# Semantic Search for Quantity Expressions

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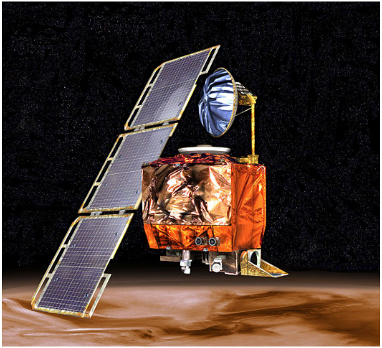
  - Mars Climate Orbiter (1999)



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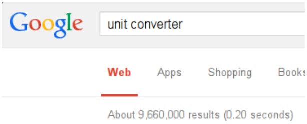

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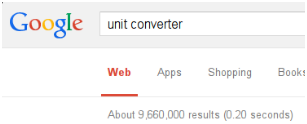
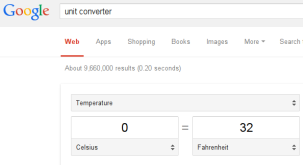



  - Google itself has one integrated



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- This is the kind of search engine we have built

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- Spotter is done by *Stiv Sherko*

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  - easy to write down theories without programming knowledge

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- so we have 9 basic dimensions

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# Our Approach: The Unit System (3) - A Theory of Dimensions

| Dimension | | |
|---|---|---|
| dim | : | type |
| none | : | dim |
| count | : | dim |
| length | : | dim |
| mass | : | dim |
| time | : | dim |
| current | : | dim |
| temperature | : | dim |
| luminous | : | dim |
| amount | : | dim |
| $\cdot$ | : | $\mathsf{dim} \to \mathsf{dim} \to \mathsf{dim}$ |
| $/$ | : | $\mathsf{dim} \to \mathsf{dim} \to \mathsf{dim}$ |

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  5. *Quotient* of two existing QEs such as $1\ \frac{\text{Meter}}{\text{Second}}$
  6. *Sum* of two existing QEs

# Our Approach: The Unit System (5) - A Theory of Quantity Expressions

| Quantity Expression | | |
|---|---|---|
| import Dimension | | |
| QE | : | $\text{dim} \rightarrow \text{type}$ |
| QENMul | : | $\forall x : \text{dim}.\mathbb{R} \rightarrow \text{QE}(x) \rightarrow \text{QE}(x)$ |
| QENDiv | : | $\forall x : \text{dim}.\text{QE}(x) \rightarrow \mathbb{R} \rightarrow \text{QE}(x)$ |
| QEAdd | : | $\forall x : \text{dim}.\text{QE}(x) \rightarrow \text{QE}(x) \rightarrow \text{QE}(x)$ |
| QEMul | : | $\forall x, y : \text{dim}.\text{QE}(x) \rightarrow \text{QE}(y) \rightarrow \text{QE}(x \cdot y)$ |
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- | Non SI Lengths |
  |---|
  | import Quantity Expression |
  | Thou : QE (length)<br>Foot = QENMul (1000, Thou)<br>Yard = QENMul (3, Foot)<br>Chain = QENMul (22, Yard)<br>Furlong = QENMul (10, Chain)<br>Mile = QENMul (8, Furlong) |

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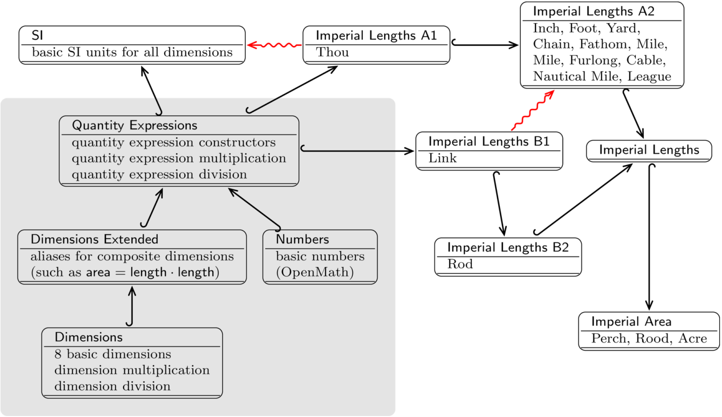
  - allows conversion

# Our Approach: The Unit System (6) - Part of the unit Theory Graph



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- *Idea*: bring QEs to normal form and use efficient indexing

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- use a two-step normalisation process

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- $42 \frac{10(22(3(1000(0.0000254\ \text{Meter}))))}{2(7(24(60(60\ \text{Second}))))}$

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- $\text{Furlong} = 10 \text{ Chain} = 10\,(22 \text{ Yard}) = \cdots = 10\,(22\,(3\,(12\,(1000\,(0.0000254 \text{ Meter})))))$
- $\text{Fortnight} = (2\,(7\,(24\,(60\,(60 \text{ Second})))))$
- Substitute this back into the original expression
- $42 \frac{10(22(3(1000(0.0000254 \text{ Meter}))))}{2(7(24(60(60 \text{ Second}))))}$
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- Demo at `http://pine.eecs.jacobs-university.de:9000/`

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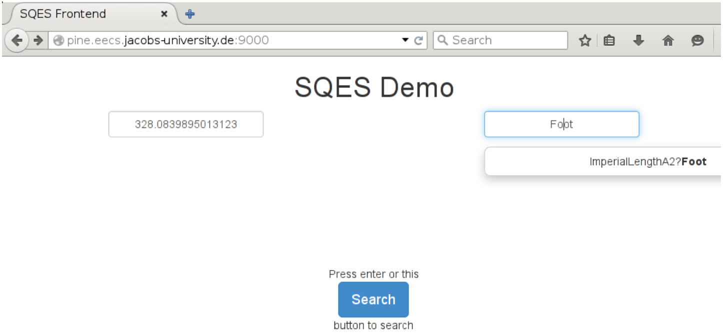

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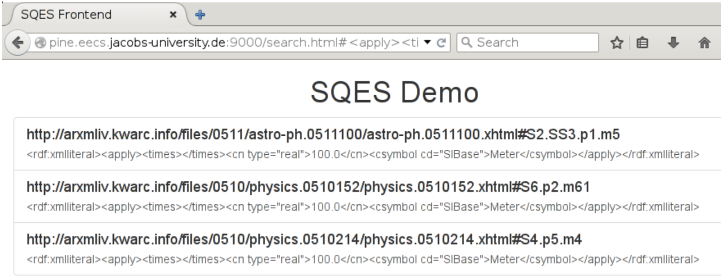

# Time for Questions

Thank You For Listening!

Image sources:

- http://www.gettingaroundgermany.info/g_imgs/z274.gif
- http://upload.wikimedia.org/wikipedia/commons/thumb/1/19/Mars_Climate_Orbiter_2.jpg/528px-Mars_Climate_Orbiter_2.jpg