Deliberate Attack

```
library(conflicted)

library(kableExtra)
```

```
## Warning in !is.null(rmarkdown::metadata$output) && rmarkdown::metadata$output
## %in% : 'length(x) = 2 > 1' in coercion to 'logical(1)'
```

```
library(knitr)
library(broom.helpers)
library(broom)
library(dtplyr)
library(furrr)
```

```
## Loading required package: future
```

```
library(arrow)
library(glue)
library(fs)
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
```

```
## v ggplot2 3.4.0      v purrr   1.0.1
## v tibble  3.1.8      v dplyr   1.0.10
## v tidyr   1.2.1      v stringr 1.5.0
## v readr   2.1.3      v forcats 0.5.2
```

```
conflict_prefer("filter", "dplyr")
```

```
## [conflicted] Will prefer dplyr::filter over any other package
```

```
source("./analysis/utils.R", local = knit_global())
set_theme()
```

```
write_bib(.packages(), glue("./analysis/packages.bib"))
```

```
## Warning in utils::citation(..., lib.loc = lib.loc): no date field in DESCRIPTION
## file of package 'kableExtra'
```

```
sessionInfo()
```

```
## R version 4.2.2 (2022-10-31)
## Platform: x86_64-apple-darwin17.0 (64-bit)
## Running under: macOS Big Sur ... 10.16
##
## Matrix products: default
## BLAS:   /Library/Frameworks/R.framework/Versions/4.2/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/4.2/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
```

```
##
## attached base packages:
## [1] stats     graphics  grDevices datasets  utils     methods   base
##
## other attached packages:
##  [1] forcats_0.5.2         stringr_1.5.0        dplyr_1.0.10
##  [4] purrr_1.0.1           readr_2.1.3          tidyr_1.2.1
##  [7] tibble_3.1.8          ggplot2_3.4.0        tidyverse_1.3.2
## [10] fs_1.5.2              glue_1.6.2           arrow_10.0.1
## [13] furrr_0.3.1           future_1.30.0        dtplyr_1.2.2
## [16] broom_1.0.2           broom.helpers_1.11.0 knitr_1.41
## [19] kableExtra_1.3.4.9000 conflicted_1.1.0
##
## loaded via a namespace (and not attached):
##  [1] httr_1.4.4        bit64_4.0.5      jsonlite_1.8.4
##  [4] viridisLite_0.4.1 here_1.0.1       modelr_0.1.10
##  [7] assertthat_0.2.1  renv_0.16.0      googlesheets4_1.0.1
## [10] cellranger_1.1.0  yaml_2.3.6       globals_0.16.2
## [13] pillar_1.8.1      backports_1.4.1  digest_0.6.31
## [16] rvest_1.0.3       colorspace_2.0-3 htmltools_0.5.4
## [19] pkgconfig_2.0.3   listenv_0.9.0    haven_2.5.1
## [22] scales_1.2.1      webshot_0.5.4    svglite_2.1.1
## [25] tzdb_0.3.0        timechange_0.2.0 googledrive_2.0.0
## [28] generics_0.1.3    ellipsis_0.3.2   withr_2.5.0
## [31] cachem_1.0.6      cli_3.6.0        crayon_1.5.2
## [34] readxl_1.4.1      magrittr_2.0.3   memoise_2.0.1
## [37] evaluate_0.19     fansi_1.0.3      parallelly_1.34.0
## [40] xml2_1.3.3        tools_4.2.2      data.table_1.14.6
## [43] hms_1.1.2         gargle_1.2.1     lifecycle_1.0.3
## [46] reprex_2.0.2      munsell_0.5.0    compiler_4.2.2
## [49] systemfonts_1.0.4 rlang_1.0.6      grid_4.2.2
## [52] rstudioapi_0.14   rmarkdown_2.19   gtable_0.3.1
## [55] codetools_0.2-18  DBI_1.1.3        R6_2.5.1
## [58] lubridate_1.9.0   fastmap_1.1.0    bit_4.0.5
## [61] utf8_1.2.2        rprojroot_2.0.3  stringi_1.7.12
## [64] parallel_4.2.2    vctrs_0.5.1      dbplyr_2.2.1
## [67] tidyselect_1.2.0  xfun_0.36
```

```r
data_dir <- path(glue("./data/{params$simulation}/results"))

success_fnames <-
  dir_ls(data_dir, glob = glue("*{params$simulation}*_trend.csv"))

# every fname is a simulation
success_raw_data <- get_data(success_fnames, read_csv) |>
  glimpse()
```

```
## Rows: 480
## Columns: 14
## $ fname                   <chr> "./data/arbitrary/results/bbox_100_dist_100_re~
## $ num_iteration           <dbl> 200, 200, 200, 200, 200, 200, 200, 200, 200, 2~
## $ attack_count            <dbl> 100, 100, 100, 100, 100, 100, 100, 100, 100, 1~
## $ success_count           <dbl> 0, 0, 0, 16, 36, 1, 2, 4, 12, 7, 0, 0, 1, 27, ~
## $ vanish_count            <dbl> 0, 0, 0, 7, 27, 1, 2, 4, 11, 6, 0, 0, 1, 26, 2~
## $ mislabel_count          <dbl> 0, 0, 0, 9, 9, 0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0~
## $ mislabel_intended_count <dbl> 0, 0, 0, 9, 9, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ sample_count            <dbl> 116, 116, 118, 118, 119, 116, 116, 118, 118, 1~
## $ model_name              <ord> Cascade R-CNN, Faster R-CNN, RetinaNet, SSD, Y~
## $ loss_target             <ord> Mislabeling, Mislabeling, Mislabeling, Mislabe~
## $ attack_bbox             <chr> "ground_truth", "ground_truth", "ground_truth"~
## $ perturb_fun             <chr> "perturb_inside", "perturb_inside", "perturb_i~
## $ arbitrary_bbox_length   <dbl> 100, 100, 100, 100, 100, 100, 100, 100, 100, 1~
## $ boundary_distance       <dbl> 100, 100, 100, 100, 100, 100, 100, 100, 100, 1~
```

