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EXPLORING INTERPRETATIONS AND CONSEQUENCES OF MICHIGAN'S EXPUNGEMENT STATUTE THROUGH FORMAL MODELING AND ANALYSIS

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EXPLORING INTERPRETATIONS AND CONSEQUENCES OF
MICHIGAN'S EXPUNGEMENT STATUTE THROUGH
FORMAL MODELING AND ANALYSIS

By
Jonathan Parks

A REPORT
Submitted in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE
In Computer Science

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This report has been approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE in Computer Science.

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Abstract

Rules and regulations often come with a lack of clarity and the possibility of multiple interpretations. Without a clear understanding of what they are supposed to mean it becomes difficult to tell the people that these rules and regulations apply what to expect from them. This report will take a closer look at one of these sets of rules, the expungement laws in the state of Michigan. The alternative interpretations and possible contradictions are explored and their effects on real people are discussed. After an introduction providing a general understanding of the issue, a proposed solution to these problems will be looked at as well. Computer models can be used to explore the consequences and different outcomes from different interpretations of these laws. A model was written in Alloy in order to show the practicality of this method and was used to further explore the Michigan expungement laws.

1 Legal Modeling and Michigan Expungement Laws

Statutory law, which is law written by the legislature, is meant to have a plain and straightforward meaning. But any set of protocols or rules written in natural language can be interpreted in multiple ways, and even statutory law is subject to interpretation by judges. To make matters more complicated, statutory law is continually amended by the legislature, and how the amendments interact with the previous versions of the law can be quite difficult to determine. It may not even be clear to the legislators making the amendments what the consequences are of their actions. The stakes can be high: the results of these decisions can span from minor inconveniences to life altering effects, all due to possible loopholes in writings that may not have been the intention of the author of those rules in the first place. In this problematic context, we are exploring the use of a model-based computational tool to seek and point out multiple interpretations and unforeseen consequences of statutory law and similar protocols and rules. The main goal of using a model based approach is to demonstrate immediately to a rule-making group what the implications are and how differing interpretations will have drastically different outcomes. For the purposes of this paper we will be looking at the State of Michigan's Expungement legislation, and more specifically the Applications and procedures for setting aside felonies and serious misdemeanor convictions.

1.1 Setting Aside Felonies and Misdemeanors in Michigan

The procedures for setting aside Felonies and Misdemeanors in Michigan are laid out in Act 213 of 1965 in the state of Michigan in section 780.621d. It explains different methods by which convictions of varying severity can be set aside and expunged, or removed from an applicant's public record. This statute has great potential benefit for those who have been convicted of crimes and who have served their sentences. If someone committed a crime in the early years of their life, the presence of that conviction on their record can make it difficult for them to get jobs, housing, or other fundamental components of reintegration into society. Having the ability to petition the court to have these convictions set aside is a crucial step to allowing well-adjusted people to work and live unhindered by past mistakes.

While both misdemeanors and felonies have impacts on one's life, they vary in severity and sentencing. In Michigan a misdemeanor is any crime that can be fined for at most 1000 dollars. These would often include lighter drugs or mild theft. A felony carries a much harsher sentence due to the increased severity of the crime, however the range of severity can vary drastically as felonies include everything from hard drugs to rape and murder.

The section itself is made up of 14 subsections, the first six of which lay out conditions under which a conviction may be expunged. A closer look at the exact process will be given in some of the following sections, but here is a brief overview. For any prior

conviction, an applicant must wait for their sentence, probation, or parole to be over. Once those have come to a close, a period of time must be waited before an application can be made: three, five, and seven years for misdemeanors, serious misdemeanors, and felonies respectively. If another crime is committed in the time, then the applicant is not able to file for the conviction to be set aside.

The focus of this report will be on the first six subsections and the possible interpretations someone may have when reading the prodacale.

1.2 Contradictions and Alternative Interpretations

Hearing the outline of how the process for expungement works will already raise some questions in most people. It is possible that at the time of writing the document, the authors knew what they wanted the interpretation to be, but years later it is not clear and has led to confusion in many court cases. There are several examples in the section that contribute to confusion among lawyers and applicants today, but for the sake of brevity this report would like to take a serious look at one of these alternative interpretations by looking at the exact wordings in the law itself.

Consider a case in which a person is able to set aside a conviction they committed while waiting for another conviction to be eligible for expungement.

Sec. 1d. (1) An application under section 1 to set aside more than 1 felony conviction shall only be filed 7 or more years after whichever of the following events occurs last:

- (a) Imposition of the sentence for the convictions that the applicant seeks to set aside.
- (b) Completion of any term of felony probation imposed for the convictions that the applicant seeks to set aside.
- (c) Discharge from parole imposed for the convictions that the applicant seeks to set aside.
- (d) Completion of any term of imprisonment imposed for the convictions that the applicant seeks to set aside.

Figure 1

The section of the statute in Figure 1 explains the conditions needed for a felony to be eligible for expungement. Notice that it says once an applicant has served their sentence and imprisonment time, as well completed felony probation and parole, then they may make an application seven years after whichever one of these events happened last.

(3) An application under section 1 to set aside 1 or more misdemeanor convictions, other than an application to set aside a serious misdemeanor or any other misdemeanor conviction for an assaultive crime, shall only be filed 3 or more years after whichever of the following events occurs last:

- (a) Imposition of the sentence for the conviction that the applicant seeks to set aside.
- (b) Completion of any term of imprisonment imposed for the conviction that the applicant seeks to set aside.
- (c) Completion of probation imposed for the conviction or convictions that the applicant seeks to set aside.

Figure 2

Section 2 includes an explanation in a similar manner of the events needed to be eligible to apply to set aside a misdemeanor conviction. In this case, all of the events are the same except for the lack of a parole. One important item to note is that for a misdemeanor an applicant must only wait three years before they may file an application for expungement.

(4) For an application under section 1, a court shall not enter an order setting aside a conviction or convictions unless all of the following apply:

(a) The applicable time period required under subsection (1), (2), or (3) has elapsed.

(b) There are no criminal charges pending against the applicant.

