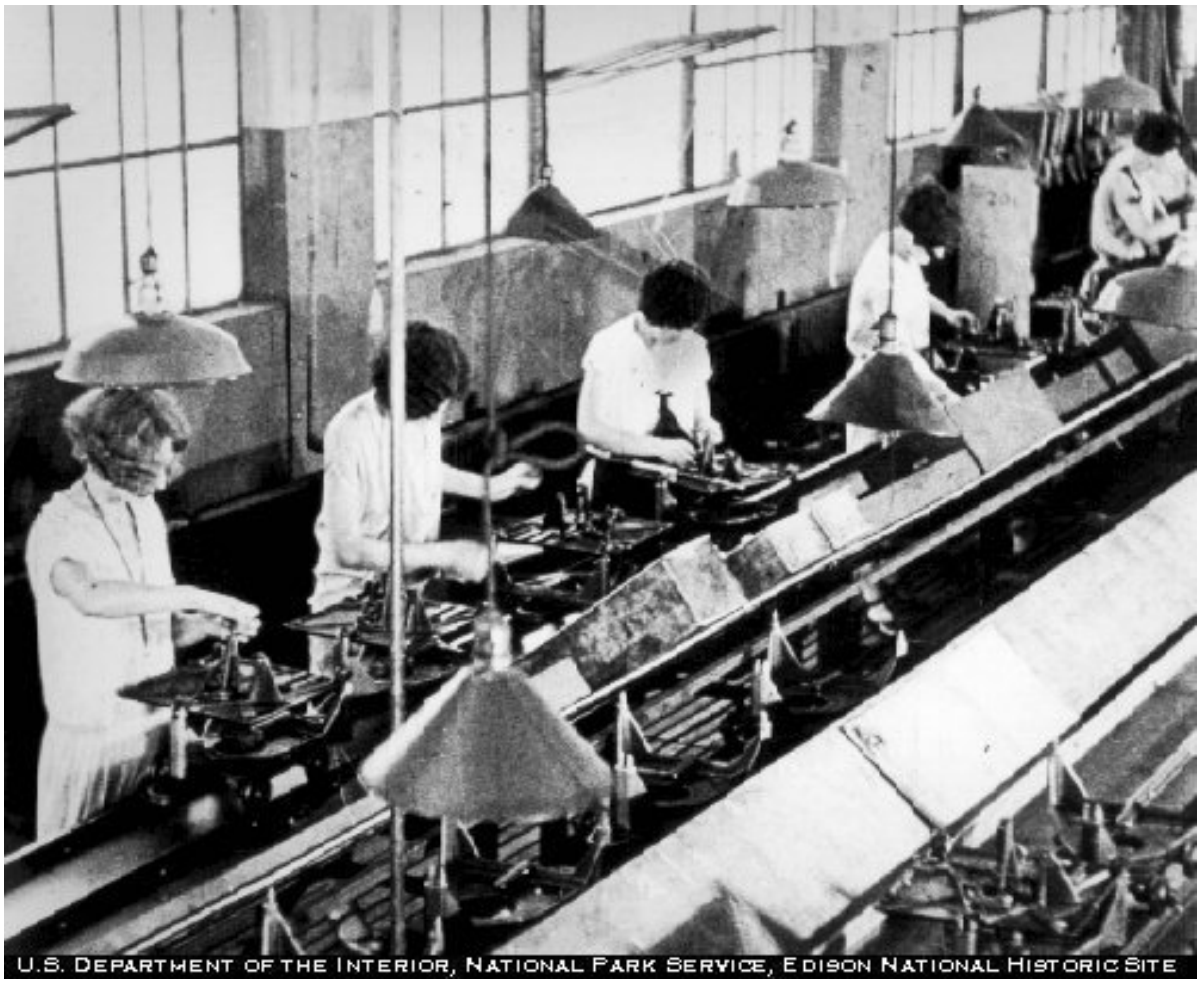
This doesn't work very well.

1. Ticks are not received asynchronously
   - Wait until tick information for all symbols is received
   - Ticks are dropped during analysis and trade
2. The loop is executed sequentially
   - Only one function executes at a time
   - Want to perform analysis while waiting for new ticks

Problem 1: R doesn't do callbacks

We resort to polling.

