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Markov Chain Modeling for US Air Force Officer Assignment

Eric J. Visger
Dept. of Industrial Engineering,
New Mexico State University
Las Cruces, NM 88003, USA
cgsilvisger@nmsu.edu

Han-suk Sohn
Dept. of Industrial Engineering,
New Mexico State University
Las Cruces, NM 88003, USA
hsohn@nmsu.edu

***Abstract*— The United States Air Force faces significant challenges with retention of higher ranking officers including experienced pilots. One of the stressors is the officer assignment system, which moves officers to new locations every two to four years. This paper presents a discrete-time Markov chain model of the officer assignment system to examine a subset of the system focusing on a single career field (operations research) and uses notional data to estimate time until separation. With real world data included, the model creates a platform for sensitivity analysis, what-if scenarios, and informed policy decisions to address personnel issues for today and decades from now.**

Keywords—Markov chain; officer assignment; US Air Force; absorption analysis

I. INTRODUCTION

The United States Air Force, like all large organizations, has challenges with human resources which include recruitment, retention, training, promotion, managing job qualifications among many other tasks. Presently, the Air Force has over 61,000 officers across a variety of career fields including pilots, navigators, air battle managers, space operators, intelligence officers, engineers, medical officers, and numerous other fields. Each of these officers receives new assignments periodically, generally every two to four years. At each assignment, the officer and their families must move to a new location (across the continental United States or overseas), receive training, and quickly take on a new job which demands exceptional performance and directly impacts lethality and survivability of armed forces personnel. Moreover, each of these moves involves a significant financial burden on the Air Force as it must pay for the shipment of house hold goods and dislocation allowances while giving the member time off for the travel itself and to get their affairs in order.

Local commanders develop specific personnel requirements and evolve them with changing missions. For example, a squadron commander may be standing up a new mission which requires an experienced flight commander with specific training in electronic warfare; the squadron commander will need to analyze their positions and 're-code' a position to fit this particular requirement, perhaps giving up a tactics officer in the process.

Assignment teams manage the immediate needs of the Air Force. They combine officers eligible for assignment with the list of all requirements from the local commanders. They prioritize the list of requirements then examine each officer's records and attempt best match an officer with an assignment taking into consideration a multitude of factors such as commander's recommendations, officer's requests, and needs of the Air Force.

The Assignment Management system has officers listed as vulnerable to move generally after they have been in a particular job for about two and a half years, which the potential to move around the three-year point. There are three cycles per year in which they examine pools of officers and job requirements. Officers generally move within the same cycle, so if an officer previously moved in the fall months they will likely move in the fall three years later. As a natural extension, job openings are as a result of an officer departing and positions tend to be locked into a particular cycle. There are exceptions of course. Some positions are not filled as the Air Force is undermanned, particularly in certain career fields like pilots and cyber officers. Some officers extend beyond their expected assignment timeline due to short-term highly critical mission requirements. In extreme cases, there are positions unfulfilled for years and officers who remain in the same assignment well beyond their expectations.

Developmental teams are composed of senior officers in each career field to manage expectations, guide force development, and provide tailored but broad recommendations to individual officers. For example, a developmental team might recommend a particular engineer to seek program management experience in order to compete for highly selective positions leading large number of personnel and budgets. In other words, they examine the long term strategic needs of the Air Force and attempt to fill personnel needs five to ten years down the road. This is especially important because the Air Force cannot simply recruit individuals into senior positions. Unlike other organizations they cannot hire external senior leaders with commensurate experience; there are no job advertisements for Colonels. Officers must be promoted from within the system to commensurate ranks to be eligible for those positions.

Complicating matters even further is all officers have numerous requirements for training and professional development. On top of this, each career field has additional requirements to be met. For example, a space operations officer must attend lengthy courses for general education at the beginning, middle, and senior levels of their career. Then they must attend weapons system specific training. In contrast, a program manager has a lengthy in-residence course at the beginning of their career then has a variety of short courses they often attend locally across their career.