(c) The applicant has not been convicted of any criminal offense during the applicable time period required under subsection (1), (2), or (3).

Figure 3

Subsection 4, given in Figure 3, lays out a set of additional conditions that must apply to all convictions. The first condition simply reinforces the need for the applicable time period to elapse. The second says that the applicant may not have pending criminal charges and the final one says that an applicant may not apply if they have committed another crime in the time they must wait.

Using these three subsections, it is not impossible to imagine a scenario that is both realistic and leads to many questions regarding the desired outcome of the initial lawmakers:

Assume an applicant with a felony conviction had gotten to the point where the designated period of waiting starts in the year 2000. For the next two years nothing happens, and then they commit a misdemeanor. They are sentenced to a small amount of jail time which is served before the completion of the year. This means that in 2002 the period of time for the misdemeanor started. The applicant commits no further crimes and is able to get the misdemeanor set aside in 2005.

At this point one should consider when they believe the felony should be eligible for application. Some may read subsection 4C and come to the conclusion that since a crime was committed in the applicable time period for the felony, there is no way for that felony conviction to ever fulfill that condition and thus should never be expunged.

Another person may read section 1D and conclude that since a conviction was set aside and that crime started its waiting period in 2002, that the waiting period for the felony should be reset to 2002, allowing the applicant to apply to have the felony set aside in 2009. Finally, a third person might argue that since the misdemeanor conviction was set aside, a judge might decide the felony could be set aside in 2007, since it is as if there is not a crime on their public record during the applicable time.

The above example is far from a comprehensive list of ways someone may argue about when or if the felony would be eligible for expungement. Every year a person is left with a felony on their record is another year of being limited to what jobs they can use or what

end of life care they may be able to get. Regardless of the intention of the author it comes down to how the deciding authority reads what they want it to mean.

1.3 Accessibility of Applying for Expungement

It is obvious that the desire of the attorney general of Michigan is to have the process of applying for expungement to be approachable by the everyday person. They offer resources which allow you to submit a pdf to submit an application, and have plans to automate some steps of the process by 2023. The desire to make the system easier to use is there and prevalent. (AG - Expungement of Criminal Offenses in Michigan, 2022)

In principle this is not inherently a bad thing. As discussed the sooner people are able to get past convictions off their public record the sooner they can get back to living with no restrictions. In addition, hiring a lawyer is not a luxury that everyone has. The option to get your convictions expunged without a professional is a good thing. Because of the confusion that can be found in the legislation, however, the process of setting aside your own convictions is something much easier said than done.

Since some lawyers are confused about what qualifies for expungement and only know if a case will pass for sure only once it has, it would be impossible for the average person to determine if their case is safe for expungement unless it is trivial.

(5) If a petition under this act is denied by the convicting court, a person shall not file another petition concerning the same conviction or convictions with the convicting court until 3 years after the date the convicting court denies the previous petition, unless the court specifies an earlier date for filing another petition in the order denying the petition.

figure 5

Section 5 adds to discouraging an applicant from trying to apply by themselves without consulting a professional because if it is rejected they will have to wait another three years before applying again. If they are already applying in order to get into something more time-sensitive such as assisted living, three years is a potentially devastating amount of time. All of this means that applicants often still feel the need to have a lawyer to ensure their best chances of knowing if they can get a conviction set aside. However as previously mentioned this isn't always practical for people. Even for the people it is practical for, lawyers will only get paid in these cases if they win, which means there is incentive for them to only take the easier cases that they are more likely sure will be expunged. This lack of accessibility stems from the fact that there simply is too much ambiguity in how the law should be read and would be solved with more rigid and better understood laws.

2 Real Life Stories and Consequences

2.1 Clean Slate

While hearing what the down sides of having an old felony on one's record could be, reading about real life stories offers a much more grounded understanding of how important it is for the people who are affected directly by these laws. Clean Slate for Michigan offers many stories regarding people who have past felonies and would like to move on from them and move their lives forward.

Robert had an altercation with his own son about a dispute over college. During the altercation Robert hit his son and was charged with battery against a family member. He served all of the necessary time needed for the felony as well as spent a large amount of time making amends with his wife and children. He also sought assistance from others to ensure that the same mistake would never happen again. To get his life back on track, he is attempting to get a bachelors in social work, but at the time of filming of the video he still had a year left. All of this sounds good, except for the fact that he knows with the felony on his record he will not be able to find work once he gets his degree, making it hard to justify borrowing the money needed to complete his degree. (McCracken, 2022)

Jarret was raised in a household where his mother would bring drugs home and he would simply take them from her and sell them to get money to feed his siblings. At the age of 20 he was caught and put in jail for all of his 20s. When he was let out he had no help reintegrating into society. He has done his best to build an organization which would provide a service to allow other people just coming out of prison to reintegrate into society. However the felony on his record for most of his life has made the process extremely difficult. (McCracken, 2022)

These examples illustrate how laws like those helping with expungement can be life changing for people, and why having clear and easy access to use the rights that are given is important.

2.2 Interpretations in a Story

One may hear the stories above and agree they are touching but not see why they call for the need of clarification in these legal regulations. One might argue that for people like above with just a single case that it is easy to understand. While that might be the case as previously mentioned, unless they have the understanding of the laws to know if their case is simple they may still need to go through the barrier of hiring a lawyer. The bigger problem is that not all stories are as clear cut as the ones of Robert and Jarret.

One of the committee members for this report is attorney Susanna Peters who works with expungement cases similar to these. She has shared a story that deals with the interpretation example from section one and will be later explored in section four. For the sake of privacy the applicant will not be referred to by name.

Commonly an applicant comes to this program after a period of trouble, often due to drugs or alcohol or other stresses that they are now managing. They may have multiple convictions in a 3-7 year period. One recent example Peters discussed was an applicant who had joined the military to go to Iran. Before he left he had a night of drinking that led to a felony conviction. Then about 3 years later he was found using marijuana, a misdemeanor, but because he ran from law enforcement he racked up two more felonies - one for fleeing and eluding and one more for resisting arrest when he cursed at police. So he now had 3 felonies in the course of 4 years. His record started back in around 2000. He served in Iraq, was a medic, and was honorably discharged after about 12 years.

