FSharpComposableQuery overview & demo

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F#unctional Programming Meetup
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Motivation

- Database programming involves generating query "code" (SQL) at run time
- Naive approach: compose SQL as strings
  - Maximal control, performance tuning
- But:
  - Type-unsafe
  - can lead to security vulnerabilities (SQL injection)

LINQ

- Language-Integrated Query (LINQ)
  - Microsoft C# (Meijer et al. 2006)
  - and F# (Syme 2006)
- Based on comprehension syntax (a.k.a. "do" notation, computation expressions, etc.)
  - and *quotation* <@ @>
  - which explicitly separates query from normal code
- Type-safety inherited from source language
  - Type providers (run-time type information in IDE) make this especially handy

LINQ (F#) example

tasks

emp	tsk
“Alex”	“build”
“Bert”	“build”
“Cora”	“abstract”
“Cora”	“build”
“Cora”	“call”
“Cora”	“dissemble”
“Cora”	“enthuse”
“Drew”	“abstract”
“Drew”	“enthuse”
“Erik”	“call”
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employees

dpt	name	salary
“Product”	“Alex”	40,000
“Product”	“Bert”	60,000
“Research”	“Cora”	50,000
“Research”	“Drew”	70,000
“Sales”	“Erik”	200,000
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```
query { for x in employees
        where (x.salary > 50000)
        yield {name=x.name} }
```

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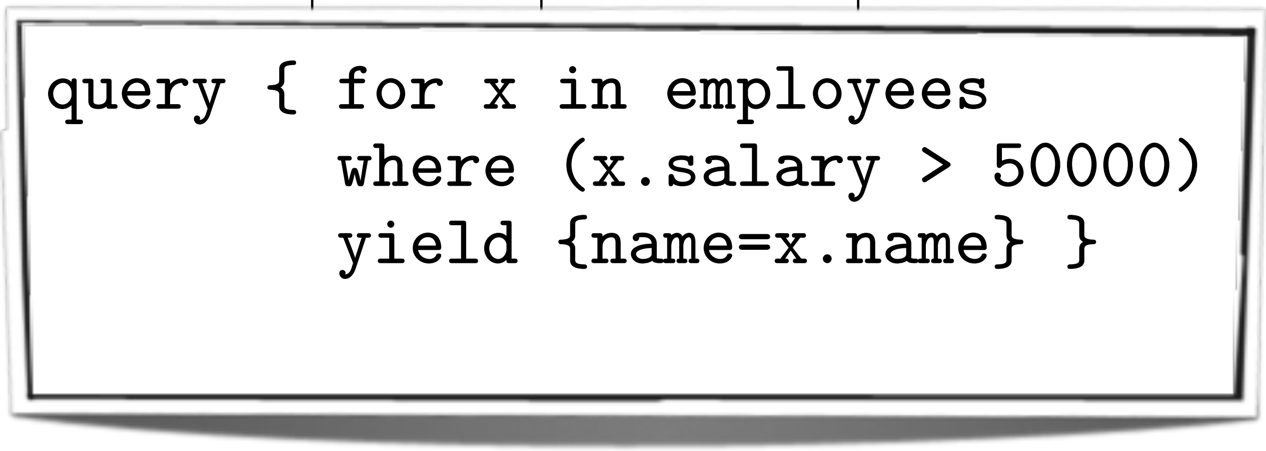

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from employees e
where e.salary > 50000
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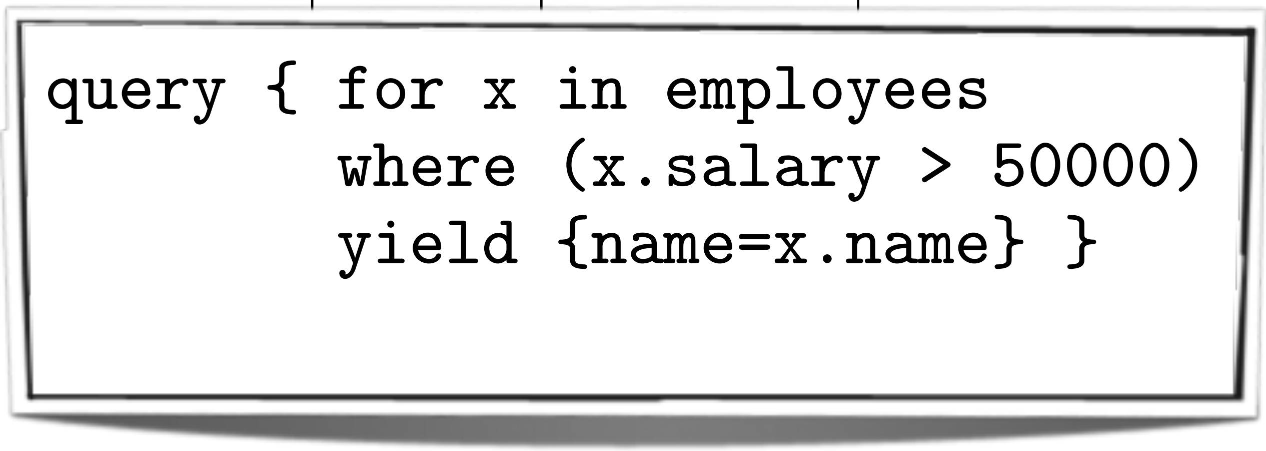

