Mining Student Time Management Patterns in Programming Projects

Dale E. Parson and Allison Seidel

Kutztown University of PA

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Outline

- The problem – What are the distinguishing attributes of poorly performing programming students?
- Related work.
- Data collection using student **make** actions.
- Analysis finds correlations to procrastination, length of work sessions and time of day.
- Some students can procrastinate successfully.
- Future work includes an automated warning system that may take the form of a game.

The Problem

- Computer science professors cite procrastination as a primary cause of poor student performance in programming assignments.
  - However, some procrastinators can do very well.
- There are many conflicting demands on student time. What other factors contribute?
  - Other course projects & exams, jobs, teams/clubs.

Approach for spring 2013 Java Programming

- Programming projects use **make** to compile, to test, and later to turn in student work.
- A student can type "make" many times while repairing compilation and testing errors.
- Make actions capture details of a student's project directory & the source file contents.
- Participation is voluntary, no grade effect except for 2 bonus points. Data analysis occurs only after end of semester and grading.

Related work

- Edwards (2009) analyzed projects across 5 years, found correlation between procrastination & poor results, but did not consider consistently performing students.
  - Edwards (2007) analyzed types of problems.
  - Ours captures more work detail for all students.
- Other cited studies find weak correlations to procrastination or number of lines of code changed per session, with very little detail.

Data archives, listings, source files

idN_2014-02-12-12-38-48-EST_BUILD.zip
idN_2014-02-12-12-41-50-EST_BUILD.zip
idN_2014-02-12-12-41-53-EST_BUILT.zip
idN_2014-02-12-12-41-53-EST_TESTING.zip
idN_2014-02-12-12-41-55-EST_TESTED.zip

TESTED 2013-03-24-21-45-38-EDT
~idN/JavaLang/FillWord2
idN 5836 Mar 3 15:43 FillWordTest.java
idN 1183 Mar 13 17:33 IFillWord.java
idN 3474 Mar 14 12:59 FillWordGrows.java
idN 8849 Mar 24 21:33 FillWordBasic.java
idN 5027 Mar 24 21:37 FillWordHelper.java

91 Data Attributes Collected

- Temporal data include date and time of day of work, session length, time between sessions, distance of first and final work session from handout and deadline, dates minus missed days.
- Size data include file numbers and sizes, bytes & lines added/changed/deleted per file.
- Student ID, year & track, conflicting project & exam survey, categories of emails to professor, project grade and centile rank.
- Incoming CS GPA and number of credits.

Finding attributes: Basic OneR projections

Jstr	hours from student start until due deadline
Mavg	average minutes of a work session
Mdev	sample standard deviation of Mavg
Snum	number of work sessions
Mtot	total minutes spent on the project
Cgpa	computer science GPA at semester start
GprjRank	centile ranking of project grade

If Jstr < 24.0 then 0 <= GprjRank <= 13.2
Elseif Jstr < 79.0 then GprjRank > 90.4
Elseif Jstr < 181.0 then 80.7 < GprjRank <= 90.4
Elseif Jstr >= 181.0 then GprjRank > 90.4
(36/111, 32.4%, instances correct)

Gprj project grade

If Cgpa < 2.24 then 0 <= Gprj <= 0.625
Elseif Cgpa < 2.635 then 0.625 < Gprj <= 0.815
Elseif Cgpa < 2.945 then 0.815 < Gprj <= 0.925
Elseif Cgpa >= 2.945 then 1.015 < Gprj <= 1.04
(28/111, 25.2% instances correct)

Simple K-means clusters for 6 most predictive attributes for grade

attribute	full data 1 1 1 records	cluster 0 24 = 22%	cluster 1 9 = 8%	cluster 2 27 = 24%	cluster 3 7 = 6%	cluster 4 16 = 14%	cluster 5 28 = 25%
Jstr	167.95	**57.88**	155.22	249.78	238	**36.19**	245.25
Mavg	58.15	**68.51**	138.89	42.50	63.02	**36.69**	49.44
Mdev	48.41	36.80	116.75	44.72	78.82	21.94	47.46
Yavg	5153.66	4435.50	20419.47	2605.75	5061.46	5635.86	3066.78
Snum	5.43	2.92	4.44	5.74	14.14	2.63	7.04
Mtot	302.05	**174.13**	589.78	242.30	884.86	**100.69**	346.18
Cgpa	3.06	**3.34**	3.34	3.62	3.14	**2.26**	2.61
Gprj	90.01%	**93.83%**	99.56%	100.89%	102.29%	**57.19%**	88.86%

Pruned M5P Model Tree

- Cgpa <= 3.205 :
- | Jstr <= 66 :
- | | Mavg <= 36.167 : **LM1** (5/29.636%)
- | | Mavg > 36.167 : **LM2** (18/106.448%)
- | Jstr > 66 : **LM3** (40/57.247%)
- Cgpa > 3.205 : **LM4** (48/31.383%)

