Enso. No-code interactive ELT and process automation tool.

Hi, we are building Enso!
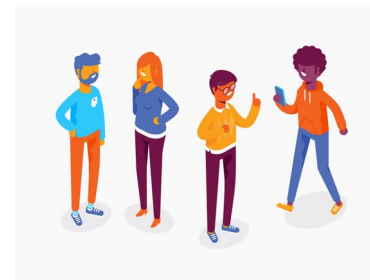

Wojciech Daniło CEO & CTO
Author of data processing tools used by **Pixar** and **Dreamworks**. Haskeller, experienced in building compilers and GPU computing.

Sylwia Brodacka COO
Scientist, Enso team leader. Used to design nano multilayered materials to **build rockets.** Also, experienced Haskell and Python developer.

Team of top notch devs
From **Google**, **Facebook**, **Bloomberg, OracleLabs** with strong experience in Data Science. Located in London, Krakow, Praha, etc .

PIXAR   DreamWorks   Google   facebook   Bloomberg

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	Segment	Country	Product	Discount Band	Units Sold	Manufacturing P	Sale Price	Gross Sales	Discounts	Sales		COGS	Profit		Date
1	Segment	Country	Product	Discount Band	Units Sold	Manufacturing	Sale Price	Gross Sales	Discounts	Sales		COGS	Profit		Date
2	Government	Canada	Carretera	None	1618.5	$ 3.00	$ 20.00	$ 32,370.00	$ -	$	32,370.00	$ 16,185.00	$	16,185.00	1/1/2014
3	Government	Germany	Carretera	None	1321	$ 3.00	$ 20.00	$ 26,420.00	$ -	$	26,420.00	$ 13,210.00	$	13,210.00	1/1/2014
4	Midmarket	France	Carretera	None	2178	$ 3.00	$ 15.00	$ 32,670.00	$ -	$	32,670.00	$ 21,780.00	$	10,890.00	1/6/2014
5	Midmarket	Germany	Carretera	None	888	$ 3.00	$ 15.00	13,320.00	$	$	13,320.00	$ 8,880.00	$	4,440.00	1/6/2014
6	Midmarket	Mexico	Carretera	None	2470						37,050.00	$ 24,700.00	$	12,350.00	1/6/2014
7	Government	Germany	Carretera	None	1513						529,550.00	$ 393,380.00	$	136,170.00	1/12/2014
8	Midmarket	Germany	Montana	None	921						13,815.00	$ 9,210.00	$	4,605.00	1/3/2014
9	Channel Partners	Canada	Montana	None	2518						30,216.00	$ 7,554.00	$	22,662.00	1/6/2014
10	Government	France	Montana	None	1899						37,980.00	$ 18,990.00	$	18,990.00	1/6/2014
11	Channel Partners	Germany	Montana	None	1545						18,540.00	$ 4,635.00	$	13,905.00	1/6/2014
12	Midmarket	Mexico	Montana	None	2470						37,050.00	$ 24,700.00	$	12,350.00	1/6/2014
13	Enterprise	Canada	Montana	None	2665.5						333,187.50	$ 319,860.00	$	13,327.50	1/7/2014
14	Small Business	Mexico	Montana	None	958						287,400.00	$ 239,500.00	$	47,900.00	1/8/2014
15	Government	Germany	Montana	None	2146						15,022.00	$ 10,730.00	$	4,292.00	1/9/2014
16	Enterprise	Canada	Montana	None	345						43,125.00	$ 41,400.00	$	1,725.00	1/10/2013
17	Midmarket	United States of America	Montana	None	615						9,225.00	$ 6,150.00	$	3,075.00	1/12/2014
18	Government	Canada	Paseo	None	292						5,840.00	$ 2,920.00	$	2,920.00	1/2/2014
19	Midmarket	Mexico	Paseo	None	974						14,610.00	$ 9,740.00	$	4,870.00	1/2/2014
20	Channel Partners	Canada	Paseo	None	2518						30,216.00	$ 7,554.00	$	22,662.00	1/6/2014
21	Government	Germany	Paseo	None	1006						352,100.00	$ 261,560.00	$	90,540.00	1/6/2014
22	Channel Partners	Germany	Paseo	None	367						4,404.00	$ 1,101.00	$	3,303.00	1/7/2014
23	Government	Mexico	Paseo	None	883						6,181.00	$ 4,415.00	$	1,766.00	1/8/2014
24	Midmarket	France	Paseo	None	549						8,235.00	$ 5,490.00	$	2,745.00	1/9/2013
25	Small Business	Mexico	Paseo	None	788	$ 10.00	$ 300.00	$ 236,400.00	$	$	236,400.00	$ 197,000.00	$	39,400.00	1/9/2013
26	Midmarket	Mexico	Paseo	None	2472	$ 10.00	$ 15.00	$ 37,080.00	$	$	37,080.00	$ 24,720.00	$	12,360.00	1/9/2014
27	Government	United States of America	Paseo	None	1143	$ 10.00	$ 7.00	$ 8,001.00	$	$	8,001.00	$ 5,715.00	$	2,286.00	1/10/2013
28	Government	Canada	Paseo	None	1725	$ 10.00	$ 350.00	$ 603,750.00	$	$	603,750.00	$ 448,500.00	$	155,250.00	1/11/2013
29	Channel Partners	United States of America	Paseo	None	912	$ 10.00	$ 12.00	$ 10,944.00	$	$	10,944.00	$ 2,736.00	$	8,208.00	1/11/2013
30	Midmarket	Canada	Paseo	None	2152	$ 10.00	$ 15.00	$ 32,280.00	$	$	32,280.00	$ 21,520.00	$	10,760.00	1/12/2013
31	Government	Canada	Paseo	None	1817	$ 10.00	$ 20.00	$ 36,340.00	$ -	$	36,340.00	$ 18,170.00	$	18,170.00	1/12/2013
32	Government	Germany	Paseo	None	1513	$ 10.00	$ 350.00	$ 529,550.00	$	$	529,550.00	$ 393,380.00	$	136,170.00	1/12/2014
33	Government	Mexico	Velo	None	1493	$ 120.00	$ 7.00	$ 10,451.00	$	$	10,451.00	$ 7,465.00	$	2,986.00	1/1/2014
34	Enterprise	Canada	Velo	None	345	$ 120.00	$ 125.00	$ 43,125.00	$	$	43,125.00	$ 41,400.00	$	1,725.00	1/10/2013
35	Small Business	Canada	VTT	None	2001	$ 250.00	$ 300.00	$ 600,300.00	$	$	600,300.00	$ 500,250.00	$	100,050.00	1/2/2014
36	Channel Partners	Germany	VTT	None	2838	$ 250.00	$ 12.00	$ 34,056.00	$	$	34,056.00	$ 8,514.00	$	25,542.00	1/4/2014
37	Midmarket	France	VTT	None	2178	$ 250.00	$ 15.00	$ 32,670.00	$	$	32,670.00	$ 21,780.00	$	10,890.00	1/6/2014
38	Midmarket	Germany	VTT	None	888	$ 250.00	$ 15.00	$ 13,320.00	$	$	13,320.00	$ 8,880.00	$	4,440.00	1/6/2014
39	Government	France	VTT	None	1527	$ 250.00	$ 350.00	$ 534,450.00	$	$	534,450.00	$ 397,020.00	$	137,430.00	1/6/2014
40	Small Business	France	VTT	None	2151	$ 250.00	$ 300.00	$ 645,300.00	$	$	645,300.00	$ 537,750.00	$	107,550.00	1/9/2014
41	Government	Canada	VTT	None	1817	$ 250.00	$ 20.00	$ 36,340.00	$	$	36,340.00	$ 18,170.00	$	18,170.00	1/12/2013

