A Functional Language for Specifying Business Reports

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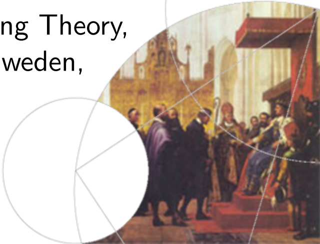

Outline

1. Enterprise Resource Planning Systems
2. Reports & Report Functions
3. Conclusions

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What are Enterprise Resource Planning Systems?

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- Supply Chain Management
- Manufacturing Resource Planning
- Human Resource Management
- Customer Relationship Management
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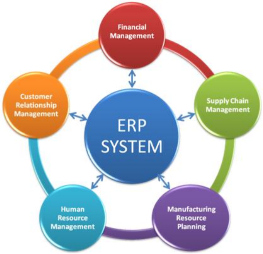
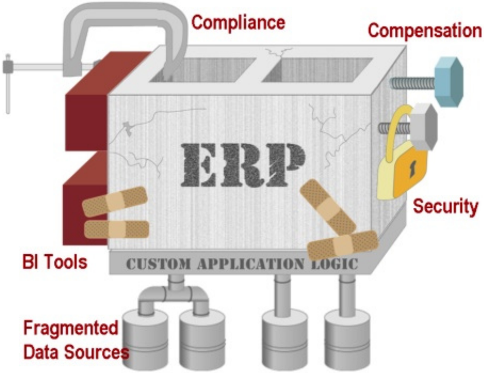

Financial Management
Supply Chain Management
Manufacturing Resource Planning
Human Resource Management
Customer Relationship Management
ERP SYSTEM

What do ERP Systems Look Like?



Issues of Many ERP Implementations

Complexity

- processes are specified in general purpose language
- gap between specification and implementation
- large monolithic system

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Inflexibility

- code is duplicated in order to avoid unexpected side effects
- the use of general purpose languages makes customisation expensive
- the (relational) database determines the way data is stored and accessed

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Entering POETS

Process-oriented event-driven transaction systems

compact core system

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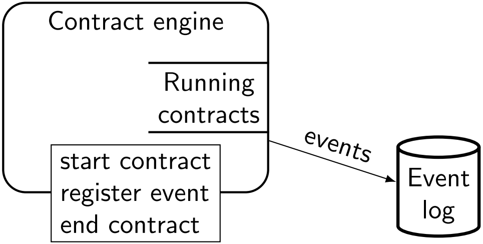


Contract engine

Running contracts

start contract
register event
end contract

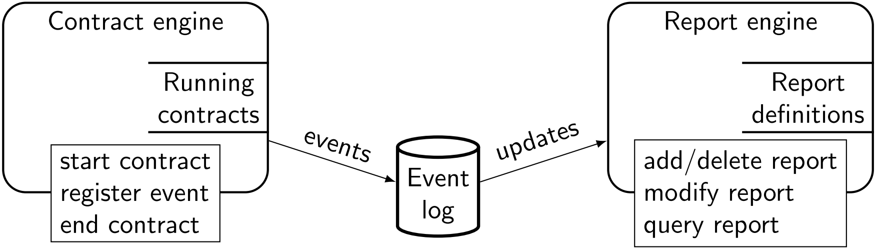
events

Event log

Entering POETS

Process-oriented event-driven transaction systems

compact core system • customisable via DSLs • simple data model



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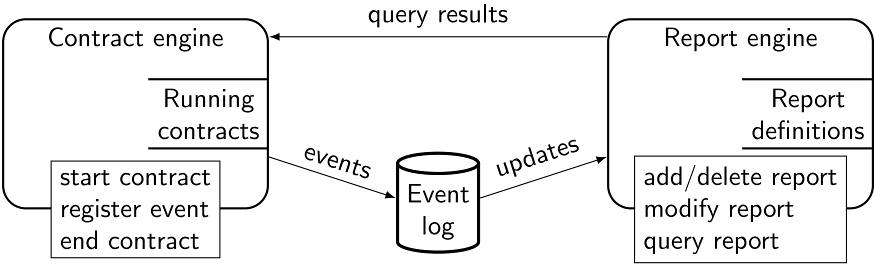

