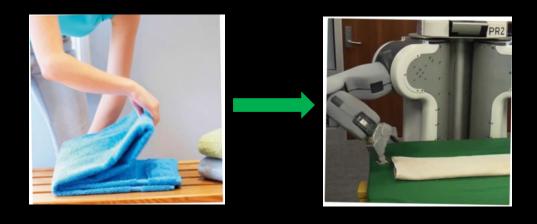


Programming by Examples



Sumit Gulwani, Microsoft

#Res8SAIS

Example-based help-forum interaction

300_w30_aniSh_c1_b
$$\rightarrow$$
 w30
300_w5_aniSh_c1_b \rightarrow w5



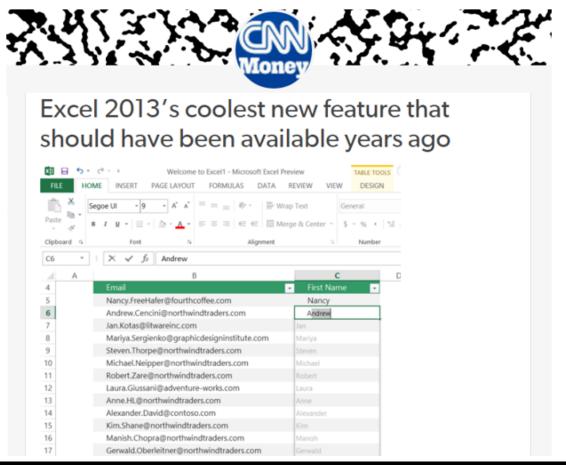
A HUGE Thank you!!!!! 🙂 😅 😅 😅



=MID(B1,5,2)

=MID(B1,FIND("_",\$B:\$B)+1, FIND("_",REPLACE(\$B:\$B,1,FIND("_",\$B:\$B),""))-1)

Flash Fill (Excel feature)





Number, DateTime Transformations

Input	Output (round to 2 decimal places)
123.4567	123.46
123.4	123.40
78.234	78.23

Excel/C#: #.00

Python/C: .2f

Java: #.##

Input	Output (3-hour weekday bucket)
CEDAR AVE & COTTAGE AVE; HORSHAM; 2015-12-11 @ 13:34:52;	Fri, 12PM - 3PM
RT202 PKWY; MONTGOMERY; 2016-01-13 @ 09:05:41-Station:STA18;	Wed, 9AM - 12PM
; UPPER GWYNEDD; 2015-12-11 @ 21:11:18;	Fri, 9PM - 12AM



Data Science Class Assignment

```
style="text-align: center;" | {{Sort | 01 | [[Super Bowl I | I]]}}}
{{Dts|1967|January|15}}
style="background:#d0e7ff;"|{{Sort|Green Bay Packers 01|[[1966 Green Bay Packers season|Green Bay Packers]]<sup>‡</sup>}}
style="text-align: center;" {{Sort|3510|35-10}}
style="background:#fcc;"[{{Sort|Kansas City Chiefs 01|[[1966 Kansas City Chiefs season|Kansas City Chiefs]]<sup>^</sup>}}
                                                                                                                   I,1967, Green Bay Packers 01,35-10, Kansas City Chiefs 01, Los Angeles Memorial Coliseum
|{{Sort|Los Angeles Memorial Coliseum 01|[[Los Angeles Memorial Coliseum]]}}
[(Sort|Pasadena, California 01|[[Los Angeles]], [[California]]{(#tag:ref|Both [[Los Angeles, California|Los Angeles]] and [[Pasadena, Ca III,1969,New York Jets 01,16-7,Indianapolis Colts 01,0range Bowl 02 IV,1970,Kansas Ci
style="text-align: center;"| {{Sort|061946|61,946}}
                                                                                                                  V,1971, Indianapolis Colts 02,16-13, Dallas Cowboys 01, Orange Bowl 03 VI,1972, Dallas Co
style="text-align: center;"|cref>{{Cite journal |last=Maule |first=Tex |url=http://sportsillustrated.cnn.com/vault/article/magazine/MAG10
                                                                                                                   VII,1973, Miami Dolphins 02,14-7, Washington Redskins 01, Los Angeles Memorial Coliseum (
style="text-align: center;"| {{Sort|02|[[Super Bowl II|II]]}}
                                                                                                                   IX,1975,Pittsburgh Steelers 01,16-6,Minnesota Vikings 03,Tulane Stadium 03 X,1976,Pit
|{{Dts|1968|January|14}}
| style="background:#d0e7ff;"|{{Sort|Green Bay Packers 02|[[1967 Green Bay Packers season|Green Bay Packers]]<sup>‡</sup> (2)} XI,1977,Oakland Raiders 02,32-14,Minnesota Vikings 04,Rose Bowl 01 XII,1978,Dallas Co
style="text-align: center;" [{{Sort|3314|33-14}}
style="background:#fcc:"|{{Sort|Oakland Raiders 01|[[1967 Oakland Raiders season|Oakland Raiders]]<sup>^</sup>}}
                                                                                                                  XIII,1979,Pittsburgh Steelers 03,35-31,Dallas Cowboys 05,Orange Bowl 05 XIV,1980,Pitt
I{{Sort|Orange Bowl 01|[[Miami Orange Bowl|Orange Bowl]]}}
                                                                                                                      1981,Oakland Raiders 03,27-10,Philadelphia Eagles 01,Louisiana Superdome 02 XVI,19
|{{Sort|Miami, Florida 01|[[Miami]], [[Florida]]{{#tag:ref|[[Miami Gardens, Florida|Miami Gardens]] was incorporated as a [[sub
style="text-align: center;" | { | Sort | 075546 | 75,546 | } |
                                                                                                                   VII,1983,Washington Redskins 02,27-17,Miami Dolphins 04,Rose Bowl 03 XVIII,1984,Oakl
style="text-align: center;"|<ref>{{Cite journal |url=http://aol.sportingnews.com/nfl/story/2008-01-15/super-bowl-2-lombardis-starr-rises
                                                                                                                   XIX,1985, San Francisco 49ers 02,38-16, Miami Dolphins 05, Stanford Stadium 01 XX,1986, C
style="text-align: center;"| {{Sort|03|[[Super Bowl |||||||]]}}<!---During the AFL-NFL merger, As the Colts moved over to the AFC, which XXI,1987, New York Giants 01,39-20, Denver Broncos 02, Rose Bowl 04 XXII,1988, Washington
|{{Dts|1969|January|12}}
                                                                                                                   XXIII,1989, San Francisco 49ers 03,20-16, Cincinnati Bengals 02, Joe Robbie Stadium 01 X
style="background:#fcc:"|{{Sort|New York Jets 01|[[1968 New York Jets season|New York Jets]]<sup>^</sup>}}
style="text-
style="back
             cat superbowl.txt | awk '$1=$1' ORS=' ' | sed 's/|- |/\n|/g' | grep "^| style=\"t
|{{Sort|Orang
|{{Sort|Miam
                                                                                                                                                                                                            dium 02 XX
style="text-
             ext-align: center;\"" | grep -v "Championship"
style="text-
<includeonly
                                                                                                                                                                                                               YYYTV 20
style="text-align: center;"| {{Sort[04][[Super Bowl [V][V]]]}}
I{{Dts|1970|January|11}}
style="background:#fcc;"|{{Sort|Kansas City Chiefs 02|[[1969 Kansas City Chiefs season|Kansas City Chiefs]]<sup>^</sup> (2)}}
style="text-align: center;" {{Sort | 2307 | 23-7 }}
style="background:#d0e7ff;"|{{Sort|Minnesota Vikings 01|[[1969 Minnesota Vikings season|Minnesota Vikings]]<sup>‡</sup>}}
```

