



**Lokmanya Tilak Jankalyan Shikshan Sanstha's**  
**Priyadarshini Bhagwati College of**  
**Engineering, Nagpur**  
**An Autonomous Institution Affiliated to R.T.M. Nagpur**  
**University, Nagpur**  
**Accredited by NAAC Grade 'A'**  
**Harpur Nagar, Umred Road, Nagpur- 440024**



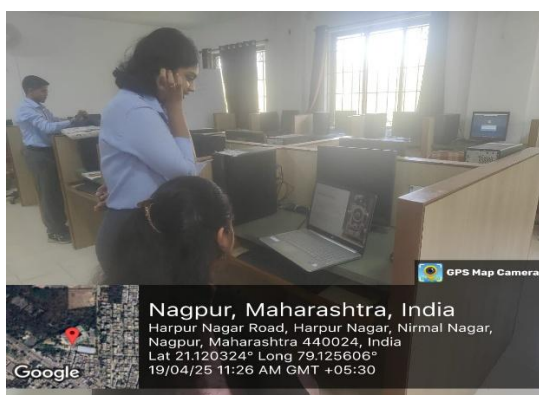
**Department of Computer Science and Engineering**

**Session: 2024-25 (Even Sem)**

**Report on Seminar**

<b>Name of the Students</b>	108-Hansika M. Kakpure
<b>Date of Seminar</b>	29/03/2025
<b>Semester</b>	Tech IV sem CSE
<b>Subject</b>	Theory of Computation
<b>Topic of Seminar</b>	Pushdown Automata
<b>Contents of the Seminar</b>	<ol style="list-style-type: none"><li>1. Introduction</li><li>2. Decoding the Formal Definition of a PDA</li><li>3. PDA in Action: Recognizing <math>L = \{0^n 1^n \mid n \geq 0\}</math></li><li>4. Instantaneous Description (ID): Tracing Computation</li><li>5. Transition diagram -DFA, NFA</li><li>6. Example</li><li>7. Difference</li><li>8. Conversion</li><li>9. Conclusion</li></ol>

**Photos of the seminar**



**Signature of Students**



## Wrapping Up: PDA, CFGs, and Their Impact

Pushdown Automata use a stack for memory. They are closely related to Context-Free Grammars. Understanding PDAs unlocks key applications in computer science. Explore further learning resources to master PDAs.



## Real-World Applications of Pushdown Automata

- Compiler Design
  - Parsing context-free languages.
- NLP
  - Syntax analysis in natural language processing.
- Verification
  - Model checking of systems.

PDAs are used in programming language parsers and protocol analysis tools.

### The Power Couple: PDA and Context-Free Grammars (CFG)

- CFG to PDA
  - Convert a CFG to an equivalent PDA.
- PDA to CFG
  - Convert a PDA to an equivalent CFG.

CFG and PDA are equivalent. For every CFG, there exists a PDA, and vice versa.



## Acceptance Methods: Empty Stack vs. Final State

- Empty Stack
    - PDA accepts if it empties its stack.
  - Final State
    - PDA accepts if it reaches a final state.
- Both methods are equivalent. Any language accepted by one can be accepted by the other.

### Instantaneous Description (ID): Tracing Computation

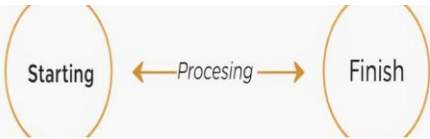
1 State (q)  
Current state of the PDA.