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name
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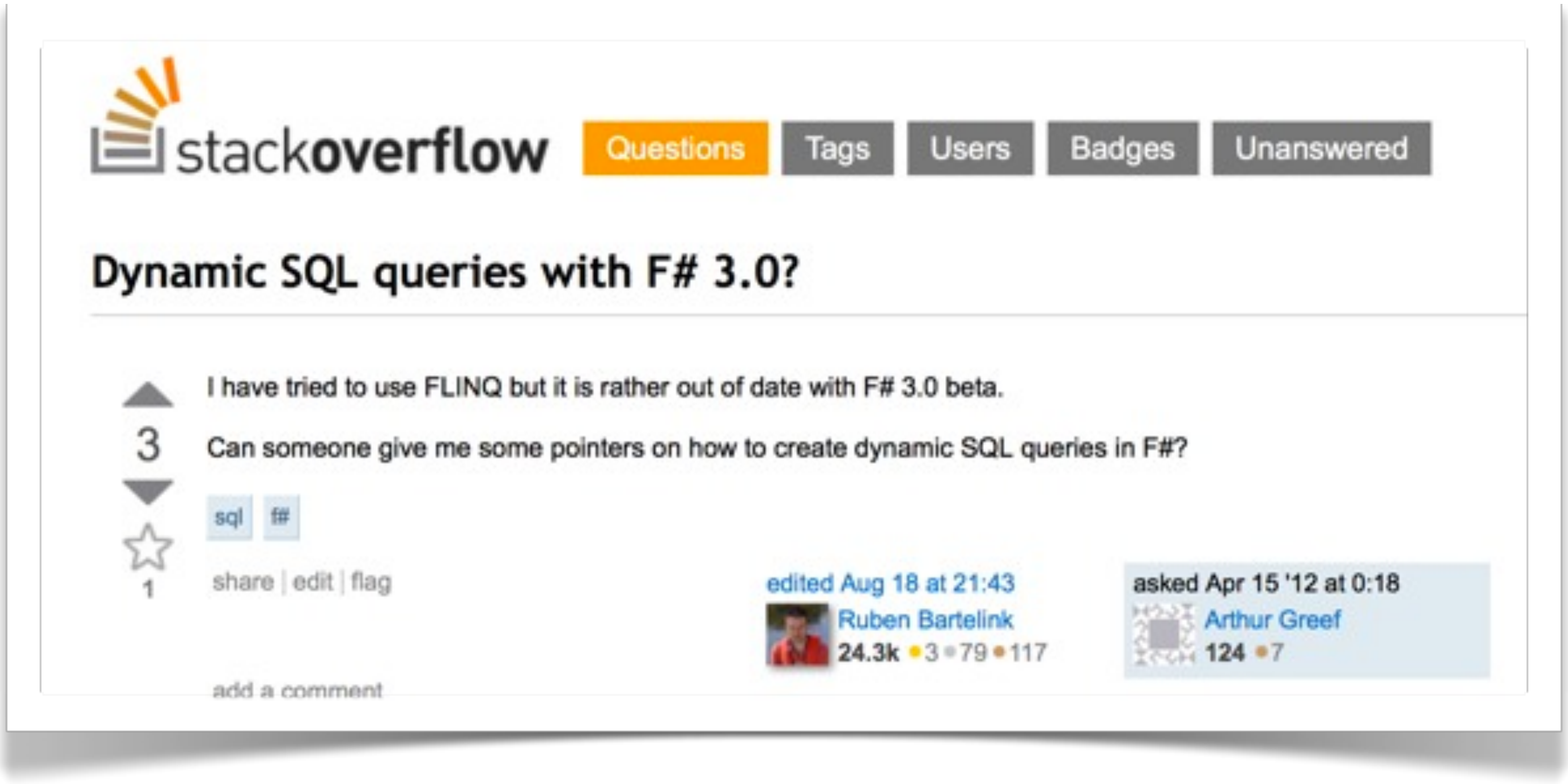
Dynamic/composable queries in F#?



Dynamic SQL queries with F# 3.0?

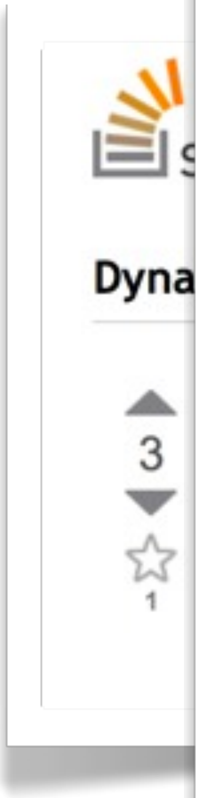
I have tried to use FLINQ but it is rather out of date with F# 3.0 beta.

Can someone give me some pointers on how to create dynamic SQL queries in F#?

edited Aug 18 at 21:43
Ruben Bartelink
24.3k ●3 ●79 ●117

asked Apr 15 '12 at 0:18
Arthur Greef
124 ●7

Dynamic/composable queries in F#?



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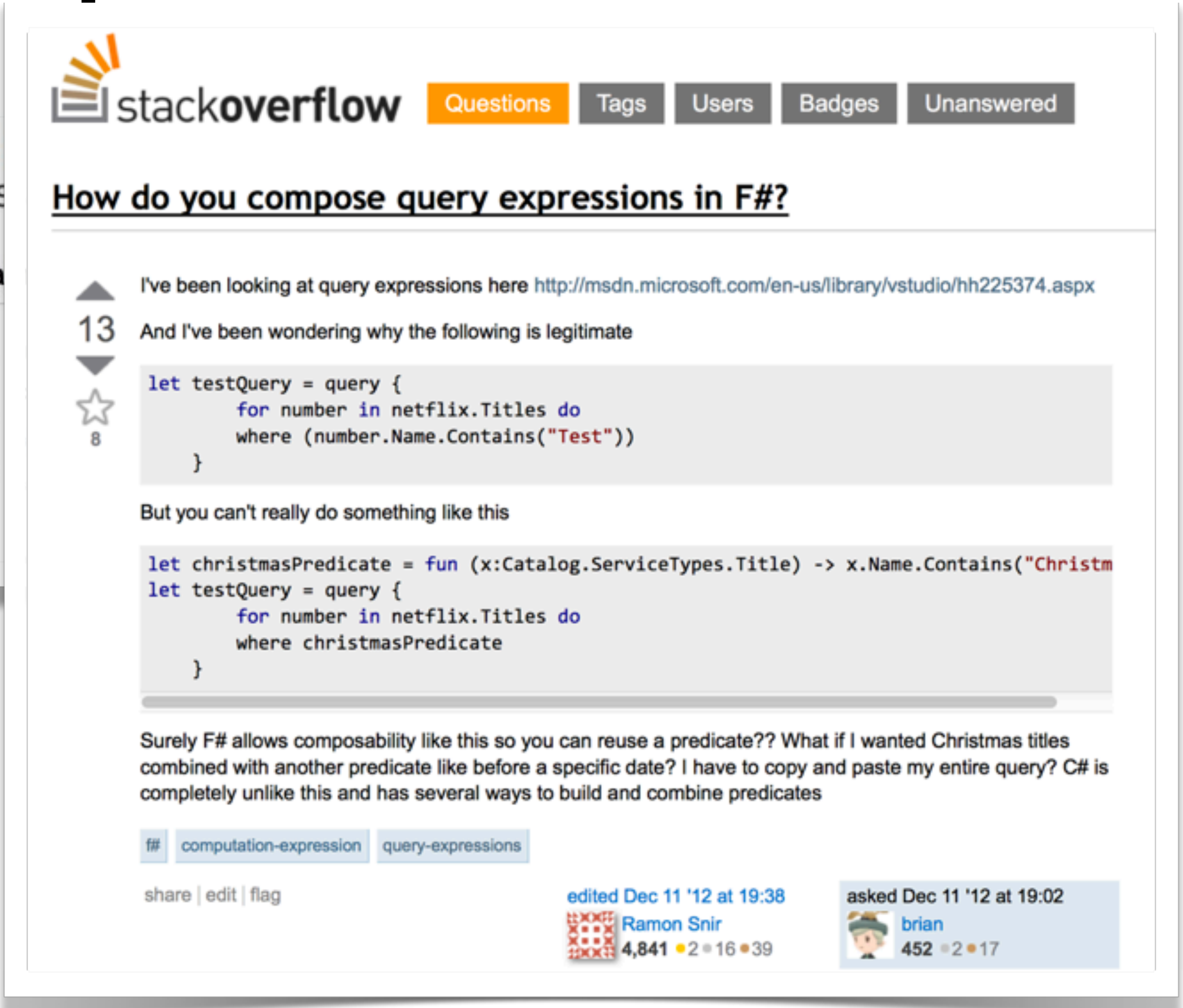

How do you compose query expressions in F#?

13

8

I've been looking at query expressions here http://msdn.microsoft.com/en-us/library/vstudio/hh225374.aspx

And I've been wondering why the following is legitimate