8%

of all enterprise employees are
advanced spreadsheet users, our target users.

Advanced spreadsheet users (5M in USA) waste 20% time on repetitive work every time data changes*. Enso automates it.

5M advanced spreadsheet users × $60k avg salary × 20% = $60b USA Market

We raised **$13M in less than 4 weeks**
(led by SignalFire & Khosla, including Y Combinator)

$1M from two of our users!
They loved Enso so much, they
invested as angels.

Building **Enso** on top of **GraalVM**

Jaroslav Tulach   Engine Team

Enso runtime engine team member. Formerly GraalVM, Oracle Labs. Even formerly NetBeans Platform architect and NetBeans Founder.

GraalVM Challenges

- **Enso** is a **Functional Language**
  Deep stack needed. Tail recursive functions are a must.

- **Enso** **Interops** with **Java**
  Unlike other GraalVM languages, Enso doesn't have *C-interop*, but *JVM-interop*!

- **Enso is** **Polyglot** **by Design**
  Designed from the ground to interop with *Python, JavaScript, R and* other GraalVM languages!

- **Enso loads** **Java** **Dynamically**
  Libraries are written in Enso & Java. Accompanied by (dynamically loaded) *JAR files.*

Enso - the Strict Functional Language

- **Recursion everywhere**

  No **for** or **while** loops. Deeper stack than imperative languages. Usually OK. Can one *switch to endless stack* while running?

- **Tail-recursive calls needed**

  "Trampoline approach" to tail calls. Leads to *megamorphic calls sites* when used all the time. Introduced **@Tail_Call** annotation.

- **Detecting tail location candidates**

  Only (but possibly nested) recursive calls. Only when part of single Graal compilation unit.

```
type List a
    Nil
    Cons x:a xs:List a

fold : List a -> (a -> a -> a) -> a
fold self init f =
    go acc list = case list of
        Nil -> acc
        Cons h t -> @Tail_Call go (f acc h) t
    res = go init self
    res
```

Enso Loves Java & JDK

● **Java as the system language**

Using **Java** for making *operating system* calls. No direct **C** bindings. Libraries carry their own *JAR* files.

● **Interop with host Java**

Dynamically loading JVM classes. Unrestricted access. Opaque *TruffleObject* instances. Bugfixes needed - #4741, overloaded methods, statics, etc.