In 2020, even though he really wanted to help at the local hospital during Covid he was not able to be employed there due to this felony record from 17-20 years earlier.

The problem they had in court was that the prosecutor argued that the law states that if a person with a felony conviction has a second within 7 years of the first one they are ineligible for any set asides - forever. Peters explained " I had to argue that this was not the "intent" of the legislature but I can see how he read it that way. It's not a crazy or unreasonable interpretation of the law. It is in fact reasonable and the only way to argue this was to say I did not "think" that's what the legislature "intended" as we all know that humans tend have some times when they are getting in trouble and the legislature intended that this new law enable people to be able to have a clean slate if they have been out of trouble for 7 years from the present day, not from the first conviction."

This example illustrates that the text is not clear even to an intelligent elected state Prosecutor. The end result is that Judges and attorneys have to interpret this statute based on outside knowledge or beliefs.

The judge for a case such as this should be able to make a good decision that is fair to the defendant in spite of the ambiguous wording of the law, however this is not always the case. In small towns the judges don't have a lot of experience with more complex expungement cases and do not know what the traditional ruling would be. In addition, even in bigger cities there is often a lack of large cases that set precedent so it can be hard to ever know what a judge will rule. Finally a judge never wants to be the person who lets a felon expunge their felony and then have that person commit another crime no matter

how unlikely that could be for a given person, especially one seeking aid to enter a retirement home.

All of these factors can lead to someone, like this man, from being conviction free, when the general public would agree that they should be able to get their public record clean. This is why clarification and understanding by both the author and reader is crucial to enforcing fair and consistent judicial decisions. This sort of understanding becomes possible with light weight modeling.

3 Computational Modeling

3.1 A Solution to Understanding Procedures and their Implications

It is clear that not only does the act of leaving rules and regulations up to interpretation can have disastrous consequences but also that these interpretations may not even be something intended by the author. This is not exclusive to legal systems. Consider a business infrastructure in which they must set up permissions and there will be sent information between people with different permissions. With a complex system in which information of different security levels is shared between employees of different access levels it is quite possible to write protocols in a manner that leads to undesired outcomes. Missing out on some of these cases can lead to large vulnerabilities in a system and for information to end up going places it should not all because the initial infrastructure was set up incorrectly.

As traditional coding systems are implemented in almost every large company and government which exceed the amount of code that is possible to be read by a person in a reasonable amount of time, it also becomes increasingly difficult to find where a potential problem in the system came from and if it is simply a problem with your implementation or with the procedure it is running. Often model driven development is used in these cases to create a working model in order to ensure the initial protocols are void of contradictions and ensure that you have a sound basis to build your system on. In some cases the model can even be used to make some of the source code that would be written.

This process is common and growing in the world of development but is not explored in the world of legislation or procedures dealing with regulations such as HIPAA. Using the modeling tool Alloy we explore this possibility by modeling the example from section 1.2 with the goal of showing the practicality of applying modeling tools to more natural language based problems as well as explain some of the challenges and solutions that arise from this sort of problem. Seeing the consequences of not fully understanding a set of rules from the expungement example it becomes clear that a tool to assist in the creation of similar protocols is needed.

3.2 Alloy and Electrum Overview

To better understand the example it is also important to have an understanding of the tool being used to develop it. Alloy is a specification language and an analyzer engine that uses predicate logic. An Alloy model consists of a set of constraints that are put on different objects and relationships between those same objects. When it is run it will try to find a satisfactory instance which will meet all the constraints put in place and display it graphically. Alloy allows for lightweight modeling, meaning it is possible to make small models quickly which do not capture every small detail in an instance but provides enough information to learn from quickly. Alloy has been used for many different applications in the past such as the aforementioned model driven development, and security. Because of the flexibility of the tool it allows for the modeling of many real world relationships in addition to digital ones. This is the reason for it being chosen for the expungement example. Since the items in Alloy, in this case signatures, are able to be as broad or restrictive as needed it was possible to take something as complicated as the legal system and abstract the information we cared about into easy to define terms and not get caught up in assigning things that otherwise would not matter. Because of the fact that Alloy is simply checking constraints and not performing any intensive calculations in the model itself it is possible to get timely and accurate results for complex systems. Simple changes can be made to an Alloy model in order to see how a simple interpretation of a set of rules will change the output graph or perhaps create a contradiction in the constraints showing a problem immediately which would not be clear as quickly using more traditional methods of checking prodecalls

Electrum is an addition to Alloy which allows for temporal operators and constraints to also be used when setting up predicates that need to be checked. It is crucial we have some form of temporal operation when dealing with the example of expungement. Since many of the interpretations that need to be explored are reliant on a very specific set of events happening in a specific order. Not every problem needs temporal operators to be expressed accurately in Alloy and it is possible that you can express these time based problems with only static relationships. The newest edition of alloy has implemented the temporal operations Electrum uses, however for the model described later in the paper Electrum was used.

4 Alloy Example using Michigan Expungement Law

In order to demonstrate the effectiveness of Alloy as a tool to perform modeling on real world scenarios an example using the ambiguous situation from the first section has been created. While not the only way to implement such a system it provides an accurate case showing that when forced to break legal code into a set of variables it can be easy to see where contradictions exist and will exist when changes are made.

4.1 Describing Legal Terms in Alloy

Before a model could be created it was necessary to determine what signatures are in the example being looked at as well as understanding what variables each one of those signatures have. If there is a key element in the example that is not modeled or the model is littered with unnecessary information then the usability of the model suffers and since the goal is to demonstrate the practicality of tools like Alloy it is important to model exactly what is needed, no more and no less. In this case looking at the example gives a clear case for what the signatures should be. Models will be made up of applicants trying to get convictions expunged and convictions themselves. Those are the only two items mentioned in the sections and external items like lawyers or prisons would only serve to overcomplicate the set of signatures.