II. Problem Statement

The Air Force officer assignments process is simple in concept. Yet it lacks formal tools for minimizing cost while maximizing filled requirements. Similarly, the status quo is inflexible at balancing short term needs with predicting long term needs. There are intangible components as well; Air Force officers like other service members often feel decisions that impact their families and careers are little more than a 'dart board' or luck of the draw. Perhaps most compelling is while the Air Force has considered a plethora of changes to the assignment system, it lacks a modeling approach to evaluate the long-term concerns with the status quo compared to alternative courses of action.

Presently, Air Force senior leaders must use their best judgement, expertise, and experience to make decisions which may lead to force structure problems such as the current Air Force pilot shortage. Secretary of the Air Force, Heather Wilson described the Air Force as having a gap of 2,000 pilots or about 10% of the expected force. General Goldfein, the Chief of Staff of the Air Force stated each of those pilots requires about ten years of work to develop the required expertise and costs $10 million dollars in total. The Air Force cannot hire expert fighter pilots from commercial airliners [1].

In this short paper, we present a simple yet practical optimization approach, which employs the concept of Markov chain, to analyze the current assignment system for the US Air Force officers as well as some potential alternatives. The Air Force does not publicly release data required for an accurate model. However, this paper proposes a conceptual model with notional data, which could be used as a proof of concept for a more robust model developed with actual statistical data. The proposed model could furthermore, be harnessed to analyze a myriad of factors beyond assignments, such as quantitative estimates of promotion rates.

III. Literature Review

The Markov chain model formulation is inspired by other works in similar fields. This section will discuss a literature review and examine applications for the Air Force problem.

Bessent and Bessent [2] evaluated the use of Markov chains in management science at the micro level to examine doctoral student progression at the University of Texas. The states for graduate students have some comparisons to Air Force officers. Students flow through enrollment, candidacy, withdrawal, lack of advancement, as well as graduation. Air Force officers move through recruitment, company grade officer ranks, field grade officer ranks, separation from the military, and retirement. Graduation requirements are largely stationary and while specific and daily tasks of Air Force officers change fairly regularly their existence and basic requirements are fairly stable. For example, a field grade officer's position may require an advanced academic degree in engineering or a closely related field; this requirement is unlikely to change even during a significant reorganization such as bringing a new weapon system online. The Air Force will still need highly educated technical experts. Another similarity is students tend to stay in one state for a long time and rarely leave and re-enter states. Air Force officers similarly progress through the ranks and positions and may be in a position for years but generally do not return to the previous position. It does happen, but such is uncommon. As Bessent and Bessent discover, small policy changes to the graduate program can have profound impacts; admitting only two more students can lead to faculty overload. Similar observations can be shown for Air Force officer assignments.

Scherer and White [3] build a Markov decision process model to explore the development of INTELSAT, a global communications satellite system. They initially build a model with 72 states including lag states to account for complex steps within in manufacturing. One of the challenges they explore is simulating the entire model with replication required extensive computing power. Thus, they compressed the original model down to four states and used probability to approximate transition out of the state. Computing power has advanced incredibly since 1985, but the principle remains the same. An enormous Markov model could be created that accounted for each of the approximately 61,000 officers as well as all of the available positions including those which are unfilled; however, such a model would require extensive computing power and would be cumbersome to wield. Yet, as Scherer and White discuss, the model can be compressed and still be insightful. For example, instead of creating states for each position in a location, there could be one state which accounts for all of those positions and an associated probability which takes the number of positions into account.

