Automated Trend Analysis for Navy-Carrier Landing Attempts

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Comparing carrier landing performance

- *Part of the IPARTS mission was automated comparison of previous pilot performance.*
- *We tested this on legacy data (85,571 passes, about 20% of Navy in last two years). No one has examined so much data in such detail before.*
- *We compared pilots, pilot groups, aircraft, and evaluators.*
- *We compared in grades, landing details, and verbal comments.*
- *This enabled predictive models of pilot performance which should help in designing training programs.*

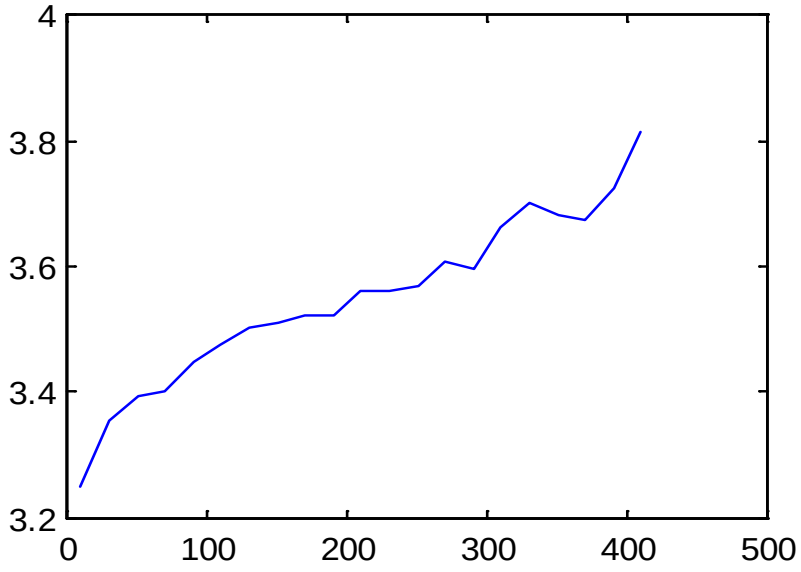
The LSO task

LSOs grade and write comments on every carrier landing attempt.

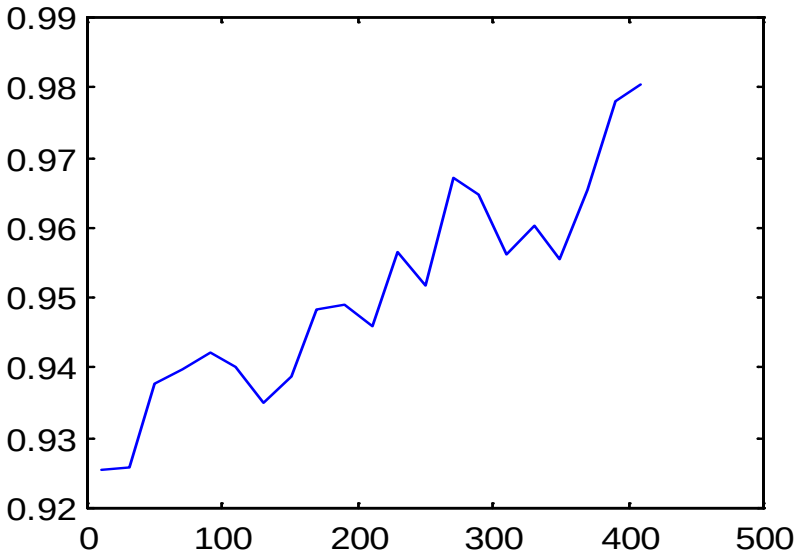
Data: Grade (0-5 or no count), wire engaged, comments in telegraphic format.

