Estimating Effectiveness

Determining the number of illegals attempting to cross and the fraction captured.

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The Problem

- Know how many arrests made
- Don’t know how many attempts to cross made.
- So have no idea how effective the inspections are!

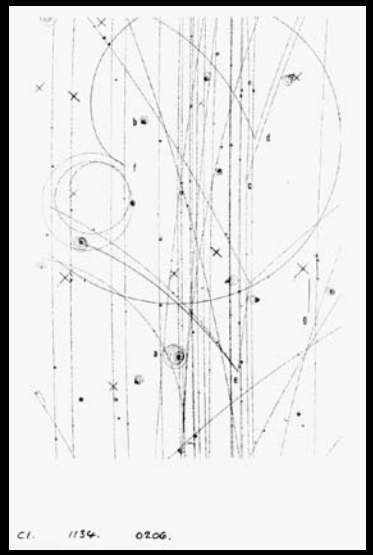
Cannot stop and search everything

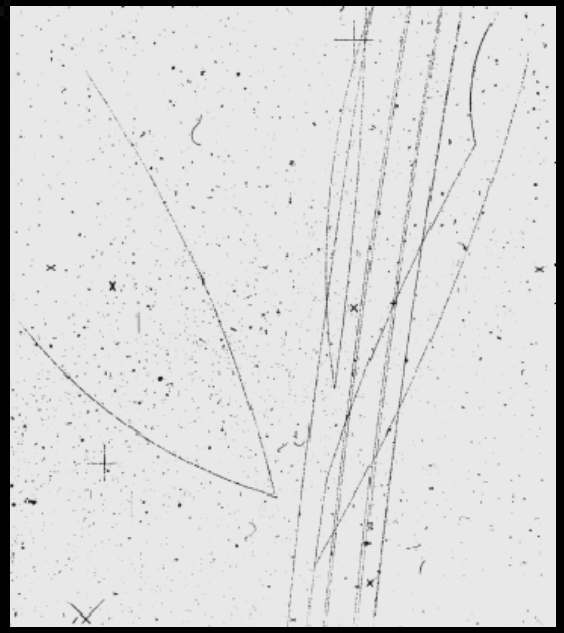
- Too many vehicles
- Too disruptive
- Anyway, would have to do it several times because the rate of attempts is function of day, date, and time of day

The problem is not unknown

- Bubble Chamber pictures.
  - At least 1,000,000 photos in an experiment
  - Very complex to scan and identify events
  - Must determine scan efficiency

Some typical pictures from the web





As done in HE Physics

- Scan a data set normally
- Prepare a data set containing a known number of real events selected from full set and a large number of dummies, also from full set
- Have all scanners scan calibrated set without knowing it is calibration set
- The fraction of “reals” found in calibration set is likely the fraction of reals found in full set.

Applying to our problem

- We know number of arrested illegals
- We can fingerprint them and photograph them so they can be identified later.
- Very small penalty for trying again.
- Almost all apprehended immigrants try again.
  - And when they are next caught they can be identified.

Assumptions

1. Illegals try until they succeed.
    1. Very low “discouragement factor”
2. Illegals learn very little about how to succeed from a failed attempt.
    1. This is critically important, and requires care.
3. Illegals who succeed do not return to their home countries or to France (NL, DK, B, etc.)

What we know or can know

- Total number apprehended
- Identity of those apprehended
  - Fingerprints and photos provide ID in the future
- Number of times any given individual has been caught.

What we need to know

- Total number of illegals attempting to enter.
- Odds that a migrant will be caught on any given attempt.
- In effect we want to know how many “reals” there are in a bubble chamber data set.
- We cannot prepare a known data set, but migrants making their “n^{th}” attempt are the required “calibration” data set

Defining variables

- Let F be the total flow of migrants
- Let P be the probability of being caught
- Let T be the total number of apprehensions

- Note: I had this worked to the stage of the table coming up when I discovered that T. Ebenshade had done similar work in 1995. I follow his procedure for the “repeated trials method.”

How many get caught?