Golabi and Shepard [4] analyze bridges within the United States, observing that funds are traditionally expended for the replacement of bridges but not the maintenance of them which might extend their life. While they observe all bridges are different with their unique requirements and lifespans they do find options for categorizing the status based on broad status terms such as delamination being present and makes recommendations for service to reduce expected costs. This too can be compared to Air Force officers, while each officer's records are unique there are some basic categories which could be modeled and linked to recommendations for future assignments. For example, as a norm officers are not allowed to remain in the same area beyond their initial assignment under the idea that moving to new positions offers opportunities for career growth and broadening the officer's realm of experience. Yet, an officer might be able to perform multiple jobs in different offices working with different domains at different levels of the organization while remaining in the same local area. Such internal movement costs the Air Force nothing and can be compared to the low-cost repairs recommended by Golabi and Shepard.

Kim, Song, and Kim [5] examine Markov chains from a marketing perspective to look at customer defection so managers can target strategies for customer retention. In their model defection is an absorbing state assuming once a customer defects they do not return afterwards. Similarly, Air Force officers are under a plethora of stresses and often consider high paying jobs in the public sector. Once Air Force officers separate or retire they do not return. Kim et al examine their Markov chain to predict how long customers remain until they defect, including data mining to identify possible indicators of increased defection probability. The Air Force is routinely offering incentives to keep high retention rates; thus, this is directly applicable.

Tandon et al. [6] apply Markov chains to look at probability of customers purchasing future products based on what products they have previously purchased. They found marketing techniques could be targeted towards customers with specific tendencies and histories to boost the probability of selling additional products. The Air Force similarly must examine histories and tendencies of Air Force officers and seek to understand what components impact likelihood of accepting a new assignment relative to the likelihood of separating.

IV. SOLUTION APPROACH

The solutions approach to improving Air Force officer assignments involves a discrete time Markov chain. The states can be identified as commissioning (initial recruitment for an officer), a collection of states for each base of assignment, as well as states for separation from military service and retirement. Like Bessent and Bessent's model, officers will spend significant time in each assignment before moving onto another assignment. This could be considered for each step in discrete time. Few officers move within a year of a new assignment, almost all move within two to four years, and only a handful stay beyond that. A triangle distribution would be a good model for the probability of remaining within a particular assignment. Alternatively, the numbers of officers who move earlier than two years or after four years is so low that it might be reasonably ignored. As discussed with Scherer, the states will reflect a collection of assignments available at a base instead of listing a state for each individual position. There are 59 active duty Air Force bases in the continental United States. There are dozens of installations overseas and many more that serve as operating locations or deployments. Often these latter locations are considered a temporary duty while the officer is assigned to a home base, thus deployments and temporary operating locations will be ignored in this model due to their short-term (in theory) nature. Tracking individual positions with this type of model would be infeasible.

We can still factor in the possibility of moving to new jobs at the same base, as discussed with respect to Golabi and Shepard's model. Bases with higher number of jobs especially across diverse organizations and mission sets can be considered to have a slightly higher probability of returning to their own state than the number of jobs would initially lead one to suspect. Like Kim, Song, & Kim's findings rarely return from an end point (separation or retirement). While it is theoretically possible for an officer to return from separation or retirement to active duty this process is only in rare circumstances and with such small numbers that for the purposes of this model such movements will be ignored. Thus, the states of separation or retirement will be absorbing and all officers will eventually separate from active duty. This includes tragically, some officers who are killed in action, grouped with the separated state. Finally, Tandon et al's work will be applied after an initial analysis to look for trends in what assignments tend to lead towards separation. In other words, this would require extensive data mining to perform a verification and validation on the model. For example, do officers assigned at Scott Air Force Base in Illinois have a higher transition probability to separation due to a stressful mission? Or do officers assigned at the Pentagon in Washington DC have a higher likelihood to retire?