2 Input (w)  
Remaining input string.

3 Stack (γ)  
Current stack contents.

Represent PDA configuration as (q, w, γ). Use IDs to trace computation paths. For example: (q0, 0011, Z0) → (q1, 011, 0Z0).

```
q0: (q0, 0011, Z0) → (q0, 0011, Z0)
q1: (q0, 0011, Z0) → (q1, 011, 0Z0)
q2: (q1, 011, 0Z0) → (q2, 011, 0Z0)
q3: (q2, 011, 0Z0) → (q3, 011, 0Z0)
q4: (q3, 011, 0Z0) → (q4, 011, 0Z0)
q5: (q4, 011, 0Z0) → (q5, 011, 0Z0)
q6: (q5, 011, 0Z0) → (q6, 011, 0Z0)
q7: (q6, 011, 0Z0) → (q7, 011, 0Z0)
q8: (q7, 011, 0Z0) → (q8, 011, 0Z0)
q9: (q8, 011, 0Z0) → (q9, 011, 0Z0)
q10: (q9, 011, 0Z0) → (q10, 011, 0Z0)
q11: (q10, 011, 0Z0) → (q11, 011, 0Z0)
q12: (q11, 011, 0Z0) → (q12, 011, 0Z0)
q13: (q12, 011, 0Z0) → (q13, 011, 0Z0)
q14: (q13, 011, 0Z0) → (q14, 011, 0Z0)
q15: (q14, 011, 0Z0) → (q15, 011, 0Z0)
q16: (q15, 011, 0Z0) → (q16, 011, 0Z0)
q17: (q16, 011, 0Z0) → (q17, 011, 0Z0)
q18: (q17, 011, 0Z0) → (q18, 011, 0Z0)
q19: (q18, 011, 0Z0) → (q19, 011, 0Z0)
q20: (q19, 011, 0Z0) → (q20, 011, 0Z0)
q21: (q20, 011, 0Z0) → (q21, 011, 0Z0)
q22: (q21, 011, 0Z0) → (q22, 011, 0Z0)
q23: (q22, 011, 0Z0) → (q23, 011, 0Z0)
q24: (q23, 011, 0Z0) → (q24, 011, 0Z0)
q25: (q24, 011, 0Z0) → (q25, 011, 0Z0)
q26: (q25, 011, 0Z0) → (q26, 011, 0Z0)
q27: (q26, 011, 0Z0) → (q27, 011, 0Z0)
q28: (q27, 011, 0Z0) → (q28, 011, 0Z0)
q29: (q28, 011, 0Z0) → (q29, 011, 0Z0)
q30: (q29, 011, 0Z0) → (q30, 011, 0Z0)
q31: (q30, 011, 0Z0) → (q31, 011, 0Z0)
q32: (q31, 011, 0Z0) → (q32, 011, 0Z0)
q33: (q32, 011, 0Z0) → (q33, 011, 0Z0)
q34: (q33, 011, 0Z0) → (q34, 011, 0Z0)
q35: (q34, 011, 0Z0) → (q35, 011, 0Z0)
q36: (q35, 011, 0Z0) → (q36, 011, 0Z0)
q37: (q36, 011, 0Z0) → (q37, 011, 0Z0)
q38: (q37, 011, 0Z0) → (q38, 011, 0Z0)
q39: (q38, 011, 0Z0) → (q39, 011, 0Z0)
q40: (q39, 011, 0Z0) → (q40, 011, 0Z0)
q41: (q40, 011, 0Z0) → (q41, 011, 0Z0)
q42: (q41, 011, 0Z0) → (q42, 011, 0Z0)
q43: (q42, 011, 0Z0) → (q43, 011, 0Z0)
q44: (q43, 011, 0Z0) → (q44, 011, 0Z0)
q45: (q44, 011, 0Z0) → (q45, 011, 0Z0)
q46: (q45, 011, 0Z0) → (q46, 011, 0Z0)
q47: (q46, 011, 0Z0) → (q47, 011, 0Z0)
q48: (q47, 011, 0Z0) → (q48, 011, 0Z0)
q49: (q48, 011, 0Z0) → (q49, 011, 0Z0)
q50: (q49, 011, 0Z0) → (q50, 011, 0Z0)
q51: (q50, 011, 0Z0) → (q51, 011, 0Z0)
q52: (q51, 011, 0Z0) → (q52, 011, 0Z0)
q53: (q52, 011, 0Z0) → (q53, 011, 0Z0)
q54: (q53, 011, 0Z0) → (q54, 011, 0Z0)
q55: (q54, 011, 0Z0) → (q55, 011, 0Z0)
q56: (q55, 011, 0Z0) → (q56, 011, 0Z0)
q57: (q56, 011, 0Z0) → (q57, 011, 0Z0)
q58: (q57, 011, 0Z0) → (q58, 011, 0Z0)
q59: (q58, 011, 0Z0) → (q59, 011, 0Z0)