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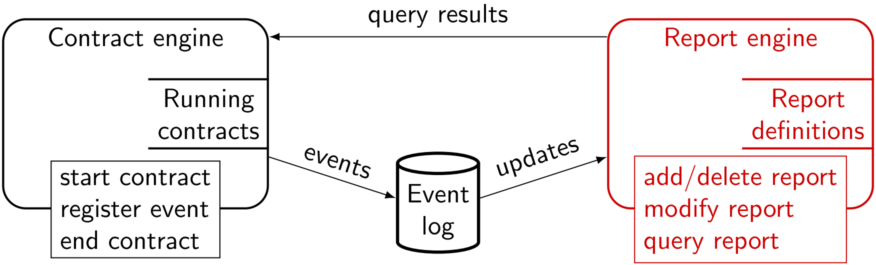

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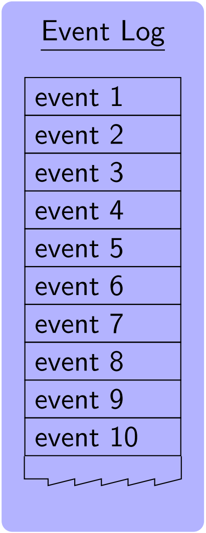

Event Log

event 1

event 2

event 3

event 4

event 5

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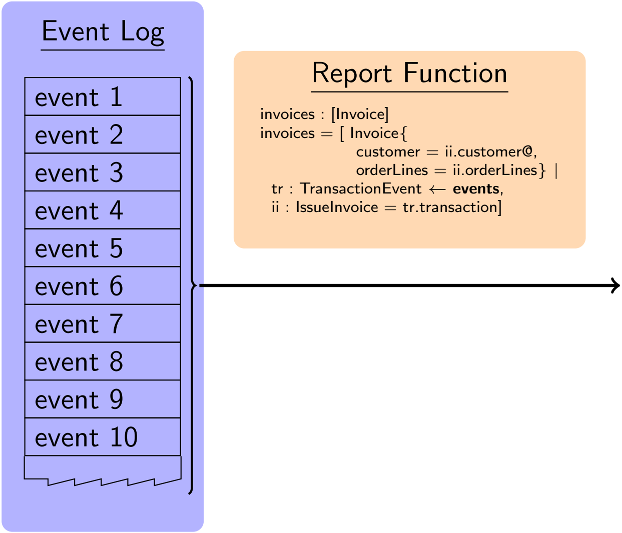

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Report Function

```
invoices : [Invoice]
invoices = [ Invoice{
                customer = ii.customer@,
                orderLines = ii.orderLines} |
  tr : TransactionEvent ← events,
  ii : IssueInvoice = tr.transaction]
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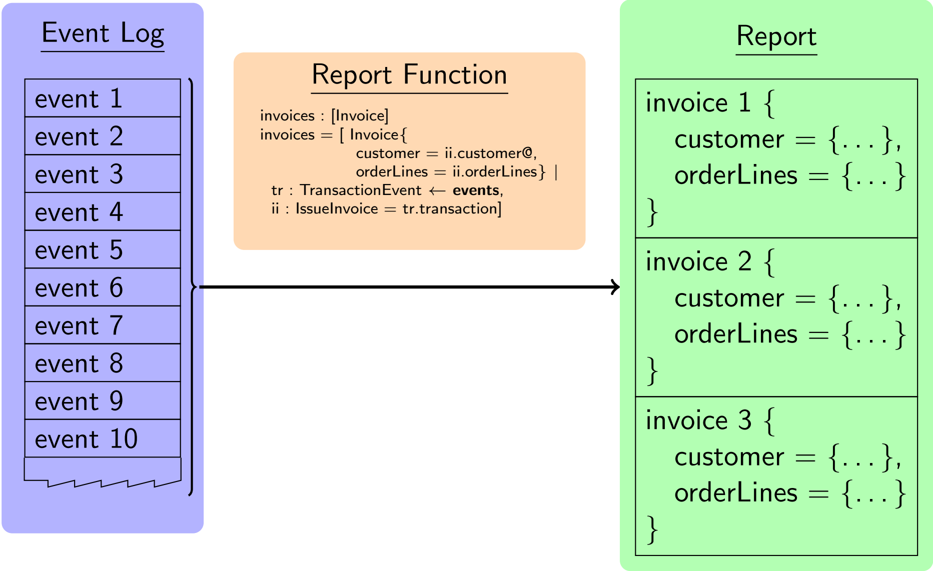

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Report

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  orderLines = {...}
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}
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}
```