```
# expand success per simulation into 1 and 0s per row
success_expanded_data <- success_raw_data |>
  rename(
    bbox_dist = boundary_distance,
    bbox_len = arbitrary_bbox_length
  ) |>
  rowwise() |>
  mutate(success = list(rep(0:1, times = c(attack_count - success_count, success_count)))) |>
  unnest_longer(success) |>
  glimpse()
```

```
## Rows: 48,000
## Columns: 15
## $ fname                   <chr> "./data/arbitrary/results/bbox_100_dist_100_re~
## $ num_iteration           <dbl> 200, 200, 200, 200, 200, 200, 200, 200, 200, 2~
## $ attack_count            <dbl> 100, 100, 100, 100, 100, 100, 100, 100, 100, 1~
## $ success_count           <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ vanish_count            <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ mislabel_count          <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ mislabel_intended_count <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ sample_count            <dbl> 116, 116, 116, 116, 116, 116, 116, 116, 116, 1~
## $ model_name              <ord> Cascade R-CNN, Cascade R-CNN, Cascade R-CNN, C~
## $ loss_target             <ord> Mislabeling, Mislabeling, Mislabeling, Mislabe~
## $ attack_bbox             <chr> "ground_truth", "ground_truth", "ground_truth"~
## $ perturb_fun             <chr> "perturb_inside", "perturb_inside", "perturb_i~
## $ bbox_len                <dbl> 100, 100, 100, 100, 100, 100, 100, 100, 100, 1~
## $ bbox_dist               <dbl> 100, 100, 100, 100, 100, 100, 100, 100, 100, 1~
## $ success                 <int> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
```

```
# check whether attack count equals experiment settings
stopifnot(all(success_raw_data$attack_count == 100))

reps <- success_raw_data |>
  count(model_name, loss_target, arbitrary_bbox_length, boundary_distance) |>
  glimpse()
```

```
## Rows: 240
## Columns: 5
## $ model_name            <ord> YOLOv3, YOLOv3, YOLOv3, YOLOv3, YOLOv3, YOLOv3, ~
## $ loss_target           <ord> Vanishing, Vanishing, Vanishing, Vanishing, Vani~
## $ arbitrary_bbox_length <dbl> 10, 10, 10, 10, 50, 50, 50, 50, 100, 100, 100, 1~
## $ boundary_distance     <dbl> 10, 50, 100, 200, 10, 50, 100, 200, 10, 50, 100,~
## $ n                     <int> 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ~
```

```
stopifnot(unique(reps$n) == 2)
```

```r
# control both
model <- partial(glm_model, predictor = "bbox_dist * bbox_len")
data <- success_expanded_data

reg_res <- get_tidied_reg(model, data, return_mod = TRUE)
```

```
## `summarise()` has grouped output by 'model_name', 'loss_target'. You can
## override using the `.groups` argument.
```

```r
reg_est <- reg_res$tidied

ext_sig(reg_est, "neg", "bbox_dist")
```

```
## ----------bbox_dist----------
## Total 15 predictors:
## 15 (100%) significant;
## 15 (100%) neg

## # A tibble: 15 x 9
## # Groups:   model_name, loss_target [15]
##    model_name    loss_ta~1 term  estim~2 std.e~3 stati~4 p.value conf.~5 conf.~6
##    <ord>         <ord>     <chr>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
##  1 YOLOv3        Vanishing bbox~  -0.015   0.002   -7.68       0  -0.018  -0.011
##  2 YOLOv3        Mislabel~ bbox~  -0.015   0.002   -8.54       0  -0.018  -0.011
##  3 YOLOv3        Untarget~ bbox~  -0.021   0.003   -7.44       0  -0.026  -0.015
##  4 SSD           Vanishing bbox~  -0.015   0.002   -7.06       0  -0.019  -0.011
##  5 SSD           Mislabel~ bbox~  -0.018   0.002   -7.55       0  -0.023  -0.014
##  6 SSD           Untarget~ bbox~  -0.018   0.002   -7.74       0  -0.023  -0.014
##  7 RetinaNet     Vanishing bbox~  -0.045   0.006   -7.19       0  -0.058  -0.033
##  8 RetinaNet     Mislabel~ bbox~  -0.031   0.007   -4.24       0  -0.047  -0.018
##  9 RetinaNet     Untarget~ bbox~  -0.038   0.005   -7.45       0  -0.049  -0.029
## 10 Faster R-CNN  Vanishing bbox~  -0.061   0.01    -6.41       0  -0.081  -0.044
## 11 Faster R-CNN  Mislabel~ bbox~  -0.054   0.012   -4.66       0  -0.08   -0.034
## 12 Faster R-CNN  Untarget~ bbox~  -0.044   0.006   -8.01       0  -0.056  -0.034
## 13 Cascade R-CNN Vanishing bbox~  -0.063   0.01    -6.58       0  -0.083  -0.046
## 14 Cascade R-CNN Mislabel~ bbox~  -0.062   0.012   -5.24       0  -0.088  -0.041
## 15 Cascade R-CNN Untarget~ bbox~  -0.061   0.008   -7.54       0  -0.079  -0.047
## # ... with abbreviated variable names 1: loss_target, 2: estimate,
## #   3: std.error, 4: statistic, 5: conf.low, 6: conf.high
```

```r
ext_sig(reg_est, "pos", "bbox_len")
```

```
## ----------bbox_len----------
## Total 15 predictors:
## 14 (93%) significant;
## 14 (93%) pos

## # A tibble: 14 x 9
## # Groups:   model_name, loss_target [14]
##    model_name    loss_ta~1 term  estim~2 std.e~3 stati~4 p.value conf.~5 conf.~6
##    <ord>         <ord>     <chr>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
##  1 YOLOv3        Vanishing bbox~   0.03    0.002   19.6        0   0.027   0.033
##  2 YOLOv3        Mislabel~ bbox~   0.019   0.001   16.6        0   0.016   0.021
##  3 YOLOv3        Untarget~ bbox~   0.007   0.001    6.53       0   0.005   0.009
##  4 SSD           Vanishing bbox~   0.024   0.001   17.7        0   0.021   0.027
##  5 SSD           Mislabel~ bbox~   0.02    0.001   16.0        0   0.017   0.022
##  6 SSD           Untarget~ bbox~   0.013   0.001   11.7        0   0.011   0.015
##  7 RetinaNet     Vanishing bbox~   0.016   0.001   10.6        0   0.013   0.019
##  8 RetinaNet     Mislabel~ bbox~   0.008   0.002    4.54       0   0.005   0.012
##  9 RetinaNet     Untarget~ bbox~   0.005   0.001    3.97       0   0.003   0.008
## 10 Faster R-CNN  Vanishing bbox~   0.011   0.001    7.13       0   0.008   0.014
## 11 Faster R-CNN  Mislabel~ bbox~   0.007   0.002    3.71       0   0.003   0.01
## 12 Faster R-CNN  Untarget~ bbox~   0.005   0.001    3.68       0   0.002   0.007
## 13 Cascade R-CNN Vanishing bbox~   0.015   0.002    9.40       0   0.012   0.018
## 14 Cascade R-CNN Mislabel~ bbox~   0.01    0.002    5.80       0   0.006   0.013
## # ... with abbreviated variable names 1: loss_target, 2: estimate,
## #   3: std.error, 4: statistic, 5: conf.low, 6: conf.high
```

```
ext_sig(reg_est, "both", "bbox_dist:bbox_len")
```

```
## ----------bbox_dist:bbox_len----------
## Total 15 predictors:
## 7 (47%) significant;
## 7 (47%) both

## # A tibble: 7 x 9
## # Groups:   model_name, loss_target [7]
##   model_name    loss_tar~1 term  estim~2 std.e~3 stati~4 p.value conf.~5 conf.~6
##   <ord>         <ord>      <chr>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1 YOLOv3        Vanishing  bbox~       0       0   -6.08   0             0       0
## 2 SSD           Vanishing  bbox~       0       0   -4.82   0             0       0
## 3 SSD           Mislabeli~ bbox~       0       0   -2.46   0.014         0       0
## 4 RetinaNet     Vanishing  bbox~       0       0   -2.15   0.032         0       0
## 5 RetinaNet     Untargeted bbox~       0       0    6.92   0             0       0
## 6 Faster R-CNN  Untargeted bbox~       0       0    6.89   0             0       0
## 7 Cascade R-CNN Untargeted bbox~       0       0    6.20   0             0       0
## # ... with abbreviated variable names 1: loss_target, 2: estimate,
## #   3: std.error, 4: statistic, 5: conf.low, 6: conf.high
```

```
dist_lab <- "Perturb-Target Distance"
len_lab <- "Perturb Box Length"

pred_name <- glue("{dist_lab} and {len_lab}")
main_pt <- glue("longer {len_lab} or shorter {dist_lab} cause success rates to significantly increase fo

print_statistics(reg_est, table_caption(pred_name, main_pt, "deliberate"))
```

Table 1: We run a logistic model regressing success against perturb-target distance and perturb box length in the deliberate attack experiment. Longer perturb box length or shorter perturb-target distance cause success rates to significantly increase for all model and attack combinations, except for perturb box length in untargeted attack on Cascade R-CNN. The interaction terms, even when significant, are negligibly close to 0. Table headers are explained in Appendix ??.