The next step is to determine what information needs to be assigned to each signature. In the model it was decided to model it so that all information would be connected to the conviction itself and not the applicant. This is since the applicant will have many convictions at differing steps in the process. If a conviction has all the relationships tied to it then it is possible to get access to other crimes committed by the same person simply by checking both of their perpetrator variables. In addition to having a relationship with a single perpetrator a conviction must also have a state that it exists in the expungement process. This is a key step in the process of converting language into an Alloy model. While the sections simply explain the necessary qualifications that a conviction must have to be expunged it is important to extrapolate out of that the information needed to model. In this case it was determined that a conviction could be in one of 4 states. It could still not be committed and simply waiting to be committed. It could be committed but not eligible for expungement, it could be eligible for expungement and not yet expunged, and finally it could be expunged. Finally it is important that the severity of the crime is known. For the sake of the example only the felony and misdemeanor severities need to be used

In addition to these three key pieces of information, the applicant, the state of the conviction, and the severity of the conviction, there is one more thing that must be known. For example it is important to have a case where the felony conviction resets to the position in the process it was in before the second conviction happened. A simple set of two variables are set in order to remember this information in case a reset to its previous location is necessary. This gives the necessary building blocks to create the constraints needed in order to accurately model the information. What is important to note is that by carefully looking at the critical information and disregarding the rest any subsections from the section of interest can be modeled similar to how the subsections will be modeled.

```

--A person looking to expunge a conviction
sig applicant {
}

--The state the conviction is in
--It can either be expunged, Eligible to be expunged or not Eligible to be expunged
abstract sig convictionState { }
abstract sig convictionSeverity { }

one sig expunged, eligible, almostEligible, notEligible, notCommitted extends convictionState { }

one sig misdemeanor, felony extends convictionSeverity { }

--The convictions a person could have
--They exist in at most one state
sig conviction {
  var state: one convictionState,
  var perpetrator: lone applicant,
  var severity: one convictionSeverity,
  var reset: lone conviction,
  var savedState: lone convictionState,
}

```

figure 6

The signatures as described can be seen above and demonstrates information in Alloy and what it looks like.

4.2 Alloy Constrictions and Predicates

In addition to the work put into carefully selecting and setting up the information needed to model the example, it is necessary to put thought into what the different events can take place during any given time step as well as ensure that the step does not allow for more to take place than what it desired.

There are three steps which can take place at a given time. An applicant could commit a crime, the crime could go from not being eligible for expungement and finally a crime could be expunged. In order to accurately capture these steps, predicates with sets of constrictions were created to model them. A closer look will be given to all of these steps as well as alternative models for the steps based on how one were to interpret the laws they are attempting to model.

When talking about the code written in the model it is important to remember that while active terms such as “setting a variable” are used, they are more so there for the ease of explanation. The code is not setting a value but rather giving a constriction that the model must meet. All of the constrictions for all the predicates must be true in the time steps.

4.2.1 Committing a Crime

When a crime is committed there are two possible predicates that are checked against based on what interpretation is being run. First look at the case where if a crime is committed while another crime is in its waiting period there is a reset for the waiting period and the new start time will stay set in stone.

```
pred commitCrime[a:applicant, c:conviction] {
  c.state = notCommitted
  c.state' = notEligible
  severity' = severity
  reset' = reset
  savedState' = savedState

  perpetrator' = perpetrator + (c-> a)
  all c1:conviction | (c1.perpetrator = a) implies c1.state' = notEligible
  all c2:conviction | ((c2.perpetrator != a) and (c2 != c)) implies c2.state' = c2.state
}
```

figure 7

Firstly note that in order for a crime to be committed there must be an applicant and a conviction. This is because the crime needs to be attached to an applicant in order to track what should happen with other crimes committed by the same applicant.

Next, the first two lines are confirming the states that the conviction must be in before and after the crime is committed. The apostrophe indicates that it is referring to the next time step and is provided by electrum. The first line is saying that the only way a crime can be committed is if, and only if, it is currently not committed. This prevents the same crime from being committed twice. The second line is stating that after this time step the crime will move to the next state which is the notEligible state. This state is simply defined by being any point where the crime is committed but it is not eligible for expungement. The order of events matters while the exact set of years is not as important so having a state that covers that point in the conviction's lifespan is ok. The rest of the lines are simply saying that there should be no changes made to any of those three variables for any conviction. No conviction will change its own severity upon another crime being committed. In addition since this form of crime does not ever revert when the first crime's wait time starts there is no need to change the saved state or the reset variable. These will remain unused for this part of the example.

The next three lines outline the important constraints that give the specific behavior that is desired. The first of these is ensuring that the only perpetrator relationship that is changed by this step is the new one being added between this conviction and applicant. No one else can commit or expunge a crime in this time step. The second of these three lines starts off by taking a look at every other conviction in the model and referring to it

as c2. For any of these convictions if the perpetrator is the same as the one that just committed the crime then that conviction must reset to not eligible, regardless of the state it is currently in. The final line uses similar logic to the first and ensures that for any conviction not committed by the applicant who committed this new crime they will not lose any of their progress on their convictions.

While the above code provides the code if there is an assumption that when the misdemeanor from the example gets expunged that the felony committed before it will not return to the state it was initially in. As discussed in section one it is not clear if this is the case or not and in spite of showing how modeling these procedures forces the author to understand what they mean and the implications of that it is important to look at how the model would be written if this was the case and the crime could resume where it previously was after a crime that happened after it is expunged

```
all c1:conviction | (c1.perpetrator = a) implies  
(c1.state' = notEligible and c1.savedState' = c1.state and c1.reset' = c)  
  
all c2:conviction | ((c2.perpetrator != a) and (c2 != c)) implies  
(c2.state' = c2.state and c2.reset' = c2.reset and c2.savedState' = c2.savedState)
```

figure 8

While the rest of the model is the same there are critical differences when comparing the last two lines. In this case it is important to know both at what point the crime was at when it was reset as well as what crime reset it so that when that new crime is expunged it is possible to know that the original crime must be reset. This is done by again checking what convictions are not committed by the same person. If they are not the same person then all of their information stays the same as seen in the final line. However if the new crime is committed by the same person as a conviction then that conviction will save both its state before the reset, known by checking its current state. It also saves what conviction reset it simply by referring to the conviction. In addition to saving this information it will also still set its state in the next time step to be not eligible so that it is still resetting.