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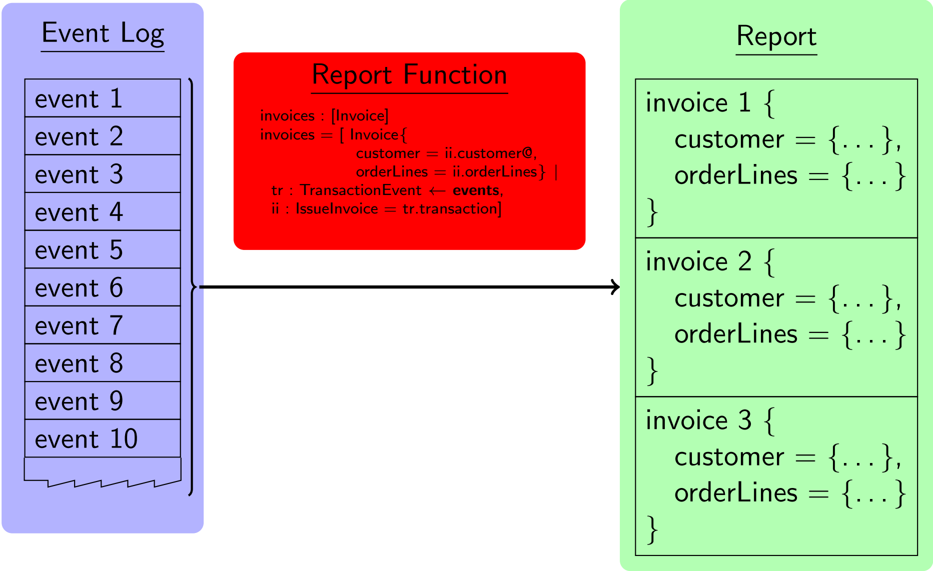

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The Report Language

The central data types

- records
- lists

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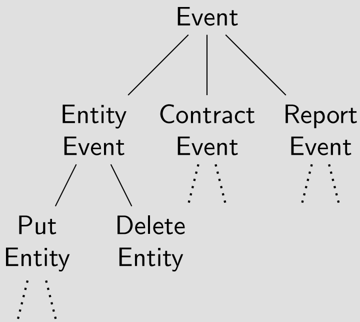
Nominal subtyping



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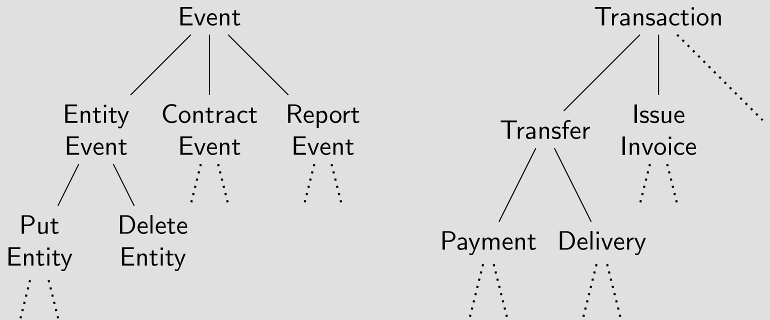


The Report Language – An Example Function

Example

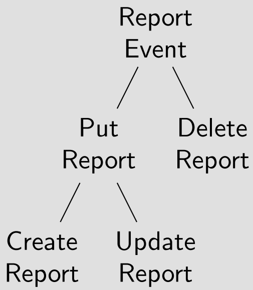
$$\begin{array}{l}
\mathit{reportNames} : [\textbf{String}] \\
\mathit{reportNames} = [\mathit{pr}.\mathit{name} \mid \\
\quad \mathit{cr} : \text{CreateReport} \leftarrow \textbf{events}, \\
\quad \mathit{pr} : \text{PutReport} = \mathit{head}\ [\mathit{ur} \mid \\
\qquad \mathit{ur} : \text{ReportEvent} \leftarrow \textbf{events}, \\
\qquad \mathit{ur}.\mathit{id} \equiv \mathit{cr}.\mathit{id}] \\
\quad]
\end{array}$$

The Report Language – An Example Function

Example

```
reportNames : [String]
reportNames = [pr.name |
    cr : CreateReport ← events,
    pr : PutReport = head [ur |
        ur : ReportEvent ← events,
        ur.id ≡ cr.id]
    ]
```

Report Event Hierarchy



Nominal Subtyping with Benefits

Nominal subtype relation $<:$

- User defined subtyping partial order on records
- Fixed subtyping relation on built-in types

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E.g. record modifier operator $\_\ \{f_1 = \_, \ldots, f_n = \_\}$ has type

$$\alpha.f_1 : \alpha_1, \ldots, \alpha.f_n : \alpha_n \Rightarrow \alpha \to \alpha_1 \to \ldots \to \alpha_n \to \alpha$$

Record Field Constraints

What do we gain?