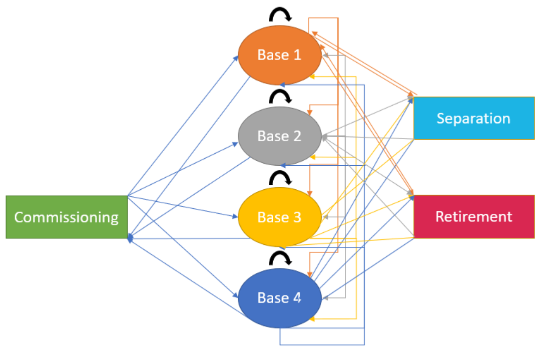

Fig. 1. Partial Conceptual Model Diagram

As Fig. 1 demonstrates, the size of this Markov model and number of communications make it difficult to map out by hand. The Air Force does not publicly release assignment data or demographics at the base level. The transition probabilities would need to be calculated based on this closed-door data. For the purposes of this paper though, the concept should be realized that each base has the probability of transitioning to another base. This would include more than simply population statistics. For example, an officer at Peterson Air Force Base (home of Air Force Space Command) most likely works in a space domain position and would be more likely to transition to Vandenberg Air Force Base (home of the Joint Space Operations Center) than Kirtland Air Force Base which has nuclear and special operations missions, but very little space related positions.

V. Results and Discussion

Since a fully examined model would extensive, this paper will next take a subset of the entire model as an example. One specific career field is the 61A Operations Research Analysts and even this relatively small career field creates a fairly significant Markov chain.

The notional transition matrix established above takes into account the assumptions discussed earlier. For example, officers begin at recruitment and are randomly assigned to a location based on the proportion of available positions. For following assignments, officers are not allowed to remain in their current location but will transfer to a new assignment which factors the proportion not including positions in their current location. It also adds in a probability for separation which for this example includes retirement and ordinary separation. As an aside, for new Air Force officers the differences between separation and retirement are fuzzier than the older generation as the military pension after twenty years of service is no longer available. Thus, for new officers this is a reasonable assumption.

With the notional transition matrix established, we can begin to identify some tendencies to help answer some of the questions in the problem statement through absorption analysis. The transient states in the upper left quadrant (recruitment through masked location) are identified as Q. The absorbing states in the upper right quadrant are identified as R. The bottom left quadrant with absorbing states that do not transition into any other assignments is identified as 0. The bottom right matrix is the absorbing state to itself is I as an identity matrix. Thus, we can examine the expected number of visits given a particular state before it is absorbed with $E = (I-Q)^{-1}$. Further we can look at the probability of starting in a given state and ending in a particular absorbing state with $A= E*R$; however, this particular component is trivial as there is only one absorbing state (separation). Looking at the E matrix (see table below) suggests that after recruitment, the Air Force can expect to get about five and a half assignments out of an officer before they separate, or about sixteen years of service (assuming an average of three years per assignment). This is done by adding up the first row (beginning with recruitment) and subtracting out the '1' as all officers must go through a commissioning source and it is not considered an assignment.

While the data is again notional, this anecdotally makes some sense. The Air Force provides many incentives for young officers to continue for another assignment (such as tuition assistant towards a Master's degree) with the hope that once officers are in past ten years they will remain for a full career.

However, as discussed in the problem statement this assumption may no longer be valid. If the Air Force continues to push frequent reassignments, back to back deployments while eliminating the pension program and facing a lucrative job market, things may drastically change. The Air Force is already in a personnel crisis, especially for seasoned pilots (over ten years of experience) and senior officers in leadership positions (e.g. Colonels), by changing certain policy positions they may drive the crisis even deeper. In the earlier example, the assumed separation rate was 20%, driving five or six assignments for about sixteen years. If that rate changed significantly, they would be a respective change in expected number of assignments as illustrated in the table below.

