

# CSE 291 I: Usability of Programming Languages ("Programmers Are People Too")

Cognitive Dimensions of Notation





# Finishing Up: Quantitative Methods



# TESTS

- To compare means of *two* groups (continuous data):
  - T test: assumes normal distribution (*parametric*)
  - Mann-Whitney U test: does not assume normal distribution (*nonparametric*)
- For  $> 2$  categories, use ANOVA (ANalysis Of VAriance)
  - ANOVA gives probability that at least two groups are different



# DEMO

- RQ: does garbage collection help Rust novices complete tasks more effectively?
- Assigned participants to use GC or not
- Measured time, scores, and a bunch of Likert-scale questions



# Cognitive Dimensions of Notation

(examples from: Green, T.R.G. and Petre, M., "Usability Analysis of Visual Programming Environments: A 'Cognitive Dimensions' Framework." Journal of Visual Languages and Computing, 1996. 7(2): pp. 131-174.)



# Expert Methods

- Recall: expert methods do not require any users
- Pros:
  - Low-cost (don't have to design studies, recruit participants)
  - Applicable at early stages of design
- Cons:
  - Results depend on expert's analytic skills and methods
- *Cognitive dimensions* serve as one analytic method.



# Cognitive Dimensions as Vocabulary

- Programming depends on *notation*
- What vocabulary can we use to describe properties of notation?
- If we can describe properties, we can analyze tradeoffs
  - Every notation highlights some kinds of information at the expense of obscuring other kinds.
  - When seeking information, there must be a cognitive fit between the mental representations and the external representation.



# Visual Programming Languages

- Programming is not just text
  - Spreadsheets
  - LabVIEW
  - Scratch
  - IDEs...
- Approaches to analyze notation should generalize to VPLs too



# Example Task

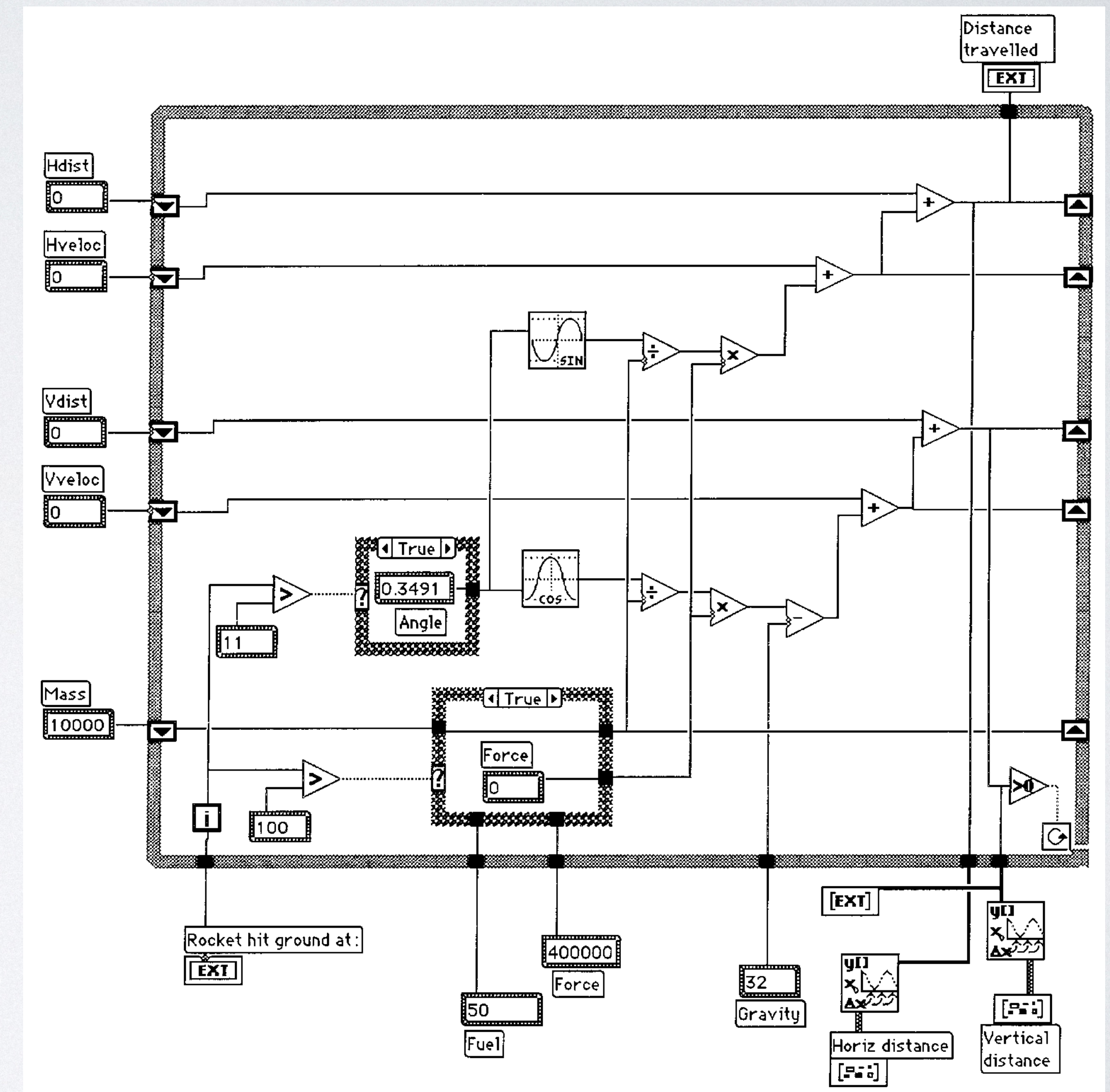
- The rocket program computes the vertical and horizontal trajectory of a rocket on which the only forces acting are its thrust and gravity. At time zero the rocket stands stationary and vertical on level ground, with a mass of 104 pounds. Its engine develops a thrust of  $4 \times 10^5$  foot-pounds, using up a mass of 50 pounds of fuel per second, until the fuel is exhausted after 100 seconds. It rises vertically for 10 seconds after which it adopts and retains an angle of 0.3941 radians (22.5 degrees) to the vertical. The downwards acceleration of gravity is 32 feet  $\text{sec}^2$ .