Group	Regression							
Attack	term	sig	estimate	std.error	statistic	p.value	conf.low	conf.high
YOLOv3								
Vanishing	distance	*	-0.015	0.002	-7.681	0.000	-0.018	-0.011
	length	*	0.030	0.002	19.637	0.000	0.027	0.033
	distance * length	*	0.000	0.000	-6.081	0.000	0.000	0.000

	Mislabeling	distance	*	-0.015	0.002	-8.540	0.000	-0.018	-0.011
		length	*	0.019	0.001	16.603	0.000	0.016	0.021
		distance * length		0.000	0.000	-1.733	0.083	0.000	0.000
	Untargeted	distance	*	-0.021	0.003	-7.440	0.000	-0.026	-0.015
		length	*	0.007	0.001	6.528	0.000	0.005	0.009
		distance * length		0.000	0.000	1.467	0.142	0.000	0.000
SSD									
	Vanishing	distance	*	-0.015	0.002	-7.055	0.000	-0.019	-0.011
		length	*	0.024	0.001	17.747	0.000	0.021	0.027
		distance * length	*	0.000	0.000	-4.823	0.000	0.000	0.000
	Mislabeling	distance	*	-0.018	0.002	-7.553	0.000	-0.023	-0.014
		length	*	0.020	0.001	15.991	0.000	0.017	0.022
		distance * length	*	0.000	0.000	-2.458	0.014	0.000	0.000
	Untargeted	distance	*	-0.018	0.002	-7.742	0.000	-0.023	-0.014
		length	*	0.013	0.001	11.665	0.000	0.011	0.015
		distance * length		0.000	0.000	-0.873	0.383	0.000	0.000
RetinaNet									
	Vanishing	distance	*	-0.045	0.006	-7.187	0.000	-0.058	-0.033
		length	*	0.016	0.001	10.614	0.000	0.013	0.019
		distance * length	*	0.000	0.000	-2.147	0.032	0.000	0.000
	Mislabeling	distance	*	-0.031	0.007	-4.240	0.000	-0.047	-0.018
		length	*	0.008	0.002	4.541	0.000	0.005	0.012
		distance * length		0.000	0.000	-1.021	0.307	0.000	0.000
	Untargeted	distance	*	-0.038	0.005	-7.446	0.000	-0.049	-0.029
		length	*	0.005	0.001	3.969	0.000	0.003	0.008
		distance * length	*	0.000	0.000	6.925	0.000	0.000	0.000
Faster R-CNN									
	Vanishing	distance	*	-0.061	0.010	-6.407	0.000	-0.081	-0.044
		length	*	0.011	0.001	7.127	0.000	0.008	0.014
		distance * length		0.000	0.000	-0.490	0.624	0.000	0.000
	Mislabeling	distance	*	-0.054	0.012	-4.664	0.000	-0.080	-0.034
		length	*	0.007	0.002	3.706	0.000	0.003	0.010
		distance * length		0.000	0.000	-0.717	0.473	0.000	0.000
	Untargeted	distance	*	-0.044	0.006	-8.012	0.000	-0.056	-0.034
		length	*	0.005	0.001	3.676	0.000	0.002	0.007
		distance * length	*	0.000	0.000	6.889	0.000	0.000	0.000
Cascade R-CNN									
	Vanishing	distance	*	-0.063	0.010	-6.579	0.000	-0.083	-0.046
		length	*	0.015	0.002	9.395	0.000	0.012	0.018
		distance * length		0.000	0.000	-1.003	0.316	0.000	0.000
	Mislabeling	distance	*	-0.062	0.012	-5.240	0.000	-0.088	-0.041

	length	*	0.010	0.002	5.795	0.000	0.006	0.013
	distance * length		0.000	0.000	-0.122	0.903	0.000	0.000
Untargeted	distance	*	-0.061	0.008	-7.544	0.000	-0.079	-0.047
	length		0.002	0.001	1.498	0.134	-0.001	0.005
	distance * length	*	0.000	0.000	6.198	0.000	0.000	0.000

```
reg_mod <- reg_res$mod

newdata <- expand_grid(
  bbox_dist = linear_space(data$bbox_dist),
  bbox_len = unique(data$bbox_len)
) |>
  glimpse()
```

```
## Rows: 400
## Columns: 2
## $ bbox_dist <dbl> 10.00000, 10.00000, 10.00000, 10.00000, 11.91919, 11.91919, ~
## $ bbox_len  <dbl> 100, 10, 200, 50, 100, 10, 200, 50, 100, 10, 200, 50, 100, 1~
```

```
# type.predict = "link" by default
# https://broom.tidymodels.org/reference/augment.glm.html
# https://stackoverflow.com/questions/14423325/confidence-intervals-for-predictions-from-logistic-regre
reg_pred <- reg_mod |>
  summarize(augment(mod, newdata = newdata, se_fit = TRUE)) |>
  mutate(success = plogis(.fitted), ul = plogis(.fitted + 1.96 * .se.fit), ll = plogis(.fitted - 1.96 *
  glimpse()
```