q60: (q59, 011, 0Z0) → (q60, 011, 0Z0)
q61: (q60, 011, 0Z0) → (q61, 011, 0Z0)
q62: (q61, 011, 0Z0) → (q62, 011, 0Z0)
q63: (q62, 011, 0Z0) → (q63, 011, 0Z0)
q64: (q63, 011, 0Z0) → (q64, 011, 0Z0)
q65: (q64, 011, 0Z0) → (q65, 011, 0Z0)
q66: (q65, 011, 0Z0) → (q66, 011, 0Z0)
q67: (q66, 011, 0Z0) → (q67, 011, 0Z0)
q68: (q67, 011, 0Z0) → (q68, 011, 0Z0)
q69: (q68, 011, 0Z0) → (q69, 011, 0Z0)
q70: (q69, 011, 0Z0) → (q70, 011, 0Z0)
q71: (q70, 011, 0Z0) → (q71, 011, 0Z0)
q72: (q71, 011, 0Z0) → (q72, 011, 0Z0)
q73: (q72, 011, 0Z0) → (q73, 011, 0Z0)
q74: (q73, 011, 0Z0) → (q74, 011, 0Z0)
q75: (q74, 011, 0Z0) → (q75, 011, 0Z0)
q76: (q75, 011, 0Z0) → (q76, 011, 0Z0)
q77: (q76, 011, 0Z0) → (q77, 011, 0Z0)
q78: (q77, 011, 0Z0) → (q78, 011, 0Z0)
q79: (q78, 011, 0Z0) → (q79, 011, 0Z0)
q80: (q79, 011, 0Z0) → (q80, 011, 0Z0)
q81: (q80, 011, 0Z0) → (q81, 011, 0Z0)
q82: (q81, 011, 0Z0) → (q82, 011, 0Z0)
q83: (q82, 011, 0Z0) → (q83, 011, 0Z0)
q84: (q83, 011, 0Z0) → (q84, 011, 0Z0)
q85: (q84, 011, 0Z0) → (q85, 011, 0Z0)
q86: (q85, 011, 0Z0) → (q86, 011, 0Z0)
q87: (q86, 011, 0Z0) → (q87, 011, 0Z0)
q88: (q87, 011, 0Z0) → (q88, 011, 0Z0)
q89: (q88, 011, 0Z0) → (q89, 011, 0Z0)
q90: (q89, 011, 0Z0) → (q90, 011, 0Z0)
q91: (q90, 011, 0Z0) → (q91, 011, 0Z0)
q92: (q91, 011, 0Z0) → (q92, 011, 0Z0)
q93: (q92, 011, 0Z0) → (q93, 011, 0Z0)
q94: (q93, 011, 0Z0) → (q94, 011, 0Z0)
q95: (q94, 011, 0Z0) → (q95, 011, 0Z0)
q96: (q95, 011, 0Z0) → (q96, 011, 0Z0)
q97: (q96, 011, 0Z0) → (q97, 011, 0Z0)
q98: (q97, 011, 0Z0) → (q98, 011, 0Z0)
q99: (q98, 011, 0Z0) → (q99, 011, 0Z0)
q100: (q99, 011, 0Z0) → (q100, 011, 0Z0)
q101: (q100, 011, 0Z0) → (q101, 011, 0Z0)
q102: (q101, 011, 0Z0) → (q102, 011, 0Z0)
q103: (q102, 011, 0Z0) → (q103, 011, 0Z0)
q104: (q103, 011, 0Z0) → (q104, 011, 0Z0)
q105: (q104, 011, 0Z0) → (q105, 011, 0Z0)
q106: (q105, 011, 0Z0) → (q106, 011, 0Z0)
q107: (q106, 011, 0Z0) → (q107, 011, 0Z0)
q108: (q107, 011, 0Z0) → (q108, 011, 0Z0)
q109: (q108, 011, 0Z0) → (q109, 011, 0Z0)
q110: (q109, 011, 0Z0) → (q110, 011, 0Z0)
q111: (q110, 011, 0Z0) → (q111, 011, 0Z0)
q112: (q111, 011, 0Z0) → (q112, 011, 0Z0)
q113: (q112, 011, 0Z0) → (q113, 011, 0Z0)
q114: (q113, 011, 0Z0) → (q114, 011, 0Z0)
q115: (q114, 011, 0Z0) → (q115, 011, 0Z0)
q116: (q115, 011, 0Z0) → (q116, 011, 0Z0)
q117: (q116, 011, 0Z0) → (q117, 011, 0Z0)
q118: (q117, 011, 0Z0) → (q118, 011, 0Z0)
q119: (q118, 011, 0Z0) → (q119, 011, 0Z0)
q120: (q119, 011, 0Z0) → (q120, 011, 0Z0)
q121: (q120, 011, 0Z0) → (q121, 011, 0Z0)
q122: (q121, 011, 0Z0) → (q122, 011, 0Z0)