4.2.2 Time Elapsing for a Crime

While both interpretations in the example will move forward in time at the same time it is still important to capture the fact that felonies take longer than a misdemeanor. This fact is what allows a crime to be committed and expunged before the original window for the felony has elapsed. Because of this there are two predicates for elapsing time, one for every crime to go through, and second one which is skipped for misdemeanors but not for

felonies. This again allows for the difference in time needed to become eligible for expungement to be preserved without the need for counting years.

```
pred elapse[c:conviction] {  
    c.severity = misdemeanor implies state' = state - (c -> notEligible) + (c-> eligible)  
    c.severity = felony implies state' = state - (c -> notEligible) + (c-> almostEligible)  
    perpetrator' = perpetrator  
    severity' = severity  
    reset' = reset  
    savedState' = savedState  
}
```

figure 9

Above is the elapse predicate which every conviction will run through. First two lines are similar and only act differently in which severity of conviction the address. For the first line the conviction must be a misdemeanor. Given that it must be a misdemeanor it will change the set of state relationships by removing the conviction's previous relationship with not eligible and adding a new one making it eligible for expungement. The act of needing to remove the past relationship ensures that no convictions that are not in the not eligible state can successfully meet the constrictions set by this predicate, meaning no crimes will skip from not committed to this step. The second line is similar to the first with the small change that it checks if the severity is of the level of felony and if that is the case it will move the state from not eligible to almost eligible, which is the extra state added for just felony to simulate more time.

Past the first two lines the rest of this predicate is simply there to ensure that nothing else can change during this time step. Since this step and the other one that will be looked at after are simply to simulate the passage of time no changes need to be made to anything other than the states they crimes are in.

```
pred elapseFelony[c:conviction] {  
    state' = state - (c -> almostEligible) + (c-> eligible)  
    perpetrator' = perpetrator  
    severity' = severity  
    reset' = reset  
    savedState' = savedState  
}
```

figure 10

One of the simpler predicates which serves a similar purpose to the first one of this section. The first line simply moves a conviction from the almost eligible state to the

eligible state. There is no need to check if the conviction is a felony or a misdemeanor since the only way for a conviction's state to be almost eligible is for it to be a felony. This means any conviction meeting the first constraint must be a felony. The last four lines are identical and serve the same purpose as they do in the other elapse predicate, keep all relationships not currently in use the same in the next time step as they are in the current time step.

4.2.3 Expungement

Within the example currently being explored it is necessary to have two different predicates for expungement. This is because in one interpretation there is no reset to the original start time for the wait period of the felony when the misdemeanor is expunged while for another interpretation there is.

```

pred expungement[c:conviction] {
    state' = state - (c -> eligible) + (c-> expunged)
    perpetrator' = perpetrator - (c->applicant)
    severity' = severity
    reset' = reset
    savedState' = savedState
}

```

figure 11

First there is the simpler predicate in which the expungement of a crime has no implications on any other convictions. If this is the case then the process of expungement is quite simple. Firstly the state is updated so that in the next time step it will have the state of expunged. The reason for this is so that it is easy to identify in the model what has been expunged rather than give it no state. Next the perpetrator relationships remain the same except for the removal of the conviction being expunged to any applicant. This frees the applicant from the conviction. The last three lines are ensuring that none of the variables change in the next time step similar to what is seen in all of the other predicates.

```

all c1:conviction | (c1.reset = c) implies
(c1.state' = c1.savedState and c1.savedState' = none and c1.reset' = none)

all c2:conviction | ((c2.reset != c) and (c2 != c)) implies
(c2.state' = c2.state and c2.reset' = c2.reset and c2.savedState' = c2.savedState)

```

figure 12

Similar to the “commit crime” predicate, both of the expungement predicates are similar outside of a little more logic for one of the interpretations. In this case all that needs to be done is when a conviction is expunged every other conviction must be checked. For any

other conviction if it was reset by the conviction being expunged then the state should reset to the state it was at when it was initially reset. This state is saved by the saved state relationship. Then both the saved state and reset relationships are set to none in order to allow them to be used again.

With all three steps looked at it is possible to get an idea of the entire process from committing a crime to getting that crime expunged.

4.3 Initialization and Constraint Checking

Before it is possible to look at results it is important to create initializations for all of the values being used as well as create predicates to run which will get the desired output. First take a look at the initializations.

```
pred init {  
    all c: conviction | c.state = notCommitted and c.reset = c | and some c.severity  
    all c: conviction | c.savedState = none and c.perpetrator = none  
}
```

figure 13

There are two sets of initializations, ones where the value goes to none and the ones where it needs to be set to a specific value. While both could be expressed in a single line for readability it is expressed as follows. Every conviction starts off not being committed and thus the state for every conviction at the start sets to that value. The reset value for every crime starts as itself. This is because it allows for checking later if the reset is none to determine if something was ever reset since the only way it can be none is if something else reset it and then go expunged. Finally there are two possible severities, felony and misdemeanor, and by using the 'some' key word it will assign each conviction with one or the other. The last two values of saved state and perpetrator are kept empty since there is no old state for it to be reset to and since the crime is yet to be committed there is no perpetrator.

Finally there are two predicates that will be run to demonstrate the model. The first is simply to ensure that a crime can be expunged and will be used to explain how the graph works.

```
pred p1 { (some c:conviction | (c.severity = felony) and eventually expungement[c]) }
```

figure 14

For some conviction that is a felony it should eventually get expunged. The other predicate will make sure that the desired order of events to create the example's scenario is able to happen.

```
pred p2{ (some c:conviction | eventually
         (elapse[c] and after eventually
          (c.state = notEligible and after eventually
           c.reset = none))))}
```

figure 15

Starting the same as the first one it states that for some conviction eventually it will run the elapse predicate. In addition to running the elapse predicate it will at some point after that check that the state of the conviction is not eligible. This is to ensure that another crime resets the progress of this conviction. Finally, in addition to the state being not eligible it also needs to have its reset value equal to none some point in the future, which can only happen if the crime that reset it gets expunged first.