Improvement with experience

Pilot grade as function of number of recorded passes by pilot



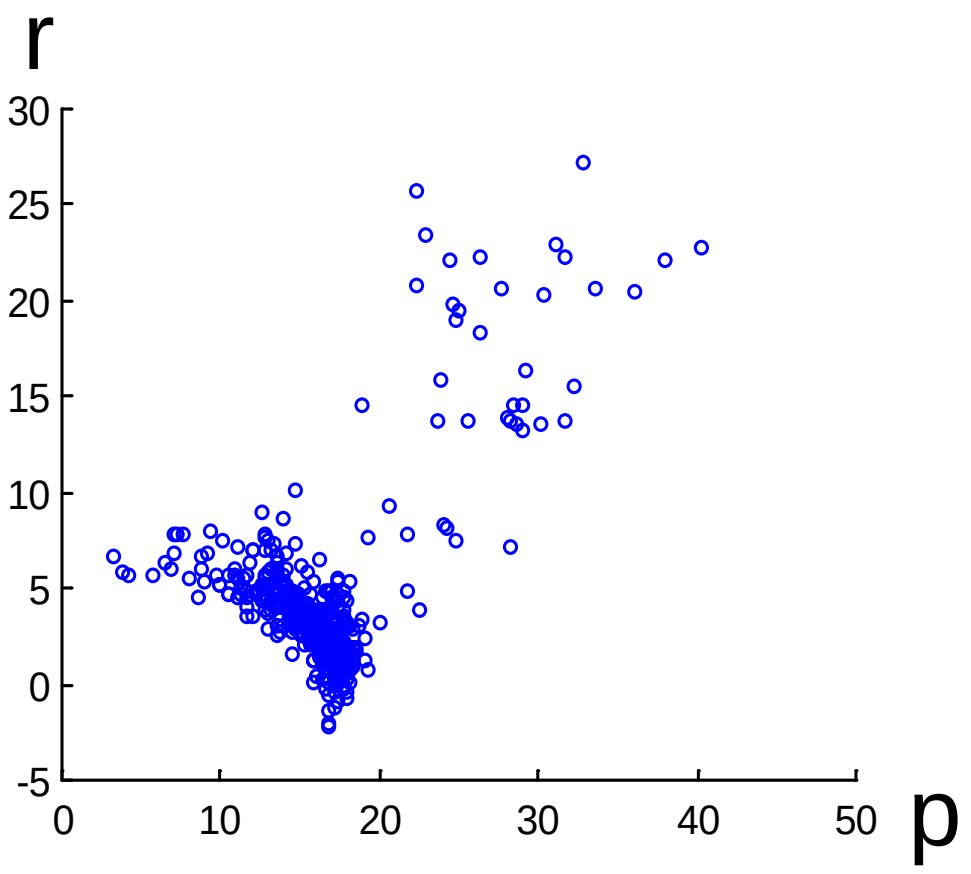
Boarding rate as function of number of recorded passes by pilot



Fitting improvement to a curve for each pilot

Both grade and boarding-rate improvements were fit with a formula of the form:

$$K(x_i + p)/(x_i + p + r)$$

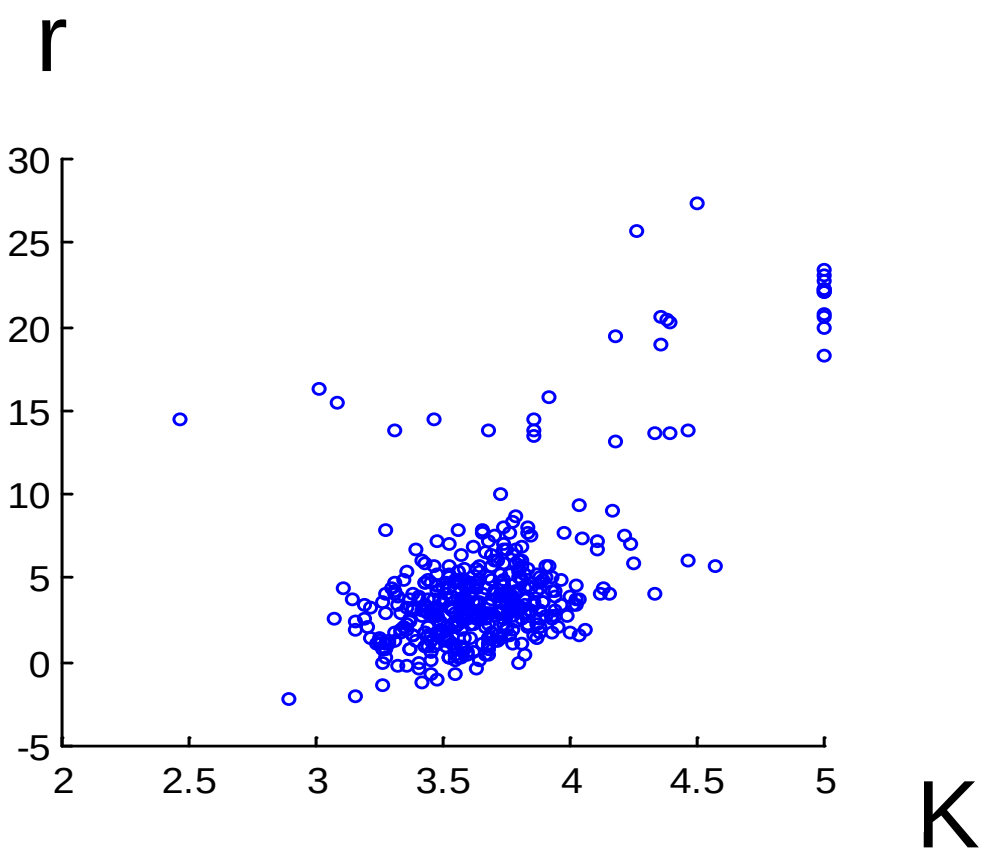


The plot shows p versus r for all pilots – some are anomalous learners and need to be investigated.

Parameter r (vertical) versus K (horizontal)

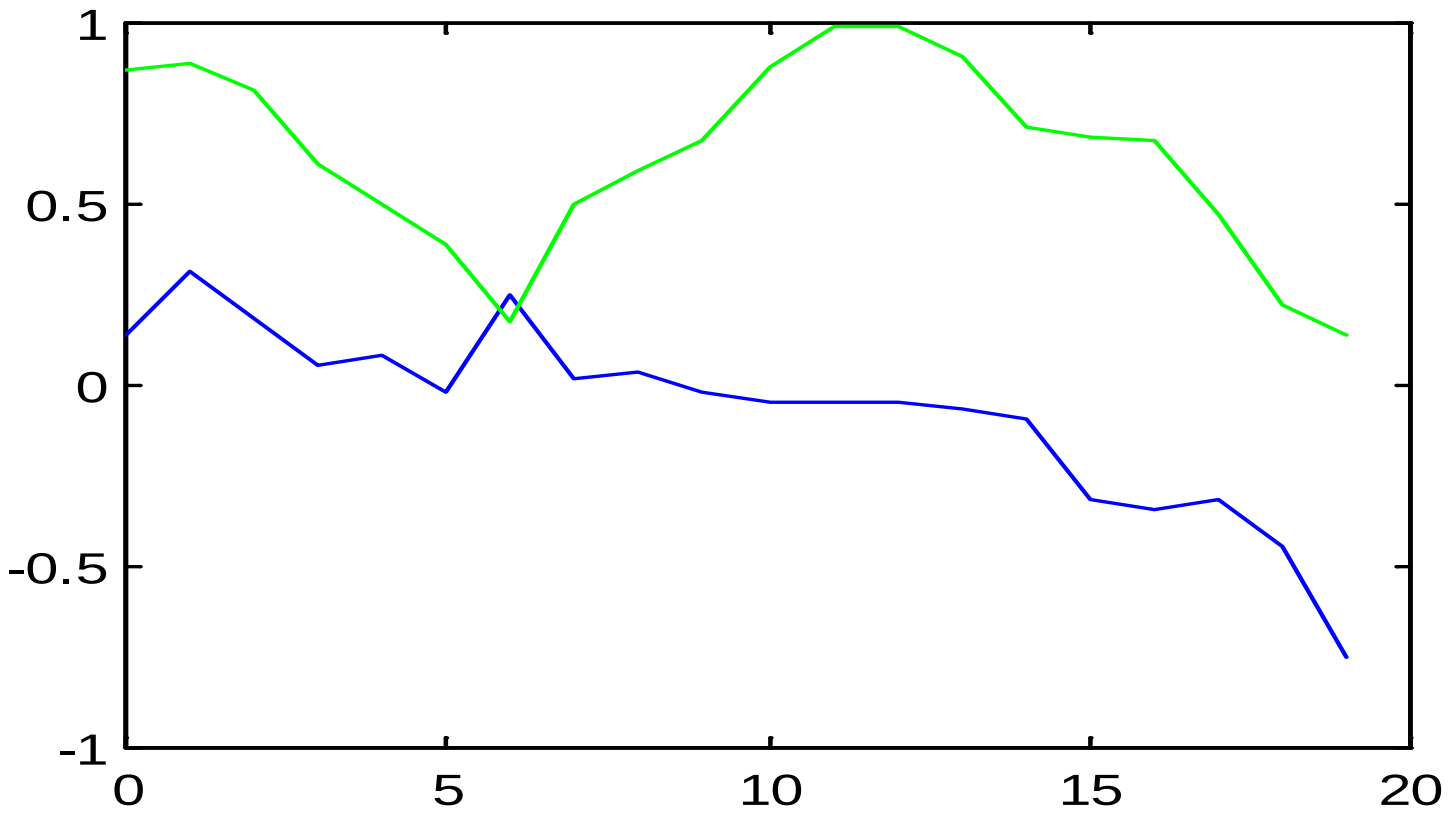
Again, formula was:

$$K(x_i + p)/(x_i + p + r)$$



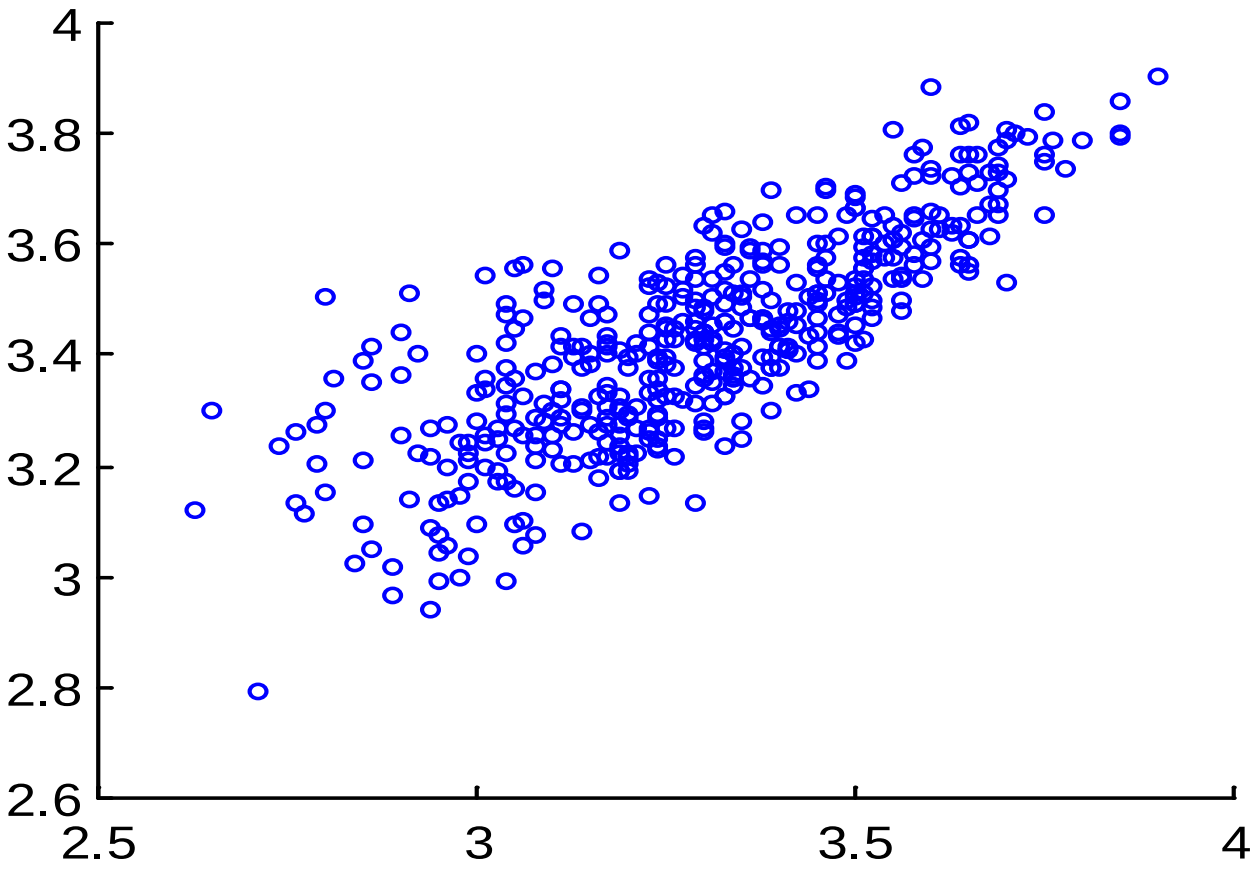
K represents the apparent ultimate performance level of the pilot. (K > 5 was automatically rounded down.)