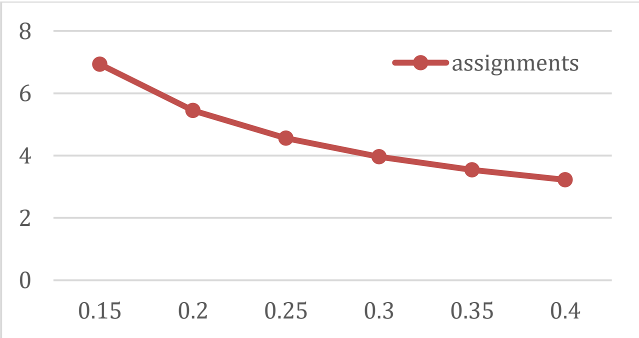

Fig. 2: Assignments by Separation Rate

Another comparison examines what if the Air Force allowed some officers to be reassignment to another position at the same location. For this excursion it follows the same model as above, but allows assignment to the previous state at a 50% reduced probability. For example, in Ohio there are 40 positions and after working one of them 20 are available for the next state. The transition matrix P is below. Following the same procedure as above, this puts an expected number of assignments after recruiting as only slightly higher, but still under six. However, with the increased stability available at large it may be that the separation rate goes down slightly. If dropped to 15% (from 20%) the number of expected assignments jumps to over 7, which is over 21 years of expected service.

Another component this excursion allows for examination is savings of dollars related to moving officers. If each move costs the Air Force an average of $10,000 (factoring in paying professional movers, storage of house hold goods, separation allowance pays, and other costs) the initial example with about 5.45 assignments per officer's career plus a final move from separation costs the Air Force about $64,500. Spread across the approximately 16 years of service compares this to about $4,000 per year for each officer. This dollar value is relatively small compared to the defense budget, but if applied to the over 61,000 officers it becomes quite significant. In

the excursion illustration, officers have approximately 7.12 assignments over 21 years which yields an average annual cost of around $3800 per year for each officer. Again, $200 is relatively small but in an era of fiscal scrutiny it can add up quite powerfully.
Again, the examples listed in this section are notional and not expected to drive policy changes or even to provide recommendations. They are; however, useful in illustrating the power of a discrete time Markov chain in analyzing the Air Force Assignment system.

VI. Conclusion and Future Research

In conclusion, the United States Air Force could greatly benefit from quantitative analysis of the officer assignment system. The Air Force is a large organization with over 61,000 officers who each move generally every two to four years to several dozens of locations around the world. In theory this creates a well-rounded leader who is experienced in multiple domains and mission sets. However, at a time when the Air Force is heavily used in multiple fronts and is facing serious personnel shortfalls at higher ranks it is more important than ever to examine how assignments are linked with retention. Recall, the Air Force cannot directly hire seasoned fighter pilots or Colonels; it must grow them and retain them.

The model presented here is fairly straight forward, but illustratively powerful. A discrete time Markov chain model as presented can be highly useful for examining what-if scenarios. With notional data it suggests the present assignment system leads towards an expectation of a typical officer separating from military service around the middle point of a career. In reality many officers separate after their first assignment, and with each assignment more and more separate as it is a natural break point that often coincides with the end of a service commitment.

Further research in this area is warranted, and there are numerous paths to explore. A continuous time Markov chain could be used for higher resolution on when officers are separating or transitioning to a new assignment. Another option would be to look at higher order Markov chains, this would consider an officer's history and provide a better predictive measure of the next assignment. Inputting real world data into a model would be critical to making informed decisions, but even notional systems could continue to be developed. Sensitivity analysis would be the logical next step to try and predict where certain breakpoints might occur. For example, as Bessent and Bessent found there may come a point of saturation for the system—too many senior Air Force officers for available positions. This in turn could drive other informed policy recommendations possibly including another round of reduction in force boards.

Similar work could be done for a variety of military problems. This paper focused on the officer assignment system, thus a logical next step would be examining enlisted assignments. The process for recruitment, assignments, and eventual separation has a number of differences but in broad strokes is fundamentally the same. Any model for officers could be easily adapted for the enlisted system.