# Example Solutions (MS BASIC, LabVIEW)

```
Mass = 10000
Fuel = 50
Force = 400000
Gravity = 32
WHILE Vdist >= 0
  IF Tim = 11 THEN Angle = .3941
  IF Tim > 100 THEN Force=0 ELSE Mass=Mass - Fuel
  Vaccel = Force*COS(Angle)/Mass - Gravity
  Vveloc = Vveloc + Vaccel
  Vdist = Vdist + Vveloc
  Haccel = Force*SIN(Angle)/Mass
  Hveloc = Hveloc + Haccel
  Hdist = Hdist + Hveloc

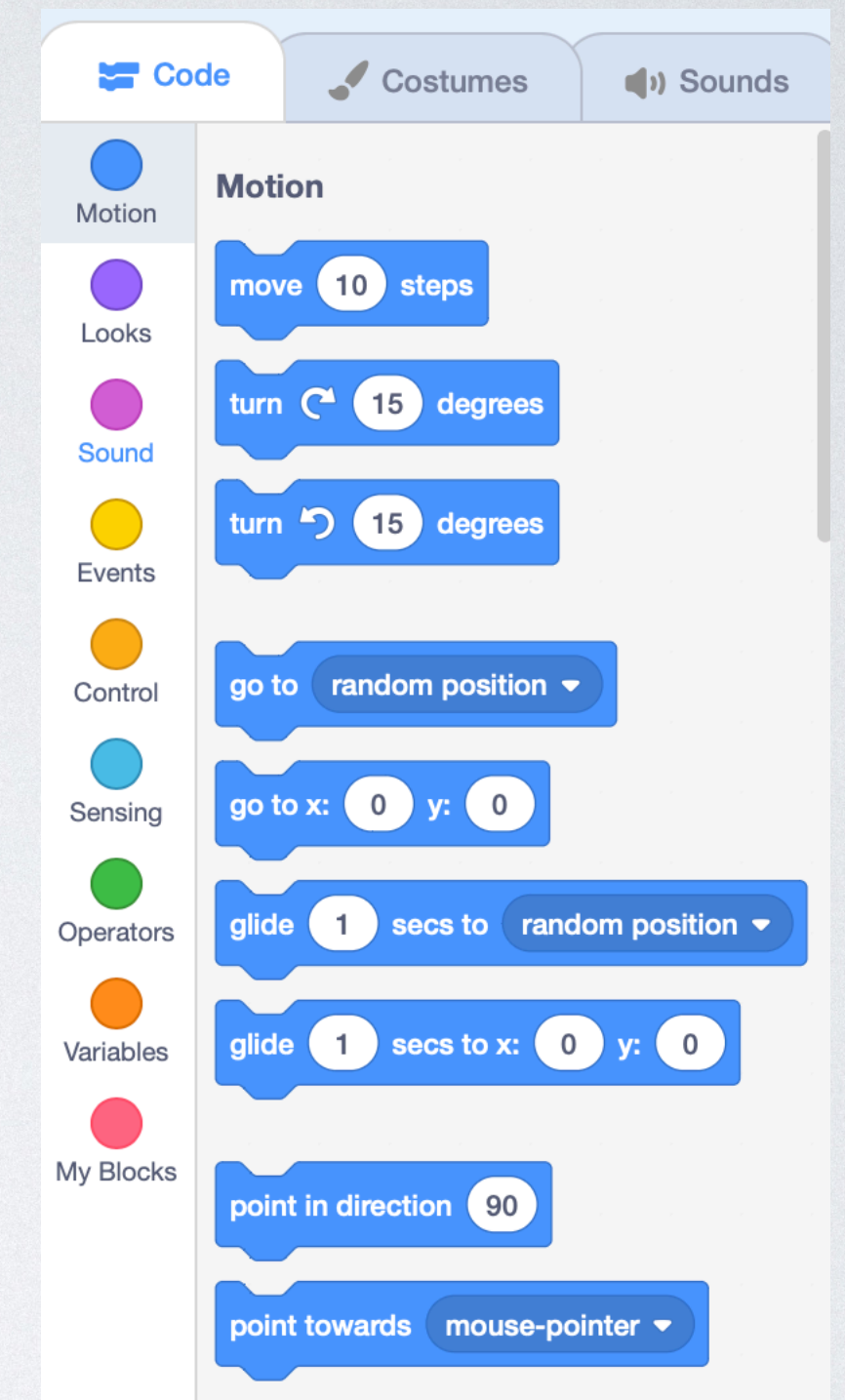
  PRINT TIM, Vdist, Holst
  Tim = Tim + 1
WEND
STOP
```