Problem 2: R doesn't do pipeline concurrency



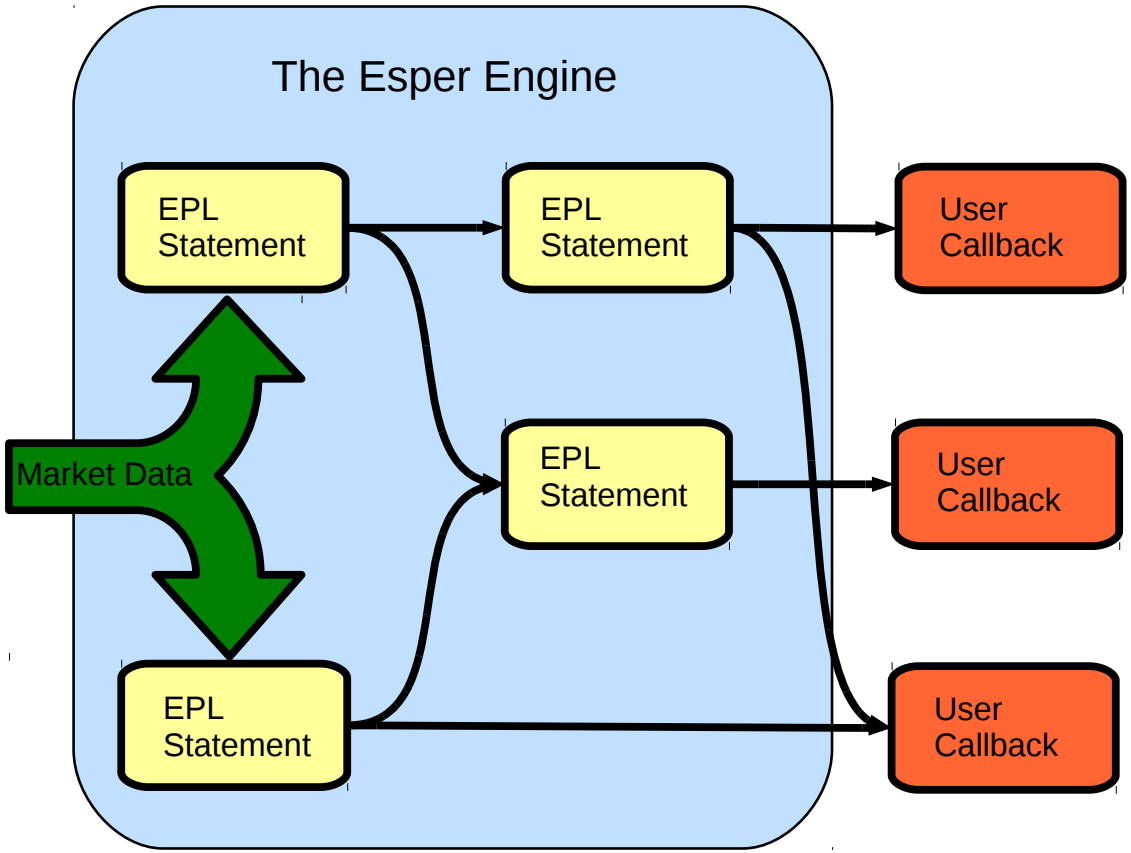
What is Esper?

- Esper is a Java library for high-throughput/low latency event stream processing.
  - Events are immutable structured data objects (XML or JavaBean)
  - An event stream is a sequence of events
- The Esper library provides an SQL-like "Event Processing Language" (EPL).
  - EPL statements map input events to an output.
  - Maps can filter and perform simple processing operations.