LM num 1: Gprj =

- 0.0012 * Jstr + 0.0009 * Mavg
- + 0.0214 * Snum - 0.0002 * Mtot
- + 0.2908 * Cgpa - 0.2251

LM num 2: Gprj =
0.0001 * Jstr + 0.0009 * Mavg
+ 0.0214 * Snum - 0.0002 * Mtot
+ 0.2278 * Cgpa + 0.0515

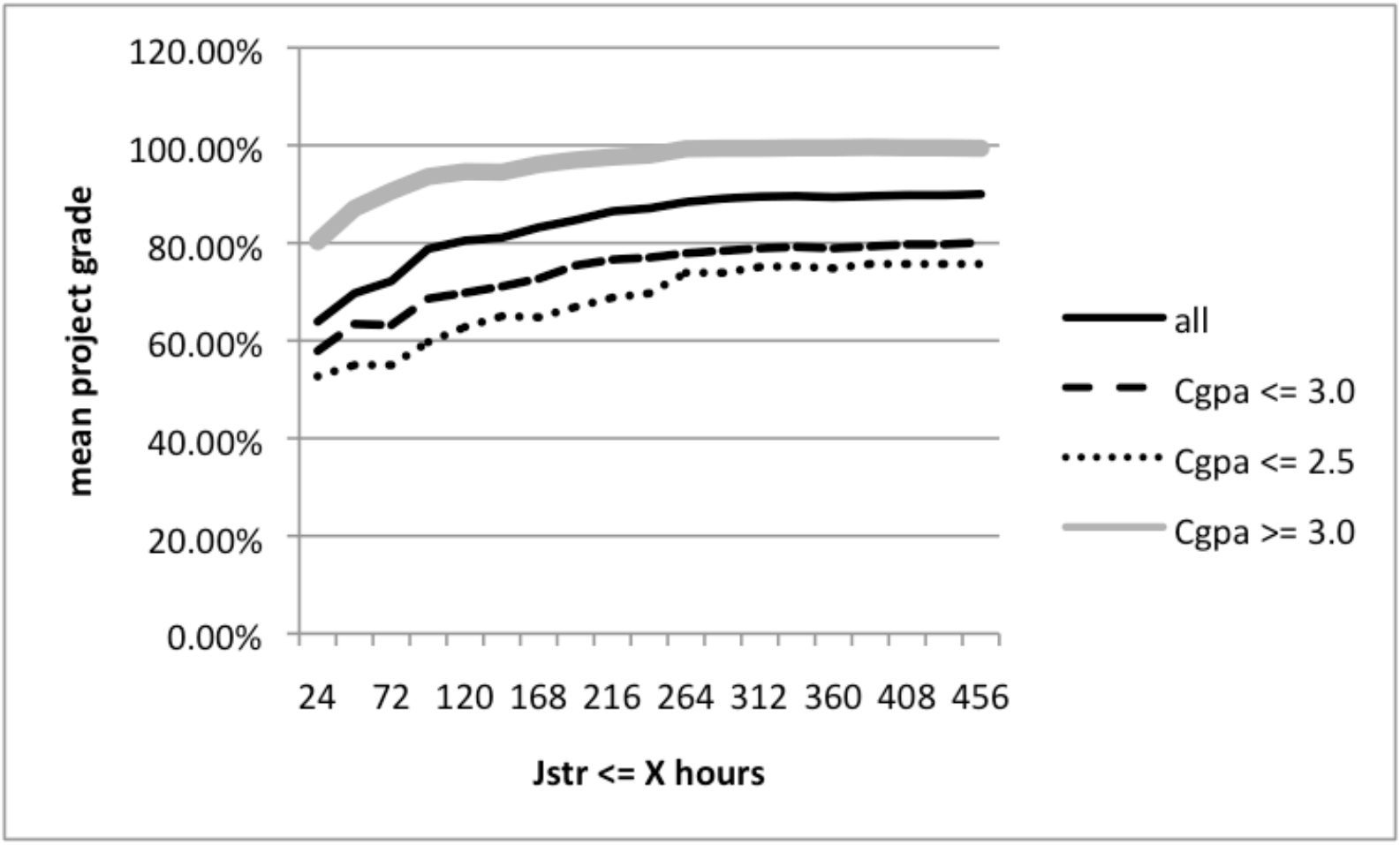
LM num 3: Gprj =

- 0.0001 * Jstr + 0.0007 * Mavg
- + 0.028 * Snum - 0.0001 * Mtot
- + 0.226 * Cgpa + 0.0893