```
## `summarise()` has grouped output by 'model_name', 'loss_target'. You can
## override using the `.groups` argument.
```

```
## Rows: 6,000
## Columns: 9
## Groups: model_name, loss_target [15]
## $ model_name  <ord> YOLOv3, YOLOv3, YOLOv3, YOLOv3, YOLOv3, YOLOv3, YOLOv3, YO~
## $ loss_target <ord> Vanishing, Vanishing, Vanishing, Vanishing, Vanishing, Van~
## $ bbox_dist   <dbl> 10.00000, 10.00000, 10.00000, 10.00000, 11.91919, 11.91919~
## $ bbox_len    <dbl> 100, 10, 200, 50, 100, 10, 200, 50, 100, 10, 200, 50, 100,~
## $ .fitted     <dbl> 1.1206648, -1.4569515, 3.9846829, -0.3113443, 1.0753688, -~
## $ .se.fit     <dbl> 0.08354473, 0.11366498, 0.19249889, 0.08011917, 0.08206361~
## $ success     <dbl> 0.7541120, 0.1889340, 0.9817412, 0.4227867, 0.7456166, 0.1~
## $ ul          <dbl> 0.7831999, 0.2254527, 0.9874075, 0.4614987, 0.7749042, 0.2~
## $ ll          <dbl> 0.7225041, 0.1571306, 0.9735935, 0.3850003, 0.7139250, 0.1~
```

```
arb_cap <- glue("{bold_tex('A deliberate attack obfuscates intent with increased success for all models

arb_cap
```

```
## \textbf{A deliberate attack obfuscates intent with increased success for all models and attacks:}  W
```

```
g <- success_expanded_data |> ggplot(aes(bbox_dist, success, color = bbox_len, group = bbox_len)) +
  stat_summary(fun.data = "mean_cl_boot") +
  facet_grid(cols = vars(model_name), rows = vars(loss_target))

# https://github.com/tidyverse/ggplot2/blob/ef00be7e2016e1259b4aef7f7c85651df123beff/R/geom-smooth.r#L1
g <- g + geom_ribbon(
```

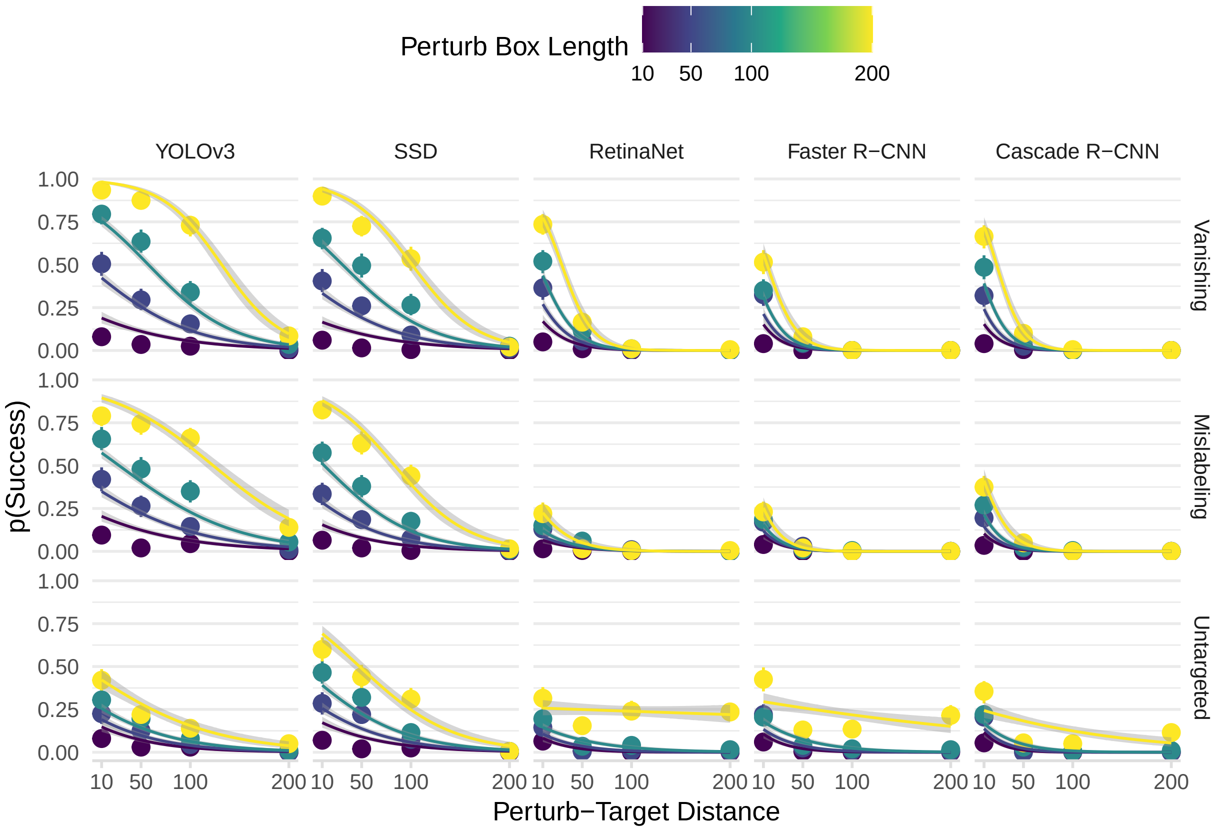

Figure 1: **A deliberate attack obfuscates intent with increased success for all models and attacks:** We implement intent obfuscating attack by perturbing an arbitrary non-overlapping square region to disrupt a randomly selected target object at various lengths and distances. The binned summaries and regression trendlines graph success proportion against perturb-target distance and perturb box length in the deliberate attack experiment. Errors are 95% confidence intervals. and every point aggregates success over 200 images. The deliberate attack multiplies success as compared to the randomized attack (Figure **??**), especially at close perturb-target distance and large perturb box length. Full details are given in Section **??**.