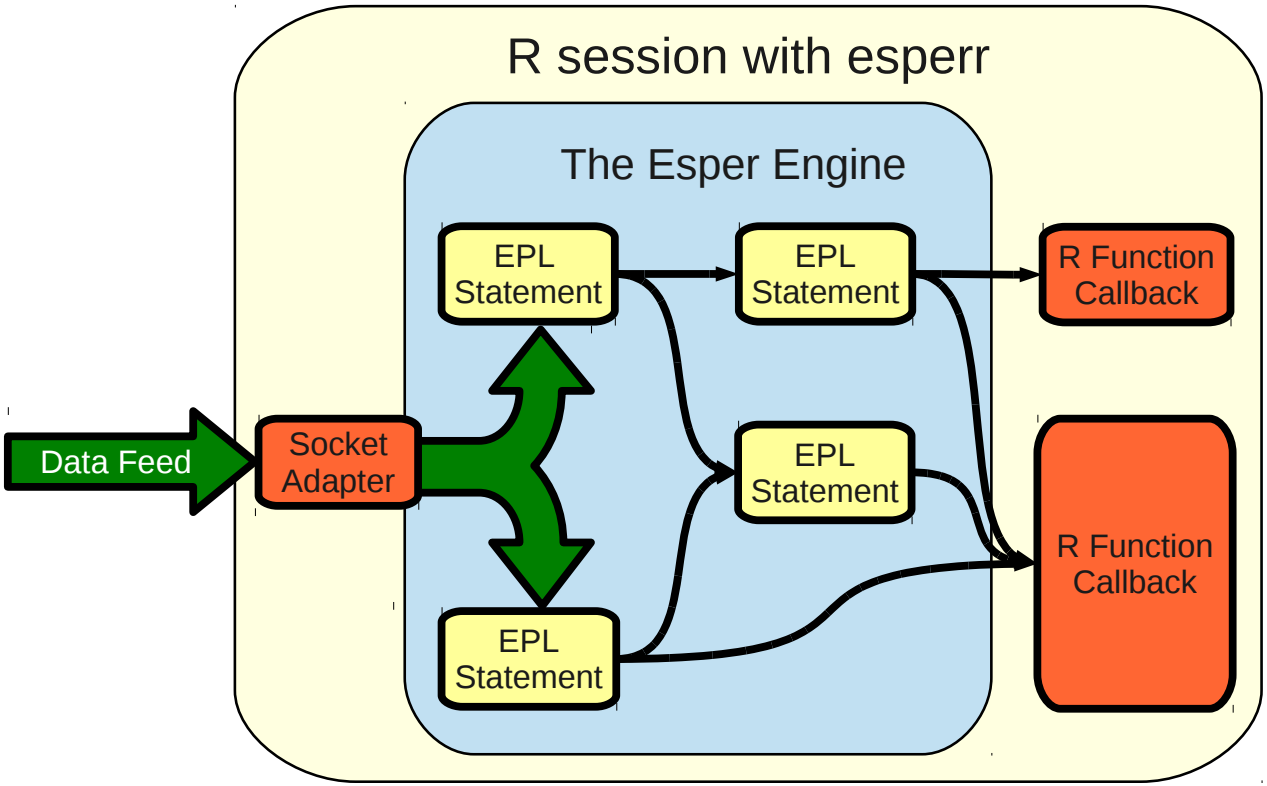
EPL Capabilities

- Event streams "flow through" EPL statements, producing new output events when the statement conditions are satisfied.
- EPL statements
  - filter
  - aggregate
  - tabulate
  - window
  - process

Flowing Market Data



Flowing Market Data with **esperr**



Example

```
schema <- "tick.xsd"
esperSchema(schema,'tick', 'TickStream')
data(tickXMLEvent)
s <- esperStatement(
  'SELECT symbol,price FROM TickStream')
f <- function(event) {
  id <- getEventString(event, 'symbol')
  command <- getEventString(event,'price')
  cat(symbol, price, '\n')
}
registerEventListener(s,'f')
sendEvent(tickXMLEvent)
```

Using **esperr**

- Procedure
  1. Plug Esper into your favorite stock feed
  2. Use EPL statements to grab interesting market data
  3. Use R to analyze the data and trade
  4. Profit
- Also generates Esper events
  - Useful for backtesting
  - Create other streams (not just stock data)

VWAP Example 1: Calculation is done in R

The VWAP Mutable Closure

```
vwapGenerator=function(size=100) {
  .prices=c(); .volumes=c(); .size=size
  function(event) {
    .prices <<- c(.vals,
      as.numeric(getEventString(event, "price")))
    .volumes <<- c(.vals,
      as.numeric(getEventString(event, "volume")))
    if (length(.prices) > .size) {
      .prices <<- .prices[-1]
      .volumes <<- .volumes[-1]
    }
    cat("VWAP for", getEventString(event,"symbol"),
      "is", sum(.prices*.volumes)/sum(.volumes), "\n")
  }
}
```

VWAP Example 1: Calculation is done in R

Associate the EPL statement with the mutable closure.

```
s <- esperStatement(
  'SELECT * FROM TickStream WHERE symbol="GOOG"')
googVWAP <- vwapGenerator()
registerEventListner(s, googVWAP)
```

VWAP Example 2: Calculation is done in Esper

```
vwap <-function(event) {
  cat("VWAP␣for", getEventString(event, "symbol"),
    "is", getEventString(event, "vwap"), "\n")
}

s <- esperStatement(paste(
  "SELECT␣sum(price*volume)/sum(volume)",
  "as␣VWAP␣from␣TickStream.win:length(100)",
  "where␣symbol='GOOG'"))

registerEventListner(s, vwap)
```