q123: (q122, 011, 0Z0) → (q123, 011, 0Z0)
q124: (q123, 011, 0Z0) → (q124, 011, 0Z0)
q125: (q124, 011, 0Z0) → (q125, 011, 0Z0)
q126: (q125, 011, 0Z0) → (q126, 011, 0Z0)
q127: (q126, 011, 0Z0) → (q127, 011, 0Z0)
q128: (q127, 011, 0Z0) → (q128, 011, 0Z0)
q129: (q128, 011, 0Z0) → (q129, 011, 0Z0)
q130: (q129, 011, 0Z0) → (q130, 011, 0Z0)
q131: (q130, 011, 0Z0) → (q131, 011, 0Z0)
q132: (q131, 011, 0Z0) → (q132, 011, 0Z0)
q133: (q132, 011, 0Z0) → (q133, 011, 0Z0)
q134: (q133, 011, 0Z0) → (q134, 011, 0Z0)
q135: (q134, 011, 0Z0) → (q135, 011, 0Z0)
q136: (q135, 011, 0Z0) → (q136, 011, 0Z0)
q137: (q136, 011, 0Z0) → (q137, 011, 0Z0)
q138: (q137, 011, 0Z0) → (q138, 011, 0Z0)
q139: (q138, 011, 0Z0) → (q139, 011, 0Z0)
q140: (q139, 011, 0Z0) → (q140, 011, 0Z0)
q141: (q140, 011, 0Z0) → (q141, 011, 0Z0)
q142: (q141, 011, 0Z0) → (q142, 011, 0Z0)
q143: (q142, 011, 0Z0) → (q143, 011, 0Z0)
q144: (q143, 011, 0Z0) → (q144, 011, 0Z0)
q145: (q144, 011, 0Z0) → (q145, 011, 0Z0)
q146: (q145, 011, 0Z0) → (q146, 011, 0Z0)
q147: (q146, 011, 0Z0) → (q147, 011, 0Z0)
q148: (q147, 011, 0Z0) → (q148, 011, 0Z0)
q149: (q148, 011, 0Z0) → (q149, 011, 0Z0)
q150: (q149, 011, 0Z0) → (q150, 011, 0Z0)
q151: (q150, 011, 0Z0) → (q151, 011, 0Z0)
q152: (q151, 011, 0Z0) → (q152, 011, 0Z0)
q153: (q152, 011, 0Z0) → (q153, 011, 0Z0)
q154: (q153, 011, 0Z0) → (q154, 011, 0Z0)
q155: (q154, 011, 0Z0) → (q155, 011, 0Z0)
q156: (q155, 011, 0Z0) → (q156, 011, 0Z0)
q157: (q156, 011, 0Z0) → (q157, 011, 0Z0)
q158: (q157, 011, 0Z0) → (q158, 011, 0Z0)
q159: (q158, 011, 0Z0) → (q159, 011, 0Z0)
q160: (q159, 011, 0Z0) → (q160, 011, 0Z0)
q161: (q160, 011, 0Z0) → (q161, 011, 0Z0)
q162: (q161, 011, 0Z0) → (q162, 011, 0Z0)
q163: (q162, 011, 0Z0) → (q163, 011, 0Z0)
q164: (q163, 011, 0Z0) → (q164, 011, 0Z0)
q165: (q164, 011, 0Z0) → (q165, 011, 0Z0)
q166: (q165, 011, 0Z0) → (q166, 011, 0Z0)
q167: (q166, 011, 0Z0) → (q167, 011, 0Z0)
q168: (q167, 011, 0Z0) → (q168, 011, 0Z0)
q169: (q168, 011, 0Z0) → (q169, 011, 0Z0)
q170: (q169, 011, 0Z0) → (q170, 011, 0Z0)
q171: (q170, 011, 0Z0) → (q171, 011, 0Z0)
q172: (q171, 011, 0Z0) → (q172, 011, 0Z0)
q173: (q172, 011, 0Z0) → (q173, 011, 0Z0)
q174: (q173, 011, 0Z0) → (q174, 011, 0Z0)
q175: (q174, 011, 0Z0) → (q175, 011, 0Z0)
q176: (q175, 011, 0Z0) → (q176, 011, 0Z0)
q177: (q176, 011, 0Z0) → (q177, 011, 0Z0)
q178: (q177, 011, 0Z0) → (q178, 011, 0Z0)
q179: (q178, 011, 0Z0) → (q179, 011, 0Z0)
q180: (q179, 011, 0Z0) → (q180, 011, 0Z0)
q181: (q180, 011, 0Z0) → (q181, 011, 0Z0)
q182: (q181, 011, 0Z0) → (q182, 011, 0Z0)