Change in pilot grade versus gap between passes



Blue is grade difference, green is number of passes, horizontal axis is logarithm of the time gap in seconds.

Predicting performance from early passes



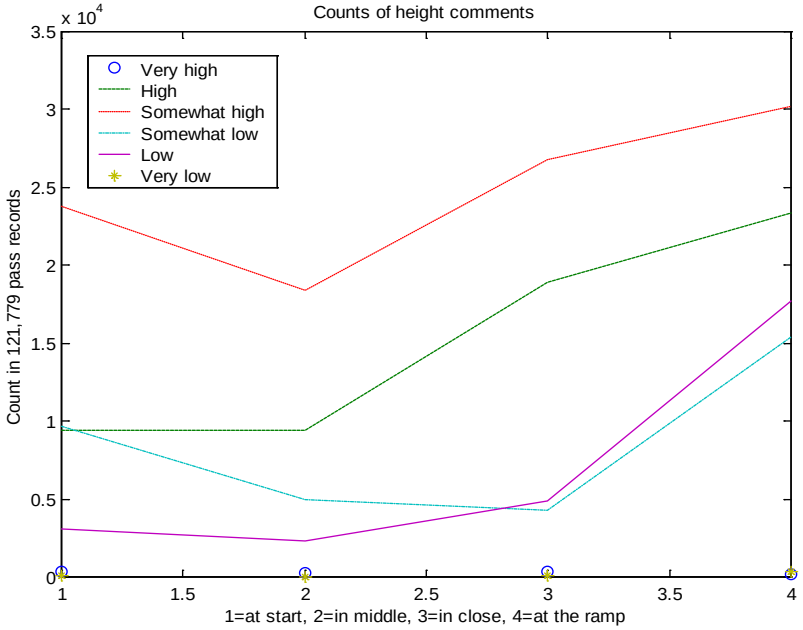
This plots pilot average grade on first 50 passes (horizontal) versus final average grade (vertical). There is much variation, so it is unfair to exclude pilots based on the grades alone of the first 50 passes.