- Field names can be used by different record types.
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Example

$$
\begin{aligned}
&\mathit{fullName} : (a.\mathit{firstName} : \textbf{String}, a.\mathit{lastName} : \textbf{String}) \Rightarrow a \rightarrow \textbf{String} \\
&\mathit{fullName}\ x = x.\mathit{firstName} +\!\!+\ \texttt{"\ \ "}\ +\!\!+\ x.\mathit{lastName}
\end{aligned}
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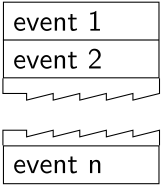
$$\begin{aligned}\mathit{setFullName} : {} & (a.\mathit{firstName} : \textbf{String},\ a.\mathit{lastName} : \textbf{String}) \Rightarrow \\ & \textbf{String} \rightarrow a \rightarrow a\end{aligned}$$
$$\begin{aligned}\mathit{setFullName}\ \mathit{name}\ x = {} & \textbf{let}\ (\mathit{first}, \mathit{last}) = \mathit{decompose}\ \mathit{name} \\ & \textbf{in}\ x\ \{\mathit{firstName} = \mathit{first},\ \mathit{lastName} = \mathit{last}\}\end{aligned}$$

Making It Scale

ain’t easy



event 1

event 2

event n

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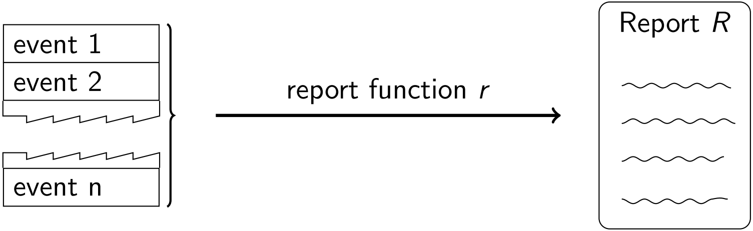

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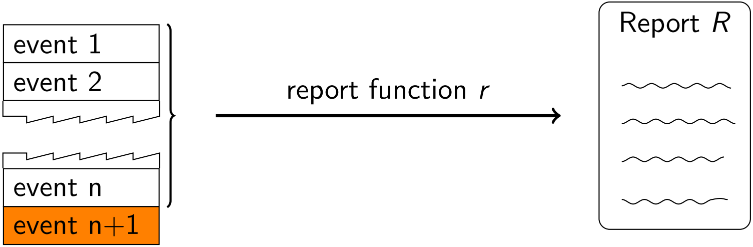

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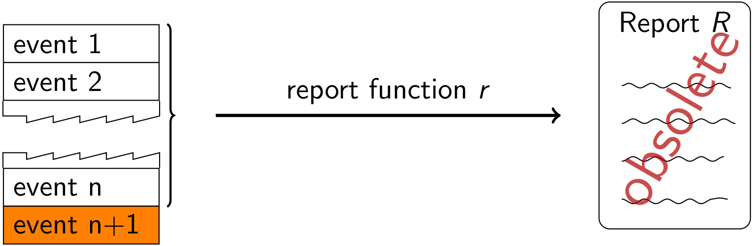

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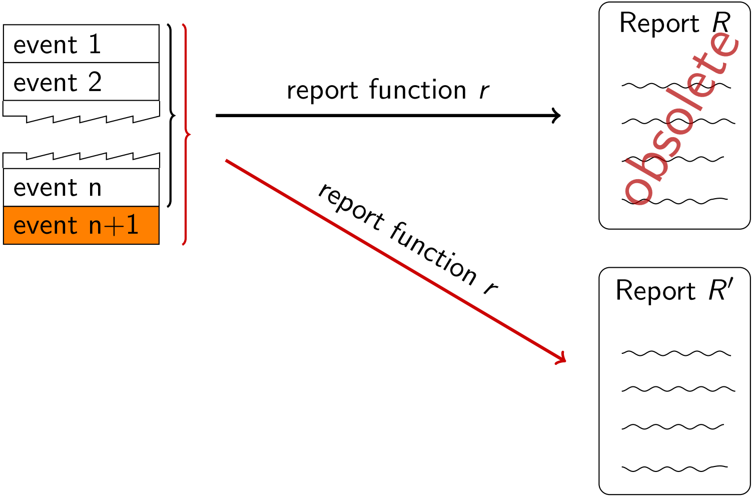