```
let testQuery = query {
        for number in netflix.Titles do
        where (number.Name.Contains("Test"))
    }
```

But you can't really do something like this

```
let christmasPredicate = fun (x:Catalog.ServiceTypes.Title) -> x.Name.Contains("Christm
let testQuery = query {
        for number in netflix.Titles do
        where christmasPredicate
    }
```

Surely F# allows composability like this so you can reuse a predicate?? What if I wanted Christmas titles combined with another predicate like before a specific date? I have to copy and paste my entire query? C# is completely unlike this and has several ways to build and combine predicates

f# computation-expression query-expressions

share | edit | flag

edited Dec 11 '12 at 19:38
Ramon Snir
4,841 ●2 ●16 ●39

asked Dec 11 '12 at 19:02
brian
452 ●2 ●17

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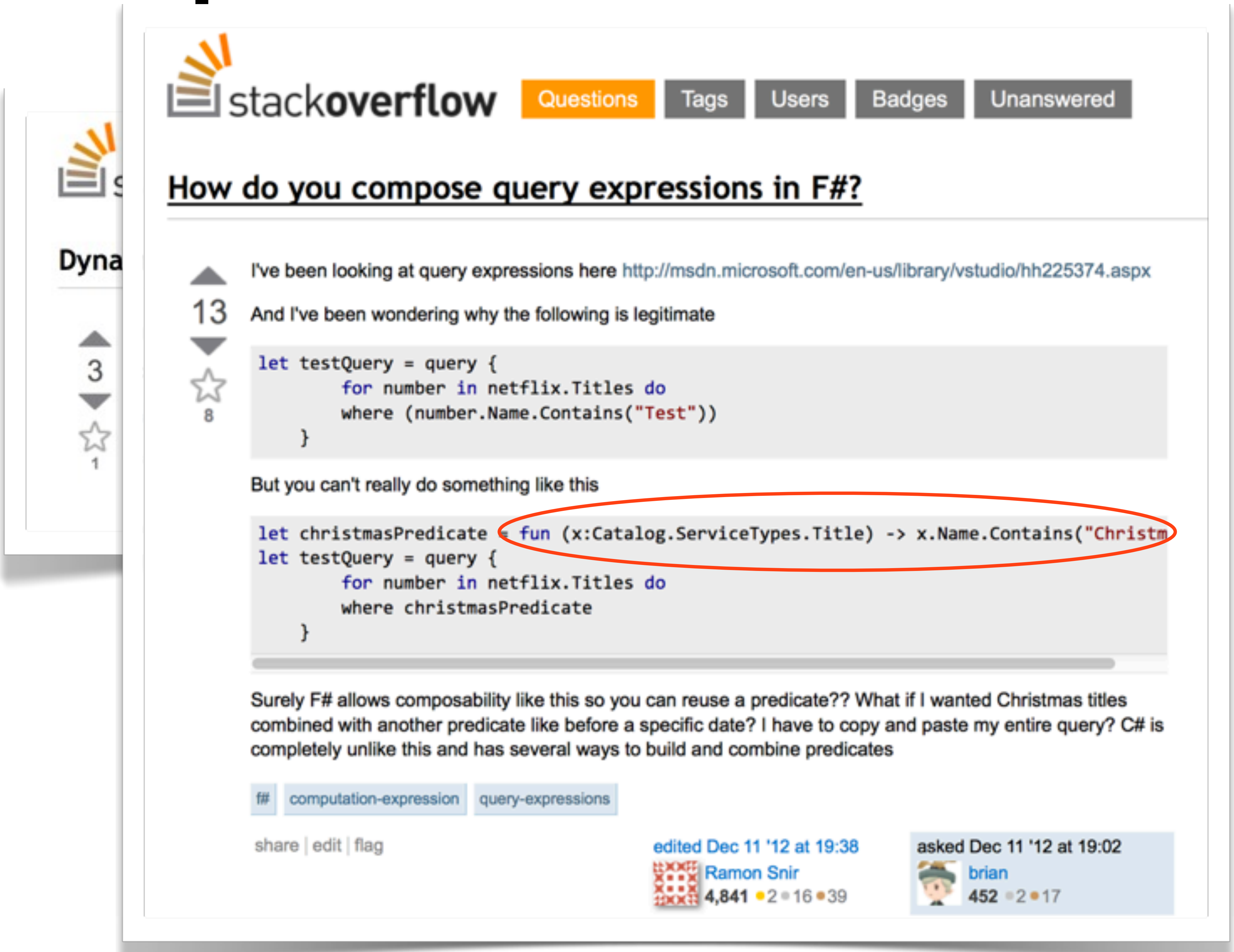

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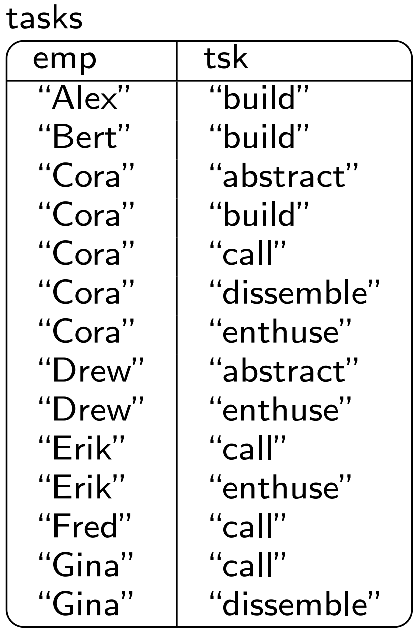
Queries with function "parameters"?

- A way to (de)compose queries into reusable chunks?
  - (avoid repeating yourself)
- This could be very useful
  - a form of staged computation/meta-programming