LSO written comments

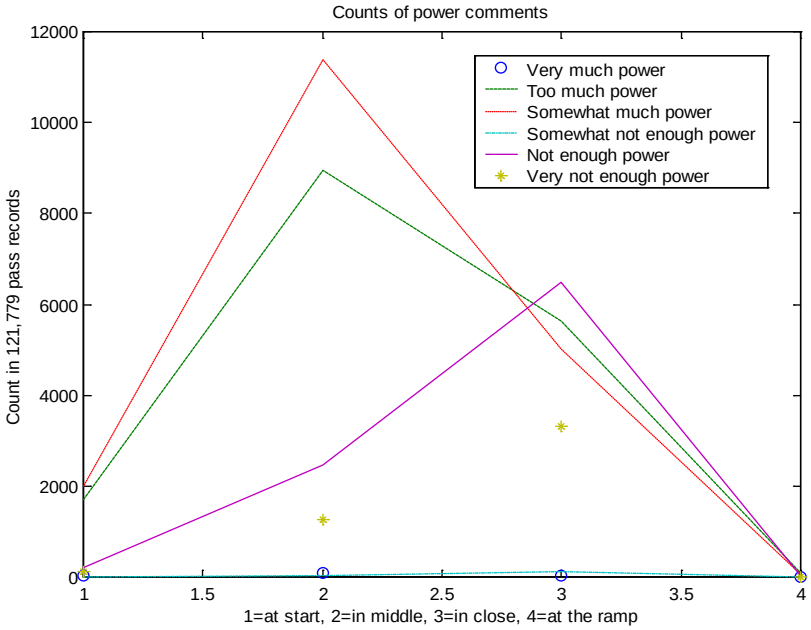
- *The most novel part of the research was understanding the LSO comments.*
- *Comments were essential in understanding the context of grades.*
- *Comments are in a telegraphic format using a unique language.*
- *Example: "(LO)SLOIC-AR“ means the aircraft was a little low and definitely slow when it was in close as well as when it was at the ramp.*
- *A 2300-rule standardization routine and a parser were built to interpret them.*

Comment trends with location

Height comments as function of location



Power comments as function of location



Trends in approach path for a pilot

Glideslope comments for 153 passes of pilot *******

	X	IM	IC	AR
_H_	1	1	0	0
H	13	10	22	40
(H)	39	20	40	45
OK	89	114	82	32
(LO)	8	6	4	14
LO	3	2	5	22
_LO_	0	0	0	0

X = at the start, IM = in the middle, IC = in close, AR = at the ramp; H = high compared to ideal path, _H_ = very high, (H) = a little low, LO = low

Counts of miscellaneous comments

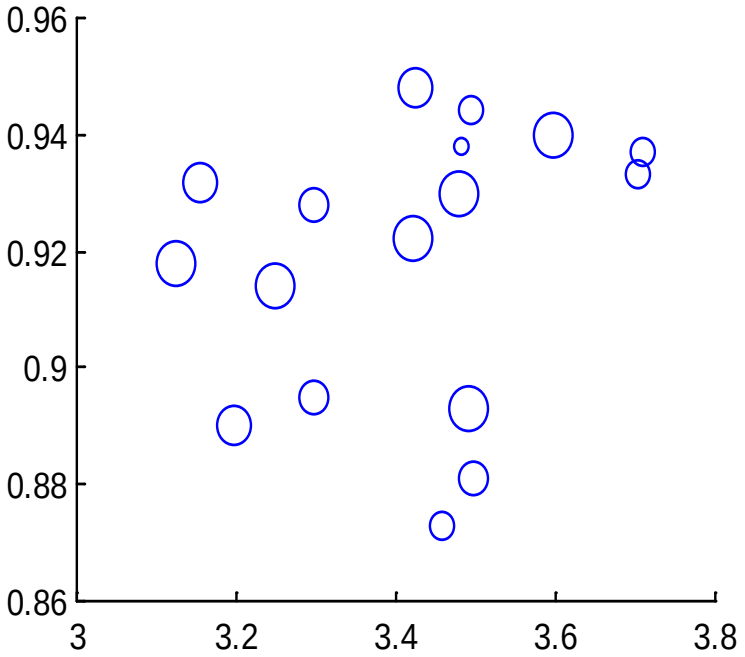
Problem	Count	Problem	Count
Wind	*531*	*Ship in turn*	*406*
Aircraft in landing area	*337*	*No heads up display*	*209*
No hook	*188*	*Gear up*	*159*
No angle of attack indicator	*134*	*Deck not ready*	*82*
Engine malfunction	*71*	*No radio*	*53*
People in landing area	*52*	*Debris in landing area*	*46*

These signal non-pilot problems that need attention.