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Table 1. Notional Transition Matrix P

	Recruitment	Arizona	California	Colorado	Florida	Georgia	Louisiana	Nevada	New Mexico	New York	Ohio	Texas	Utah	Virginia	Al Udeid	Chili	Germany	Hawaii	Korea	United Kingdom	Masked location	Separation
Recruitment	0	0.8%	6.6%	2.6%	8.2%	0.3%	1.6%	8.9%	4.7%	6.3%	10.5%	13.2%	0.5%	22.9%	0.3%	0.3%	2.1%	3.7%	2.4%	3.4%	0.8%	0
Arizona	0	0	5.5%	2.2%	6.8%	0.2%	1.3%	7.5%	4.0%	5.3%	8.8%	11.0%	0.4%	19.2%	0.2%	0.2%	1.8%	3.1%	2.0%	2.9%	0.7%	16.8%
California	0	0.7%	0	2.3%	7.2%	0.2%	1.4%	7.9%	4.2%	5.6%	9.3%	11.6%	0.5%	20.2%	0.2%	0.2%	1.9%	3.2%	2.1%	3.0%	0.7%	17.6%
Colorado	0	0.7%	5.6%	0	7.0%	0.2%	1.3%	7.6%	4.0%	5.4%	9.0%	11.2%	0.4%	19.5%	0.2%	0.2%	1.8%	3.1%	2.0%	2.9%	0.7%	17.0%
Florida	0	0.7%	5.9%	2.4%	0	0.2%	1.4%	8.0%	4.2%	5.6%	9.4%	11.8%	0.5%	20.5%	0.2%	0.2%	1.9%	3.3%	2.1%	3.1%	0.7%	17.9%
Georgia	0	0.7%	5.5%	2.2%	6.8%	0	1.3%	7.5%	4.0%	5.3%	8.8%	11.0%	0.4%	19.1%	0.2%	0.2%	1.8%	3.1%	2.0%	2.9%	0.7%	16.7%
Louisiana	0	0.7%	5.6%	2.2%	6.9%	0.2%	0	7.6%	4.0%	5.3%	8.9%	11.1%	0.4%	19.3%	0.2%	0.2%	1.8%	3.1%	2.0%	2.9%	0.7%	16.9%
Nevada	0	0.7%	5.9%	2.4%	7.3%	0.2%	1.4%	0	4.3%	5.7%	9.5%	11.8%	0.5%	20.6%	0.2%	0.2%	1.9%	3.3%	2.1%	3.1%	0.7%	18.0%
New Mexico	0	0.7%	5.7%	2.3%	7.1%	0.2%	1.4%	7.8%	0	5.5%	9.1%	11.4%	0.5%	19.9%	0.2%	0.2%	1.8%	3.2%	2.1%	3.0%	0.7%	17.4%
New York	0	0.7%	5.8%	2.3%	7.2%	0.2%	1.4%	7.9%	4.2%	0	9.3%	11.6%	0.5%	20.1%	0.2%	0.2%	1.9%	3.2%	2.1%	3.0%	0.7%	17.6%