```
  data = reg_pred, aes(ymin = ll, ymax = ul),
  fill = "grey60", linetype = 0, alpha = 0.4
) +
  geom_line(data = reg_pred)

g + labs(x = dist_lab, y = "p(Success)") +
  scale_x_continuous(breaks = unique(success_expanded_data$bbox_dist)) +
  scale_color_viridis_c(name = len_lab, breaks = unique(success_expanded_data$bbox_len))
```

```
get_reg_vars <- function(data) {
  data |> select(bbox_dist, bbox_size_perturb, model_name, loss_target, success, object)
}

# run random.Rmd 1st
rand_dist_size <- readRDS("./analysis/rand_dist_size.RDS") |>
  mutate(object = 1) |>
  get_reg_vars() |>
  glimpse()
```

```
## Rows: 75,000
## Columns: 6
## $ bbox_dist          <dbl> 11.250000, 74.020000, 267.290000, 161.231650, 61.260~
## $ bbox_size_perturb <dbl> 4705.2345, 3803.1889, 595.2576, 29362.0050, 43664.54~
## $ model_name         <ord> Cascade R-CNN, Cascade R-CNN, Cascade R-CNN, Cascade~
## $ loss_target        <ord> Mislabeling, Mislabeling, Mislabeling, Mislabeling, ~
## $ success            <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ object             <dbl> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1~
```

```r
comb_dist_size <- success_expanded_data |>
  mutate(object = 0, bbox_size_perturb = bbox_len^2) |>
  get_reg_vars() |>
  bind_rows(rand_dist_size) |>
  mutate(
    bbox_dist = bbox_dist / 1e2,
    bbox_size_perturb = bbox_size_perturb / 1e5
  ) |>
  glimpse()
```

```
## Rows: 123,000
## Columns: 6
## $ bbox_dist          <dbl> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1~
## $ bbox_size_perturb <dbl> 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.~
## $ model_name         <ord> Cascade R-CNN, Cascade R-CNN, Cascade R-CNN, Cascade~
## $ loss_target        <ord> Mislabeling, Mislabeling, Mislabeling, Mislabeling, ~
## $ success            <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
## $ object             <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
```

```r
stopifnot(nrow(comb_dist_size) == nrow(success_expanded_data) +
            nrow(rand_dist_size) && sum(is.na(comb_dist_size)) == 0)
```

```r
# control both
model <- partial(glm_model, predictor = "object + bbox_dist * bbox_size_perturb")
data <- comb_dist_size

reg_est <- get_tidied_reg(model, data)
```

```
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## `summarise()` has grouped output by 'model_name', 'loss_target'. You can
## override using the `.groups` argument.
```

```
ext_sig(reg_est, "both", "object")
```

```
## ----------object----------
## Total 15 predictors:
## 10 (67%) significant;
## 10 (67%) both
```

```
## # A tibble: 10 x 9
## # Groups:   model_name, loss_target [10]
##    model_name    loss_ta~1 term  estim~2 std.e~3 stati~4 p.value conf.~5 conf.~6
##    <ord>         <ord>     <chr>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
##  1 YOLOv3        Vanishing obje~  -0.317   0.063   -5.03   0       -0.44  -0.193
##  2 YOLOv3        Untarget~ obje~  -0.201   0.079   -2.54   0.011  -0.357  -0.046
##  3 SSD           Untarget~ obje~   0.176   0.066    2.66   0.008   0.047   0.306
##  4 RetinaNet     Vanishing obje~  -0.551   0.093   -5.95   0      -0.734  -0.37
##  5 RetinaNet     Untarget~ obje~  -0.448   0.091   -4.90   0      -0.628  -0.269
##  6 Faster R-CNN  Vanishing obje~  -0.768   0.113   -6.81   0      -0.991  -0.549
##  7 Faster R-CNN  Mislabel~ obje~  -0.384   0.139   -2.77   0.006  -0.657  -0.113
##  8 Faster R-CNN  Untarget~ obje~  -0.275   0.089   -3.10   0.002  -0.449  -0.101
##  9 Cascade R-CNN Vanishing obje~  -0.665   0.104   -6.40   0       -0.87  -0.462
## 10 Cascade R-CNN Mislabel~ obje~  -0.282   0.117   -2.40   0.016  -0.513  -0.052
## # ... with abbreviated variable names 1: loss_target, 2: estimate,
## #   3: std.error, 4: statistic, 5: conf.low, 6: conf.high
```

```
ext_sig(reg_est, "neg", "bbox_dist")
```

```
## ----------bbox_dist----------
## Total 15 predictors:
## 15 (100%) significant;
## 15 (100%) neg
```

```
## # A tibble: 15 x 9
## # Groups:   model_name, loss_target [15]
##    model_name    loss_ta~1 term  estim~2 std.e~3 stati~4 p.value conf.~5 conf.