While it is expected that both interpretations successfully pass the first predicate, only the interpretation which allows for a crime to go back to its initial starting time should pass the second one.

4.4 Results

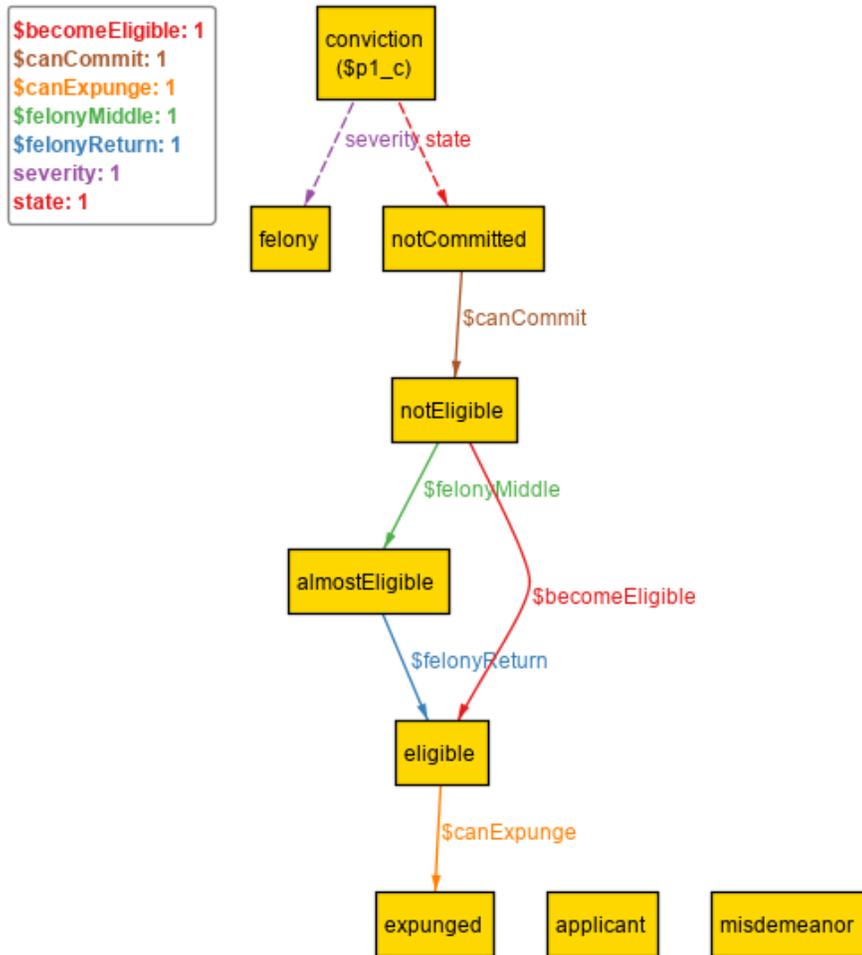


figure 16

First take a look at a solution to the predicate that simply expunges the crime. It begins in a state similar to the figure above. There are some convictions, in this case one felony, which starts off in the not committed state. Moving forward in time shows the whole process as the crime is moved through all of the necessary steps before finally being expunged.

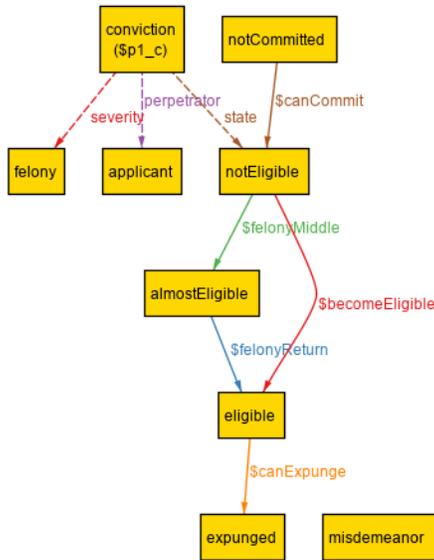


figure 17

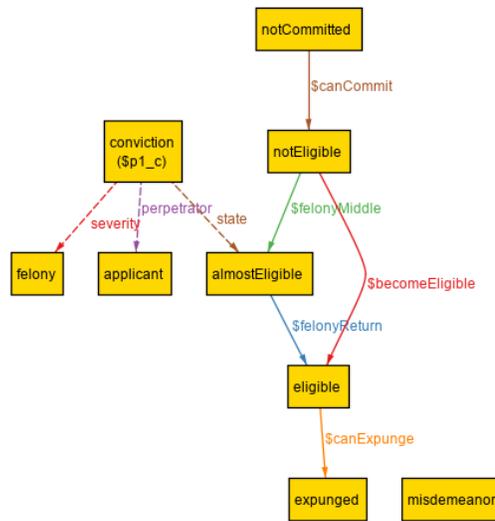


figure 18

These are the next two steps. The first one is where the crime gets committed and assigned to an applicant. The second step is the crime being moved from not eligible to almost eligible, which only happens because the severity is a felony.