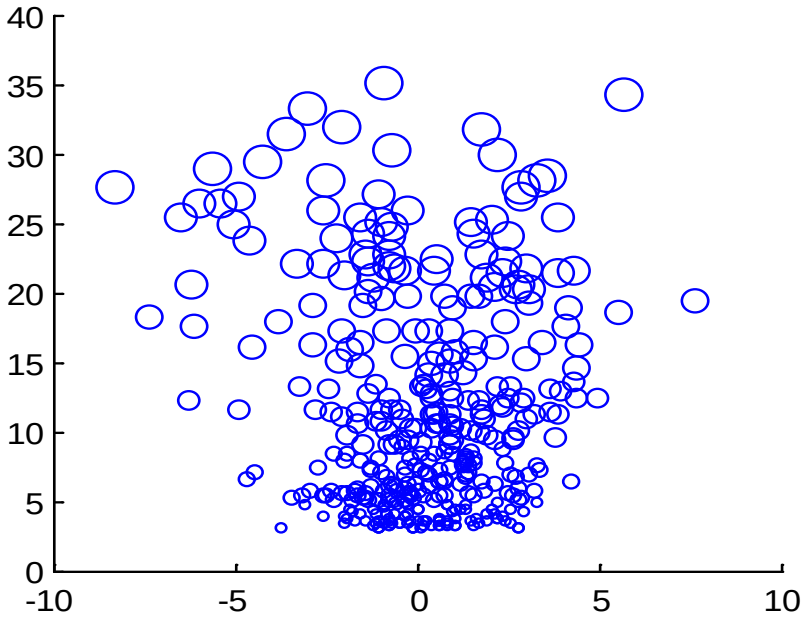
Effects of comments on final grade average

Comment	Count	Effect on average grade	Effect on number of passes
High	*25480*	*-0.10*	*+43*
Too much power	*10688*	*-0.10*	*+44*
Very high	*490*	*-0.22*	*+60*
Stopped rate of descent	*703*	*-0.18*	*+51*
High before 180 degree turn	*9*	*-1.21*	*-64*
Nose down	*2836*	*-0.07*	*+41*
Late	*4*	*-1.72*	*-98*
Chased centerline	*28*	*-0.53*	*-7*
Overcorrection on too much power	*23*	*-0.62*	*+14*
Much power in the wires	*10*	*-0.45*	*-3*
Not enough rudder	*66*	*-0.15*	*+31*
Tanker drill	*6*	*+0.06*	*+77*
Too much showing off	*4*	*-0.67*	*-27*
Showing off	*163*	*+0.09*	*+0*
Nose up a little	*4217*	*+0.10*	*+11*