~6
##    <ord>         <ord>     <chr>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
##  1 YOLOv3        Vanishing bbox~    -1.71   0.076   -22.4       0   -1.86   -1.56
##  2 YOLOv3        Mislabel~ bbox~    -1.52   0.066   -22.8       0   -1.65   -1.39
##  3 YOLOv3        Untarget~ bbox~    -1.97   0.114   -17.4       0   -2.20   -1.75
##  4 SSD           Vanishing bbox~    -1.92   0.084   -23.0       0   -2.09   -1.76
##  5 SSD           Mislabel~ bbox~    -1.95   0.091   -21.4       0   -2.13   -1.78
##  6 SSD           Untarget~ bbox~    -2.06   0.093   -22.0       0   -2.25   -1.88
##  7 RetinaNet     Vanishing bbox~   -4.95   0.261   -19.0       0   -5.47   -4.45
##  8 RetinaNet     Mislabel~ bbox~   -3.97   0.357   -11.1       0   -4.70   -3.30
##  9 RetinaNet     Untarget~ bbox~   -1.33   0.106   -12.6       0   -1.55   -1.13
## 10 Faster R-CNN  Vanishing bbox~   -6.00   0.408   -14.7       0   -6.83   -5.23
## 11 Faster R-CNN  Mislabel~ bbox~   -5.87   0.483   -12.1       0   -6.86   -4.96
## 12 Faster R-CNN  Untarget~ bbox~   -1.80   0.124   -14.6       0   -2.05   -1.57
## 13 Cascade R-CNN Vanishing bbox~   -6.50   0.388   -16.7       0   -7.28   -5.76
## 14 Cascade R-CNN Mislabel~ bbox~   -6.32   0.438   -14.4       0   -7.21   -5.49
## 15 Cascade R-CNN Untarget~ bbox~   -2.46   0.159   -15.5       0   -2.79   -2.16
## # ... with abbreviated variable names 1: loss_target, 2: estimate,
## #   3: std.error, 4: statistic, 5: conf.low, 6: conf.high
```

```
ext_sig(reg_est, "pos", "bbox_size_perturb")
```

```
## ----------bbox_size_perturb----------
## Total 15 predictors:
## 14 (93%) significant;
## 14 (93%) pos

## # A tibble: 14 x 9
## # Groups:   model_name, loss_target [14]
##    model_name    loss_ta~1 term  estim~2 std.e~3 stati~4 p.value conf.~5 conf.~6
##    <ord>         <ord>     <chr>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
##  1 YOLOv3        Vanishing bbox~   8.59    0.367   23.4        0   7.88     9.32
##  2 YOLOv3        Mislabel~ bbox~   4.54    0.253   17.9        0   4.05     5.04
##  3 YOLOv3        Untarget~ bbox~   1.59    0.17     9.36       0   1.26     1.93
##  4 SSD           Vanishing bbox~   5.88    0.296   19.9        0   5.31     6.47
##  5 SSD           Mislabel~ bbox~   4.23    0.249   17.0        0   3.75     4.73
##  6 SSD           Untarget~ bbox~   1.96    0.187   10.5        0   1.60     2.33
##  7 RetinaNet     Vanishing bbox~   2.69    0.251   10.7        0   2.21     3.19
##  8 RetinaNet     Mislabel~ bbox~   1.16    0.231    5.03       0   0.712    1.62
##  9 RetinaNet     Untarget~ bbox~   1.68    0.165   10.2        0   1.36     2.00
## 10 Faster R-CNN  Vanishing bbox~   2.06    0.256    8.05       0   1.57     2.58
## 11 Faster R-CNN  Untarget~ bbox~   2.10    0.182   11.6        0   1.75     2.46
## 12 Cascade R-CNN Vanishing bbox~   2.90    0.277   10.5        0   2.38     3.46
## 13 Cascade R-CNN Mislabel~ bbox~   0.886   0.22     4.02       0   0.459    1.32
## 14 Cascade R-CNN Untarget~ bbox~   0.913   0.161    5.68       0   0.598    1.23
## # ... with abbreviated variable names 1: loss_target, 2: estimate,
## #   3: std.error, 4: statistic, 5: conf.low, 6: conf.high
```

```
ext_sig(reg_est, "both", "bbox_dist:bbox_size_perturb")
```

```
## ----------bbox_dist:bbox_size_perturb----------
## Total 15 predictors:
## 8 (53%) significant;
## 8 (53%) both

## # A tibble: 8 x 9
## # Groups:   model_name, loss_target [8]
##   model_name    loss_tar~1 term  estim~2 std.e~3 stati~4 p.value conf.~5 conf.~6
##   <ord>         <ord>      <chr>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1 YOLOv3        Vanishing  bbox~ -3.26   0.31   -10.5    0       -3.87  -2.66
## 2 YOLOv3        Mislabeli~ bbox~ -0.908  0.231  -3.94    0       -1.36  -0.462
## 3 SSD           Vanishing  bbox~ -2.26   0.289  -7.83    0       -2.84  -1.71
## 4 SSD           Mislabeli~ bbox~ -1.51   0.282  -5.36    0       -2.08  -0.971
## 5 RetinaNet     Untargeted bbox~  1.77   0.203   8.70    0        1.37   2.17
## 6 Faster R-CNN  Mislabeli~ bbox~   2.06    0.747    2.75   0.006    0.44   3.36
## 7 Faster R-CNN  Untargeted bbox~   2.23    0.233    9.57   0          1.78   2.69
## 8 Cascade R-CNN Untargeted bbox~   2.09    0.216    9.69   0          1.67   2.52
## # ... with abbreviated variable names 1: loss_target, 2: estimate,
## #   3: std.error, 4: statistic, 5: conf.low, 6: conf.high
```

```
dist_lab <- "Perturb-Target Distance (100 pixels)"
size_lab <- "Perturb Box Size (100,000 squared pixels)"

pred_name <- glue("object (versus non-object), with {dist_lab} and {size_lab} as covariates")
main_pt <- "perturbing an object (in the randomized attack) rather than a non-object (in the deliberate

tab_cap <- glue("We combined the data in the randomized and deliberate attack experiments to run a logis

print_statistics(reg_est, tab_cap)
```

Table 2: We combined the data in the randomized and deliberate attack experiments to run a logistic model regressing success against object (versus non-object), with perturb-target distance (100 pixels) and perturb box size (100,000 squared pixels) as covariates. The "object" term codes object as 1 and non-object as 0. Perturbing an object (in the randomized attack) rather than a non-object (in the deliberate attack) significantly decreases success rates for most model and attack combinations, after controlling for perturb sizes and perturb-target distances. Table headers are explained in Appendix **??**.