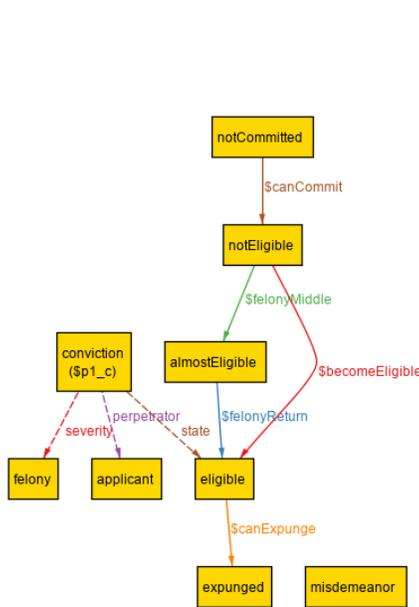


figure 19

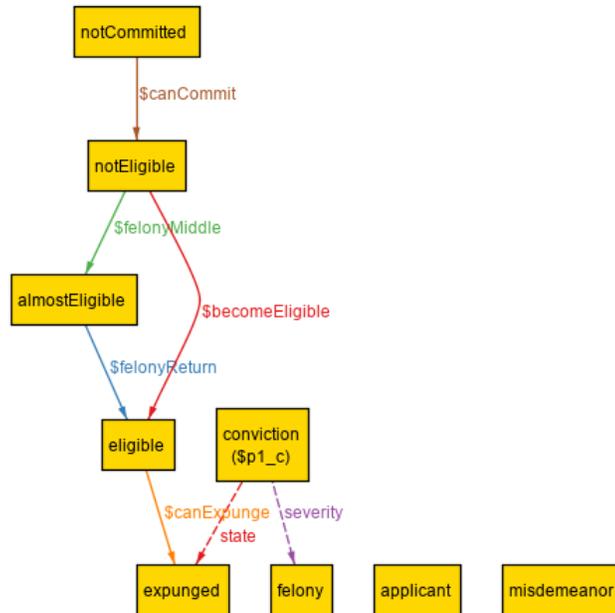


figure 20

These are the last two steps. The first one is simply the crime moving to be eligible for expungement and the final step is the conviction getting expunged which frees the

applicant from any connection to the system and leaves the conviction to not be committed again since its final state is in expunged.

The above example shows what the most basic expungement process would look like with only one applicant and one conviction. Regardless of interpretation the above example would look the same. The advantage of modeling procedures like the expungement law is to see where some sets or rules end up with no possible result whereas other sets do give results allowing for the comparing and contrasting of interpretations to happen immediately.

Running the second predicate on the set of predicates in which a person can never reset to their initial start time for their waiting period simply returns no instance found from the solver.

```
Executing "Run p3 for exactly 1 applicant, 4 conviction"  
Solver=sat4j Bitwidth=4 MaxSeq=4 SkolemDepth=1 Symmetry=20  
1341 vars. 80 primary vars. 3257 clauses. 27ms.  
No instance found. Predicate may be inconsistent. 724ms.
```

figure 21

This happens because there is no way to change the reset value in that set of predicates making the final statement in the run predicate 'c.reset = none' impossible to satisfy as it must stay as itself

Running the same predicate on the set of predicates that allows for the old start time to be reinstated returns a valid instance.

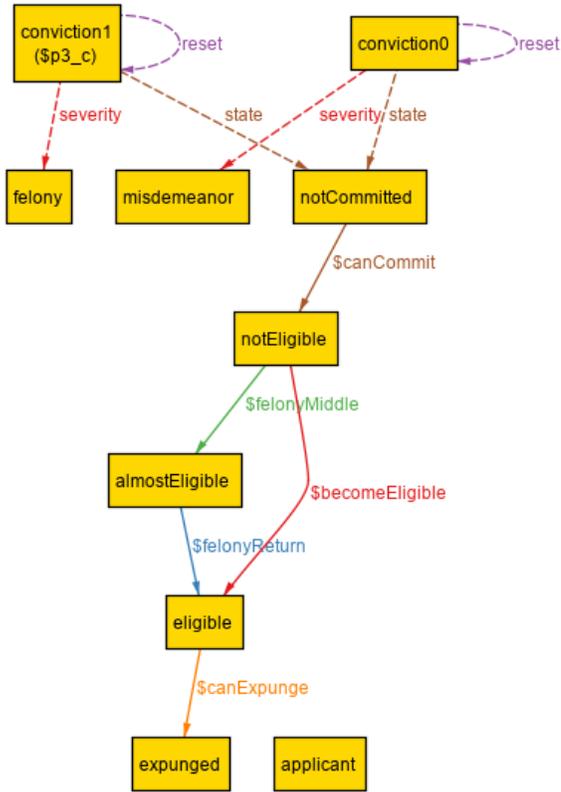


figure 22

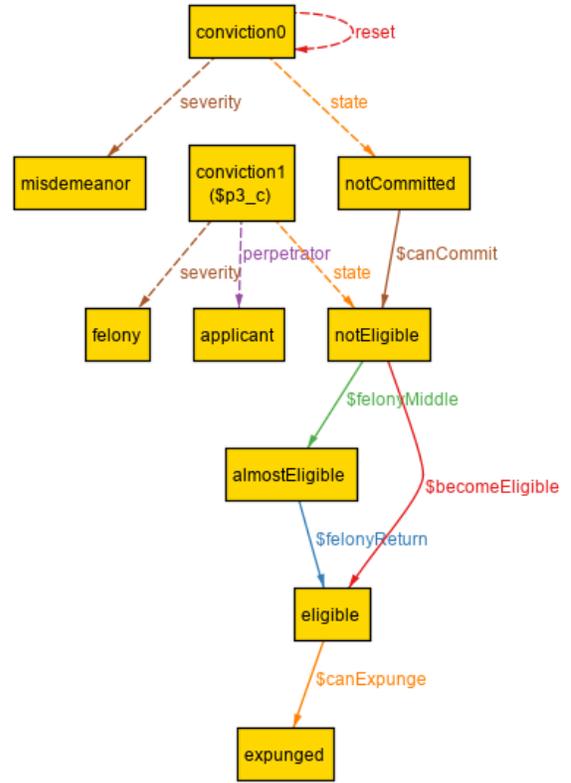


figure 23

The start state has a bit more going on but is very similar to the first example. The only big difference is that there are two crimes, one of which is a felony and one is a misdemeanor. The second step is also very similar, the felony gets committed and is attached to an applicant.