# Dimensions Examples

- Viscosity: how hard is it to make changes?
- Which changes?
- Structured editors typically have high viscosity (vs. text editors)

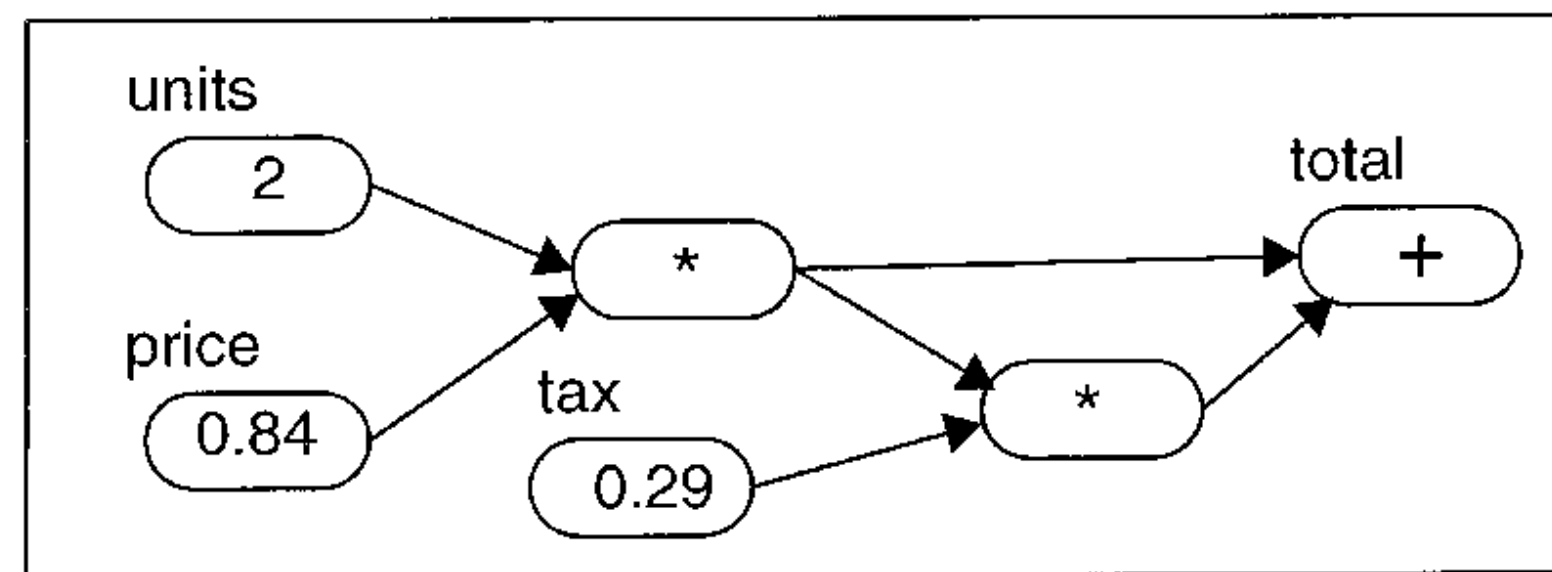




# Hidden Dependencies

- Spreadsheets tend to hide dependencies
- Textual languages partially hide dependencies
- Dataflow languages expose dependencies

	A	B	C	D	E	F
1	item	unit price	units	price	tax	total price
2	apples	£ 0.84	2	= B2*C2	0.29	= E2*D2