q183: (q182, 011, 0Z0) → (q183, 011, 0Z0)
q184: (q183, 011, 0Z0) → (q184, 011, 0Z0)
q185: (q184, 011, 0Z0) → (q185, 011, 0Z0)
q186: (q185, 011, 0Z0) → (q186, 011, 0Z0)
q187: (q186, 011, 0Z0) → (q187, 011, 0Z0)
q188: (q187, 011, 0Z0) → (q188, 011, 0Z0)
q189: (q188, 011, 0Z0) → (q189, 011, 0Z0)
q190: (q189, 011, 0Z0) → (q190, 011, 0Z0)
q191: (q190, 011, 0Z0) → (q191, 011, 0Z0)
q192: (q191, 011, 0Z0) → (q192, 011, 0Z0)
q193: (q192, 011, 0Z0) → (q193, 011, 0Z0)
q194: (q193, 011, 0Z0) → (q194, 011, 0Z0)
q195: (q194, 011, 0Z0) → (q195, 011, 0Z0)
q196: (q195, 011, 0Z0) → (q196, 011, 0Z0)
q197: (q196, 011, 0Z0) → (q197, 011, 0Z0)
q198: (q197, 011, 0Z0) → (q198, 011, 0Z0)
q199: (q198, 011, 0Z0) → (q199, 011, 0Z0)
q200: (q199, 011, 0Z0) → (q200, 011, 0Z0)
q201: (q200, 011, 0Z0) → (q201, 011, 0Z0)
q202: (q201, 011, 0Z0) → (q202, 011, 0Z0)
q203: (q202, 011, 0Z0) → (q203, 011, 0Z0)
q204: (q203, 011, 0Z0) → (q204, 011, 0Z0)
q205: (q204, 011, 0Z0) → (q205, 011, 0Z0)
q206: (q205, 011, 0Z0) → (q206, 011, 0Z0)
q207: (q206, 011, 0Z0) → (q207, 011, 0Z0)
q208: (q207, 011, 0Z0) → (q208, 011, 0Z0)
q209: (q208, 011, 0Z0) → (q209, 011, 0Z0)
q210: (q209, 011, 0Z0) → (q210, 011, 0Z0)
q211: (q210, 011, 0Z0) → (q211, 011, 0Z0)
q212: (q211, 011, 0Z0) → (q212, 011, 0Z0)
q213: (q212, 011, 0Z0) → (q213, 011, 0Z0)
q214: (q213, 011, 0Z0) → (q214, 011, 0Z0)
q215: (q214, 011, 0Z0) → (q215, 011, 0Z0)
q216: (q215, 011, 0Z0) → (q216, 011, 0Z0)
q217: (q216, 011, 0Z0) → (q217, 011, 0Z0)
q218: (q217, 011, 0Z0) → (q218, 011, 0Z0)
q219: (q218, 011, 0Z0) → (q219, 011, 0Z0)
q220: (q219, 011, 0Z0) → (q220, 011, 0Z0)
q221: (q220, 011, 0Z0) → (q221, 011, 0Z0)
q222: (q221, 011, 0Z0) → (q222, 011, 0Z0)
q223: (q222, 011, 0Z0) → (q223, 011, 0Z0)
q224: (q223, 011, 0Z0) → (q224, 011, 0Z0)
q225: (q224, 011, 0Z0) → (q225, 011, 0Z0)
q226: (q225, 011, 0Z0) → (q226, 011, 0Z0)
q227: (q226, 011, 0Z0) → (q227, 011, 0Z0)
q228: (q227, 011, 0Z0) → (q228, 011, 0Z0)
q229: (q228, 011, 0Z0) → (q229, 011, 0Z0)
q230: (q229, 011, 0Z0) → (q230, 011, 0Z0)
q231: (q230, 011, 0Z0) → (q231, 011, 0Z0)
q232: (q231, 011, 0Z0) → (q232, 011, 0Z0)
q233: (q232, 011, 0Z0) → (q233, 011, 0Z0)
q234: (q233, 011, 0Z0) → (q234, 011, 0Z0)
q235: (q234, 011, 0Z0) → (q235, 011, 0Z0)
q236: (q235, 011, 0Z0) → (q236, 011, 0Z0)
q237: (q236, 011, 0Z0) → (q237, 011, 0Z0)
q238: (q237, 011, 0Z0) → (q238, 011, 0Z0)
q239: (q238, 011, 0Z0) → (q239, 011, 0Z0)
q240: (q239, 011, 0Z0) → (q240, 011, 0Z0)
q241: (q240, 011, 0Z0) → (q241, 011, 0Z0)
q242: (q241, 011, 0Z0) → (q242, 011, 0Z0)
q243: (q242, 011, 0Z0) → (q243, 011, 0Z0)