If *F* people try to cross, and if *P* is the probability of being caught, the number caught is *FP*

If *FP* are caught, *F(1-P) get through.*

If *FP* are caught and try again, the number caught on the second try is FP^2*; on the third try it is* FP^3 *etc.*

Putting things together

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Attempt no. (i)	Size of group making Attempt i	Size of group apprehended for Attempt i	Size of group apprehended exactly i times	Number of apprehensions accounted for by the group in Column 4 for Attempt i	Size of group entering UK successfully
	Column 3 for Attempt i-1	Column 2 × P	Column 3 for Attempt i – Column 3 for Attempt i+1	Column 4 × i	Column 2 – Column 3
1	F	FP	FP(1-P)	FP(1-P)	F(1-P)
2	FP	FP^2	$FP^2(1-P)$	$2FP^2(1-P)$	FP(1-P)
3	FP^2	FP^3	$FP^3(1-P)$	$3FP^3(1-P)$	$FP^2(1-P)$
4	FP^3	FP^4	$FP^4(1-P)$	$4FP^4(1-P)$	$FP^3(1-P)$
...	...	...	...	...	...
i	FP^{i-1}	FP^i	$FP^i(1-P)$	$iFP^i(1-P)$	$FP^{i-1}(1-P)$
...	...	...	...	...	...
Column sum	F/(1-P)	FP/(1-P)	FP	FP/(1-P)	F

Doing some algebra

- Sum the columns in the table using standard formulas.

$$1 + P + P^2 + P^3 + \ldots = \sum_{i=1}^{\infty} P^{i-1} = \frac{1}{1-P}, \quad \text{for } P < 1$$

$$1 + 2P + 3P^2 + 4P^3 + \ldots = \sum_{i=1}^{\infty} iP^{i-1} = \frac{1}{(1-P)^2}, \quad \text{for } P < 1$$

Total & recidivist arrests

- A recidivist got caught more that once.
- We know the total number of migrants that get arrested.
- If we can identify migrants when they are caught again, we can determine that they are recidivists.
- Number of recidivist arrests is just total # of arrests minus the number caught 2 or more times.

Total & recidivist arrests

$$T = \frac{FP}{1 - P}$$

Let T_r be the number of *recidivist* apprehensions, which equals T minus the number of *first* apprehensions

$$T_r = T - FP = \frac{FP^2}{1 - P}$$

So we need to solve for

- F, the total number of migrants attempting to cross, and
- P, the probability of a migrant being caught on any attempt.
  - We know T and T_r because we arrest and identify.

Easy algebra… ;-)

Getting to the answer!

Therefore, the ratio of T_r to T gives the probability of apprehension, P.