- Queries could be constructed dynamically
  - including constructing queries of different "shape"
  - goes beyond simple int/string parameters
  - yet still strongly typed

LINQ example



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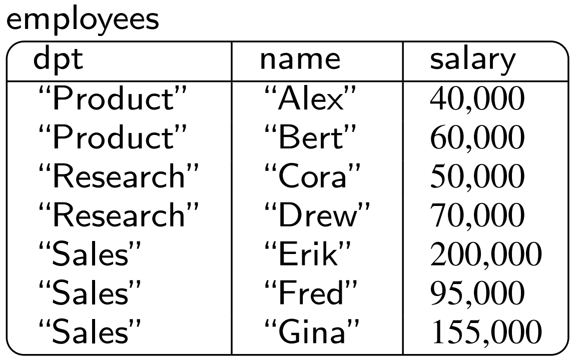

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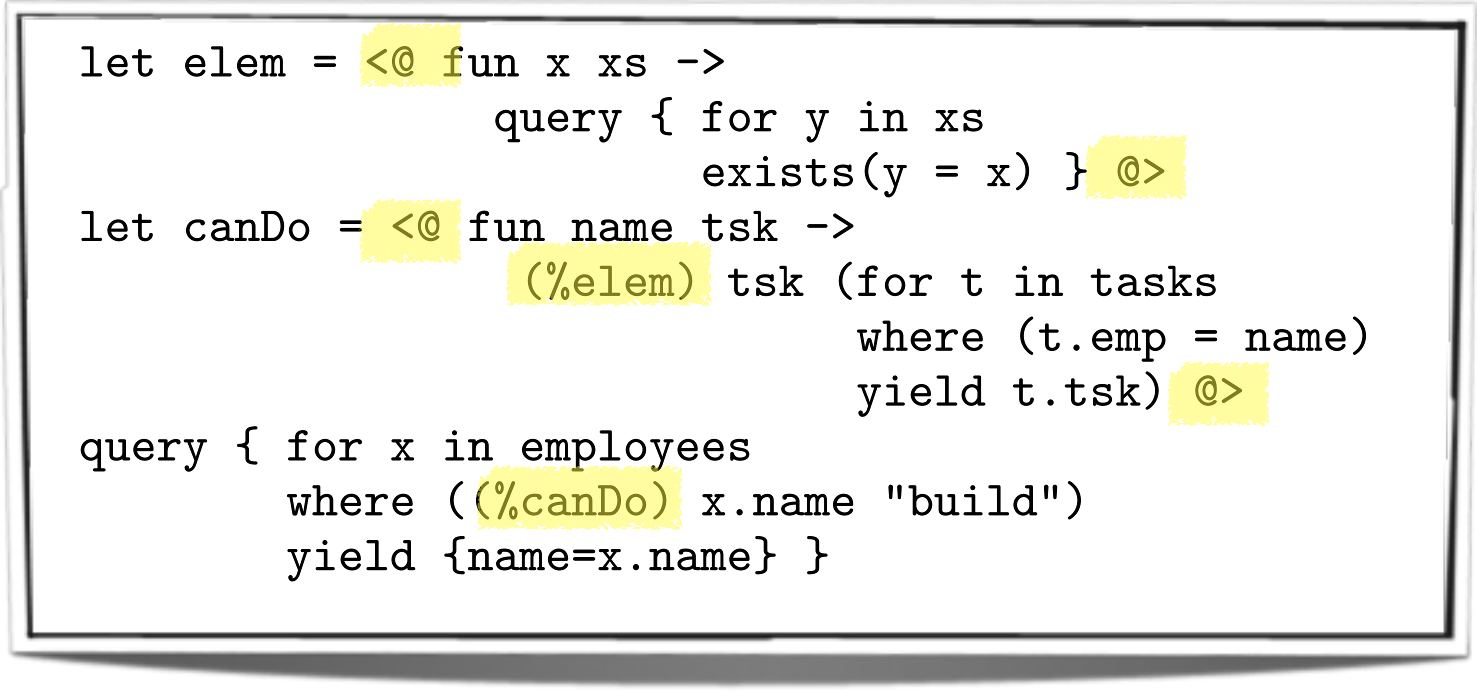
quotation
<@ @>

antiquote
(%)



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let canDo = <@ fun name tsk ->
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        where ((%canDo) x.name "build")
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LINQ example

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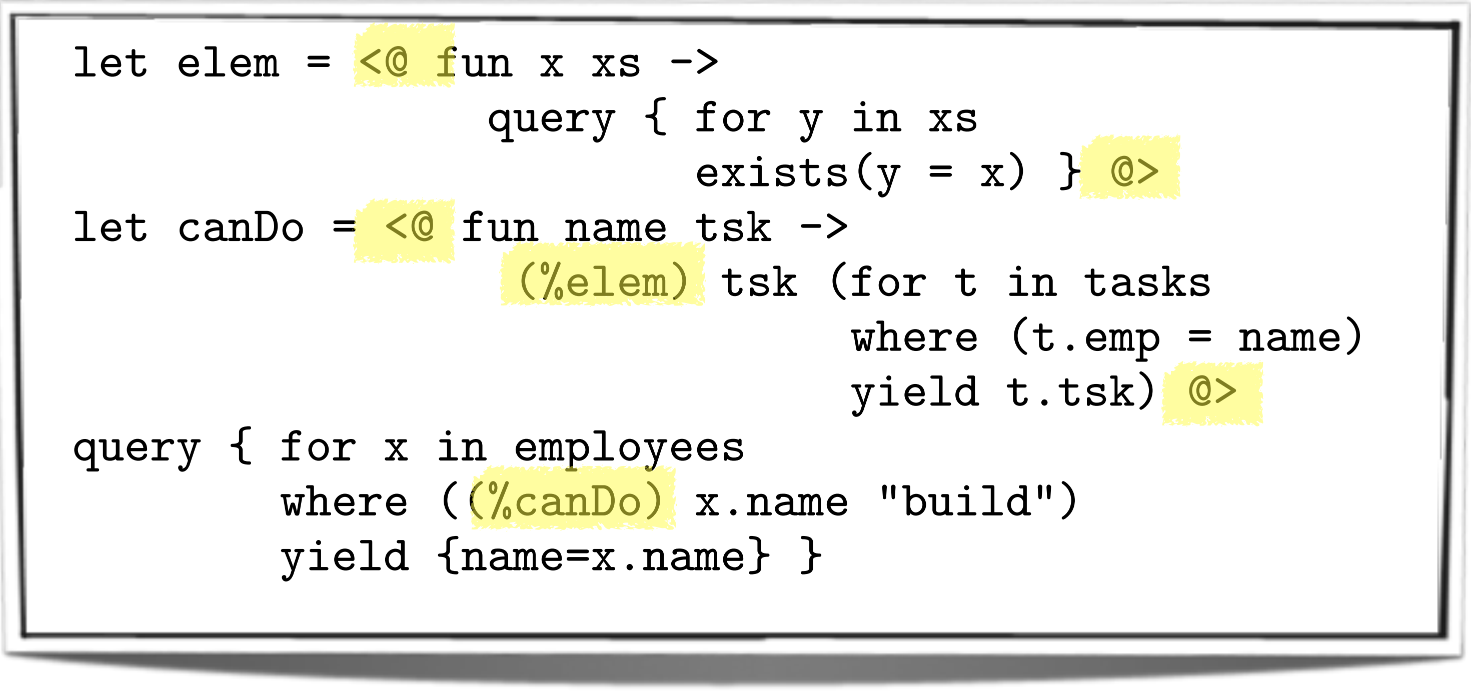

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antiquote
(%)

name
Alex
Bert
Cora

Normalization

- Monadic comprehensions (including nonrecursive higher-order functions) can be *normalized*
  - Worked out by Wong for Kleisli system, extended to higher-order in Links by Cooper
  - Translation to SQL then straightforward
- However (surprisingly), LINQ (F#) doesn't fully support this normalization