q244: (q243, 011, 0Z0) → (q244, 011, 0Z0)
q245: (q244, 011, 0Z0) → (q245, 011, 0Z0)
q246: (q245, 011, 0Z0) → (q246, 011, 0Z0)
q247: (q246, 011, 0Z0) → (q247, 011, 0Z0)
q248: (q247, 011, 0Z0) → (q248, 011, 0Z0)
q249: (q248, 011, 0Z0) → (q249, 011, 0Z0)
q250: (q249, 011, 0Z0) → (q250, 011, 0Z0)
q251: (q250, 011, 0Z0) → (q251, 011, 0Z0)
q252: (q251, 011, 0Z0) → (q252, 011, 0Z0)
q253: (q252, 011, 0Z0) → (q253, 011, 0Z0)
q254: (q253, 011, 0Z0) → (q254, 011, 0Z0)
q255: (q254, 011, 0Z0) → (q255, 011, 0Z0)
q256: (q255, 011, 0Z0) → (q256, 011, 0Z0)
q257: (q256, 011, 0Z0) → (q257, 011, 0Z0)
q258: (q257, 011, 0Z0) → (q258, 011, 0Z0)
q259: (q258, 011, 0Z0) → (q259, 011, 0Z0)
q260: (q259, 011, 0Z0) → (q260, 011, 0Z0)
q261: (q260, 011, 0Z0) → (q261, 011, 0Z0)
q262: (q261, 011, 0Z0) → (q262, 011, 0Z0)
q263: (q262, 011, 0Z0) → (q263, 011, 0Z0)
q264: (q263, 011, 0Z0) → (q264, 011, 0Z0)
q265: (q264, 011, 0Z0) → (q265, 011, 0Z0)
q266: (q265, 011, 0Z0) → (q266, 011, 0Z0)
q267: (q266, 011, 0Z0) → (q267, 011, 0Z0)
q268: (q267, 011, 0Z0) → (q268, 011, 0Z0)
q269: (q268, 011, 0Z0) → (q269, 011, 0Z0)
q270: (q269, 011, 0Z0) → (q270, 011, 0Z0)
q271: (q270, 011, 0Z0) → (q271, 011, 0Z0)
q272: (q271, 011, 0Z0) → (q272, 011, 0Z0)
q273: (q272, 011, 0Z0) → (q273, 011, 0Z0)
q274: (q273, 011, 0Z0) → (q274, 011, 0Z0)
q275: (q274, 011, 0Z0) → (q275, 011, 0Z0)
q276: (q275, 011, 0Z0) → (q276, 011, 0Z0)
q277: (q276, 011, 0Z0) → (q277, 011, 0Z0)
q278: (q277, 011, 0Z0) → (q278, 011, 0Z0)
q279: (q278, 011, 0Z0) → (q279, 011, 0Z0)
q280: (q279, 011, 0Z0) → (q280, 011, 0Z0)
q281: (q280, 011, 0Z0) → (q281, 011, 0Z0)
q282: (q281, 011, 0Z0) → (q282, 011, 0Z0)
q283: (q282, 011, 0Z0) → (q283, 011, 0Z0)
q284: (q283, 011, 0Z0) → (q284, 011, 0Z0)
q285: (q284, 011, 0Z0) → (q285, 011, 0Z0)
q286: (q285, 011, 0Z0) → (q286, 011, 0Z0)
q287: (q286, 011, 0Z0) → (q287, 011, 0Z0)
q288: (q287, 011, 0Z0) → (q288, 011, 0Z0)
q289: (q288, 011, 0Z0) → (q289, 011, 0Z0)
q290: (q289, 011, 0Z0) → (q290, 011, 0Z0)
q291: (q290, 011, 0Z0) → (q291, 011, 0Z0)
q292: (q291, 011, 0Z0) → (q292, 011, 0Z0)
q293: (q292, 011, 0Z0) → (q293, 011, 0Z0)
q294: (q293, 011, 0Z0) → (q294, 011, 0Z0)
q295: (q294, 011, 0Z0) → (q295, 011, 0Z0)
q296: (q295, 011, 0Z0) → (q296, 011, 0Z0)
q297: (q296, 011, 0Z0) → (q297, 011, 0Z0)
q298: (q297, 011, 0Z0) → (q298, 011, 0Z0)
q299: (q298, 011, 0Z0) → (q299, 011, 0Z0)
q300: (q299, 011, 0Z0) → (q300, 011, 0Z0)
q301: (q300, 011, 0Z0) → (q301, 011, 0Z0)
q302: (q301, 011, 0Z0) → (q302, 011, 0Z0)
q303: (q302, 011, 0Z0) → (q
```