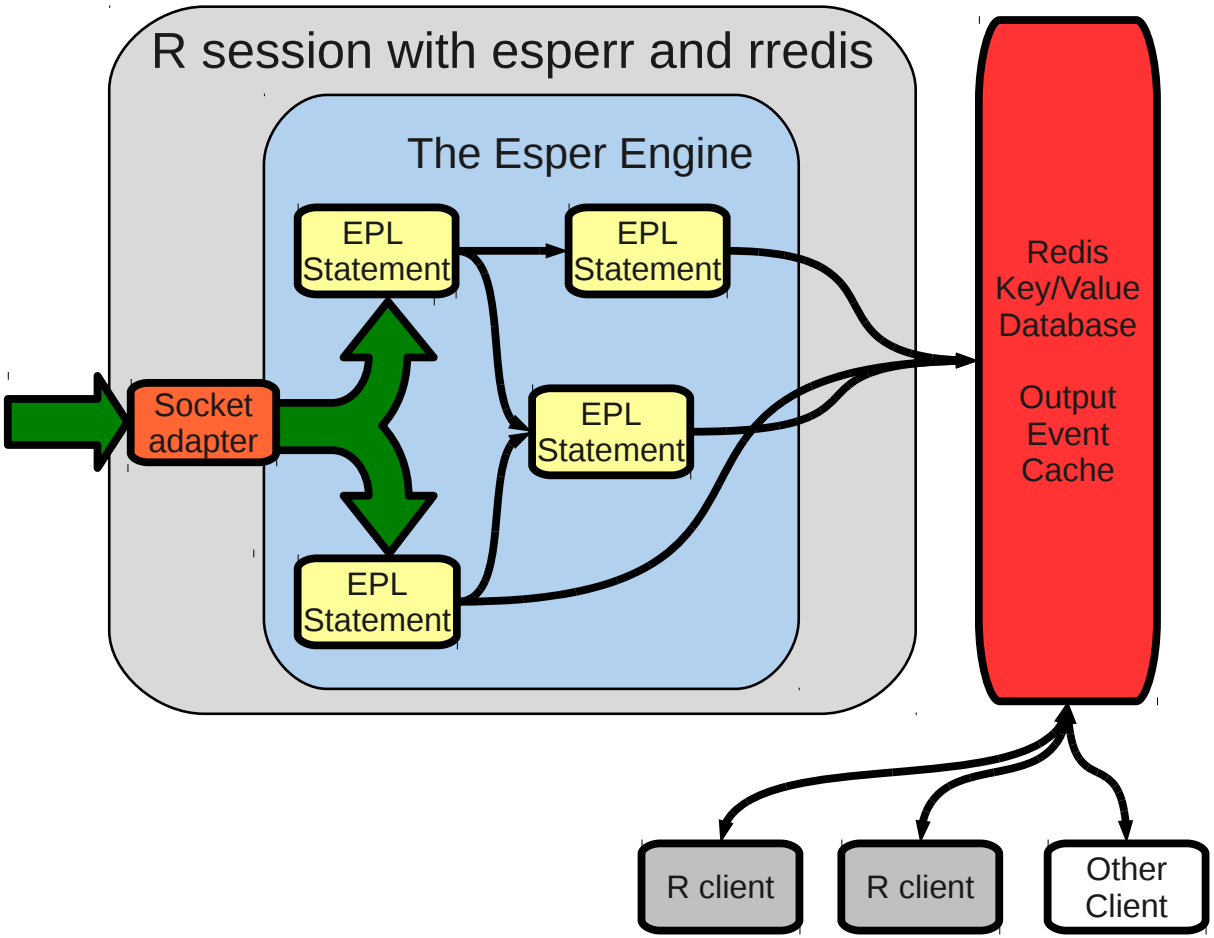
Implementation Guidelines

- Use Esper
  - Filter on the events of interest
  - Perform simple processing (VWAP, MA, etc.)
- Use R
  - High-level analysis
  - “Strategies” implemented with mutable closures

Performance

- VWAP on 5 minute intervals $\approx$ 4,000 events/s on generic hardware with current implementation
- Next version will include Apache Axiom streaming XML protocol to improve performance by at least an order of magnitude (maybe two)
- Can use Redis as an output event cache

R, Esper and Redis



Conclusions

esperr

- Handles asynchronous events
  - Events are processed in Esper
  - Callbacks are defined in R
- Provides pipeline concurrency
  - Esper processing and R analysis runs on different processes
  - Increased throughput

For Further Reading

The Esper Website.

`http://esper.codehaus.org`

The **esperr** R package.

`http://github.com/bwlewis/esperr`

The redis Website.

`http://code.google.com/p/redis/`

The **rredis** R package.

`http://cran.r-project.org/web/packages/rredis/index.html`