  - our ICFP '13 paper shows how to add this

Normalisation: symbolic evaluation

$$
\begin{aligned}
(\textbf{fun}(x) \to N)\ M &\leadsto N[x := M] \\
\{\overline{\ell = M}\}.\ell_i &\leadsto M_i \\
\textbf{for}\ x\ \textbf{in}\ (\textbf{yield}\ M)\ \textbf{do}\ N &\leadsto N[x := M] \\
\textbf{for}\ y\ \textbf{in}\ (\textbf{for}\ x\ \textbf{in}\ L\ \textbf{do}\ M)\ \textbf{do}\ N &\leadsto \textbf{for}\ x\ \textbf{in}\ L\ \textbf{do}\ (\textbf{for}\ y\ \textbf{in}\ M\ \textbf{do}\ N) \\
\textbf{for}\ x\ \textbf{in}\ (\textbf{if}\ L\ \textbf{then}\ M)\ \textbf{do}\ N &\leadsto \textbf{if}\ L\ \textbf{then}\ (\textbf{for}\ x\ \textbf{in}\ M\ \textbf{do}\ N) \\
\textbf{for}\ x\ \textbf{in}\ \texttt{[ ]}\ \textbf{do}\ N &\leadsto \texttt{[ ]} \\
\textbf{for}\ x\ \textbf{in}\ (L\ \texttt{@}\ M)\ \textbf{do}\ N &\leadsto (\textbf{for}\ x\ \textbf{in}\ L\ \textbf{do}\ N)\ \texttt{@}\ (\textbf{for}\ x\ \textbf{in}\ M\ \textbf{do}\ N) \\
\textbf{if true then}\ M &\leadsto M \\
\textbf{if false then}\ M &\leadsto \texttt{[ ]}
\end{aligned}
$$

slide stolen from Phil Wadler's talk

Normalisation: *ad hoc* rewriting

$$
\begin{aligned}