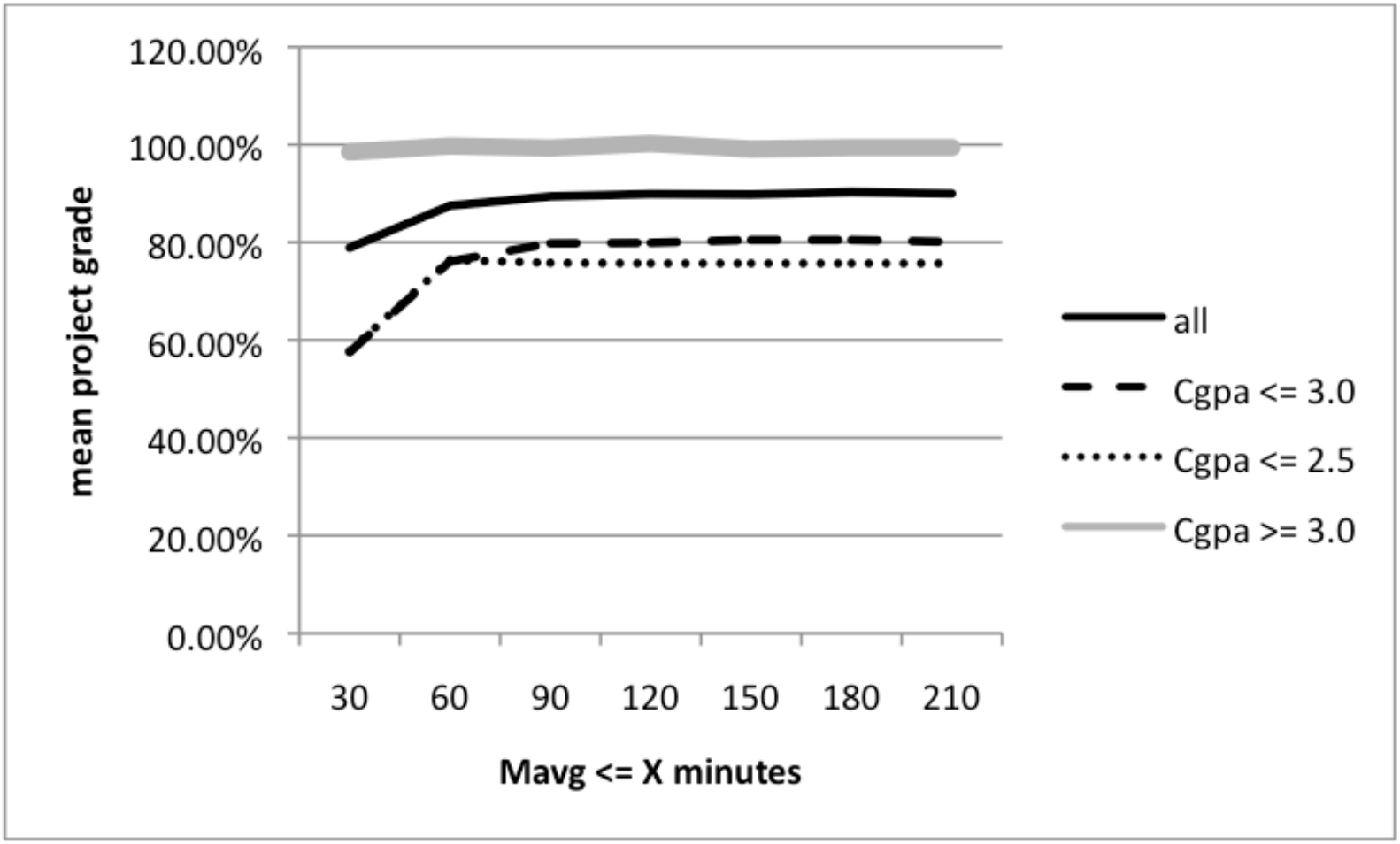
LM num 4: Gprj =

- 0.0008 * Mavg + 0.0143 * Snum
- - 0.0001 * Mtot + 0.1052 * Cgpa + 0.5199

Mean project grade as a function of cumulative start-before-deadline



Mean project grade as a function of cumulative work session time



Other patterns from spring 2013 Java Programming dataset

- Time of day of work sessions loosely correlated with project grade.
- Students with low grades tended to work exclusively after 8 PM.
- Students with higher grades tended to work periodically throughout the time of day.
- Office hour interaction with the professor & class attendance not measured, likely contributors.