● **Meta-level issues & mismatch**
Three types of Java classes:
  - Engine implementation classes
  - JDK classes
  - Guest objects wrapping hosted objects

```
polyglot java import java.lang.System as Java_System

exit : Integer -> Nothing
exit code = Java_System.exit code
```

Enso Loves GraalPy

- **Interop with any dynamic language**
  Embed code snippets directly with **foreign** keyword in Enso source files.

- **Opaque interop**
  No special support for Java, Python, JavaScript after creation of an *TruffleObject* instance.

- **Own context for each language**
  PolyglotProxy is a *TruffleObject* that keeps GIL, *TruffleContext* and delegates to foreign *TruffleObject*

- **Missing BigInteger interop**
  Enso Number represented as *long, double* or *BigInteger*. How to exchange *BigInteger* with Java or other languages?
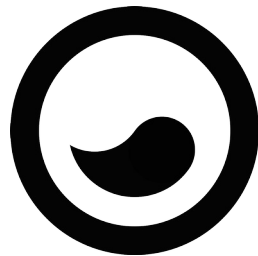
```
type Foo
    Foo_Data vec

compare_tco a b = case a.vec.length == b.vec.length of
    False -> a.vec.length . compare_to b.vec.length
    True -> cmp = (a.vec.at ix) . compare_to (b.vec.at ix)

foreign js generate_js_array = """
    return [1, 2, 3, 4, 5]

## 'python'

foreign python generate_py_array = """
    return [1, 2, 3, 4, None]
```

Enso and Native Image

- **Enso written in Enso**

  Core Enso libraries are written in Enso – *bootstrap takes time*. Compile with Native Image! Starts much faster.

- **Libraries carry own JAR files**

  Recompile Enso for every set of libraries? Use Espresso?

- **Dual execution mode**

  Need the *JVM mode* as well *Native mode*. Libraries (including their JAR part) have to behave the same.

- **Host Java vs. Espresso interop**

  How compatible is Espresso interop? Does *StaticObject* behave exactly the same as *HostObject*?

- **Security, scalability, multi-tenancy**

  Espresso allows restricting *operating system* access. Running multiple engines in a single process.

Enso Tooling

- **Instrumentation essential**
  Enso IDE observes and manipulates live objects in the engine.
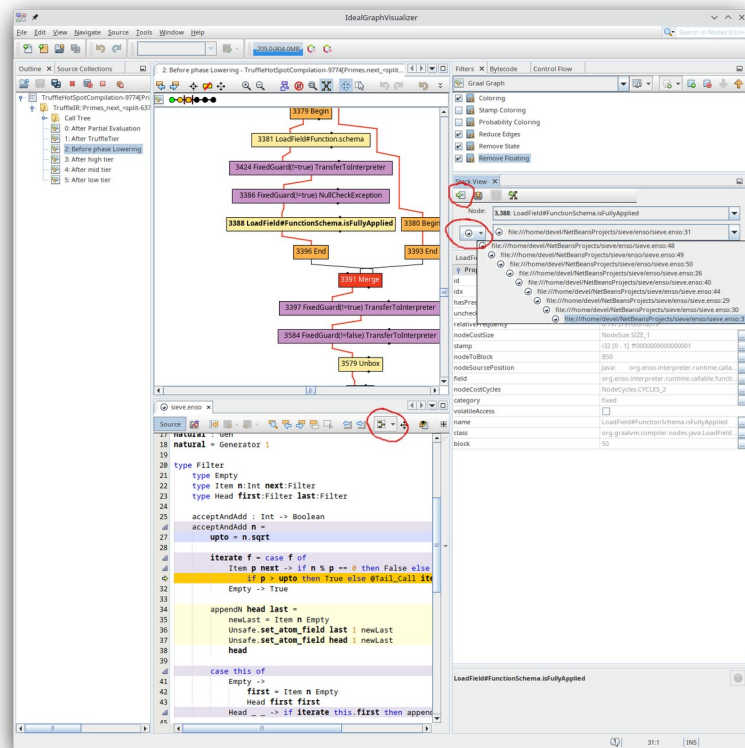
- **Debugger**
  Chrome developer tools for *Enso only* debugging. VSCode for mixed *Enso and Java* debugging.

- **Ideal Graph Visualizer**
  IGV recognizes Enso source files. It can connect source locations graphs. More...

- **VisualVM**
  Polyglot sampling of Enso programs working and useful.

The future of Enso

- **Enso Cloud (work in progress)**
  Automatic scalability, real-time collaboration, easy sharing/selling custom data processing components and visualizations.

- **Enso for AI and ML**
  Create, train, test, and manage machine learning models with ease and integrate them in your pipelines.

- **"The WordPress for software." A platform to rapidly build software on top of**
  We've already seen our community build all kind of software on top of Enso – procedural CAD tools, CI/CD automation, genome analysis. The ETL/data automation market is just a tiny segment of where we want to be.
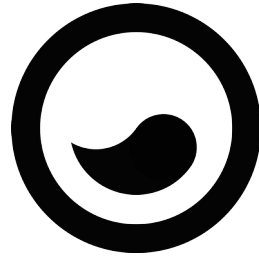
Thank you!
jaroslav.tulach@enso.org