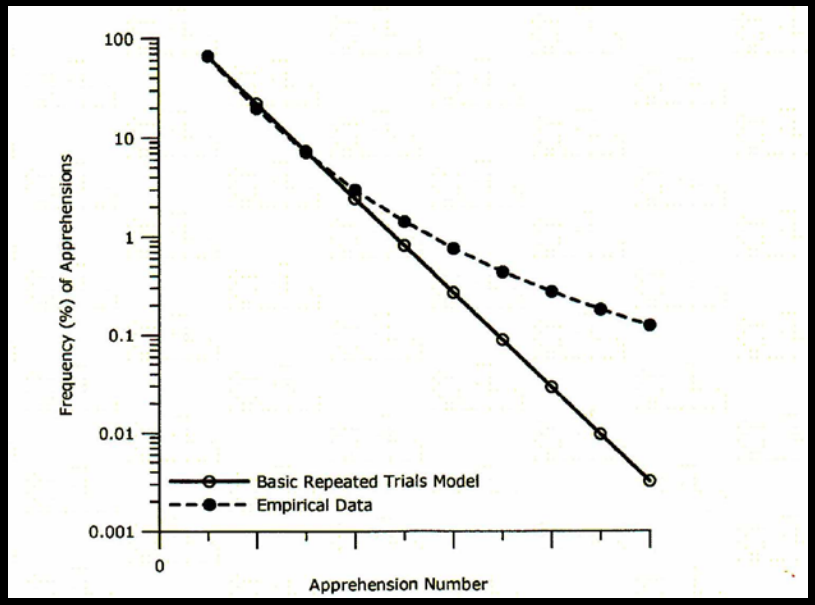
$$P = \frac{T_r}{T}$$

Substituting Eq. (5) into Eq. (3) yields

$$F = \frac{T(1-P)}{P} = \frac{T}{T_r}(T - T_r)$$

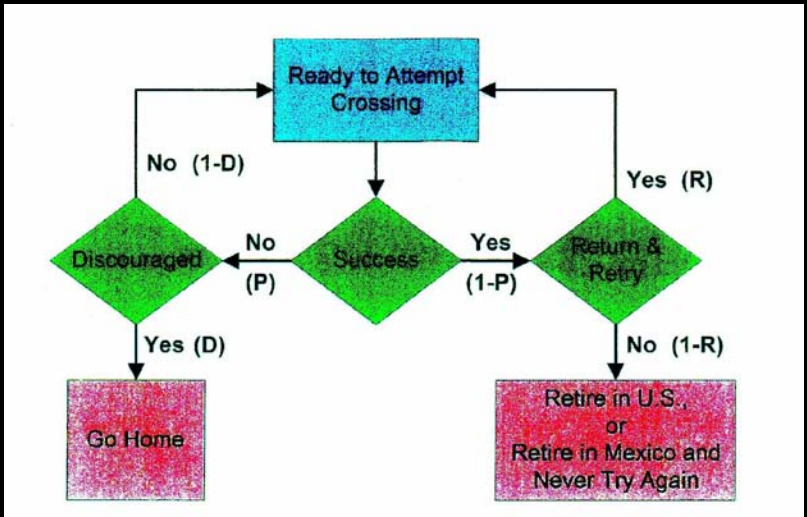
- These are exactly what we need to know, and all the quantities on the right hand side are measured!

Does it work?



- A (sanitized) example from the US-Mexican Border
- Fairly well, in fact
- I can request release of a full report to Andy and Dick if you don't already have it.

This model is too simple

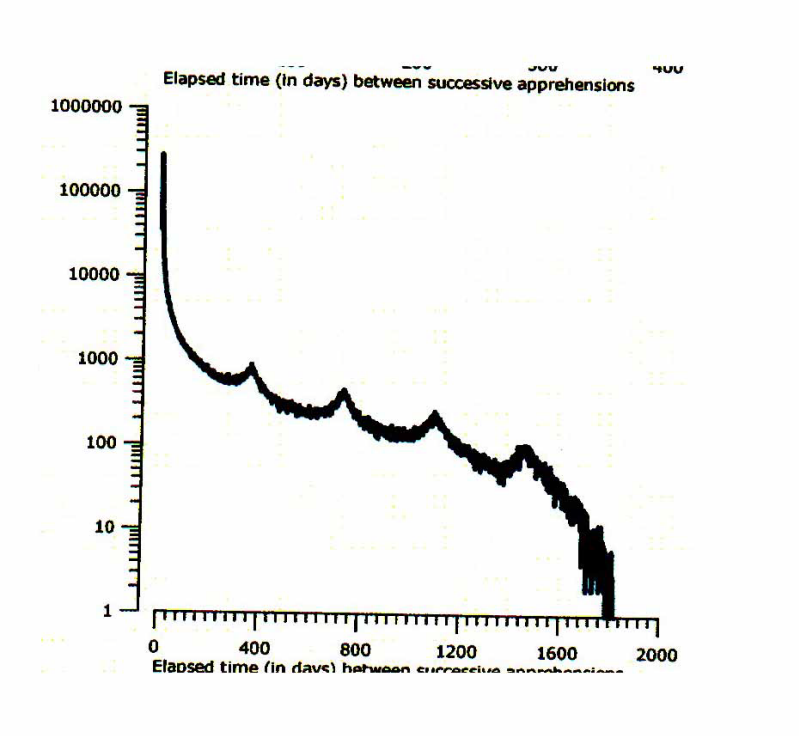


- Some migrants do get discouraged
- In the US case, some seasonal workers enter the country (say, for agricultural work), go home “for Christmas,” and then try to reenter US.

Modified repeated trials method

- Works very well at reproducing observations
- Much more complicated than simple model
- Requires modest numerical analysis using a spreadsheet
- Can quantify discouragement and reentry
- May not need the reentry term for our problem

Do migrants to US really enter and leave?



- Yes
- Graph shows recidivist arrests over time
- Peaks are ~360 days apart.
- Plot is *# of arrests* vs. *days between arrests of same person.*

We could know how well we're doing

- Must maintain good records on apprehended migrants
- May want to include French CCI statistics
- Must use some math and must model the problem.
- Must accept that the model is statistical, and that even intermittent 100% screening would tell little or nothing additional of use.

Other work

- Epenshade, T.J., “Using INS Border apprehension data to measure the flow of undocumented migrants crossing the US-Mexico Frontier,” *International Migration Review*, 29 pp 545-565, 1995.
- HIS, 2006, *Customs and Border Protection Apprehensions at the Mexican Border*. [Official Use Only]