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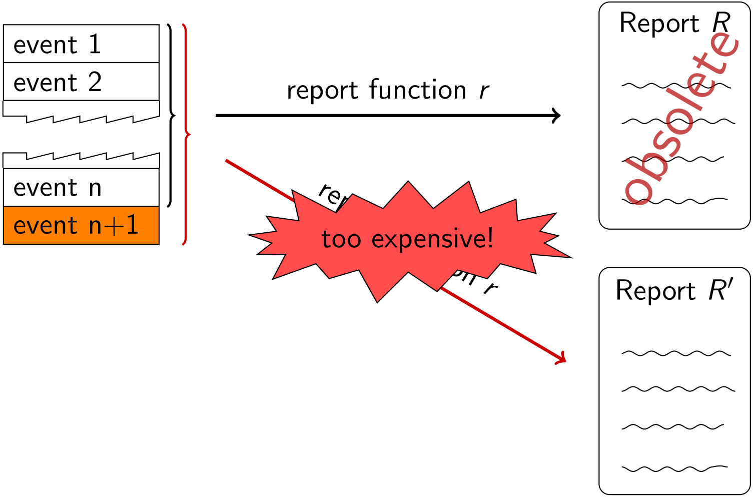

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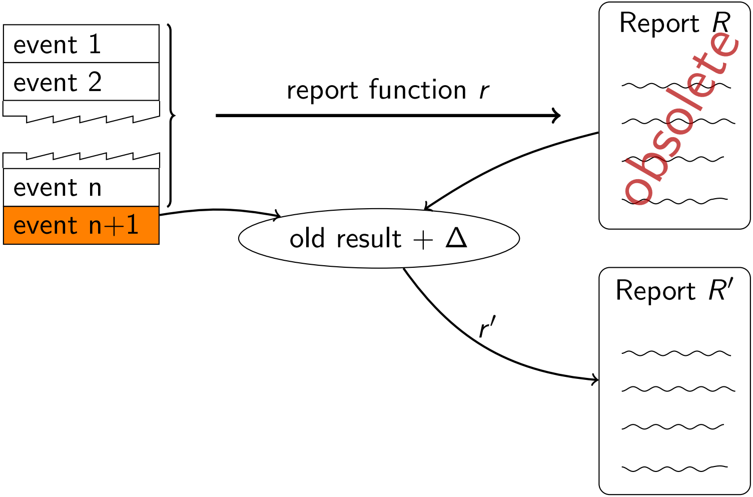

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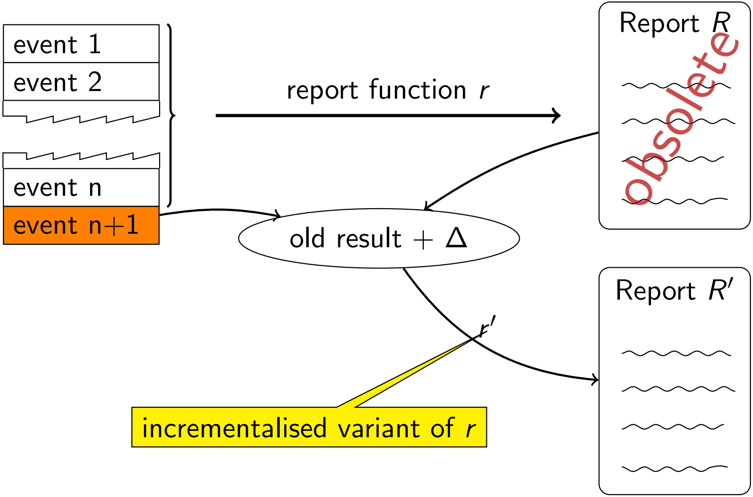

Automatic Incrementalisation of Report Functions

Basic idea: unfolding folds

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  - commutative operations
  - multisets instead of lists

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The Last Slide

What do we have?

- Simple yet powerful data model for ERP
- Purely functional language for extracting & aggregating complex information
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What are we planning?

- More powerful incrementalisation transformations
- Possibly restricting the language further
- A better cost model