Ohio	0	0.7%	6.0%	2.4%	7.5%	0.2%	1.4%	8.2%	4.3%	5.8%	0	12.0%	0.5%	20.9%	0.2%	0.2%	1.9%	3.4%	2.2%	3.1%	0.7%	18.3%
Texas	0	0.7%	6.2%	2.5%	7.6%	0.2%	1.5%	8.4%	4.4%	5.9%	9.9%	0	0.5%	21.4%	0.2%	0.2%	2.0%	3.4%	2.2%	3.2%	0.7%	18.7%
Utah	0	0.7%	5.5%	2.2%	6.8%	0.2%	1.3%	7.5%	4.0%	5.3%	8.8%	11.0%	0	19.2%	0.2%	0.2%	1.8%	3.1%	2.0%	2.9%	0.7%	16.7%
Virginia	0	0.8%	6.8%	2.7%	8.4%	0.3%	1.6%	9.2%	4.9%	6.5%	10.8%	13.6%	0.5%	0	0.3%	0.3%	2.2%	3.8%	2.4%	3.5%	0.8%	20.6%
Al Udeid	0	0.7%	5.5%	2.2%	6.8%	0.2%	1.3%	7.5%	4.0%	5.3%	8.8%	11.0%	0.4%	19.1%	0	0.2%	1.8%	3.1%	2.0%	2.9%	0.7%	16.7%
Chili	0	0.7%	5.5%	2.2%	6.8%	0.2%	1.3%	7.5%	4.0%	5.3%	8.8%	11.0%	0.4%	19.1%	0.2%	0	1.8%	3.1%	2.0%	2.9%	0.7%	16.7%
Germany	0	0.7%	5.6%	2.2%	6.9%	0.2%	1.3%	7.6%	4.0%	5.4%	8.9%	11.2%	0.4%	19.4%	0.2%	0.2%	0	3.1%	2.0%	2.9%	0.7%	17.0%
Hawaii	0	0.7%	5.7%	2.3%	7.0%	0.2%	1.4%	7.7%	4.1%	5.4%	9.0%	11.3%	0.5%	19.7%	0.2%	0.2%	1.8%	0	2.0%	2.9%	0.7%	17.2%
Korea	0	0.7%	5.6%	2.2%	6.9%	0.2%	1.3%	7.6%	4.0%	5.4%	8.9%	11.2%	0.4%	19.5%	0.2%	0.2%	1.8%	3.1%	0	2.9%	0.7%	17.0%
United Kingdom	0	0.7%	5.6%	2.3%	7.0%	0.2%	1.4%	7.7%	4.1%	5.4%	9.0%	11.3%	0.5%	19.6%	0.2%	0.2%	1.8%	3.2%	2.0%	0	0.7%	17.2%
Masked location	0	0.7%	5.5%	2.2%	6.8%	0.2%	1.3%	7.5%	4.0%	5.3%	8.8%	11.0%	0.4%	19.2%	0.2%	0.2%	1.8%	3.1%	2.0%	2.9%	0	16.8%
Separation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Table 2. Notional E matrix