Differences among units and LSOs

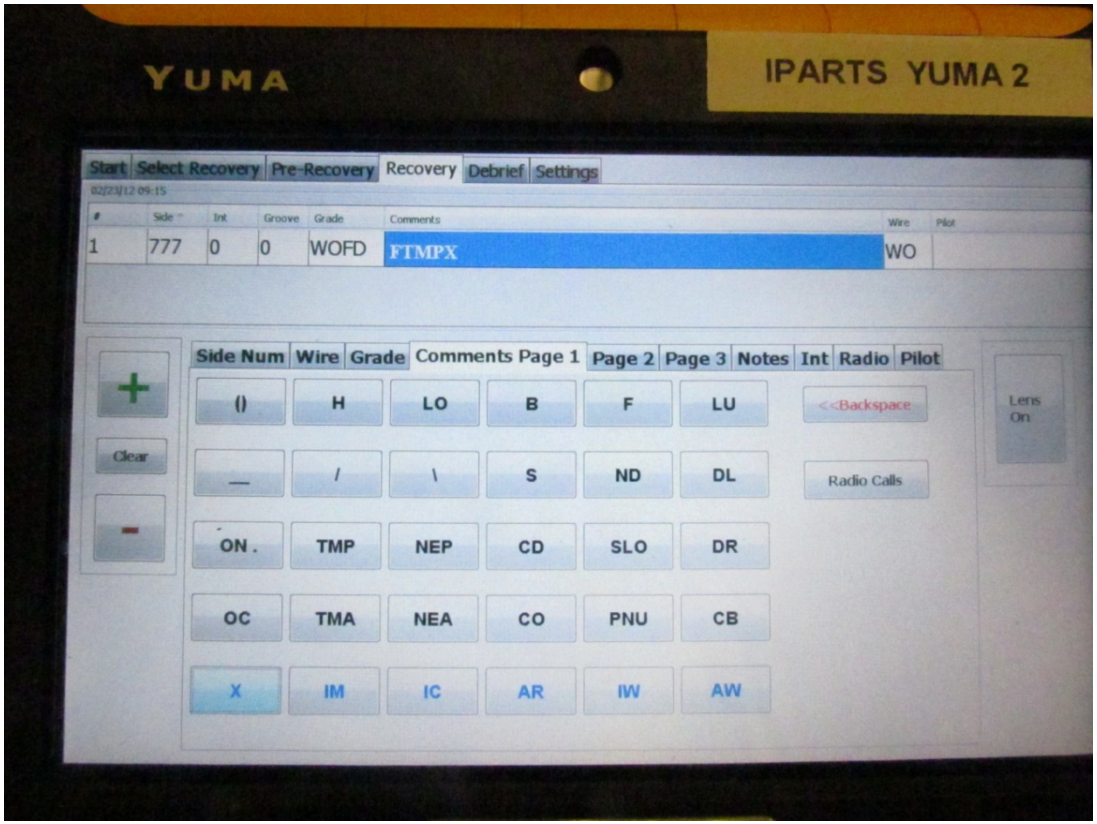


This plots average grade versus boarding rate for each squadron and air wing. Circle size represents number of passes.



This plots number of standard deviations from average grade for each LSO versus square root of number of passes. Some are clearly unfair graders.

Optimizing the button layout on IPARTS device



Using the binary sequence probabilities on LSO comments in the legacy data, we can optimize the choice menus for faster LSO use. Our best placement reduced number of button presses by 0.5 per atomic comment.

The optimal button placement

Menu 1: [h, lo, b, f, lu, /, \\, s, tmp, nep, cd, tma, co, (, _, x, im, ic, ar, iw, aw, s, cd, tmp, b, nep, co, lu, f]

Menu 2: [cb, ch, dd, dec, dl, dr, du, ll, lr, lso, ltr, lul, lur, nd, nea, oc, nea, cb, dr, nd, dl, ewit, p, tma, os, att, wu, ll, pnu, pnu, slo, slo, rtl, srd, call, lu+call, nerr, pwr+call, tl, clu]

Menu 3: [nh, nsu, or, ot, rot, rud, ruf, drw, rr, sd, sht, skd, st, tlu, tmrd, tmrr, ttl, ttsl, twa, two, w, wl, xctl, nelr, n, ho, acc, afu, cf, cu, dn, eg, stby+nh, llu, nh, [, dlw, nelr, nerd, lenson, eng+problem]

Menu 4: [clara, luckybuck, wind, a/c+in+la, sit, hoot, wo, “4”, "3", "2", "1", upgrade, no+hud, on, gear+up, interval, deep, deck+not+ready, ^3^4, stripped, lrwd, talking+on+ball, a/c, ^2^3, interval+upgrade, ^1, ^2, ^3, ^4, stby, no+aoa, ^3^4, shb, stot, people+in+la, heavy, last+pass, debris+in+la, pwr, movlas, straight+in, m1, ^2^3^4, xp, ^2^3, 3pts, lensoff, ok, lig, nc, fd, egtl, 90, 45, aa, nesa, c, e, pd, tca]

Conclusions

- *We have an excellent new tool for collecting and analyzing performance in graded military tasks..*
- *We can more fairly assess performance of pilots and judge their ultimate potential.*
- *We can also grade aircraft, squadrons, and graders to see if there are problems.*
- *We can use this data to design a better user interface.*