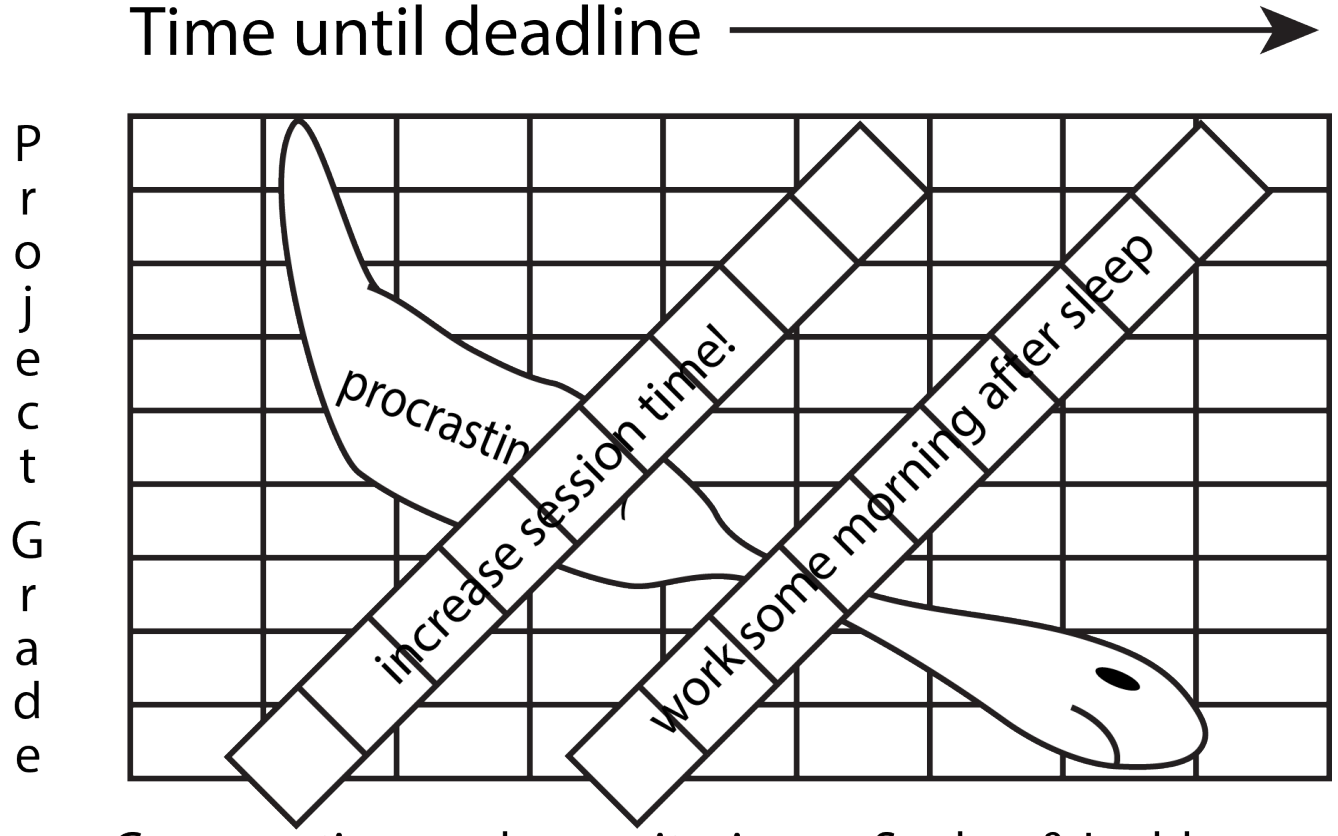
Semesters after spring 2013

- Fall 2013 Operating Systems data discarded because projects consisted primarily of analysis that did not use make or other tools.
  - Most student time not in collected data set.
- Spring 2014 two additional sections of Java Programming, and one of Programming Lang.
  - Linear Regression has become slightly more predictive than more complex M5P model tree.
  - Subtracting unused days from start date improves accuracy.
  - Contributing attributes remain consistent.

Active versus Passive Procrastination (new for us)

- Rethinking Procrastination: Positive Effects of "Active" Procrastination Behavior on Attitudes and Performance, Chu, *The Journal of Social Psychology*, 2005, 145(3), 245–264.
- The Relationship of Flow and Self-regulated Learning to active Procrastination, Kim & Seo, *Social Behavior and Personality*, 2013, 41(7), 1099-1114.
- Good time management among active procrastinators.
  - Manage time by prioritizing work, not ASAP!
  - Increase flow (engagement) by increasing scheduling pressure!
  - We may be able to sort active vs. passive from our data.

Future work – Automated Nag or Interactive Game? (Try both.)



Comparative grade monitoring as Snakes & Ladders
Use M5P Model Tree or Linear Regression to set slopes

Conclusions

- Procrastination is a factor in success, but:
- Some procrastinators can succeed.
  - High incoming GPA correlates, but it is no guarantee. Some high GPAs do not procrastinate well.
  - Are the successes self-identifying active procrastinators?
- Some non-procrastinators do poorly.
  - Length of work sessions and time of day are two strong contributing factors.
  - More analysis is upcoming.
- Results point direction towards automated assistant for at-risk students.