	Recruitment	Arizona	California	Colorado	Florida	Georgia	Louisiana	Nevada	New Mexico	New York	Ohio	Texas	Utah	Virginia	Al Udeid	Chili	Germany	Hawaii	Korea	United Kingdom	Masked location
Recruitment	1	0.0590	0.4791	0.1952	0.5896	0.0197	0.1176	0.6442	0.3479	0.4605	0.7520	0.9277	0.0394	1.5315	0.0197	0.0197	0.1565	0.2719	0.1758	0.2528	0.0590
Arizona	0	1.0479	0.4166	0.1697	0.5127	0.0171	0.1023	0.5602	0.3025	0.4004	0.6539	0.8067	0.0343	1.3318	0.0171	0.0171	0.1361	0.2364	0.1529	0.2198	0.0513
California	0	0.0513	1.3869	0.1696	0.5123	0.0171	0.1022	0.5597	0.3023	0.4001	0.6534	0.8060	0.0342	1.3307	0.0171	0.0171	0.1360	0.2363	0.1528	0.2196	0.0513
Colorado	0	0.0513	0.4165	1.1581	0.5126	0.0171	0.1023	0.5601	0.3025	0.4004	0.6539	0.8066	0.0343	1.3316	0.0171	0.0171	0.1361	0.2364	0.1529	0.2198	0.0513
Florida	0	0.0513	0.4161	0.1695	1.4754	0.0171	0.1022	0.5595	0.3022	0.3999	0.6531	0.8057	0.0342	1.3301	0.0171	0.0171	0.1359	0.2361	0.1527	0.2195	0.0513
Georgia	0	0.0513	0.4166	0.1697	0.5127	1.0160	0.1023	0.5602	0.3025	0.4004	0.6539	0.8067	0.0343	1.3318	0.0171	0.0171	0.1361	0.2364	0.1529	0.2198	0.0513
Louisiana	0	0.0513	0.4166	0.1697	0.5127	0.0171	1.0954	0.5601	0.3025	0.4004	0.6539	0.8066	0.0343	1.3317	0.0171	0.0171	0.1361	0.2364	0.1529	0.2198	0.0513
Nevada	0	0.0513	0.4160	0.1694	0.5119	0.0171	0.1021	1.5190	0.3021	0.3998	0.6529	0.8055	0.0342	1.3298	0.0171	0.0171	0.1359	0.2361	0.1527	0.2195	0.0513
New Mexico	0	0.0513	0.4164	0.1696	0.5125	0.0171	0.1023	0.5599	1.2814	0.4003	0.6537	0.8063	0.0342	1.3312	0.0171	0.0171	0.1360	0.2363	0.1528	0.2197	0.0513
New York	0	0.0513	0.4163	0.1696	0.5123	0.0171	0.1022	0.5597	0.3023	1.3719	0.6534	0.8061	0.0342	1.3308	0.0171	0.0171	0.1360	0.2363	0.1528	0.2197	0.0513
Ohio	0	0.0512	0.4157	0.1693	0.5116	0.0171	0.1021	0.5590	0.3019	0.3996	1.6048	0.8050	0.0342	1.3290	0.0171	0.0171	0.1358	0.2360	0.1526	0.2194	0.0512
Texas	0	0.0512	0.4152	0.1691	0.5110	0.0171	0.1020	0.5583	0.3016	0.3991	0.6518	1.7438	0.0341	1.3274	0.0171	0.0171	0.1356	0.2357	0.1524	0.2191	0.0512
Utah	0	0.0513	0.4166	0.1697	0.5127	0.0171	0.1023	0.5602	0.3025	0.4004	0.6539	0.8067	1.0320	1.3318	0.0171	0.0171	0.1361	0.2364	0.1529	0.2198	0.0513
Virginia	0	0.0508	0.4125	0.1680	0.5077	0.0170	0.1013	0.5547	0.2996	0.3965	0.6475	0.7988	0.0339	2.2103	0.0170	0.0170	0.1347	0.2341	0.1514	0.2177	0.0508
Al Udeid	0	0.0513	0.4166	0.1697	0.5127	0.0171	0.1023	0.5602	0.3025	0.4004	0.6539	0.8067	0.0343	1.3318	1.0160	0.0171	0.1361	0.2364	0.1529	0.2198	0.0513
Chili	0	0.0513	0.4166	0.1697	0.5127	0.0171	0.1023	0.5602	0.3025	0.4004	0.6539	0.8067	0.0343	1.3318	0.0171	1.0160	0.1361	0.2364	0.1529	0.2198	0.0513
Germany	0	0.0513	0.4166	0.1697	0.5127	0.0171	0.1023	0.5601	0.3025	0.4004	0.6539	0.8066	0.0343	1.3317	0.0171	0.0171	1.1268	0.2364	0.1529	0.2198	0.0513
Hawaii	0	0.0513	0.4165	0.1697	0.5126	0.0171	0.1023	0.5600	0.3025	0.4003	0.6538	0.8065	0.0342	1.3314	0.0171	0.0171	0.1360	1.2201	0.1529	0.2198	0.0513
Korea	0	0.0513	0.4165	0.1697	0.5126	0.0171	0.1023	0.5601	0.3025	0.4004	0.6539	0.8066	0.0343	1.3316	0.0171	0.0171	0.1361	0.2364	1.1425	0.2198	0.0513
United Kingdom	0	0.0513	0.4165	0.1697	0.5126	0.0171	0.1023	0.5600	0.3025	0.4003	0.6538	0.8065	0.0343	1.3315	0.0171	0.0171	0.1360	0.2364	0.1529	1.2047	0.0513
Masked location	0	0.0513	0.4166	0.1697	0.5127	0.0171	0.1023	0.5602	0.3025	0.4004	0.6539	0.8067	0.0343	1.3318	0.0171	0.0171	0.1361	0.2364	0.1529	0.2198	1.0479