Delving into the Transition Function ( $\delta$ )

→ Current State ( $q$ )  
The automaton's present state.

••• Input Symbol ( $a$ )  
The current input being read.

📄 Top of Stack ( $X$ )  
Symbol at the top of the stack.

$\delta(q, a, X) = \{(p, Y), (q, Z), \dots\}$  defines transitions. Epsilon transitions allow moves without consuming input. PDAs are inherently non-deterministic.

Decoding the Formal Definition of a PDA

PDA Components

- $Q$ : Finite set of states
- $\Sigma$ : Input alphabet
- $\Gamma$ : Stack alphabet

Key Functions

- $\delta$ : Transition function
- $q_0$ : Initial state
- $Z_0$ : Initial stack symbol
- $F$ : Set of accepting states

Understanding each component is crucial. The transition function ( $\delta$ ) is particularly important for PDA operation.

Mastering the Stack: LIFO Data Structure

- 1 Push  
Adding elements to the stack.
- 2 Pop  
Removing elements from the stack.

The stack uses LIFO (Last-In, First-Out). It is vital for storing and retrieving information during PDA execution.



Pushdown Automata

Pushdown Automata are a powerful computational model that extend the capabilities of Finite Automata by introducing a stack data structure. This additional memory allows PDAs to recognize a broader class of languages, including context-free languages, which cannot be recognized by Finite Automata alone.

In this deck, we will delve into the formal definition of a PDA, understanding the role of the stack and the transition function. We'll also explore how PDAs can be used to recognize specific languages, such as the language  $L = \{0^n 1^n \mid n \geq 0\}$ , and trace the computation through the concept of Instantaneous Description (ID).