\textbf{for}\ x\ \textbf{in}\ L\ \textbf{do}\ (M\ \mathtt{@}\ N) &\hookrightarrow (\textbf{for}\ x\ \textbf{in}\ L\ \textbf{do}\ M)\ \mathtt{@}\ (\textbf{for}\ x\ \textbf{in}\ L\ \textbf{do}\ N) \\
\textbf{for}\ x\ \textbf{in}\ L\ \textbf{do}\ \mathtt{[\ ]} &\hookrightarrow \mathtt{[\ ]} \\
\textbf{if}\ L\ \textbf{then}\ (M\ \mathtt{@}\ N) &\hookrightarrow (\textbf{if}\ L\ \textbf{then}\ M)\ \mathtt{@}\ (\textbf{if}\ L\ \textbf{then}\ N) \\
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\textbf{if}\ L\ \textbf{then}\ (\textbf{for}\ x\ \textbf{in}\ M\ \textbf{do}\ N) &\hookrightarrow \textbf{for}\ x\ \textbf{in}\ M\ \textbf{do}\ (\textbf{if}\ L\ \textbf{then}\ N) \\
\textbf{if}\ L\ \textbf{then}\ (\textbf{if}\ M\ \textbf{then}\ N) &\hookrightarrow \textbf{if}\ (L\ \ \&\&\ \ M)\ \textbf{then}\ N
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Example

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This is what LINQ normally sees. Note β-redexes!

X (failure or query avalanche)

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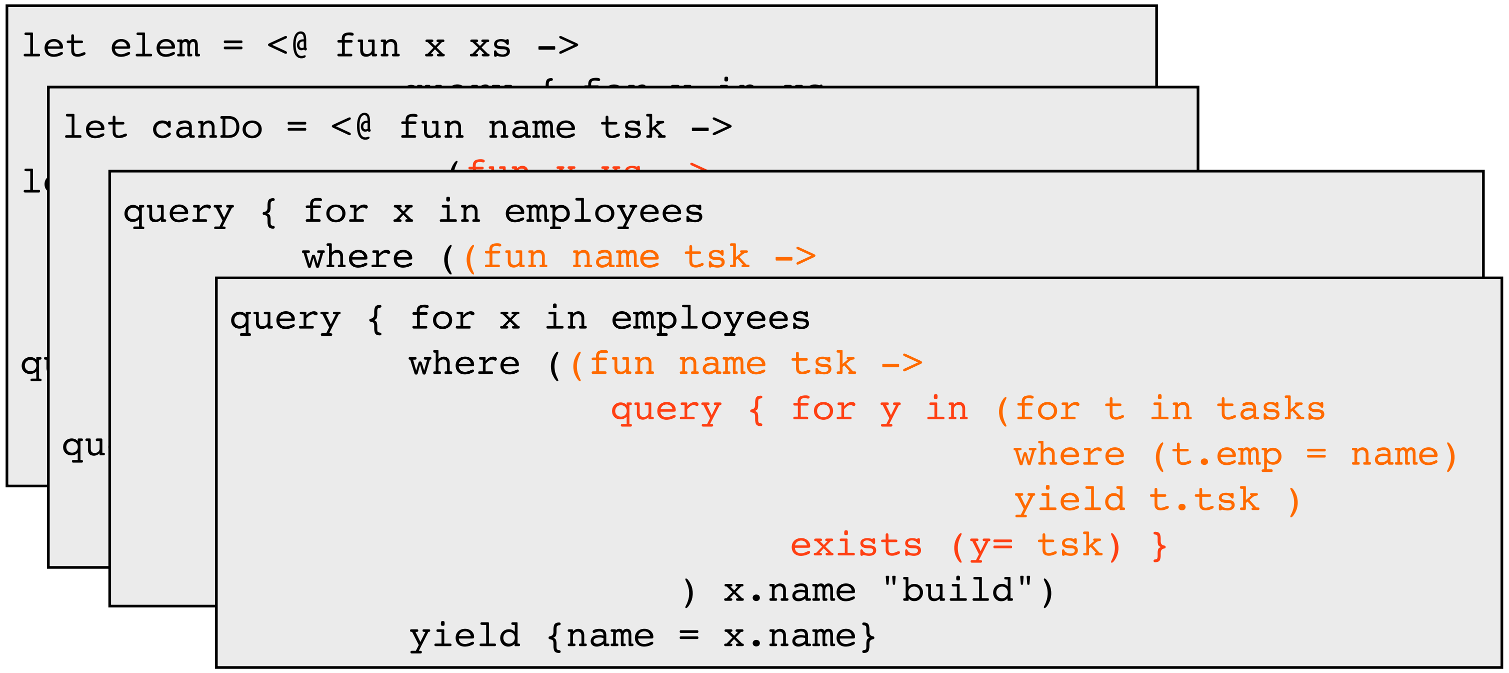

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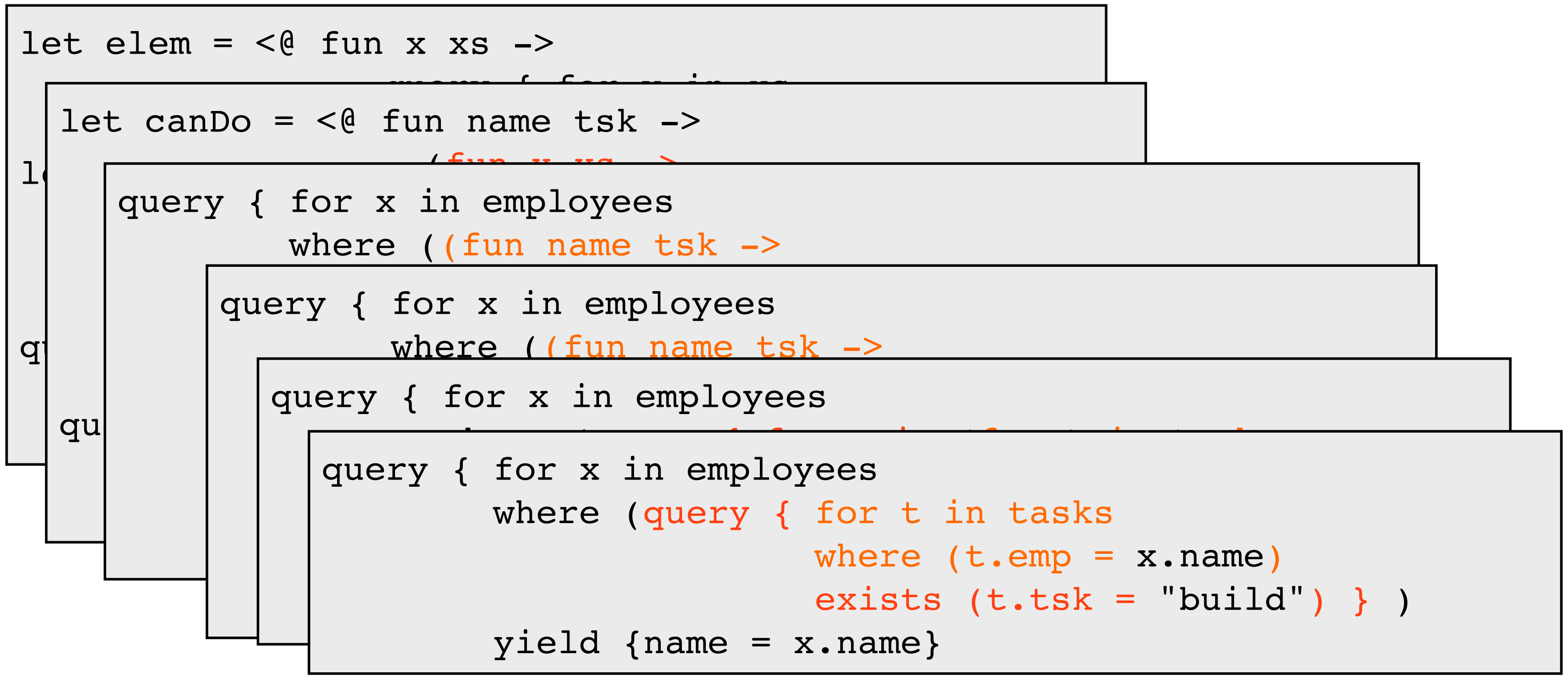

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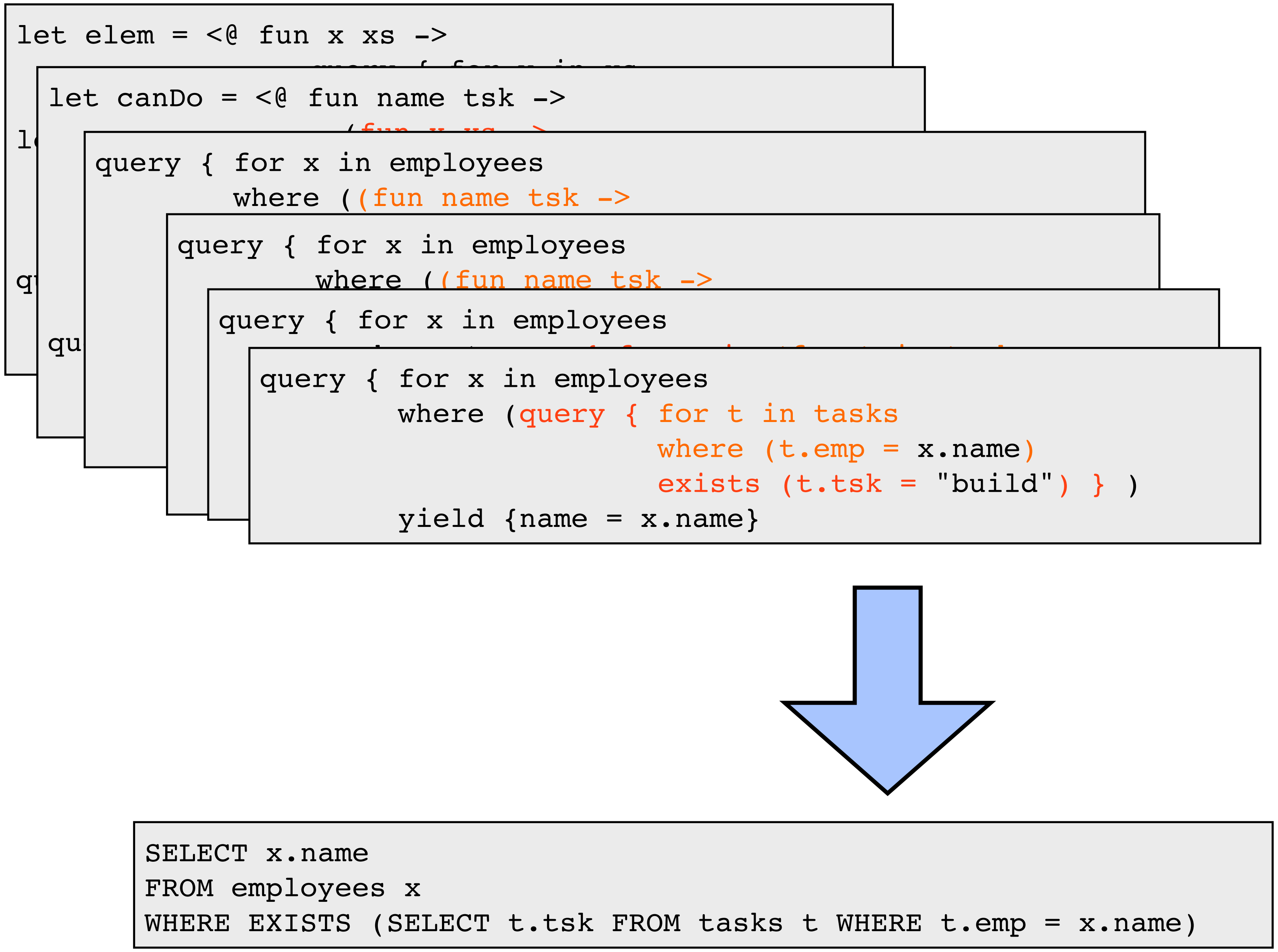

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```
SELECT x.name
FROM employees x
WHERE EXISTS (SELECT t.tsk FROM tasks t WHERE t.emp = x.name)
```

FSharpComposableQuery library

- A library that implements normalization from our ICFP paper
- "No assembly required"
  - Replaces standard QueryBuilder `query` operator
  - including (subtle) overloading tricks (thanks to Don Syme for helping with this)
  - Tested on a wide range of query expressions
    - Should preserve or improve on default behavior

Demo

- Tutorial examples from ICFP paper

Conclusions

- F# 3.0's LINQ capabilities are powerful, but have some (ad hoc?) limitations
  - Quotation and higher-order functions can be used to compose queries
  - But, existing LINQ implementation doesn't always handle these correctly or efficiently
- Normalization techniques developed in other contexts can help
- Presented FSharpComposableQuery
  - a drop-in library that augments F#'s LINQ facilities with better support for query composition and higher-order functions
- https://github.com/fsprojects/FSharp.Linq.ComposableQuery
- http://www.nuget.org/packages/FSharpComposableQuery/