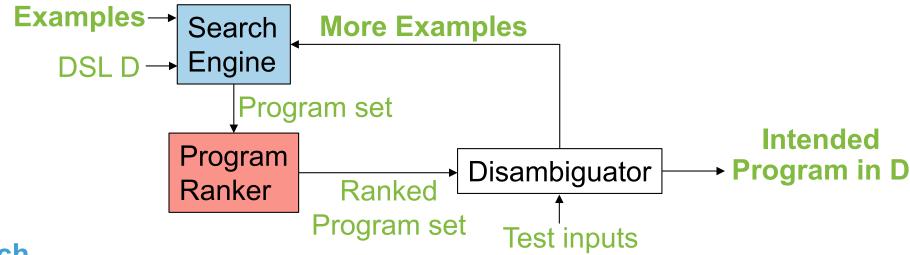


|{{Sort|Tulane Stadium 01|[[Tulane Stadium]]}}

|{{Sort|New Orleans, Louisiana|[[New Orleans]], [[Louisiana]]}} | style="text-align: center;"| {{Sort|080562|80,562}}

style="text-align: center;"|fettp://www.cbsnews.com/htdocs/sports/football/history/superbowl_04.html | title=Super Bowl History: Super E

PBE Architecture



Search

- Logical Deduction: [OOPSLA '15] FlashMeta: A framework for inductive program synthesis
- Machine Learning: [ICLR '18] Neural-guided deductive search for real-time program synthesis from examples

Ranking

- Program Features: [CAV '15] Predicting a correct program in programming by example
- Output Features: [IJCAI '17] Learning to learn programs from examples: going beyond program structure

New Frontiers

Predictive Synthesis

Synthesis of intended programs from just the input.

Tabular data extraction, Sort, Join

Synthesis of readable/modifiable code

Synthesis in target language of choice.

- Scala, R, PySpark
 Code first experience in existing
- Code-first experience in existing workflows.
- IDE, Notebook



Code Transformations by Examples

- Code refactoring consumes 40% time in migration.
 - Old version to new version
 - On-prem to cloud
 - One framework to another
- Custom formatting
- Performance enhancements
- Repetitive bug fixes
 - Feedback generation for programming education

Conclusion

Programming by examples is a new frontier in Al.

- 10-100x productivity increase in some domains.
 - Data Wrangling: Data scientists spend 80% time.
 - Code Refactoring: Developers spend 40% time in migration.
- 99% of end users are non-programmers.

Next-generational AI techniques under the hood

Logical Reasoning + Machine Learning

The Future: Multi-modal programming with Examples and NL

Questions/Feedback: Contact me at sumitg@microsoft.com