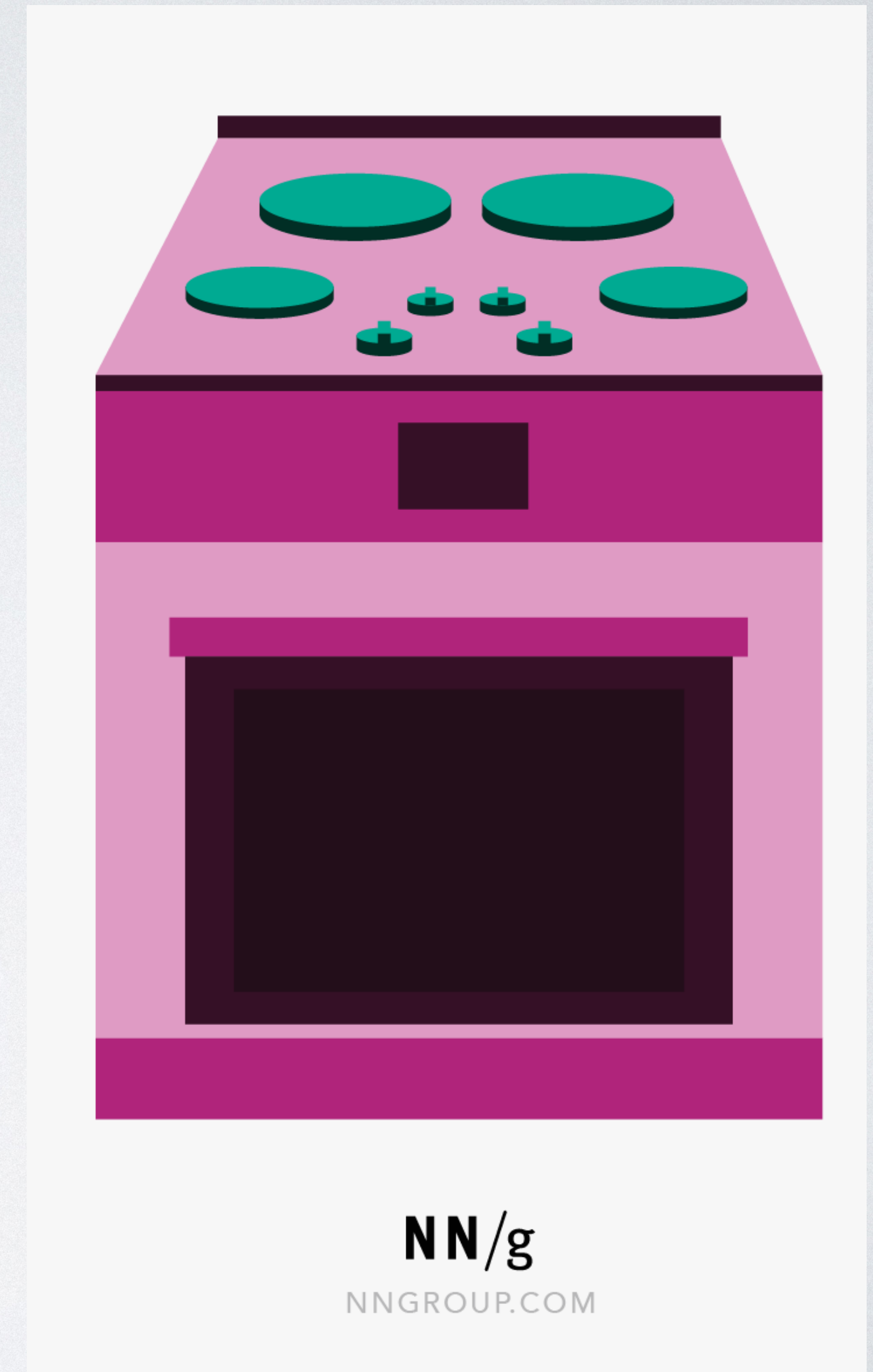


```
read (UnitPrice, Units, Tax)
Nett = Units * UnitPrice
Total = Nett + Tax * Nett
```



# Contrast: Nielsen's Heuristics

- 10 heuristics
- Example: *Match between system and the real world*
- Applicable to UIs in general, not just PLs



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# Nielsen's Heuristics

- Recognition rather than recall
  - "What's the capital of Portugal?"
  - "Is Lisbon the capital of Portugal?"
  - The latter is much easier for most people!
- GUIs vs. command line



# Group Activity

- Analyze (using CDs):
  - Flowcharts
  - Assembly programs
  - Paper/pencil mathematics
  - To-dos on sticky notes
  - Word processor styles
  - Musical notation
- Compare (using CDs): spreadsheets vs. databases
- Identify examples in real life:
  - Premature commitment
  - Viscosity
  - Hidden dependencies
  - Abstraction gradient
  - Closeness of mapping