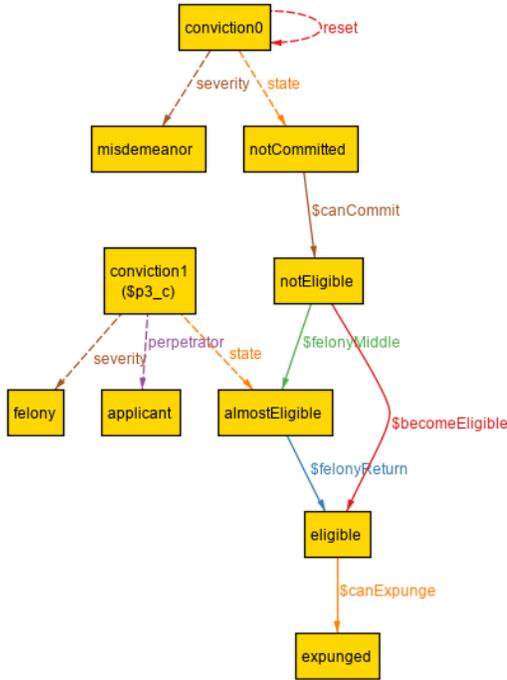


figure 24

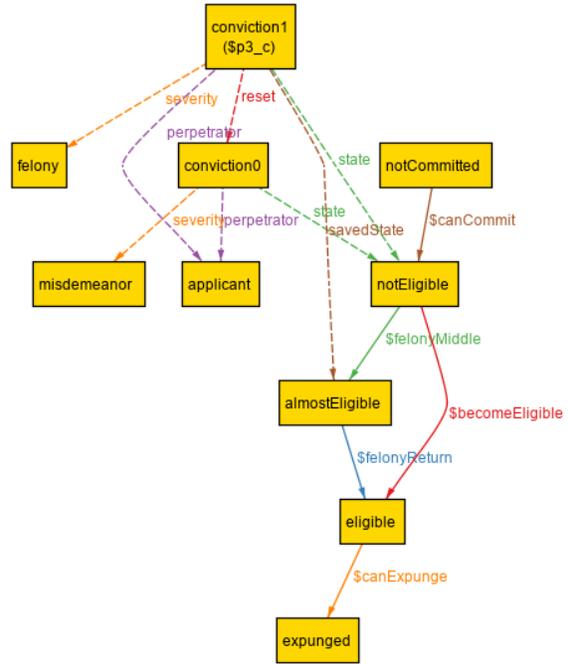
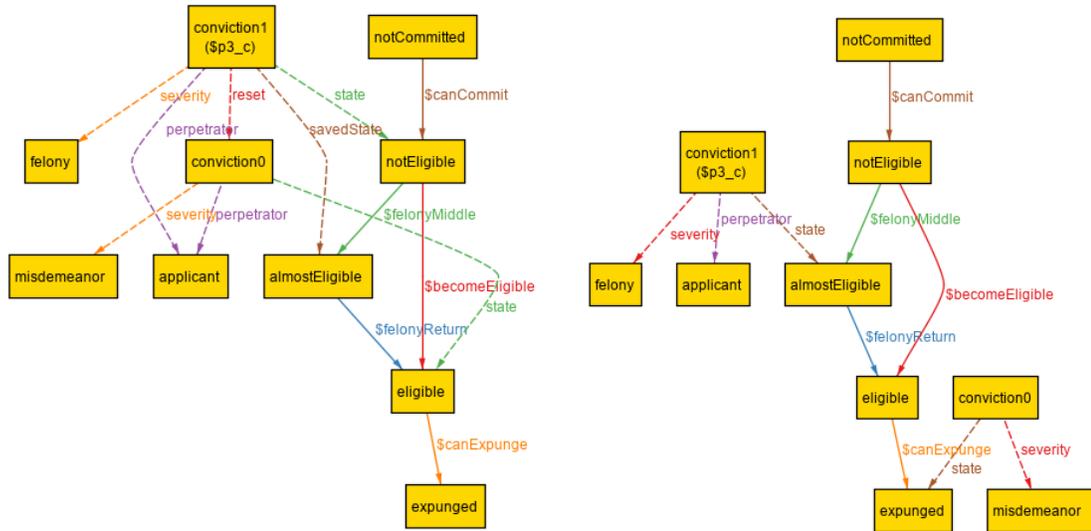


figure 25

The third step is again rather trivial, it will simply run the elapse predicate for conviction one and move it to almost eligible. The next step is when this example starts to take more shape. The conviction labeled conviction 0 happens and is assigned to the same applicant. This means that the first conviction will need to be reset, which it is. Both of the convictions are now not eligible.



The final two steps show the desired result. The first one shows conviction 0, the misdemeanor, being moved from not eligible to eligible, skipping almost eligible since it is not a felony. The last step the misdemeanor gets expunged. While in the other interpretation this would have no impact on the other conviction, in this interpretation it means that it is almost like no crime happened in the middle time period of the felony and thus it moves back to where it was when the reset happened, in this case almost eligible. The example stops here for simplicity but the felony could easily go on to be expunged similar to the misdemeanor of the felony from the first example.

5 Conclusion

By taking two of the interpretations of the law it was possible to make a model with two sets of predicates which accurately capture both of the interpretations. After creating the model it was possible to find a difference between the interpretations and showcase exactly what that would be. Describing protocols and rules this way forces the author to have an understanding of exactly what they want to say as well as allow for multiple interpretations to be tested and see which one gives the desired results.

This method of developing sets of rules and regulations is not limited to legal cases and is applicable in any instance where there is a defined list of events that take place. Once any possible interpretation discrepancies are worked out it is possible to maintain a model with low effort to check in the future if changes need to be made and what ramifications those changes would have on the current procedure the company or organization uses.

In the future it would be possible to develop a model alongside written English protocols. As the model is developed to reflect the rules an author could quickly check if circumstances they did not desire are possible. As time goes on and amendments are made to the protocols changes to the model would be made as well. This allows for two benefits. The first is the model can be used to ensure the validity of the protocol and that it lines up with the author's intent. The second is when a case that is not expected comes up the model can be used in order to check what the outcome should be. This method could be used by businesses in sharing data, or by judges in cases similar to the discussed example. A front end for a model like this would allow anyone, even ordinary people with no expertise in the field to use the model and discover what would happen under a certain set of circumstances.

While the usefulness of models in computer programming has been explored and implemented, its role in the world of modeling written rules is still open to be explored. The example presented in this report is a simple example to show the simplicity of modeling and testing these sets of rules. It would have been possible to push the model further and model the entire set of laws regarding expungement to get a better idea of the

system as a whole rather than just the small section regarding the conditions needed to set aside normal convictions.

6 Reference List

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