Group	Regression							
Attack	term	sig	estimate	std.error	statistic	p.value	conf.low	conf.high
YOLOv3								
Vanishing	object	*	-0.317	0.063	-5.031	0.000	-0.440	-0.193
	distance	*	-1.711	0.076	-22.383	0.000	-1.863	-1.563
	size	*	8.585	0.367	23.423	0.000	7.878	9.315
	distance * size	*	-3.258	0.310	-10.498	0.000	-3.872	-2.655
Mislabeling	object		-0.026	0.059	-0.440	0.660	-0.141	0.089
	distance	*	-1.515	0.066	-22.796	0.000	-1.647	-1.386
	size	*	4.538	0.253	17.940	0.000	4.050	5.041
	distance * size	*	-0.908	0.231	-3.938	0.000	-1.365	-0.462
Untargeted	object	*	-0.201	0.079	-2.544	0.011	-0.357	-0.046
	distance	*	-1.970	0.114	-17.351	0.000	-2.197	-1.752
	size	*	1.593	0.170	9.364	0.000	1.265	1.932
	distance * size		0.356	0.250	1.423	0.155	-0.149	0.837
SSD								
Vanishing	object		0.096	0.063	1.532	0.125	-0.027	0.219
	distance	*	-1.924	0.084	-22.955	0.000	-2.090	-1.762
	size	*	5.883	0.296	19.896	0.000	5.313	6.472
	distance * size	*	-2.263	0.289	-7.826	0.000	-2.844	-1.707
Mislabeling	object		-0.039	0.064	-0.609	0.542	-0.166	0.087
	distance	*	-1.953	0.091	-21.407	0.000	-2.134	-1.776
	size	*	4.228	0.249	16.958	0.000	3.749	4.726

		distance * size	*	-1.509	0.282	-5.356	0.000	-2.077	-0.971
	Untargeted	object	*	0.176	0.066	2.661	0.008	0.047	0.306
		distance	*	-2.060	0.093	-22.041	0.000	-2.246	-1.879
		size	*	1.958	0.187	10.482	0.000	1.599	2.331
		distance * size		-0.227	0.244	-0.929	0.353	-0.719	0.240
RetinaNet									
	Vanishing	object	*	-0.551	0.093	-5.947	0.000	-0.734	-0.370
		distance	*	-4.949	0.261	-18.960	0.000	-5.472	-4.448
		size	*	2.686	0.251	10.722	0.000	2.208	3.190
		distance * size		-0.881	0.569	-1.548	0.122	-2.035	0.197
	Mislabeling	object		-0.245	0.136	-1.799	0.072	-0.513	0.022
		distance	*	-3.968	0.357	-11.109	0.000	-4.697	-3.297
		size	*	1.163	0.231	5.032	0.000	0.712	1.621
		distance * size		0.117	0.696	0.168	0.867	-1.323	1.403
	Untargeted	object	*	-0.448	0.091	-4.902	0.000	-0.628	-0.269
		distance	*	-1.333	0.106	-12.560	0.000	-1.546	-1.130
		size	*	1.675	0.165	10.157	0.000	1.355	2.002
		distance * size	*	1.766	0.203	8.701	0.000	1.373	2.170
Faster R-CNN									
	Vanishing	object	*	-0.768	0.113	-6.813	0.000	-0.991	-0.549
		distance	*	-6.002	0.408	-14.728	0.000	-6.829	-5.230
		size	*	2.062	0.256	8.052	0.000	1.572	2.577
		distance * size		-1.190	0.905	-1.315	0.188	-3.059	0.485
	Mislabeling	object	*	-0.384	0.139	-2.770	0.006	-0.657	-0.113
		distance	*	-5.868	0.483	-12.144	0.000	-6.858	-4.961
		size		0.461	0.252	1.832	0.067	-0.029	0.958
		distance * size	*	2.055	0.747	2.752	0.006	0.440	3.362
	Untargeted	object	*	-0.275	0.089	-3.096	0.002	-0.449	-0.101
		distance	*	-1.804	0.124	-14.599	0.000	-2.053	-1.568
		size	*	2.104	0.182	11.585	0.000	1.752	2.464
		distance * size	*	2.226	0.233	9.570	0.000	1.778	2.690
Cascade R-CNN									
	Vanishing	object	*	-0.665	0.104	-6.395	0.000	-0.870	-0.462
		distance	*	-6.496	0.388	-16.731	0.000	-7.279	-5.757
		size	*	2.905	0.277	10.474	0.000	2.378	3.465
		distance * size		-1.579	0.840	-1.881	0.060	-3.310	-0.020
	Mislabeling	object	*	-0.282	0.117	-2.402	0.016	-0.513	-0.052
		distance	*	-6.317	0.438	-14.410	0.000	-7.210	-5.489
		size	*	0.886	0.220	4.018	0.000	0.459	1.325
		distance * size		1.310	0.746	1.757	0.079	-0.265	2.666
	Untargeted	object		-0.175	0.100	-1.739	0.082	-0.371	0.022

	distance	*	-2.464	0.159	-15.457	0.000	-2.786	-2.160
	size	*	0.913	0.161	5.677	0.000	0.598	1.229
	distance * size	*	2.093	0.216	9.686	0.000	1.670	2.519